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HSRI TWO-DIMENSIONAL CRASH VICTIM SIMULATOR: ANALYSIS, VERIFICATION, AND USERS' MANUAL. REVISION NO. 1

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Michigan University

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WASHINGTON, D.C. 20590

N O T I C E

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16. Abstract
This ~~is~~ report deals with the development and use of mathematical models for the simulation of automobile occupant ~~kinematics~~ in the event of a collision. This model was developed as a tool to study advanced concepts and designs of seat-restraint systems from the viewpoint of occupant protection. After a discussion of the state-of-the-art of mathematical modeling of the crash victim, an analytical description of the ~~HSRI~~ Two-Dimensional Crash Victim Simulator is presented. This model consists of a segmented, eight-mass dynamic model of a human interacting with the interior of a vehicle in a symmetric frontal or rear crash. Pedestrian-vehicle interactions can also be considered. The degree to which predictions of the model agree with experimental impact sled test data is presented followed by a detailed Users' Manual for those individuals desiring to exercise the model. Sample data sets and computer output are included. A description of the program including detailed subroutine flow diagrams concludes the report with a program source listing included, as an appendix.

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Mrs. J. M. Becker deserves special mention for her contributions to this work, particularly in the handling of discontinuous forces.

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I. INTRODUCTION

This report deals with the development and use of a mathematical model for the simulation of automobile occupant kinematics in two dimensions in event of a collision. The model was developed as a tool to study advanced concepts and designs of seat restraint systems from the viewpoint of occupant protection.

A schematic for the two-dimensional model is shown in Figure 1. The three parts of the model are the occupant, the vehicle, and the deceleration profile. The occupant is represented by eight mass elements located in the head, upper torso, lower torso, upper leg, lower leg, upper arm, and lower arm. Attached to the various body elements are geometric surfaces serving to outline the body in order that contact between the occupant and the interior or exterior of a vehicle can be predicted. The vehicle is represented by a series of planar contact surfaces which can be arranged to represent either a vehicle interior for occupant kinematics studies or the exterior for pedestrian studies. Belt restraints are included in the model if their use is desired. Forces are applied to the body of the occupant whenever interaction is sensed between the occupant and the vehicle. In order to produce occupant motions, a front-end or rear-end deceleration is applied to the vehicle and the resulting occupant motions listed as computer program output.

In addition to the analytical description of the model in Part II, a Users' Guide is included as Part IV of this report. Sections are included describing preparation of input data decks and the options available in studying the output produced by the computer program. The techniques which can be used in operating the model at a teletype terminal remote from The University of Michigan are described in a Teletype Users' Guide. Documentation of the program includes an overall program description, subroutine descriptions and flow diagrams, and a complete symbol dictionary.

The comparison of the predictions of the model with experimental

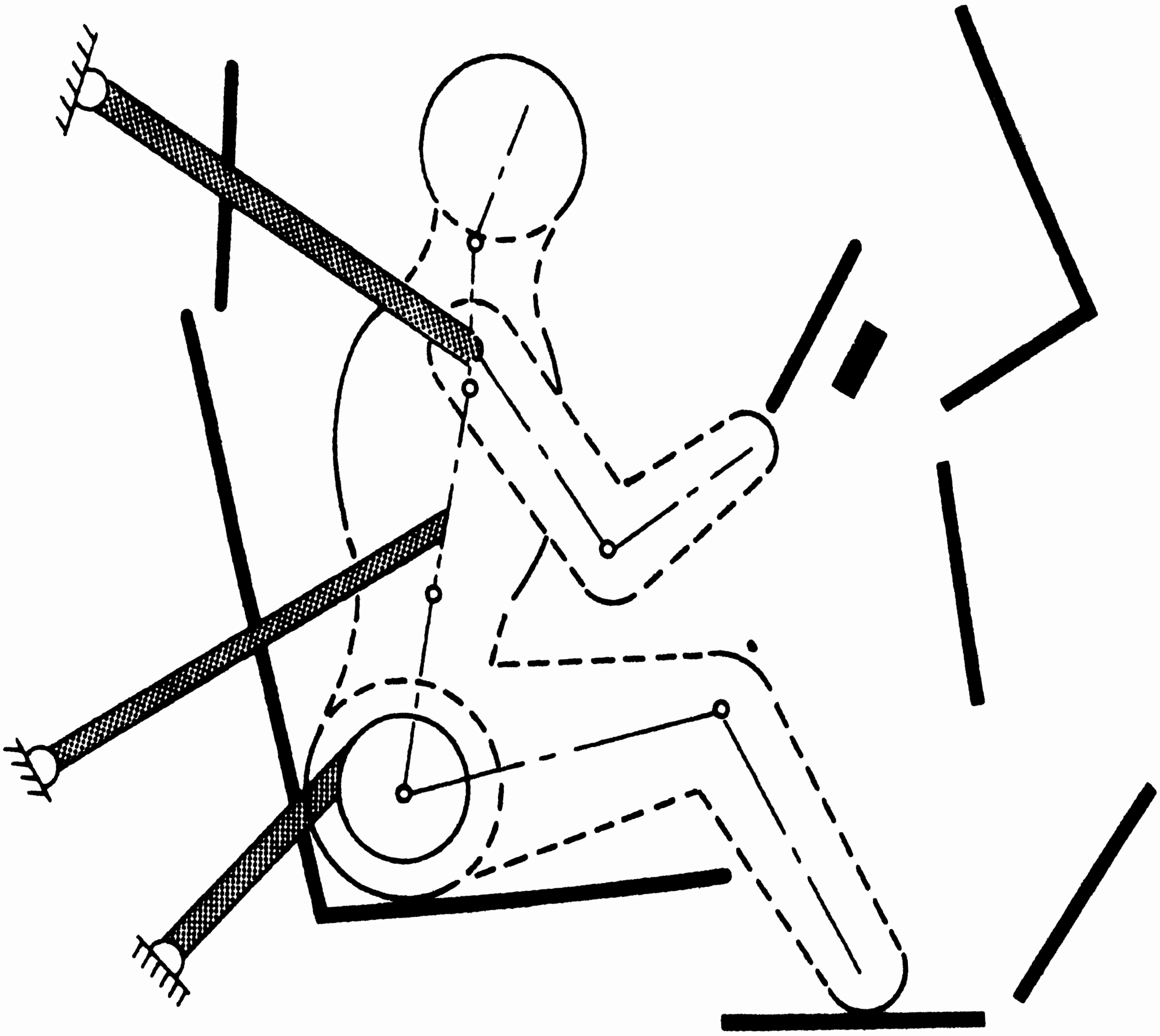


Figure 1. Schematic of mathematical model showing occupant, possible contact surfaces, seat, and restraint system.

impact sled tests is the subject of Part III of the report. The complex problem of gathering a set of input data describing the occupant and the vehicle is discussed and the techniques by which this is carried out are described. The equally difficult task of obtaining appropriate experimental data is also considered. Comparisons between a 30 mph impact sled test involving a belt-restrained 50th percentile male dummy and the predictions of the model conclude Part III.

The model which is described in this report is proposed as a powerful tool for studying and designing advanced integrated seat-restraint systems. It has been exercised several hundred times to study belt restraint systems, various deceleration profiles, headrest and seatback shape, pedestrian kinematics, occupant size and position, etc., and represents the current state of the art in two-dimensional crash victim simulators.

A. STATE OF THE ART

Mathematical models have been developed for the motion of the human body in several environments, including auto occupant dynamics,*[1-8] human gait, and the motions experienced by the legs and arms during walking.[9-11] This work is often applied to the design, development and use of prosthetic devices. In connection with aerospace applications, analytical studies of self-generated motions possible in free-fall[12-14] and 0-gravity environments are being carried out and find application in such activities as sky-diving and space-walking. Also, studies are being made of such work tasks as lifting,[15,16] resulting in the development of work capability amplifiers.

Fundamental theoretical work has been carried out in the field of mathematical models for more than sixty years, as seen in the work of Fischer.[17] However, it is only with the coming-of-age of the high speed computer in the last twenty years that practical solutions of equations as

*Note: Only a small number of representative papers published on this subject are included in this list.

complex as those proposed by Fischer have been realized. Hence, the mathematical simulation of human body motions has become a very active research topic in the last ten years.

Generally, two approaches have been used in analyses simulating auto occupant protection. On one hand, various researchers have adopted relatively simple physical models for studying specific aspects of human kinematics. Weaver[18] has used a two-mass, two-degree-of-freedom model to simulate belt loadings and head impact velocity in the case of a lap-belted occupant. Similar models have been developed by Aldman[19] and Renneker[20] for studying slack in restraint systems and the effect of various input deceleration profiles. Other authors, including Martinez,[21] Mertz,[22] and Roberts,[23] have used somewhat more sophisticated models for studying the phenomenon of whiplash. Roberts has added an additional complicating factor to his model—the motion of the brain mass inside the brain case.

On the other hand, several authors[1-8] have developed more complex models of human kinematics utilizing several masses for simulating body motions. In addition, complex vehicle geometry is introduced in these simulations to provide an intricate array of forces acting on the segmented occupant. Particularly noteworthy in the early development of these models are the efforts of McHenry.[2] All these models are marked by extensive development programs requiring at least two years from project initiation to the production of a functioning computer program.

Most of the modeling work mentioned above has been concerned with simulations of occupant motion in two dimensions. The only known published simulations involving three dimensions are those of Roberts,[1] Thompson,[4] Robbins,[6] and Young.[7] The first of these is a simple-one-mass model capable of simulating belt loads and upper torso motions in three dimensions, while the second is part of a large program involving vehicle crush characteristics. The third model simulates a three-dimensional occupant by three masses and twelve degrees-of-freedom while the recently completed fourth model describes the occupant by twelve masses and thirty-one degrees-of-freedom while possessing a less sophisticated model of occupant-vehicle interactions than that of Robbins.[6]

Even with the advent of the highly complex computer programs described here, there still exist major problem areas such as:

1. Verification of the model by experiment;
2. Lack of highly controlled tests;
3. Lack of anthropometric data and verification of the models using human volunteers;
4. Lack of impact test data reduction techniques specifically oriented towards mathematical model verification.
5. Difficulty in using the models because of the complex input data requirements; and
6. Difficulty in using the model at locations other than the laboratories of the developer.

These problems can be classified into two general types: (a) lack of closely coordinated efforts to insure that the mathematical models predict and anticipate physical reality, and (b) ease of use. The latter problem is somewhat easier to approach than the first one. One needs to identify the user and his capabilities and then write a program which is user-oriented. Computer programs of this nature are in actual use, particularly in styling and design laboratories in the auto industry. The users need not be highly trained computer experts.

In assigning staff to the various subject areas of the current research project, a concerted effort was made to coordinate the sled test program and the analytical program. One group was assigned the task of analysis; another group was responsible for the impact sled test program; and a new key group was formed to bridge the gap which was found to exist between the analytical and experimental groups. The task of the key group was to insure that meaningful data was generated in the tests and to establish techniques for reducing this data into a form which could be compared with the output of a mathematical model.

This discussion is intended to show that the current state of the art is quite advanced from the viewpoint of producing computer programs which predict vehicle occupant motions in a crash environment. However, considerable research must be carried out to make programs of this nature easily usable. Additionally, it is recommended that experimental work accompany the development of future models to make assessment of their validity more straightforward.

II. ANALYTICAL DESCRIPTION OF THE TWO-DIMENSIONAL CRASH VICTIM SIMULATOR

This part of the report consists of an analytical description of the two-dimensional crash victim simulator, a schematic of which is shown in Figure 1. The parameters which have been chosen for use in the physical model are discussed, then there is a brief presentation of the equations of motion describing the movements of the crash victim. This is followed by a detailed description of the analytical models used to define the mass and geometry of the body, the contact surface causing force interactions between the occupant and the vehicle, the seat, the joint structures connecting the various segments of the body, and a belt restraint system.

A. SELECTION OF PARAMETERS

Four major groups of parameters have been considered in the development of this model: the occupant, seat, external restraint environment, and the deceleration profile.

The occupant is difficult to describe both experimentally and analytically. Controversy arises over the use of anthropometric dummies, cadavers, human volunteers, and laboratory animals. The physical properties of dummies are the most easily obtained and controlled but there is a question whether they represent human kinematics. Four sets of parameters are used to model the dynamic behavior of the body. First, the body is modeled by eight rigid mass elements representing the head, upper torso, middle torso, lower torso, upper arm, lower arm, upper leg, and lower leg. Second, these mass elements are connected by joint structures represented as viscoelastic, nonlinear, torsional springs. Resistance is slight over most of the range of motion of each joint. However, stops, located at the end of practical motion of each joint, are modeled by a torsional spring possessing a high degree of stiffness. Third, muscle tone is delineated rather crudely in this model by a constant torque, acting in each joint, resisting whatever relative motion is experienced by the adjacent rigid body elements. Constant torque is also used to model the friction joints found in present generation anthropometric dummies. Fourth, body geometry is represented by the moments of inertia of the eight rigid masses as well as contact body surfaces. These surfaces, which are rigidly attached to the head, torso, hip, and extremities, allow the user of the model to ascertain if a body part impacts any part of the vehicle or seat.

The seat would seem to be easier to describe for use in a model. However, it is unfortunate that very little research has been carried out to determine dynamic deformation characteristics such as stiffness and damping of seats. Three parts of the seat are included in this model: seat back, seat cushion, and head rest. The seat back may apply a force to the lower part of the occupant's back at the hip and to the upper torso. The seat back is modeled by a plane surface. The head rest is independent of the seat back and can be composed of a number of contact surfaces representing a nonplanar geometry. The seat cushion is again represented by a plane. Vertical forces are applied at the hip and at the front of the seat. A horizontal force is also applied at the front of the seat cushion to prevent the lower leg from rotating back "through the seat cushion." Each of these elements is described by dynamic force-deformation relations, friction coefficients, and geometrical configurations.

The external system restraining an occupant is ordinarily defined in terms of specific devices such as a seat belt or an airbag. One common feature of all these devices is the fact that they can be described in terms of a dynamic force-deformation profile. For example, an acceleration-dependent inertial reel used in conjunction with a shoulder harness will have a different characteristic curve than a controlled permanent deformation device or one of the harnesses used in most current production vehicles. In each case a different formula must be used which computes force as a function of deformation and deformation rate. Therefore, provisions must be made for forces to be applied to the occupant in a rather general manner in order that they can be used in modeling any one of the proposed restraint devices.

Three types of interactions are possible between the occupant and vehicle: (a) the seat, already discussed, (b) a system of belts attached to the occupant as a seat belt and/or shoulder harness, and (c) a collection of geometric surfaces representing the profile of a vehicle interior or exterior. These surfaces, each represented by a different dynamic force-deformation relationship, interact with the contact surfaces fixed to the body of the occupant to generate a complex interaction of forces and occupant motions representing the collision of the occupant with seat, restraint system, or vehicle structural member.

An example of a complex set of force interactions between an occupant and a vehicle interior is represented by simulating the airbag restraint system. The occupant is represented in the usual way and may or may not be restrained by a lap belt. Vehicle components such as the seat back, seat cushion, floor, windshield, and lower dash panel are described in terms of contact surfaces. It is necessary to know the force-motion interrelationship between the head or torso and the bag before the simulation can be carried out as the model itself cannot predict any force-deformation relationships. They must be obtained using experimental procedures and be provided as input data for the operation of the computer simulation.

It should also be noted that this general formulation allows studies of much more than a seated occupant restrained in some manner inside the vehicle. Studies have been carried out of more esoteric concepts such as the airbag, the rear-end collision, and the pedestrian. Also, studies of the dynamics of a child in any one of the large number of seats and restraint devices available on today's market are possible.

The deceleration profile which is used in this model is relatively simple, it can be either a forward or rearward deceleration. However, the shape of the profile is limited to 200 linear segments. Typical examples are shown in Figures 2 and 3.

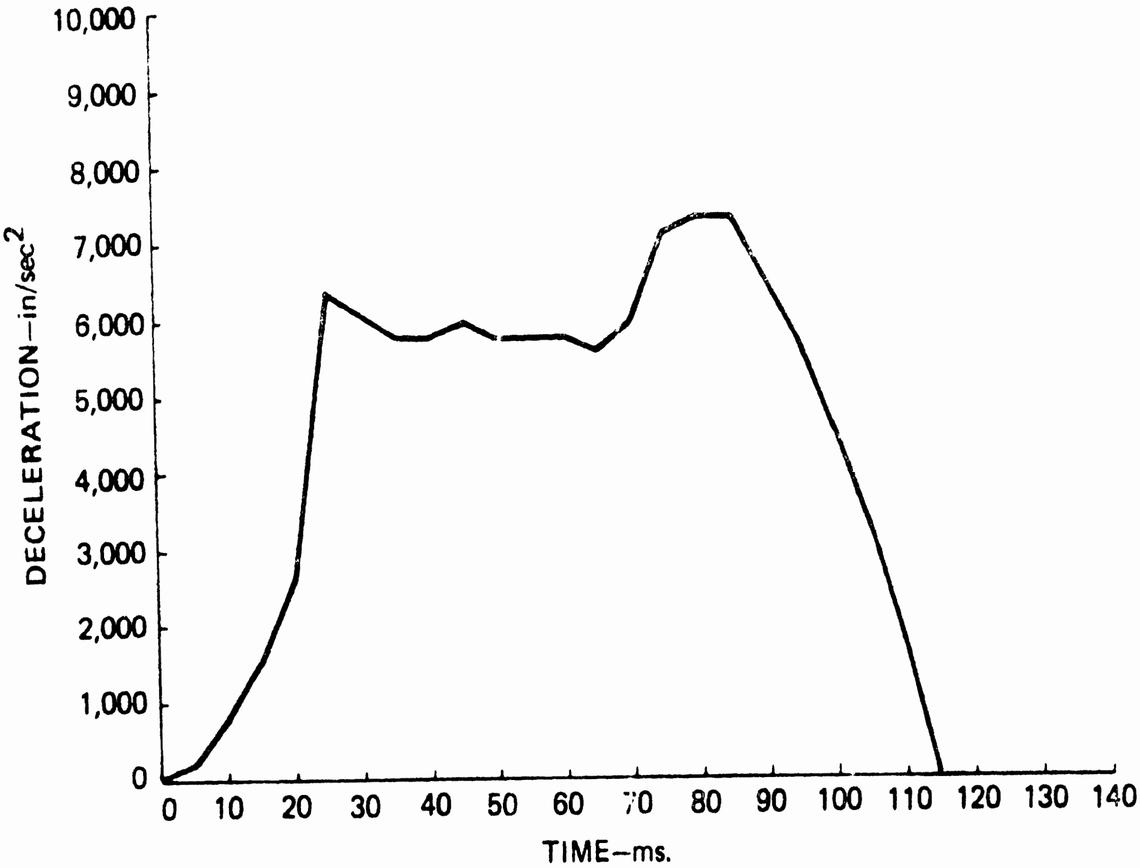


Figure 2. AMA deceleration profile.

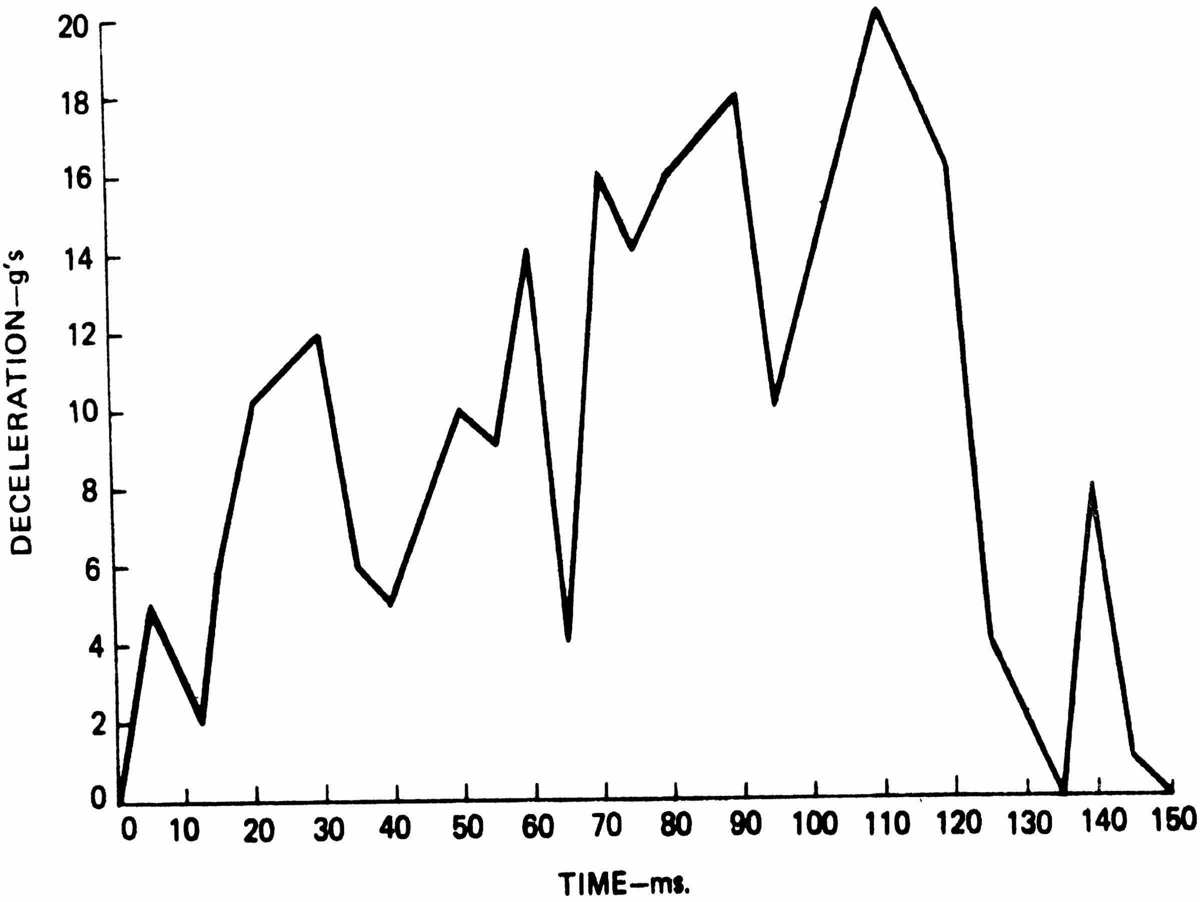


Figure 3. Complex deceleration trace.

B. FORMULATION OF THE MODEL

The equations of motion are derived by Lagrangian techniques[24]:

$$\frac{d}{dt}\left[\frac{\partial(KE)}{\partial \dot{Z}_i}\right] - \frac{\partial(KE)}{\partial Z_i} + \frac{\partial(PE)}{\partial Z_i} + \frac{\partial(DE)}{\partial \dot{Z}_i} = F_{Z_i} \qquad \text{(II.B.1)}$$

where

KE is the system kinetic energy

PE is the system potential energy

DE is the system dissipated energy rate

F_{Z_i} are the classical generalized forces

Z_i are the classical generalized coordinates or degrees of freedom of the model

Since the only driving force is applied to the vehicle and not directly to the body, the F_{Z_i} terms are all zero. After the energy terms have been written, the resulting equations of motion are rearranged so that all the terms containing generalized accelerations appear on the left-hand side and all others appear on the right-hand side. Thus rearranged, these equations are of the form

$$m \ddot{\vec{Z}} = \vec{b} \qquad \text{(II.B.2)}$$

where m is the matrix of generalized acceleration coefficients and $\ddot{\vec{Z}}$ is the acceleration vector. In this analysis the right-hand side, $\vec{b}$, will be called the "generalized force" and contributions to it from the potential and kinetic energy in Eq. (II.B.1) will be referred to as the generalized force from that part of the model. The total generalized force is the vectorial sum of each contributing component (gravity, joints, belts, seat cushion, and contacts). The kinetic energy contributions to the generalized force are centrifugal and Coriolis force terms.

Kinetic energy alone determines the left-hand side of the equations of motion. In the computational procedure, the inverse of the matrix, m^{-1}, multiplied by the generalized force vector, $\vec{b}$, yields the solution for the generalized accelerations, i.e.,

$$\ddot{\vec{Z}} = m^{-1} \vec{b} \tag{II.B.3}$$

The generalized force vector may be expanded to show the various contributions

$$\vec{b} = \vec{B} - \vec{G} + \vec{Q} + \vec{D} + \vec{C} + \Delta\vec{b}_Q + \Delta\vec{b}_s + \Delta\vec{b}_J + \vec{D}_b \tag{II.B.4}$$

where

$\vec{B}$ is due to kinetic energy

$\vec{G}$ is due to gravity

$\vec{Q}$ is due to contact forces

$\vec{D}$ is due to seat cushion

$\vec{C}$ is due to joint elasticity

$\Delta\vec{b}_Q$ is due to contact friction

$\Delta\vec{b}_s$ is due to seat friction

$\Delta\vec{b}_J$ is due to joint friction

$\vec{D}_b$ is due to belts

C. BODY

The crash victim is simulated by eight body segments: three segments in the torso to introduce some flexibility into the spine, one segment for the head, two segments in the arms (right and left combined) representing the forearm and upper arm, and two segments for the legs (right and left combined) representing upper and lower legs. Figure 1 shows a crash victim in a typical seating configuration restrained by a shoulder harness and lap belt. Figure 4 illustrates the body segments and their lengths, centers of gravity, and moments of inertia. Tables I and II contain the subscripting schemes for the body elements and joints which are used in the computer program while Figure 5 shows the angular coordinates defining the orientation in space of

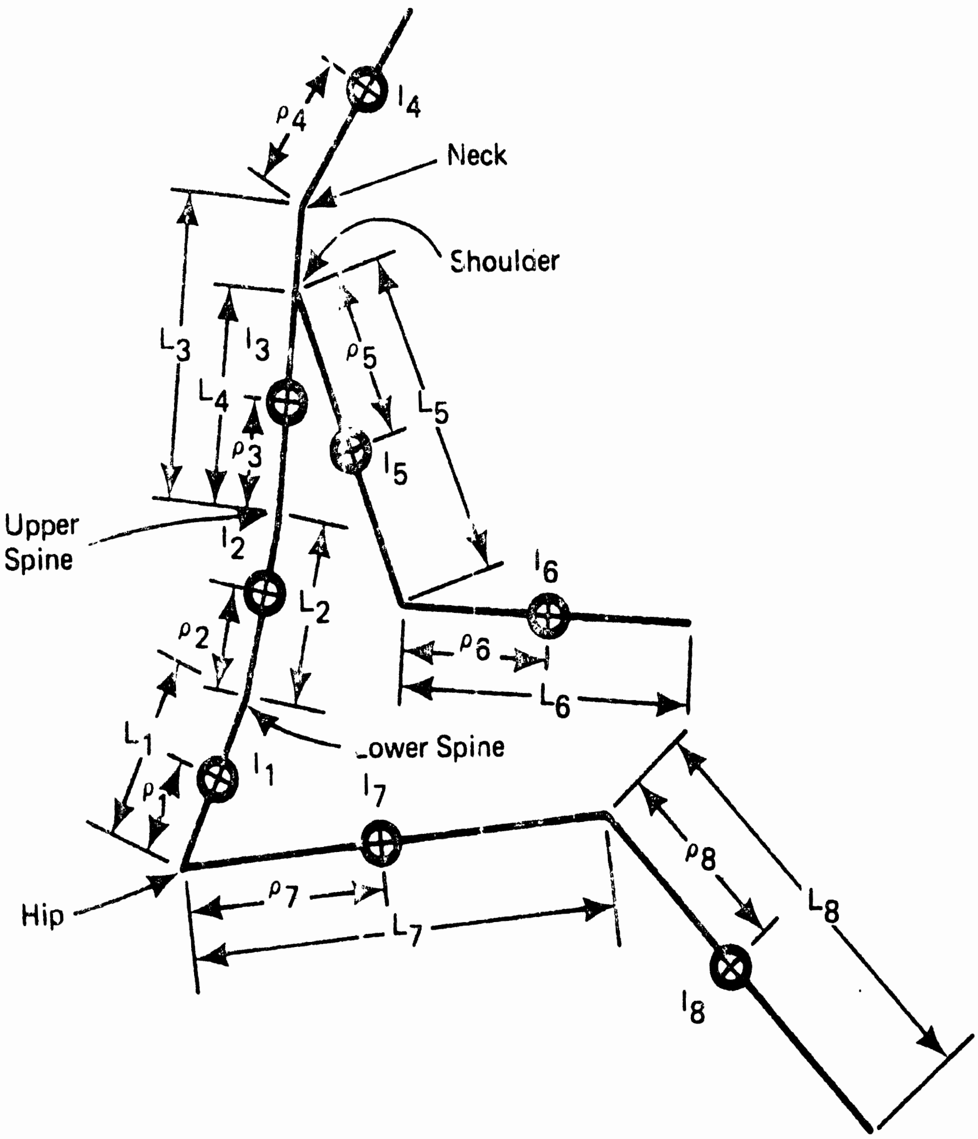
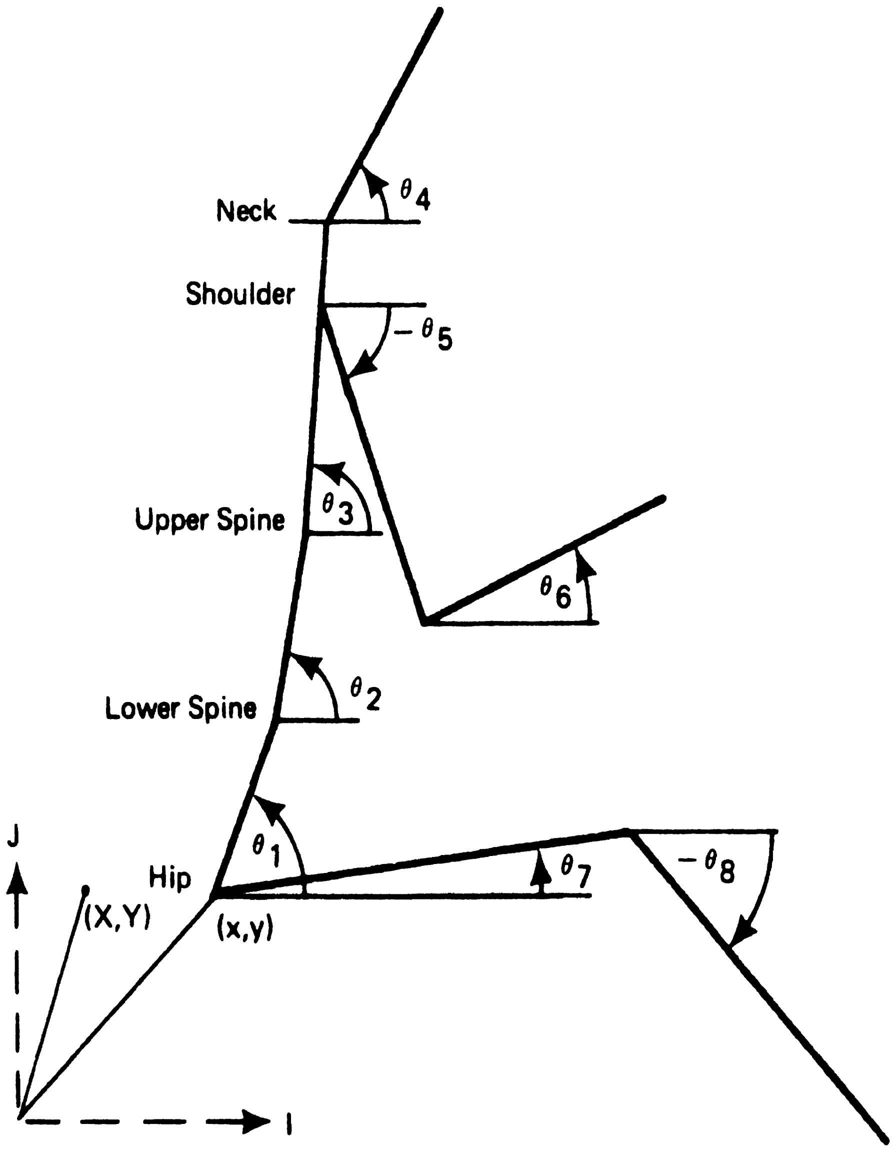


Figure 4. Body element lengths, centers of gravity, and moments of inertia.



(X,Y) = Coordinates for vehicle relative to inertial system. This is the point on the vehicle occupied by the hip at zero time.

(x,y) = coordinates of hip relative to inertial system.

Figure 5. Body angles.

the various body elements and the translational coordinates of the hip. It should be noted that x and y plus the eight angles defined in this figure are the generalized coordinates used in the analysis.

TABLE I. SUBSCRIPTS OF BODY JOINTS

Subscript	1	2	3	4	5	6	7
Joint	Hip	Lower Spine	Upper Spine	Neck	Shoulder	Elbow	Knee

TABLE II. SUBSCRIPTS OF BODY SEGMENTS

Subscript	1	2	3	4	5	6	7	8
Body segment	Lower Torso	Middle Torso	Upper Torso	Head	Upper Arm	Lower Arm	Upper Leg	Lower Leg

TABLE III. SUBSCRIPTS OF CONTACT ARCS

Subscript	1	2	3	4	5	6	7	8
Contact arc	Hip	---	Upper Torso	Head	Elbow	Hand	Knee	Foot

The coordinates for the center-of-gravity of each body segment are stated in Eq. (II.C.1) in terms of the generalized coordinates. Based on this the velocities of the eight centers-of-gravity are given in Eq. (II.C.2). Tables I, II, and XIV as well as Figures 4 and 5 should be referred to in reading these equations.

Using Eqs. (II.C.1) and (II.C.2) the kinetic and potential energy associated with the body can be written. After extensive formal manipulation of the kinetic and potential energies, those portions of the equations of motion which can be stated are terms due to centrifugal and gravitational forces as well as to the matrix. This matrix is shown in Eq. (II.B.2) which forms the bulk of the left-hand side of the equations of motion.

$$
\begin{aligned}
x_1 &= x + \rho_1 \cos\theta_1 \\
y_1 &= y + \rho_1 \sin\theta_1 \\
x_2 &= x + L_1 \cos\theta_1 + \rho_2 \cos\theta_2 \\
y_2 &= y + L_1 \sin\theta_1 + \rho_2 \sin\theta_2 \\
x_3 &= x + L_1 \cos\theta_1 + L_2 \cos\theta_2 + \rho_3 \cos\theta_3 \\
y_3 &= y + L_1 \sin\theta_1 + L_2 \sin\theta_2 + \rho_3 \sin\theta_3 \\
x_4 &= x + L_1 \cos\theta_1 + L_2 \sin\theta_2 + L_3 \cos\theta_3 + \rho_4 \cos\theta_4 \\
y_4 &= y + L_1 \sin\theta_1 + L_2 \sin\theta_2 + L_3 \sin\theta_3 + \rho_4 \sin\theta_4 \\
x_5 &= x + L_1 \cos\theta_1 + L_2 \cos\theta_2 + L_4 \cos\theta_3 + \rho_5 \cos\theta_5 \\
y_5 &= y + L_1 \sin\theta_1 + L_2 \sin\theta_2 + L_4 \sin\theta_3 + \rho_5 \sin\theta_5 \\
x_6 &= x + L_1 \cos\theta_1 + L_2 \cos\theta_2 + L_4 \cos\theta_3 + L_5 \cos\theta_5 + \rho_6 \cos\theta_6 \\
y_6 &= y + L_1 \sin\theta_1 + L_2 \sin\theta_2 + L_4 \sin\theta_3 + L_5 \sin\theta_5 + \rho_6 \sin\theta_6 \\
x_7 &= x + \rho_7 \cos\theta_7 \\
y_7 &= y + \rho_7 \sin\theta_7 \\
x_8 &= x + L_7 \cos\theta_7 + \rho_8 \cos\theta_8 \\
y_8 &= y + L_7 \sin\theta_7 + \rho_8 \sin\theta_8
\end{aligned}
\qquad \text{(II.C.1)}
$$

$$
\begin{aligned}
\dot{x}_1 &= \dot{x} - \rho_1 \dot{\theta}_1 \sin \theta_1 \\
\dot{y}_1 &= \dot{y} + \rho_1 \dot{\theta}_1 \cos \theta_1 \\
\dot{x}_2 &= \dot{x} - L_1 \dot{\theta}_1 \sin \theta_1 - \rho_2 \dot{\theta}_2 \sin \theta_2 \\
\dot{y}_2 &= \dot{y} + L_1 \dot{\theta}_1 \cos \theta_1 + \rho_2 \dot{\theta}_2 \cos \theta_2 \\
\dot{x}_3 &= \dot{x} - L_1 \dot{\theta}_1 \sin \theta_1 - L_2 \dot{\theta}_2 \sin \theta_2 - \rho_3 \dot{\theta}_3 \sin \theta_3 \\
\dot{y}_3 &= \dot{y} + L_1 \dot{\theta}_1 \cos \theta_1 + L_2 \dot{\theta}_2 \cos \theta_2 + \rho_3 \dot{\theta}_3 \cos \theta_3 \\
\dot{x}_4 &= \dot{x} - L_1 \dot{\theta}_1 \sin \theta_1 - L_2 \dot{\theta}_2 \sin \theta_2 - L_3 \dot{\theta}_3 \sin \theta_3 - \rho_4 \dot{\theta}_4 \sin \theta_4 \\
\dot{y}_4 &= \dot{y} + L_1 \dot{\theta}_1 \cos \theta_1 + L_2 \dot{\theta}_2 \cos \theta_2 + L_3 \dot{\theta}_3 \cos \theta_3 + \rho_4 \dot{\theta}_4 \cos \theta_4 \\
\dot{x}_5 &= \dot{x} - L_1 \dot{\theta}_1 \sin \theta_1 - L_2 \dot{\theta}_2 \sin \theta_2 - L_4 \dot{\theta}_3 \sin \theta_3 - \rho_5 \dot{\theta}_5 \sin \theta_5 \\
\dot{y}_5 &= \dot{y} + L_1 \dot{\theta}_1 \cos \theta_1 + L_2 \dot{\theta}_2 \cos \theta_2 + L_4 \dot{\theta}_3 \cos \theta_3 + \rho_5 \dot{\theta}_5 \cos \theta_5 \\
\dot{x}_6 &= \dot{x} - L_1\dot{\theta}_1 \sin \dot{\theta}_1 - L_2\dot{\theta}_2 \sin \theta_2 - L_4\dot{\theta}_3 \sin \theta_3 - L_5\dot{\theta}_5 \sin \theta_5 - \rho_6\dot{\theta}_6 \sin \theta_6 \\
\dot{y}_6 &= \dot{y} + L_1\dot{\theta}_1 \cos \theta_1 + L_2\dot{\theta}_2 \cos \theta_2 + L_4\dot{\theta}_3 \cos \theta_3 + L_5\dot{\theta}_5 \cos \theta_5 + \rho_6\dot{\theta}_6 \cos \theta_6 \\
\dot{x}_7 &= \dot{x} - \rho_7 \dot{\theta}_7 \sin \theta_7 \\
\dot{y}_7 &= \dot{y} + \rho_7 \dot{\theta}_7 \cos \theta_7 \\
\dot{x}_8 &= \dot{x} - L_7 \dot{\theta}_7 \sin \theta_7 - \rho_8 \dot{\theta}_8 \sin \theta_8 \\
\dot{y}_8 &= \dot{y} + L_7 \dot{\theta}_7 \cos \theta_7 + \rho_8 \dot{\theta}_8 \cos \theta_8
\end{aligned}
\qquad \text{(II.C.2)}
$$

The components of the equations of motion due to centrifugal force form $\vec{B}$ and can be written

$$B_1 = L_1 \sum_{j=2}^{6} a_j \dot{\theta}_j^2 \sin [\theta_j - \theta_1]$$

$$B_2 = L_2 a_2 \dot{\theta}_1^2 \sin (\theta_1 - \theta_2) + L_2 \sum_{j=3}^{6} a_j \dot{\theta}_j^2 \sin (\theta_j - \theta_2)$$

$$B_3 = a_3 \sum_{j=1}^{2} L_j \dot{\theta}_j^2 \sin (\theta_j - \theta_3) + L_3 a_4 \dot{\theta}_4^2 \sin (\theta_4 - \theta_3)$$

$$+ L_4 \sum_{j=5}^{6} a_j \dot{\theta}_j^2 \sin (\theta_j - \theta_3)$$

$$B_4 = a_4 \sum_{j=1}^{3} L_j \dot{\theta}_j^2 \sin (\theta_j - \theta_4)$$

$$B_5 = a_5 \sum_{j=1}^{3} L_j \dot{\theta}_j^2 \sin (\theta_j - \theta_5) + L_4 a_5 \dot{\theta}_3^2 \sin (\theta_3 - \theta_5)$$

$$+ a_6 L_5 \dot{\theta}_6^2 \sin (\theta_6 - \theta_5)$$

$$B_6 = a_6 \sum_{j=1}^{3,5} L_j \dot{\theta}_j^2 \sin (\theta_j - \theta_6)$$

$$B_7 = L_7 a_8 \dot{\theta}_8^2 \sin (\theta_8 - \theta_7)$$

$$B_8 = L_7 a_8 \dot{\theta}_7^2 \sin (\theta_7 - \theta_8)$$

$$B_9 = \sum_{j=1}^{8} a_j \dot{\theta}_j^2 \cos \theta_j$$

$$B_{10} = \sum_{j=1}^{8} a_j \dot{\theta}_j^2 \sin \theta_j \qquad \text{(II.C.3)}$$

Due to gravity the contribution to the right-hand side of the equations of motion forms $\vec{G}$ and can be written

$$G_1 = g\, a_1 \cos\theta_1$$

$$G_2 = g\, a_2 \cos\theta_2$$

$$G_3 = g\, a_3 \cos\theta_3$$

$$G_4 = g\, a_4 \cos\theta_4$$

$$G_5 = g\, a_5 \cos\theta_5$$

$$G_6 = g\, a_6 \cos\theta_6$$

$$G_7 = g\, a_7 \cos\theta_7$$

$$G_8 = g\, a_8 \cos\theta_8$$

$$G_9 = 0$$

$$G_{10} = g\, a_9 \qquad \text{(II.C.4)}$$

where

$$a_i = m_i\, \rho_i + L_i \sum_{j=i+1}^{6} m_j \qquad i = 1,2$$

$$a_3 = m_3\, \rho_3 + m_4\, L_3 + (m_5+m_6)\, L_4$$

$$a_i = m_i\, \rho_i \qquad i = 4,6,8$$

$$a_i = m_i\, \rho_i + m_{i+1}\, L_i \qquad i = 5,7$$

$$a_9 = \sum_{i=1}^{8} m_i \qquad \text{(II.C.5)}$$

$$
= \begin{bmatrix}
a_{10} & a_2L_1\cos(\theta_1-\theta_2) & a_3L_1\cos(\theta_1-\theta_3) & a_4L_1\cos(\theta_1-\theta_4) & a_5L_1\cos(\theta_1-\theta_5) & a_6L_1\cos(\theta_1-\theta_6) & 0 & 0 & -a_1\sin\theta_1 & a_1\cos\theta_1 \\
a_2L_1\cos(\theta_1-\theta_2) & a_{11} & a_3L_2\cos(\theta_2-\theta_3) & a_4L_2\cos(\theta_2-\theta_4) & a_5L_2\cos(\theta_2-\theta_5) & a_6L_2\cos(\theta_2-\theta_6) & 0 & 0 & -a_2\sin\theta_2 & a_2\cos\theta_2 \\
a_3L_1\cos(\theta_1-\theta_2) & a_3L_2\cos(\theta_2-\theta_3) & a_{12} & a_4L_3\cos(\theta_2-\theta_4) & a_5L_4\cos(\theta_3-\theta_5) & a_6L_4\cos(\theta_3-\theta_6) & 0 & 0 & -a_3\sin\theta_3 & a_3\cos\theta_3 \\
a_4L_1\cos(\theta_1-\theta_4) & a_4L_2\cos(\theta_2-\theta_4) & a_4L_3\cos(\theta_3-\theta_4) & a_{13} & 0 & 0 & 0 & 0 & -a_4\sin\theta_4 & a_4\cos\theta_4 \\
a_5L_1\cos(\theta_1-\theta_5) & a_5L_2\cos(\theta_2-\theta_5) & a_5L_4\cos(\theta_3-\theta_5) & 0 & a_{14} & a_6L_5\cos(\theta_5-\theta_6) & 0 & 0 & -a_5\sin\theta_5 & a_5\cos\theta_5 \\
a_6L_1\cos(\theta_1-\theta_6) & a_6L_2\cos(\theta_2-\theta_6) & a_6L_4\cos(\theta_3-\theta_6) & 0 & a_6L_5\cos(\theta_5-\theta_6) & a_{15} & 0 & 0 & -a_6\sin\theta_6 & a_6\cos\theta_6 \\
0 & 0 & 0 & 0 & 0 & 0 & a_{16} & a_8L_7\cos(\theta_7-\theta_8) & -a_7\sin\theta_7 & a_7\cos\theta_7 \\
0 & 0 & 0 & 0 & 0 & 0 & a_8L_7\cos(\theta_7-\theta_8) & a_{17} & -a_8\sin\theta_8 & a_8\cos\theta_8 \\
-a_1\sin\theta_1 & -a_2\sin\theta_2 & -a_3\sin\theta_3 & -a_4\sin\theta_4 & -a_5\sin\theta_5 & -a_6\sin\theta_6 & -a_7\sin\theta_7 & -a_8\sin\theta_8 & a_9 & 0 \\
a_1\cos\theta_1 & a_2\cos\theta_2 & a_3\cos\theta_3 & a_4\cos\theta_4 & a_5\cos\theta_5 & a_6\cos\theta_6 & a_7\cos\theta_7 & a_8\cos\theta_8 & 0 & a_9
\end{bmatrix} \qquad \text{(II.C.6)}
$$

The matrix m in Eq. (II.B.2) formed from the kinetic energy terms is shown as Eqs. (II.C.6) and (II.C.7).

$$a_i = I_j + m_j \rho_j^2 + L_j^2 \sum_{k=j+1}^{6} m_k \qquad \text{for } i = 10,11 \text{ and } j = i-9$$

$$a_{12} = I_3 + m_3 \rho_3^2 + m_4 L_3^2 + (m_5+m_6) L_4^2$$

$$a_i = I_j + m_j \rho_j^2 \qquad \text{for } i = 13,15,17 \text{ and } j = i-9$$

$$a_i = I_j + m_j \rho_j^2 + m_{j+1} L_j^2 \qquad \text{for } i = 14,16 \text{ and } j = i-9 \qquad \text{(II.C.7)}$$

D. CONTACT SURFACES

The nine distinct surfaces simulating the interior of the vehicle and capable of applying forces on the body of the occupant are represented by straight line segments as shown in Figure 7. After the computer program user chooses whether the occupant is a driver, front-seat passenger, or rear-seat passenger, a table is generated showing which body segments are allowed to contact which surfaces.

This computer generated table is equivalent to the corresponding column in Table V. The user may choose to model any special contact surface with one of the standard contact surfaces. The choice of which standard contact to use must include matching the expected interactions of this contact with the table of permissible interactions (the appropriate column of Table V). Each contact surface has a unique name shown in Table IV which will be used in the program output. The user has the option of changing these names to represent, for example, an airbag.

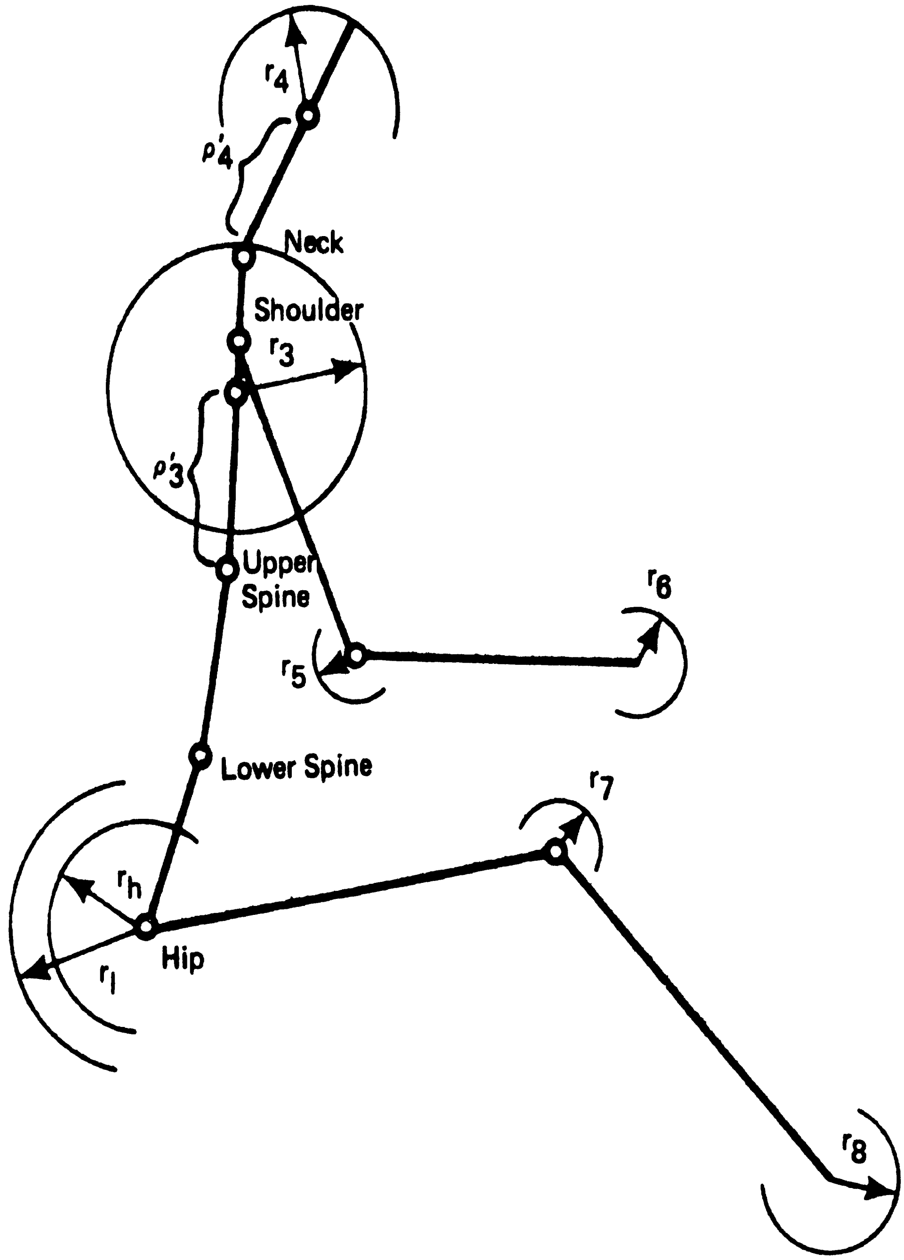


Figure 6. Definition of body contact radii.

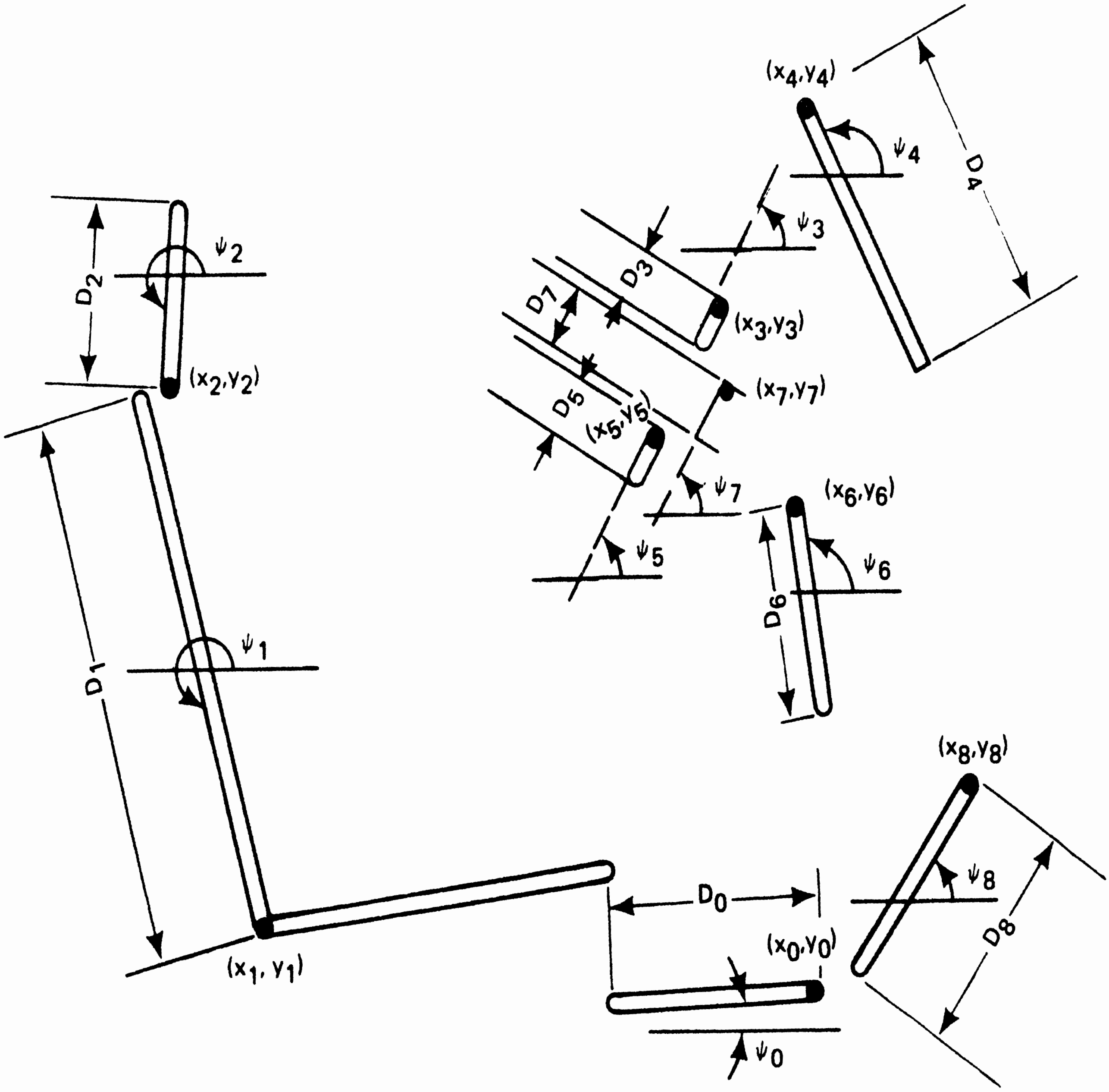


Figure 7. Definitions of vehicle contact surface (shown for driver).

TABLE IV. NORMAL CONTACT SURFACE INDICES

Index*	Normal Contact Surface
0	Floor
1	Seat back
2	Roof or head rest
3	Upper steering wheel, upper dash, back of front seat
4	Windshield
5	Lower steering wheel
6	Lower panel
7	Steering column
8	Toeboard
9	Steering wheel

*It is permissible to use any index for any other contact surface as long as it is compatible with the table of possible contacts in Table V. For example, an airbag could be simulated by using the various segments of the steering wheel.

Each contact surface is defined by four quantities: the x and y coordinates of its reference point, its length, and its angular orientation. This reference point is at the end of the surface line which is most counterclockwise relative to the origin. The angle is found by drawing a horizontal line through the other end point and measuring the angle from the forward part of this line to the surface.

Each contact surface produces two forces. The first force acts perpendicularly to the surface through the center of curvature of the contacting body segments and the second force is frictional in nature and has the form:

$$P' = \begin{cases} -\mu_a \ P \ \mathrm{sgn} \ v_T \ \text{for} \ |v_T| \geq \xi_a \\ 0 \qquad\qquad\qquad\quad |v_T| < \xi_a \end{cases} \qquad \text{(II.D.1)}$$

where

V_T is the tangential velocity of the body segment along the surface

P is the force applied normal to the contact surface

μ_k is the friction coefficient

ξ_k is the velocity limit

When the velocity limit (a small quantity such as 0.1 in/sec) is exceeded the friction force is applied; otherwise, it is set to zero representing sliding or Coulomb friction.

The material properties of the contact surfaces have two features. The first of these is a load-deflection polynomial which may be up to the fifth order in both deflection and deflection rate representing a nonlinear, viscoelastic material. This polynomial is applied during the time while the load is being applied to the surface while unloading is based on a parabolic function. The second feature is a force-limiting mechanism which prevents contact forces from exceeding a specified limit and allows simple modeling of energy-absorbing structures.

The force developed at any contact interface is given in the following polynomial form

$$P_k = \sigma_{0,k} + \sum_{m=1}^{5} \left[\sigma_{m,k}\, \delta_k^{m} + \sigma_{m+5,k}\, \dot{\delta}_k^{m} \right] \qquad \text{(II.D.2)}$$

where

$$\sigma_{0,k} = -\sum_{m=1}^{5} \sigma_{m+5,k} \, \dot{\delta}_{k_0}^{\,m}$$

where

δ_k is the distance which a particular body element impinges into a particular surface representing a segment of the vehicle interior

$\dot{\delta}_k$ is the deflection rate

$\dot{\delta}_{k_0}$ is the value of $\dot{\delta}_k$ when δ_k first becomes positive

$\sigma_{0,k}$ is a preload on any given contact surface

$\sigma_{1,k}$ through $\sigma_{10,k}$ are the material polynomial coefficients

The quantity k is the general force index. Values of k greater than four correspond to particular combinations of contact arcs on the body and contact surfaces and are shown in brackets in Table V. Hence, for each value of k and choice of passenger position, there corresponds a unique contact arc subscript which appears in parenthesis on the left margin of Table V and a unique contact surface subscript which appears in parentheses in the body of Table V. Throughout the remainder of this section "i" is this contact arc subscript and "a" is this contact surface subscript.

$$\delta_k = r_i - (x''_a - x'_i)\sin\psi_a + (y''_a - y'_i)\cos\psi_a$$

$$\dot{\delta}_k = \dot{x}'_i \sin\psi_a - \dot{y}'_i \cos\psi_a$$

$$v_T = \dot{x}'_i \cos\psi_a + \dot{y}'_i \sin\psi_a + r_i\,\dot{\theta}_i \qquad \text{(II.D.3)}$$

$$x'_1 = x$$

$$y'_1 = y$$

$$x'_3 = x + L_1\cos\theta_1 + L_2\cos\theta_2 + \rho'_3\cos\theta_3$$

$$y'_3 = y + L_1\sin\theta_1 + L_2\sin\theta_2 + \rho'_3\sin\theta_3$$

$$x'_4 = x + L_1\cos\theta_1 + L_2\cos\theta_2 + L_3\cos\theta_3 + \rho'_4\cos\theta_4$$

$$y'_4 = y + L_1\sin\theta_1 + L_2\sin\theta_2 + L_3\sin\theta_3 + \rho'_4\sin\theta_4$$

$$x'_5 = x + L_1\cos\theta_1 + L_2\cos\theta_2 + L_4\cos\theta_3 + L_5\cos\theta_5$$

$$y'_5 = y + L_1\sin\theta_1 + L_2\sin\theta_2 + L_4\sin\theta_3 + L_5\sin\theta_5$$

$$x'_7 = x + L_7\cos\theta_7$$

$$y'_7 = y + L_7\sin\theta_7$$

$$x'_8 = x + L_7\cos\theta_7 + L_8\cos\theta_8$$

$$y'_8 = y + L_7\sin\theta_7 + L_8\sin\theta_8 \qquad \text{(II.D.4)}$$

x''_a, y''_a, ψ_a are the contact surface reference coordinates and orientation, r_i is the radius of the contact arc attached to each body segment.

TABLE V. OCCUPANT CONTACTS VERSUS VEHICLE CONTACTS

Contact Arc Subscript	Contacts		
	Driver (1)	Front Passenger (2)	Rear Passenger (3)
Hip (1)	Seat back (1) [5]	Seat back (1) [5]	Seat back (1) [5]
Upper torso (3)	Seat back (1) [6] Upper steering wheel (3) [7] Lower steering wheel (5) [8] Steering column (7) [9]	Seat back (1) [6] Upper dash (3) [7]	Seat back (1) [6] Back of front seat (3) [7]
Head (4)	Seat back (1) [10] Roof or head rest (2) [11] Upper steering wheel (3) [12] Windshield (4) [13] Lower steering wheel (5) [14]	Seat back (1) [8] Roof or head rest (2) [9] Upper dash (3) [10] Windshield (4) [11]	Seat (1) [8] Roof or head rest (2) [9] Back of front seat (3) [10]
Elbow (5)	Seat back (1) [15]	Seat back (1) [12]	Seat back (1) [11]
Knee (7)	Lower panel (6) [16]	Lower panel (6) [13]	Back of front seat (3) [12]
Foot (8)	Floorboard (0) [17] Toeboard (8) [18]	Floorboard (0) [14] Toeboard (8) [15]	Floorboard (0) [13] Back of front seat (3) [14]

NOTE: Numbers in brackets refer to indices 5-18 used in LODFEC and CONTACT printouts (see flow diagrams and Table XX).

$$\dot{x}'_1 = \dot{x}$$

$$\dot{y}'_1 = \dot{y}$$

$$\dot{x}'_3 = \dot{x} - L_1 \dot{\theta}_1 \sin\theta_1 - L_2 \dot{\theta}_2 \sin\theta_2 - \rho'_3 \dot{\theta}_3 \sin\theta_3$$

$$\dot{y}'_3 = \dot{y} + L_1 \dot{\theta}_1 \cos\theta_1 + L_2 \dot{\theta}_2 \cos\theta_2 + \rho'_3 \dot{\theta}_3 \cos\theta_3$$

$$\dot{x}'_4 = \dot{x} - L_1 \dot{\theta}_1 \sin\theta_1 - L_2 \dot{\theta}_2 \sin\theta_2 - L_3 \dot{\theta}_3 \sin\theta_3 - \rho'_4 \dot{\theta}_4 \sin\theta_4$$

$$\dot{y}'_4 = \dot{y} + L_1 \dot{\theta}_1 \cos\theta_1 + L_2 \dot{\theta}_2 \cos\theta_2 + L_3 \dot{\theta}_3 \cos\theta_3 + \rho'_4 \dot{\theta}_4 \cos\theta_4$$

$$\dot{x}'_5 = \dot{x} - L_1 \dot{\theta}_1 \sin\theta_1 - L_2 \dot{\theta}_2 \sin\theta_2 - L_4 \dot{\theta}_3 \sin\theta_3 - L_5 \dot{\theta}_5 \sin\theta_5$$

$$\dot{y}'_5 = \dot{y} + L_1 \dot{\theta}_1 \cos\theta_1 + L_2 \dot{\theta}_2 \cos\theta_2 + L_4 \dot{\theta}_3 \sin\theta_3 + L_5 \dot{\theta}_5 \cos\theta_5$$

$$\dot{x}'_7 = \dot{x} - L_7 \dot{\theta}_7 \sin\theta_7$$

$$\dot{y}'_7 = \dot{y} + L_7 \dot{\theta}_7 \cos\theta_7$$

$$\dot{x}'_8 = \dot{x} - L_7 \dot{\theta}_7 \sin\theta_7 - L_8 \dot{\theta}_8 \sin\theta_8$$

$$\dot{y}'_8 = \dot{y} + L_7 \dot{\theta}_7 \cos\theta_7 + L_8 \dot{\theta}_8 \cos\theta_8 \qquad \text{(II.D.5)}$$

and the other quantities are defined in Figures 4-7.

The form of P_k shown in Eq. (II.D.2) is used only while a load is being applied, i.e., when the deflection is increasing. During loading, the material may absorb energy so that its characteristics while unloading can be different than before.

The resulting permanent deformation is modeled by means of two parameters:

G, the ratio of permanent deformation to maximum deflection, and

R, the ratio of conserved to total energy.

These two parameters are not independent but the relationship is complex so both are required by the program. The unloading force is assumed to be parabolic in nature and deflection to decrease from a maximum at $\delta = \Omega_k$ to zero force at $\delta = G\,\Omega_k$. This latter value $(G\,\Omega_k)$ is taken as the permanent deformation, i.e., the value of deflection which must be exceeded before loading will begin again. The formula used for P_k for unloading is

$$P_k = \frac{3[F_k\,\Omega_k(1-G) - 2E_{1k}]}{\Omega_k^3(1-G)^3}(\delta_k - G\,\Omega_k) \left\{\delta_k + \frac{\Omega_k[6E_{1k} - F_k\,\Omega_k(1-G)(2+G)]}{3[F_k\,\Omega_k(1-G) - 2E_{1k}]}\right\} \qquad \text{(II.D.6)}$$

where

F_k is the loading force (P_k) at the maximum deflection

Ω_k is the maximum deflection

E_{1k} is the conserved energy. This quantity is computed as R times the total energy for this load-unload cycle plus the conserved energy from previous cycles if any.

The Eq. (II.D.6) results from an evaluation of the coefficients of a parabola which fits the constraints stated below:

(1) The unloading curve starts at the point of maximum deflection Ω_k with the force F_k.

(2) The unloading curve goes to zero at the point where deflection equals the permanent deformation (i.e., $G\,\Omega$ by definition of G).

(3) The total work done by the unloading curve (the conserved energy in the contact) is RE_k where E_k is the total energy and R is the ratio of conserved to total energy as defined above. The total energy is computed by a stepwise approximation through the loading portion of the cycle and

E_{1k} which appears in the formulas above is computed as RE_k. Since G and R are not really independent, a constraint:

$$2E_{1k} \leq F_k \Omega_k (1-G) \leq 3E_{1k} \qquad \text{(II.D.7)}$$

is applied to insure that the force goes to zero at $\delta = G\Omega_k$. The constraint equation (II.D.7) comes about from evaluation of the roots of the unloading curve. The conditions that $G\Omega_k$ be the larger root and that the unloading curve increase for increasing deflection at that point yield the two halves of the constraint.

Loading followed by unloading constitutes one cycle. Provision is made for accumulating permanent deformations over several cycles. The effect of this accumulation is used to determine the starting point of succeeding cycles; however, the shape of the loading curve is always the same as the first cycle. The unloading curve is recomputed for each cycle.

The saturation feature is illustrated in Figure 8. During loading of a surface, the usual polynomial is used to compute the force. When a specified saturation force level is reached, this value is used as deflection increases. When unloading ($\dot{\delta}$ negative) occurs, a specified linear slope is used to reduce force to zero. For reloadings, the polynomial loading curve is moved to the permanent deformation or turn-around position whichever applicable and the standard loading sequence restarts including the possibility of saturation.

The contribution to the equations of motion due to contact forces is a sum of the effects of the many possible interactions. For each passenger position, the number of possible interactions changes. In particular, the total number of interactions is fourteen for the driver (NPASGR = 1), eleven for the front right passenger (NPASGR = 2), and ten for the back seat passenger (NPASGR = 3). NS is the maximum value of the subscript k and is the above stated total number of interactions plus four.

$$Q_1 = L_1 \sum_{k=6}^{NS-3} P_k \cos(\Theta_1 - \Psi_a) \qquad \text{(II.D.8)}$$

where a again is the corresponding a for the k as explained on page 27.

$$Q_2 = L_2 \sum_{k=6}^{NS-3} P_k \cos(\Theta_2 - \Psi_a) \qquad \text{(II.D.9)}$$

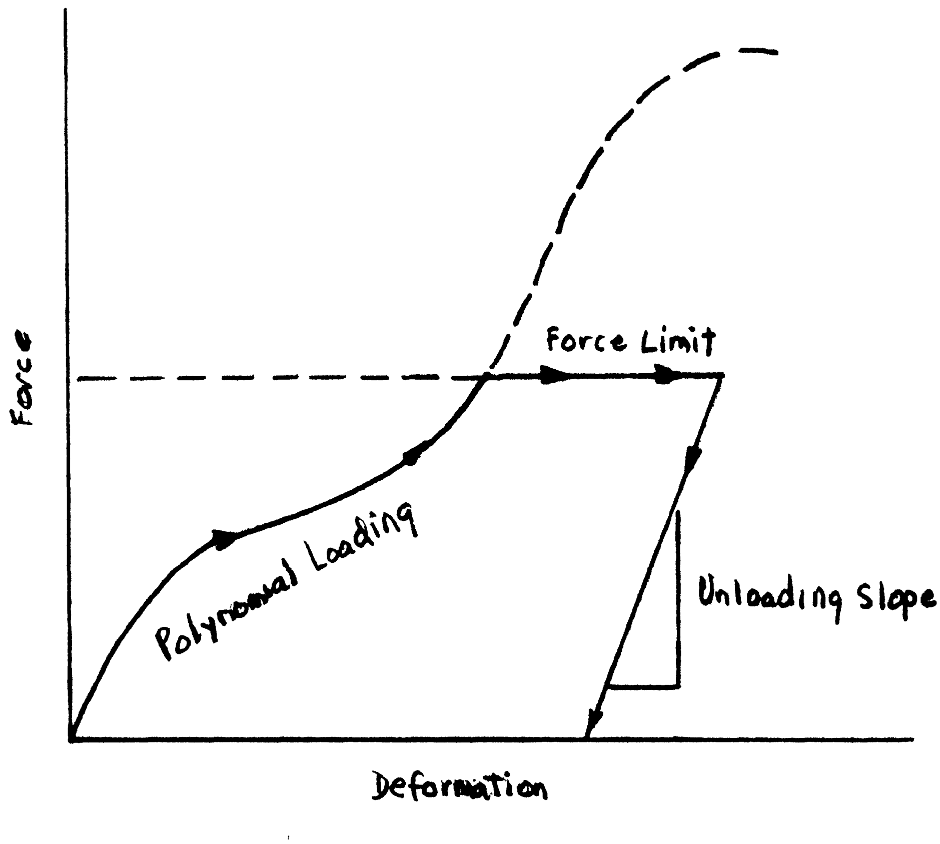


Figure 8. Force-limiting Mechanism

$$Q_3 = \rho_3' \sum_{k=6}^{L} P_k \cos(\theta_3 - \psi_a) + L_3 \sum_{k=K+1}^{L} P_k \cos(\theta_3 - \psi_a)$$

$$+ L_4 P_{L+1} \cos(\theta_3 - \psi_1) \quad \text{(II.D.10)}$$

$$Q_4 = \rho_4' \sum_{k=K+1}^{K} P_k \cos(\theta_4 - \psi_a) \quad \text{(II.D.11)}$$

$$Q_5 = L_5 P_{L+1} \cos(\theta_5 - \psi_1) \quad \text{(II.D.12)}$$

where K and L are a function of NPASGR as follows:

NPASGR	K	L
1	9	14
2	7	11
3	7	10

$$Q_6 = 0$$

$$Q_7 = L_7 \sum_{k=NS-3}^{NS} P_k \cos(\theta_7 - \psi_a)$$

$$Q_8 = L_8 \sum_{k=NS-1}^{NS} P_k \cos(\theta_8 - \psi_a)$$

$$Q_9 = -\sum_{k=5}^{NS} P_k \sin \psi_a$$

$$Q_{10} = \sum_{k=5}^{NS} P_k \cos \psi_a \quad \text{(II.D.13)}$$

The contribution to the generalized force due to friction at the force contact is of the form

$$\Delta\vec{b}_q = P_k' \vec{U}_i \quad \text{(II.D.14)}$$

where P_k' is the computed frictional force explained on page 26 corresponding to the normal force P_k.

$\vec{U}_i$ is the proper "lever arm" vector defined below for the value of the contact arc subscript corresponding to k. The quantity a is the matching contact surface subscript for the k in what follows.

Where

$$\vec{U}_1 = \begin{bmatrix} -r_1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -\cos\psi_a \\ -\sin\psi_a \end{bmatrix} \tag{II.D.15}$$

$$\vec{U}_2 = 0 \quad . \tag{II.D.16}$$

$$\vec{U}_3 = \begin{bmatrix} L_1 \sin(\theta_1-\psi_a) \\ L_2 \sin(\theta_2-\psi_a) \\ \rho_3' \sin(\theta_3-\psi_a) - r_3 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -\cos\psi_a \\ -\sin\psi_a \end{bmatrix} \tag{II.D.17}$$

$$\vec{U}_4 = \begin{bmatrix} L_1 \sin(\theta_1-\psi_a) \\ L_2 \sin(\theta_2-\psi_a) \\ L_3 \sin(\theta_3-\psi_a) \\ \rho_4' \sin(\theta_4-\psi_a) - r_4 \\ 0 \\ 0 \\ 0 \\ 0 \\ -\cos\psi_a \\ -\sin\psi_a \end{bmatrix} \tag{II.D.18}$$

$$\vec{U}_5 = \begin{bmatrix} L_1 \sin(\theta_1-\psi_a) \\ L_2 \sin(\theta_2-\psi_a) \\ L_4 \sin(\theta_3-\psi_a) \\ 0 \\ L_5 \sin(\theta_5-\psi_a) - r_5 \\ 0 \\ 0 \\ 0 \\ -\cos\psi_a \\ -\sin\psi_a \end{bmatrix} \tag{II.D.19}$$

$$\vec{U}_6 = 0 \tag{II.D.20}$$

$$\vec{U}_7 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ L_7 \sin(\theta_7-\psi_a) - r_7 \\ 0 \\ -\cos\psi_a \\ -\sin\psi_a \end{bmatrix} \tag{II.D.21}$$

$$\vec{U}_8 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ L_7 \sin(\theta_7 - \psi_a) \\ L_8 \sin(\theta_7 - \psi_a) - r_8 \\ -\cos\psi_a \\ -\sin\psi_a \end{bmatrix} \qquad \text{(II.D.22)}$$

E. SEAT CUSHION

The seat cushion model contains provision for four separate forces as shown in Figure 9. The first one acts vertically at the hip joint whenever it is above the seat cushion and is modeled by a third order polynomial spring and a linear damper. The second, modeled by a linear spring, acts vertically at the front edge of the seat and affects the upper or lower leg depending on the size of the occupant and his position. This is especially useful in the case of children whose lower legs often are on the seat cushion. The third force, also modeled by a linear spring, acts in a forward direction at the top of the front edge of the seat. This force was included to prevent the lower legs from passing backward through the seat and producing large spurious forces. All three of these forces are continuous. The fourth force models seat friction and is discontinuous as well as dissipative. The force applied at the hip is

$$F_s = W_o - \sum_{m=1}^{3} \beta_m y_s^m - C_s \dot{y}_s \qquad \text{(II.E.1)}$$

where

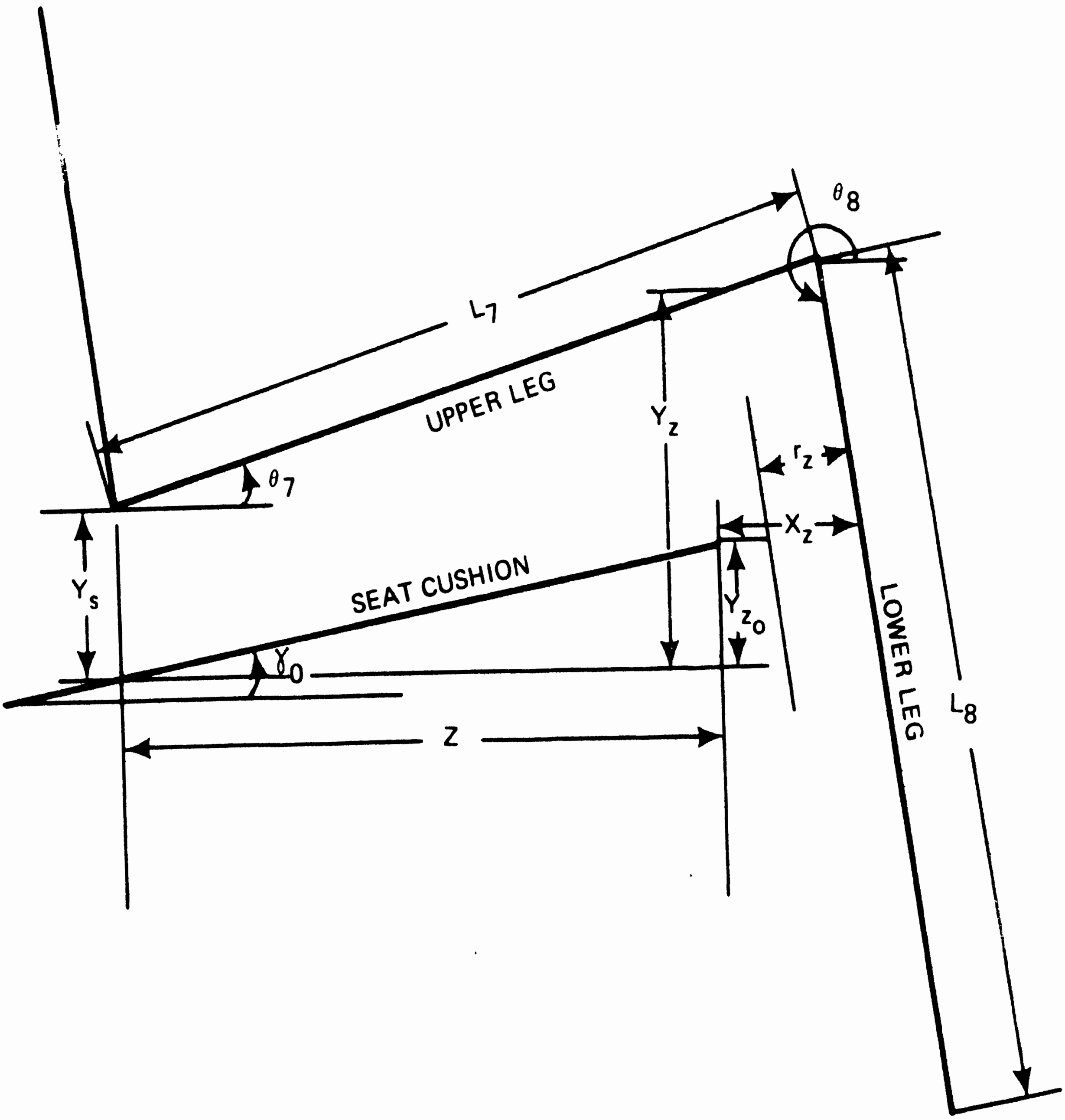


Figure 9. Description of seat bottom.

$$y_s = y + (X-x) \tan \gamma_o$$

$$\dot{y}_s = \dot{y} + (\dot{X}-\dot{x}) \tan \gamma_o$$

W_o = equilibrium force on seat cushion at hip

β_m = polynomial spring constants

C_s = damping constant

X = horizontal position of seat as a function of time

x = horizontal position of hip as a function of time

y = vertical position of hip as a function of time (II.E.2)

The force acting vertically at the at the front edge of the seat cushion is

$$F'_s = F'_{so} - s(y_z - y_{zo}) \qquad \text{(II.E.3)}$$

where

$$y_z = \begin{cases} y + z \tan \theta_7 \text{ for the upper leg} \\ y + L_7 \sin \theta_7 + (z - L_7 \cos \theta_7) \tan \theta_8 \text{ for the lower leg} \end{cases} \qquad \text{(II.E.4)}$$

and

z = $z_o + X - x$

F'_{so} = initial upward force at front of seat

s = spring constant

y_{zo} = vertical distance from seat front edge to level of seat cushion directly below hip joint at time zero

z_o = initial value of z

with all other quantities defined in Figure 9.

The force acting horizontally at the front edge of the seat is

$$F_z = \begin{cases} s_z(r_z - x_z) \text{ for } x_z - r_z < 0 \\ 0 \text{ otherwise} \end{cases} \qquad \text{(II.E.5)}$$

where

$$x_z = (z_o \tan \gamma_o - y - L_7 \sin \theta_7) \frac{\cos \theta_8}{\sin \theta_8} - (z - L_7 \cos \theta_7)$$

s_z = spring constant

r_z = distance from centerline of lower leg to outside of calf

and the other quantities are previously defined. (II.E.6)

The friction force is

$$f = \begin{cases} -\mu_s (F_s + F'_s) \operatorname{sgn}(\dot{X} - \dot{x}) \text{ for } |\dot{X} - \dot{x}| \geq \xi_{\dot{s}} \\ 0 \text{ otherwise} \end{cases} \quad \text{(II.E.7)}$$

where

μ_s = friction coefficient

The contributions from the seat cushion to the generalized force vector, $\vec{D}$, are:

$$D_i = 0, \quad i = 1\text{-}6$$

$$D_7 = \begin{cases} F'_s\, z \sec^2 \theta_7 \text{ for } z \leq L_7 \cos \theta_7 \\ F'_s\, L_7 (\cos \theta_7 + \sin \theta_7 \tan \theta_8) - F_z\, L_7 \cdot \\ \quad (\sin \theta_7 + \cos \theta_7 \cot \theta_8) \text{ for } z > L_7 \cos \theta_7 \end{cases} \quad \text{(II.E.8)}$$

$$D_8 = \begin{cases} 0 \text{ for } z \leq L_7 \cos \theta_7 \\ F'_s (z - L_7 \cos \theta_7) \sec^2 \theta_8 + F_z (y + L_7 \sin \theta_7 - y_{zo}) \csc^2 \theta_8 \\ \text{otherwise} \end{cases}$$

$$D_9 = \begin{cases} -F'_s \tan \theta_7 \text{ for } z \leq L_7 \cos \theta_7 \\ -F'_s \tan \theta_8 + F_z \text{ otherwise} \end{cases}$$

$$D_{10} = F_s + F'_s - F_z \cot \theta_8 \quad \text{(II.E.9)}$$

The components of the contribution of seat friction to the generalized force vector, $\Delta\vec{b}_s$, are

$$\Delta b_i = \begin{cases} 0 & \text{for } i = 1\text{-}8, 10 \\ -f & \text{for } i = 9 \end{cases} \qquad \text{(II.E.10)}$$

F. JOINTS

Each joint is considered to have an elastic torque resisting motion away from its initial position, a coulomb-type friction resisting any relative motion above a certain velocity limit (see Figure 10), and a joint stop to prevent substantial motion beyond specified angular limits (see Figure 11 or Figure 12).

The contribution to the system potential energy from torque is defined by

$$J_{ei} = K_i(\theta_m - \theta_i + \theta_{io} - \theta_{mo}) \text{ for } i = 1\text{-}7 \qquad \text{(II.F.1)}$$

(see Table I for joints associated with each subscript), with each i defining a unique m as follows for calculation of proper relative angle.

i	1	2	3	4	5	6	7
m	7	1	2	3	3	5	8

The other two torques are dissipative in nature. The coulomb friction equation is:

$$J_{fi} = \begin{cases} -C_i' \operatorname{sgn}(\dot{\theta}_i - \dot{\theta}_m) \text{ for } |\dot{\theta}_i - \dot{\theta}_m| \geq \xi_i \\ 0 \text{ otherwise} \end{cases} \qquad \text{(II.F.2)}$$

Also the stop torque is of the same type:

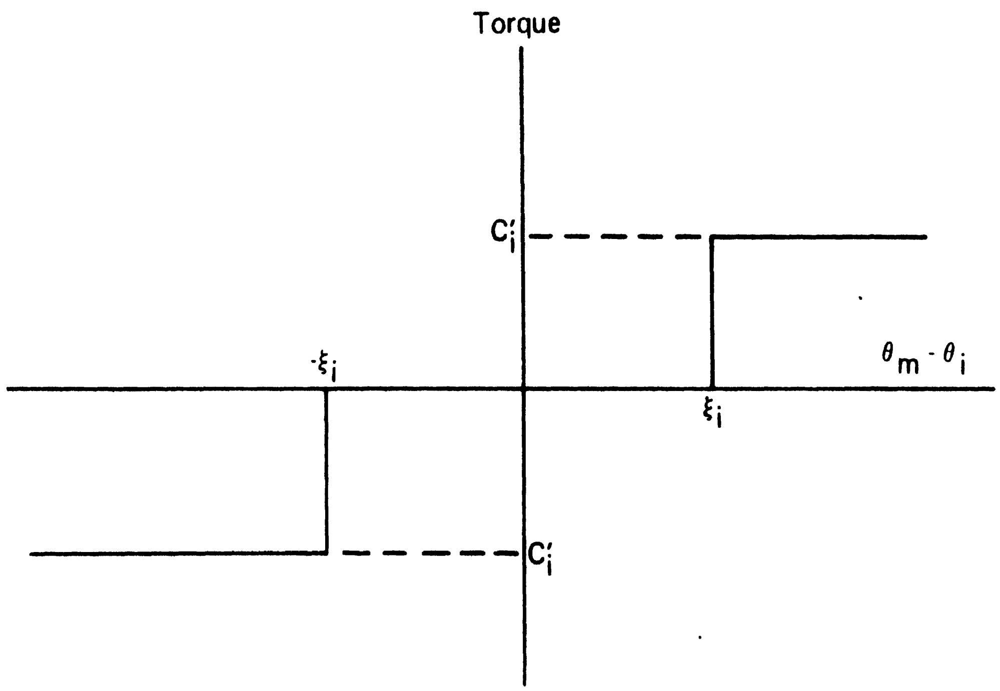


Figure 10. Form of friction in joints.

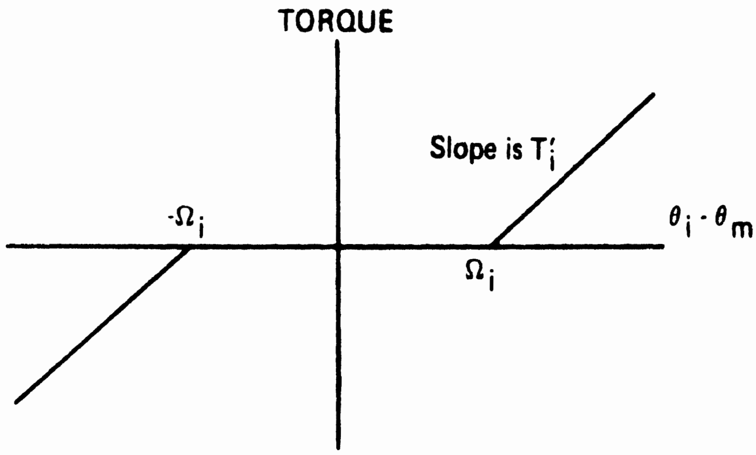


Figure 11. Form of symmetric joint stops for neck and two spinal joints.

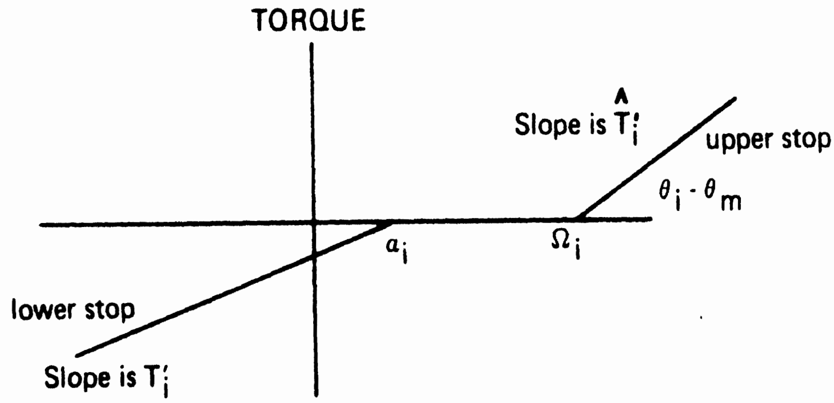


Figure 12. Form of nonsymmetric joint stops of hip, shoulder, elbow, and knee.

$$J_{si} = \begin{cases} T_i \text{ for } |\dot{\theta}_i - \dot{\theta}_m| \geq \xi_i \\ 0 \text{ otherwise} \end{cases} \qquad \text{(II.F.3)}$$

where the form of T_i depends on the particular joint.

The elements of the stop torque vector are defined as follows.

$$T_1 = \begin{cases} T_1' (\alpha_1 - \theta_1 + \theta_7) & \text{for } \theta_1 - \theta_7 < \alpha_1 \text{ and } \dot{\theta}_1 - \dot{\theta}_7 < 0 \\ \hat{T}_1' (\Omega_1 - \theta_1 - \theta_7) & \text{for } \theta_1 - \theta_7 > \Omega_1 \text{ and } \dot{\theta}_1 - \dot{\theta}_7 > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$T_2 = \begin{cases} T_2'[\theta_1 - \theta_2 - \Omega_2 \operatorname{sgn}(\theta_1 - \theta_2)] & \text{for } |\theta_1 - \theta_2| > \Omega_2 \\ & \text{and } \operatorname{sgn}(\dot\theta_1 - \dot\theta_2) = \operatorname{sgn}(\theta_1 - \theta_2) \\ 0 & \text{otherwise} \end{cases}$$

$$T_3 = \begin{cases} T_3'[\theta_2 - \theta_3 - \Omega_3 \operatorname{sgn}(\theta_2 - \theta_3)] & \text{for } |\theta_2 - \theta_3| > \Omega_3 \\ & \text{and } \operatorname{sgn}(\dot\theta_2 - \dot\theta_3) = \operatorname{sgn}(\theta_2 - \theta_3) \\ 0 & \text{otherwise} \end{cases}$$

$$T_4 = \begin{cases} T_4'[\theta_3 - \theta_4 - \Omega_4 \operatorname{sgn}(\theta_3 - \theta_4)] & \text{for } |\theta_3 - \theta_4| > \Omega_4 \\ & \text{and } \operatorname{sgn}(\dot\theta_3 - \dot\theta_4) = \operatorname{sgn}(\theta_3 - \theta_4) \\ 0 & \text{otherwise} \end{cases}$$

$$T_5 = \begin{cases} T_5'(\theta_3 - \theta_5 - \alpha_5) & \text{for } \theta_3 - \theta_5 < \alpha_5 \text{ and } \dot\theta_3 - \dot\theta_5 < 0 \\ \hat{T}_5'(\theta_3 - \theta_5 - \Omega_5) & \text{for } \theta_3 - \theta_5 > \Omega_5 \text{ and } \dot\theta_3 - \dot\theta_5 > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$T_6 = \begin{cases} T_6'(\theta_5 - \theta_6 + \alpha_6) & \text{for } \theta_6 - \theta_5 < \alpha_6 \text{ and } \dot\theta_5 - \dot\theta_6 > 0 \\ \hat{T}_6'(\theta_5 - \theta_6 + \Omega_6) & \text{for } \theta_6 - \theta_5 > \Omega_6 \text{ and } \dot\theta_5 - \dot\theta_6 < 0 \\ 0 & \text{otherwise} \end{cases}$$

$$T_7 = \begin{cases} T_7'(\alpha_7 - \theta_7 + \theta_8) & \text{for } \theta_7 - \theta_8 < \alpha_7 \text{ and } \dot\theta_8 - \dot\theta_7 > 0 \\ \hat{T}_7'(\Omega_7 - \theta_7 + \theta_8) & \text{for } \theta_7 - \theta_8 > \Omega_7 \text{ and } \dot\theta_8 - \dot\theta_7 < 0 \\ 0 & \text{otherwise} \end{cases} \tag{II.F.4}$$

Note that the neck and the two spinal joints are assumed symmetric, while the hip, shoulder, elbow and knee are not.

The joint elasticity generalized force vector is:

$$C_1 = K_1(\theta_7 - \theta_1 + \theta_{10} - \theta_{70}) - K_2(\theta_1 - \theta_2 + \theta_{20} - \theta_{10})$$

$$C_2 = K_2(\theta_1 - \theta_2 + \theta_{20} - \theta_{10}) - K_3(\theta_2 - \theta_3 + \theta_{30} - \theta_{20})$$

$$C_3 = K_3(\theta_2 - \theta_3 + \theta_{30} - \theta_{20}) - K_4(\theta_3 - \theta_4 + \theta_{40} - \theta_{30})$$

$$- K_5(\theta_3 - \theta_5 + \theta_{50} - \theta_{30})$$

$$C_4 = K_4(\theta_3 - \theta_4 + \theta_{40} - \theta_{30}$$

$$C_5 = K_5(\theta_3 - \theta_5 + \theta_{50} - \theta_{30}) - K_6(\theta_5 - \theta_6 + \theta_{60} - \theta_{50})$$

$$C_6 = K_6(\theta_5 - \theta_6 + \theta_{60} - \theta_{50})$$

$$C_7 = K_7(\theta_8 - \theta_7 + \theta_{70} - \theta_{80}) - K_1(\theta_7 - \theta_1 + \theta_{10} - \theta_{70})$$

$$C_8 = K_7(\theta_7 - \theta_8 + \theta_{80} - \theta_{70})$$

$$C_9 = 0$$

$$C_{10} = 0 \qquad \text{(II.F.5)}$$

Joint friction and the joint stops are applied to the generalized force vector by the equation

$$\Delta\vec{b}_j = (J_{fi} + J_{si})\,\vec{V}_i \qquad \text{(II.F.6)}$$

where $\vec{V}_i$ is a vector whose components are all zero except for the ith and the mth which are plus one and minus one, respectively.

The i is the joint index and m is as specified previously on page 39.

G. RESTRAINT SYSTEM

The conventional restraint system simulated in this program consists of a set of three belt segments, all of whose forces act independently at fixed points on the body.

The shoulder harness is modeled by two such independent segments (see Figure 13); the upper is assumed to act at the shoulder joint, the lower at a specified distance above the first spinal joint. Both segments have their attachment points fixed in the vehicle and the forces act along the lines connecting the point on the occupant with the belt attachment points in the vehicle.

The lap belt is modeled by one segment, thus assuming that the two sides of the real lap belt have the same fixed attachment point coordinates in the plane of motion. The force produced is twice that of one real segment. The shape of the lap belt segment is more complicated than that of the shoulder harness segments. It has not only a linear portion, but also a circular arc portion centered on the hip joint (see Figure 14). The linear portion is tangent to this circle.

An option in the program allows the user to specify no belts, lap belt only, shoulder harness only, or all three segments. Unconventional restraint systems such as an airbag may be crudely simulated by proper selection of contact surfaces.

For each of the three belt segments, elongation is computed as the current length (l_k) minus the zero-time length (l_{ko}). Deflection rate ($\dot{\delta}$) is just $\dot{l}_k$. The same load-deflection procedure is used to compute force as has been previously used for contact forces including the force-limiting feature which allows studies of energy-absorbing belts. The quantity Φ_k is the belt angle for the corresponding segment.

For the lap belt, the following equations apply (see Figure 14).

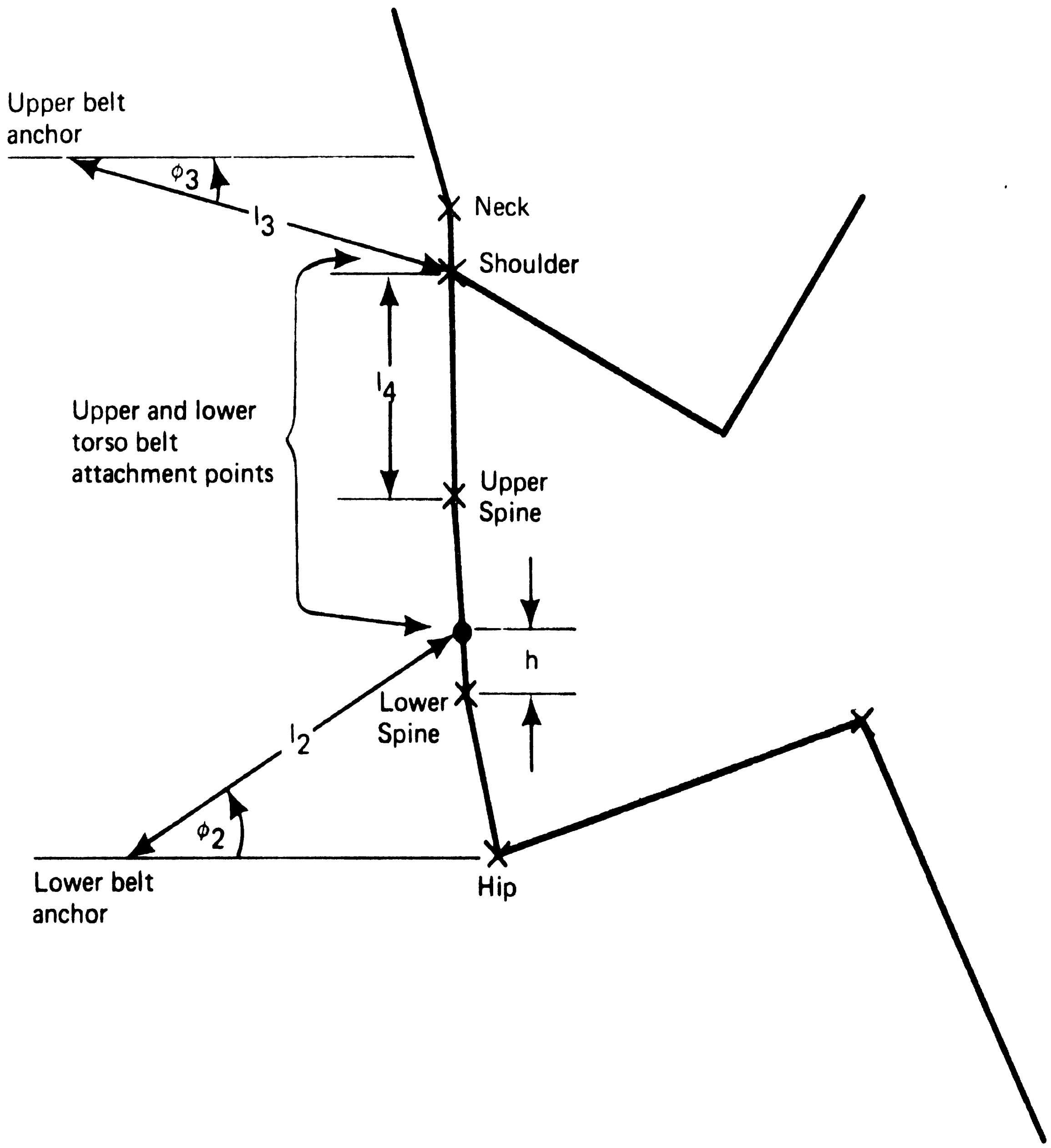


Figure 13. Shoulder belt geometry.

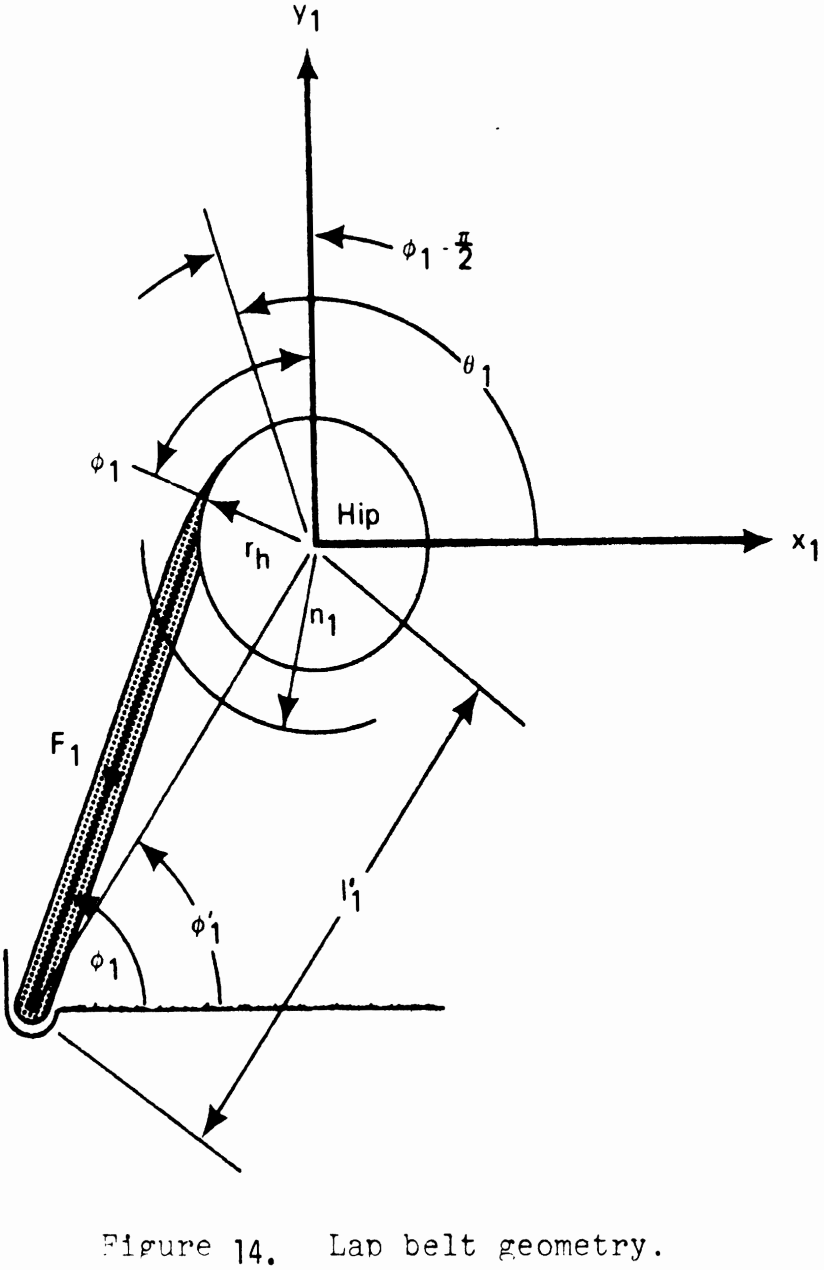


Figure 14. Lap belt geometry.

$$l_1 = \sqrt{(x + l'_{10} \cos \phi'_{10})^2 + (y + l'_{10} \sin \phi'_{10})^2 - r_h^2}$$

$$+ r_h(\phi_1 - \phi_1 + \pi/2)$$

$$l_{10} = \sqrt{(l'_{10})^2 - r_h^2} + r_h(\phi_{10} - \theta_{10} + \pi/2)$$

$$\phi_1 = \tan^{-1}\left(\frac{y + l'_{10} \sin \phi'_{10}}{x + l'_{10} \cos \phi'_{10}}\right)$$

$$+ \tan^{-1}\left(\frac{r_h}{\sqrt{(x + l'_{10} \cos \phi'_{10})^2 + (y + l'_{10} \sin \phi'_{10})^2 - r_h^2}}\right)$$

$$\dot{l}_1 = \dot{x} \cos \phi_1 + \dot{y} \sin \phi_1 - r_h \dot{\theta}_1 \qquad \text{(II.G.1)}$$

For the lower and upper shoulder belt segments ($k = 2$ and 3, respectively), the equations are: (see Figure 13)

$$l_k = \sqrt{\Delta x_k^2 + \Delta y_k^2} \qquad \text{for } k = 2,3$$

$$\phi_k = \tan^{-1}\left(\frac{\Delta y_k}{\Delta x_k}\right) \qquad \text{(II.G.2)}$$

A zero appended to the subscripts of a variable denotes the zero time value of that variable.

$$\Delta x_2 = x + L_1 \cos \theta_1 + h \cos \theta_2 - L_1 \cos \theta_{10} - h \cos \theta_{20} + l_{20} \cos \phi_{20}$$

$$\Delta y_2 = y + L_1 \sin \theta_1 + h \sin \theta_2 - L_1 \sin \theta_{10} - h \sin \theta_{20} + l_{20} \sin \phi_{20}$$

$$\dot{l}_2 = \dot{x} \cos \phi_2 + \dot{y} \sin \phi_2 - L_1 \dot{\theta}_1 \sin(\theta_1 - \phi_2) - h \dot{\theta}_2 \sin(\theta_2 - \phi_2)$$

and

$$\Delta x_3 = x + L_1 \cos \theta_1 + L_2 \cos \theta_2 + L_4 \cos \theta_3 - L_1 \cos \theta_{10}$$
$$- L_2 \cos \theta_{20} - L_4 \cos \theta_{30} + l_{30} \cos \phi_{30}$$

$$\Delta y_3 = y + L_1 \sin \theta_1 + L_2 \sin \theta_2 + L_4 \sin \theta_3 - L_1 \sin \theta_{10}$$
$$- L_2 \sin \theta_{20} - L_4 \sin \theta_{30} + l_{30} \sin \phi_{30}$$

$$\dot{l}_3 = \dot{x} \cos \phi_3 + \dot{y} \sin \phi_3 - L_1 \dot{\theta}_1 \sin(\theta_1 - \phi_3)$$
$$- L_2 \dot{\theta}_2 \sin(\theta_2 - \phi_3) - L_4 \dot{\theta}_3 \sin(\theta_3 - \phi_3) \qquad \text{(II.G.3)}$$

The belt contributions to the generalized force vector are:

$$D_{b1} = r_h P_1 + L_1 \sum_{m=2}^{3} P_m \sin(\theta_1 - \phi_m)$$

$$D_{b2} = h P_2 \sin(\theta_2 - \Phi_2) + L_2 P_3 \sin(\theta_2 - \Phi_3)$$

$$D_{b3} = L_4 P_3 \sin(\theta_3 - \Phi_3)$$

$$D_{bi} = 0, \; i = 4\text{-}8$$

$$D_{b9} = -\sum_{m=1}^{3} P_m \cos \Phi_m$$

$$D_{b10} = -\sum_{m=1}^{3} P_m \sin \Phi_n \qquad \text{(II.G.4)}$$

where P_k is the force computed by use of the load-deflection procedure for the kth segment.

III. EXPERIMENTAL VERIFICATION OF THE MATHEMATICAL MODEL

In this section of the report comparisons are made between the predictions of the mathematical model and an experiment carried out on the HSRI impact sled with an anthropometric dummy. Beginning with an outline of the criteria on which the validation is based, the report continues with a description of the sled test and concludes with a description of the degree to which the model describes the real test situation.

A. CHOICE OF A CRITERION OF VERIFICATION

The choice of a criterion of verification of the mathematical model describing human body impact is based on three premises: (a) whether or not the mathematical analysis and computer program are correct; (b) the extraction of appropriate experimental data on which the validation procedures can be based; and (c) the observation that the mathematical model consists of parameters describing the occupant, the force field consisting of belts and contact surfaces which act on the occupant, and the externally applied deceleration forcing function.

The use of a Lagrangian formulation of Newtonian mechanics as a basis for these models follows a long history of successful application to problems in impact, and hence, offers no cause for concern. Thus, sources of problems can arise only in writing down the particular equations and computer program which apply to the present analysis. All equations and the computer program have been derived independently by two or more persons leading to very low incidence of errors in the final computer program.

The second premise, which is concerned with the extraction of appropriate experimental data on which the validation can be based, has been the basis for a major research effort. The acquisition of the necessary transducer and photometric data is straightforward and requires only the proper usage of the appropriate high speed cameras, data tape recorders, and light beam oscillographs. The processing of the transducer data is also relatively simple. For example, the determination of the magnitude of the linear acceleration of the head of the dummy requires computation of the simple vector sum of the three linear acceleration components.

Analysis and graphing of the test data is only part of the problem because preparation of a well-founded set of input data is necessary for the successful operation of any computer analysis. Therefore, a description of the mass, geometric, and inertial properties of the test subject is required. This must be supplemented by a geometrical profile of the vehicle components with which the test subject is expected to interact. Finally, the force-deformation characteristics of the interactions between the test subject and the vehicle components must be measured in order to specify the proper balance between subject motions and loadings.

In order to define the test subject, the eight basic body elements were weighed and moments of inertia measured using a trifilar pendulum or predicted using formulas similar to those of Hanavan[25] and Patten.[26] After the geometry of the test sled and the initial position of the dummy subject were carefully measured, it was then necessary to develop test procedures defining the force-motion relationships between test subject and vehicle elements. This was carried out for the seat and for a belt restraint system using a combination of photometric and transducer data described later in this report. (The simulation of an airbag restraint system was accomplished using similar techniques and will be discussed in the final report on that phase of the research project.)

The third premise serves to define the mathematical model as a system of parameters describing the occupant, the force field consisting of belts and contact surfaces which acts on the occupant, and the externally applied deceleration forcing function. All these basic parameters must be included in any test validation.

To properly study the field of forces acting on the subject it is necessary to simulate both contact surfaces (such as a seat cushion and seat back) and belts (such as a lap belt and single diagonal shoulder harness). The use of an occupant unrestrained by belts would not provide a sufficient test of this important section of the analysis.

Based on these three premises, an impact sled test using a 50th percentile male anthropometric dummy was carried out at a speed of approximately 30 mph. This represented the most standard test configuration in use in impact sled test laboratories. The dummy was restrained by a lap belt and a single diagonal shoulder harness. Thus, this test represented a complete and economical test of the basic parameters described in the model—the occupant, the restraint and interior contact forces, and the vehicle deceleration.

B. THE EXPERIMENT

The validation experiment was carried out on the HSRI impact sled (Figure 15), which is of the acceleration-deceleration type. It can be accelerated over a 12-ft distance up to a top speed of 40 mph using a compressed air-actuated puller arm. The deceleration stroke has a maximum length of 3 ft and a maximum potential of 88 g's. For the purpose of high-speed photography a total of 50 kw of lighting is available. Real time and high-speed movies are taken as well as still photographs before and after each test.

Kistler Piezotron 818's triaxial accelerometer packs were located in the head and chest of the 50th percentile Sierra dummy. A Statham strain-gage accelerometer was used to record the sled deceleration pulse. Four Lebow seat-belt load transducers were mounted on the seat belt and shoulder harness.

The data was recorded simultaneously on a Honeywell 7600 tape recorder and a Honeywell 1612 Visicorder. No filtering was used during

Figure 15. HSRI Impact Sled

NOT REPRODUCIBLE

the initial recording other than the limitation of the light-beam galvanometers to frequencies under 1000 cps. The following transducer data was recorded: (a) lower right shoulder belt force; (b) left lap belt force; (c) upper left shoulder belt force; (d) right lap belt force; (e) sled deceleration; (f) head anterior-posterior G-loading; (g) chest anterior-posterior G-loading; (h) head superior-inferior G-loading; (i) chest superior-inferior G-loading; (j) head left-right G-loading; (k) chest left-right G-loading; (l) impact velocity; and (m) timing signals.

The test setup for the validation of the model is shown in Figure 16. The bucket seat is bolted securely to a framework which is attached to the sled. This framework serves as a mount for attaching belts and other types of restraint systems, and can be rotated to simulate lateral or oblique impact.

The test data presented in Figures 17 through 26 were obtained as a result of either detailed analysis of the high-speed films using a Vanguard Film Analyzer of by measuring points from the oscillographic recording. All acceleration and belt transducer data were determined from the oscillographic records and appropriate sums and resultant values were computed.

In the model, the excursion and forward motion of the head were determined directly by measurement of the motion of a target placed on the head of the dummy. Likewise the angle of head pitch and the upper leg were obtained by direct measurement (and the subsequent scaling and tabulation by means of specially developed computer programs). The motion of the H-point was very difficult to determine as no direct measurements were possible. However, its location was determinable by trigonometry using data from a thigh target, a lower back target, and the angle of the upper leg with a horizontal line. These data, determined on the Vanguard Analyzer, were then processed on the HSRI 1130 digital computer using the appropriate trigonometric data handling subroutines.

Figure 16. Test Setup for Two-dimensional Model Validation

NOT REPRODUCIBLE

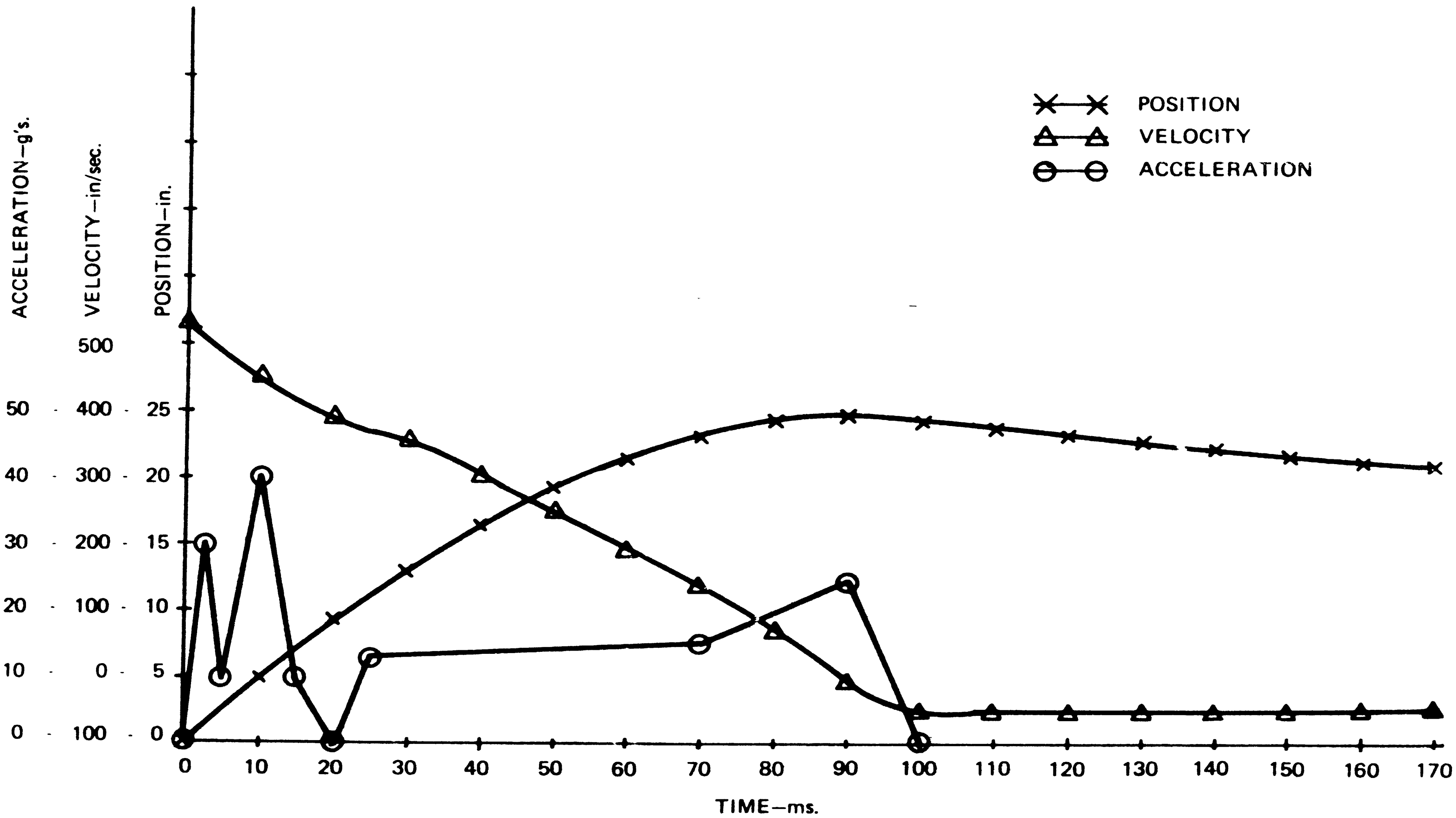


Figure 17. Vehicle Kinematics.

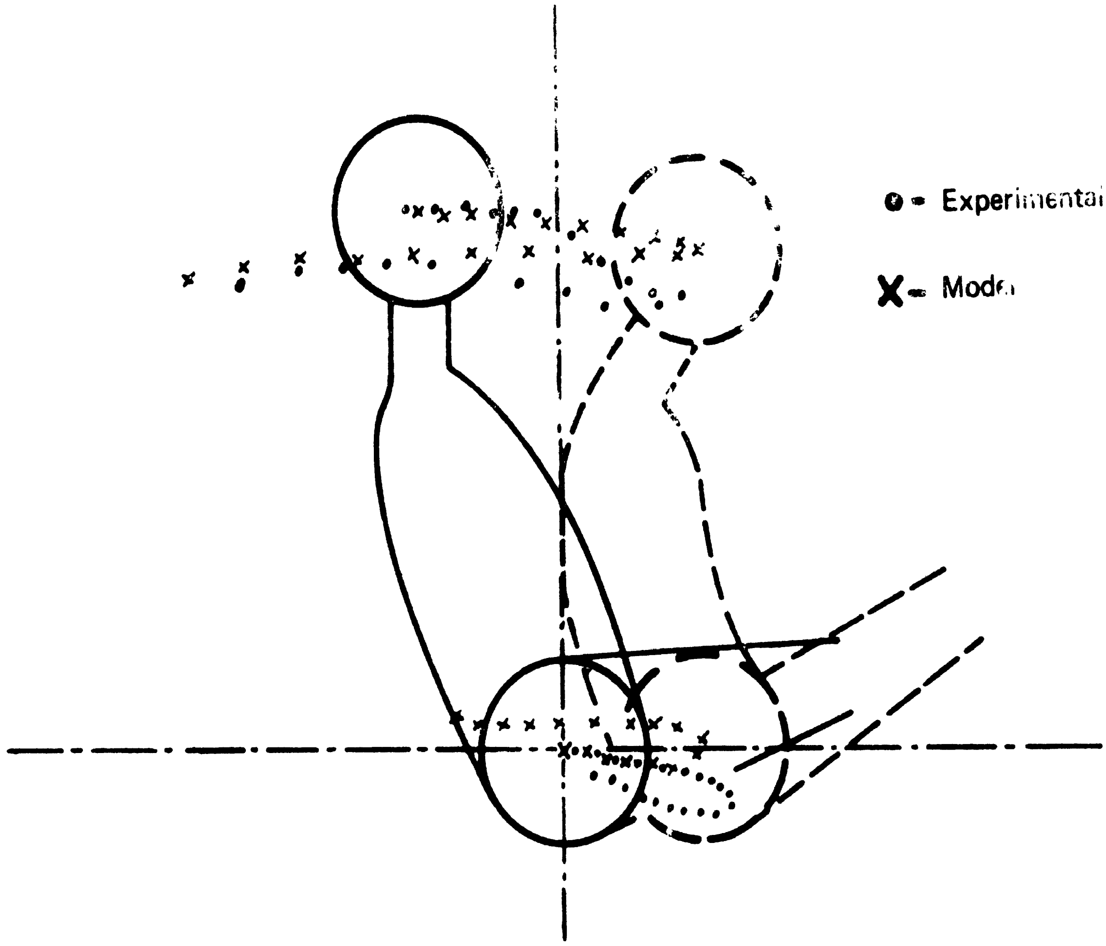


Figure 18. Excursion of head center-of-gravity and H-point as a function of time.

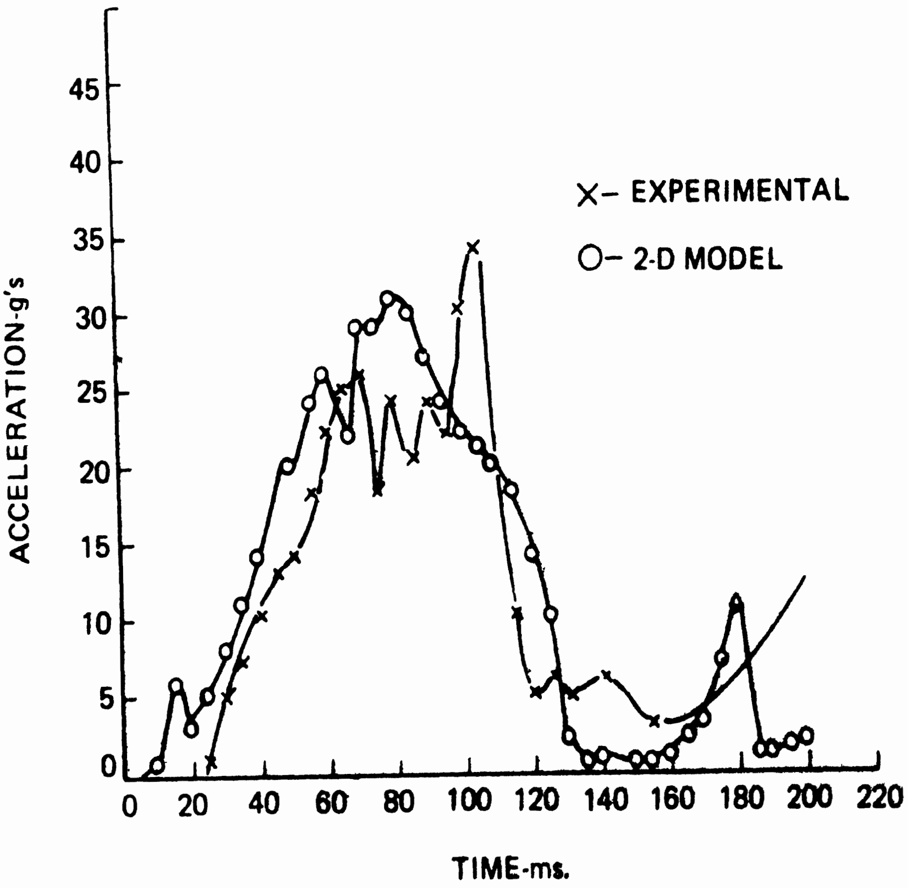


Figure 19. Resultant chest linear acceleration in g's.

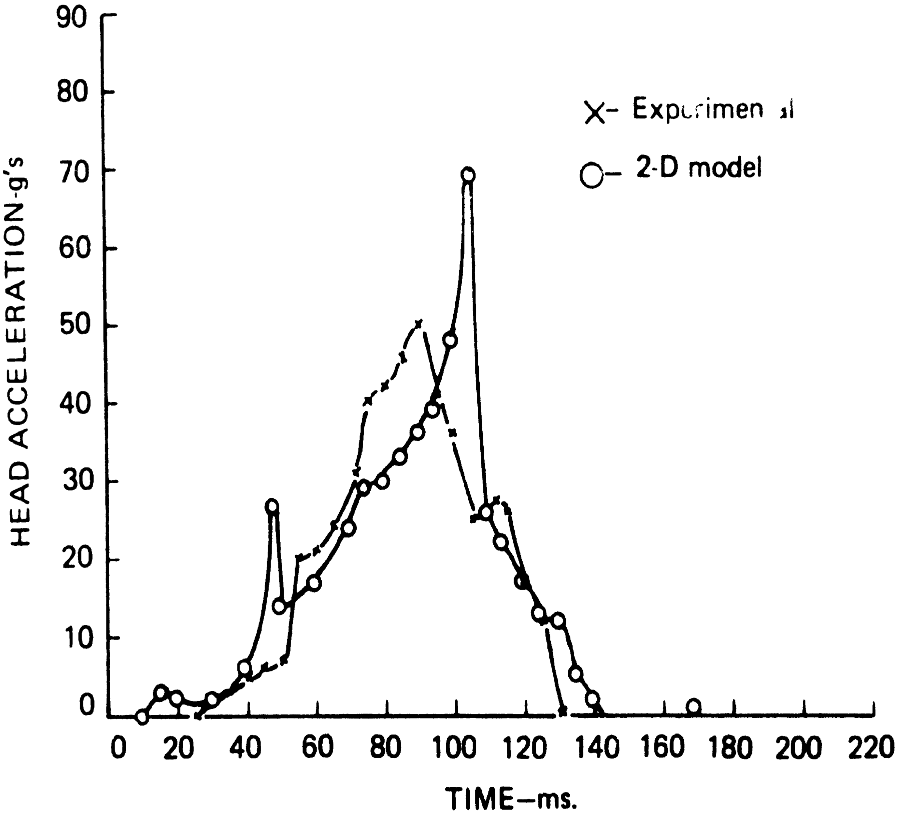


Figure 20. Resultant head linear acceleration in g's.

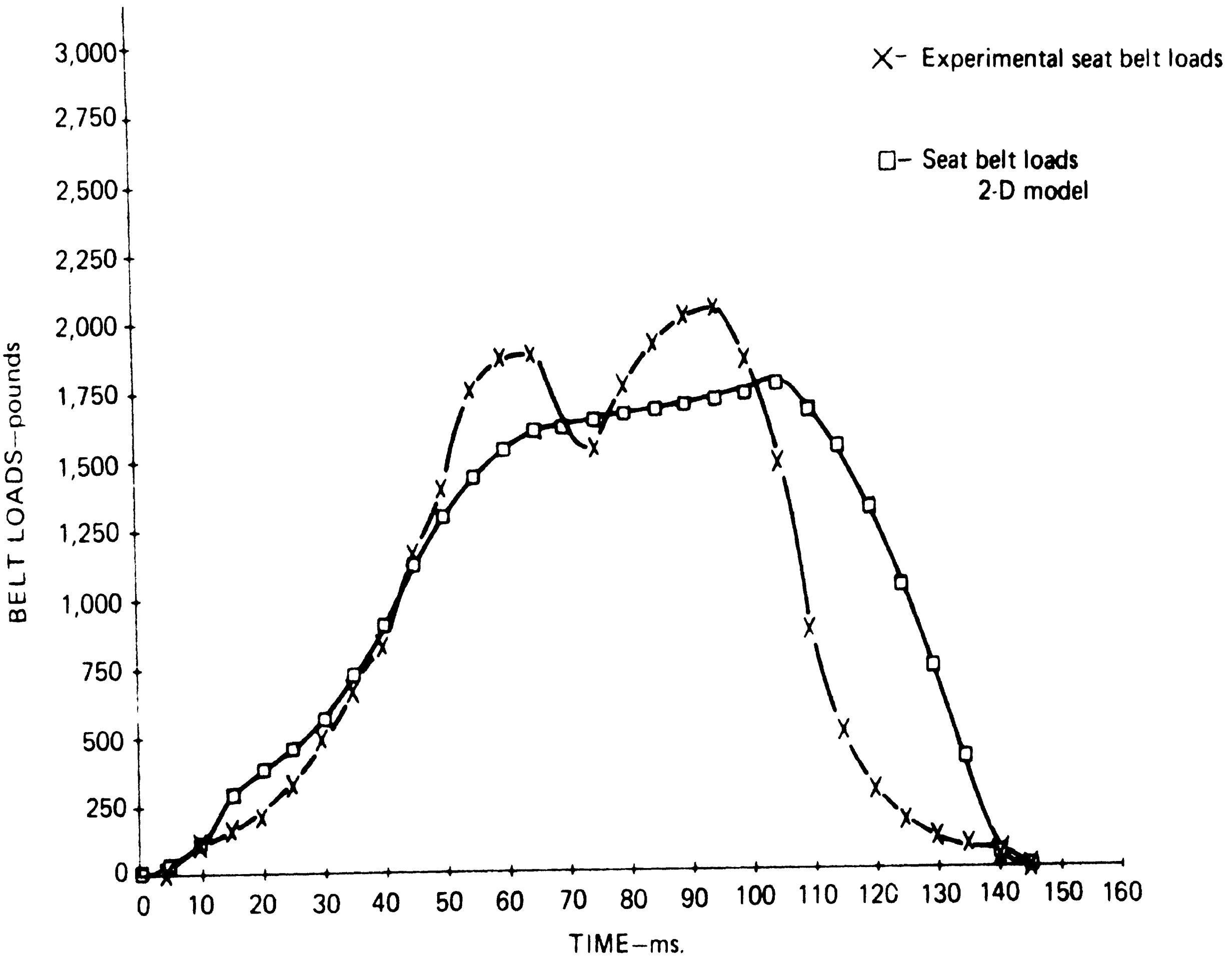


Figure 21. Seat belt loads.

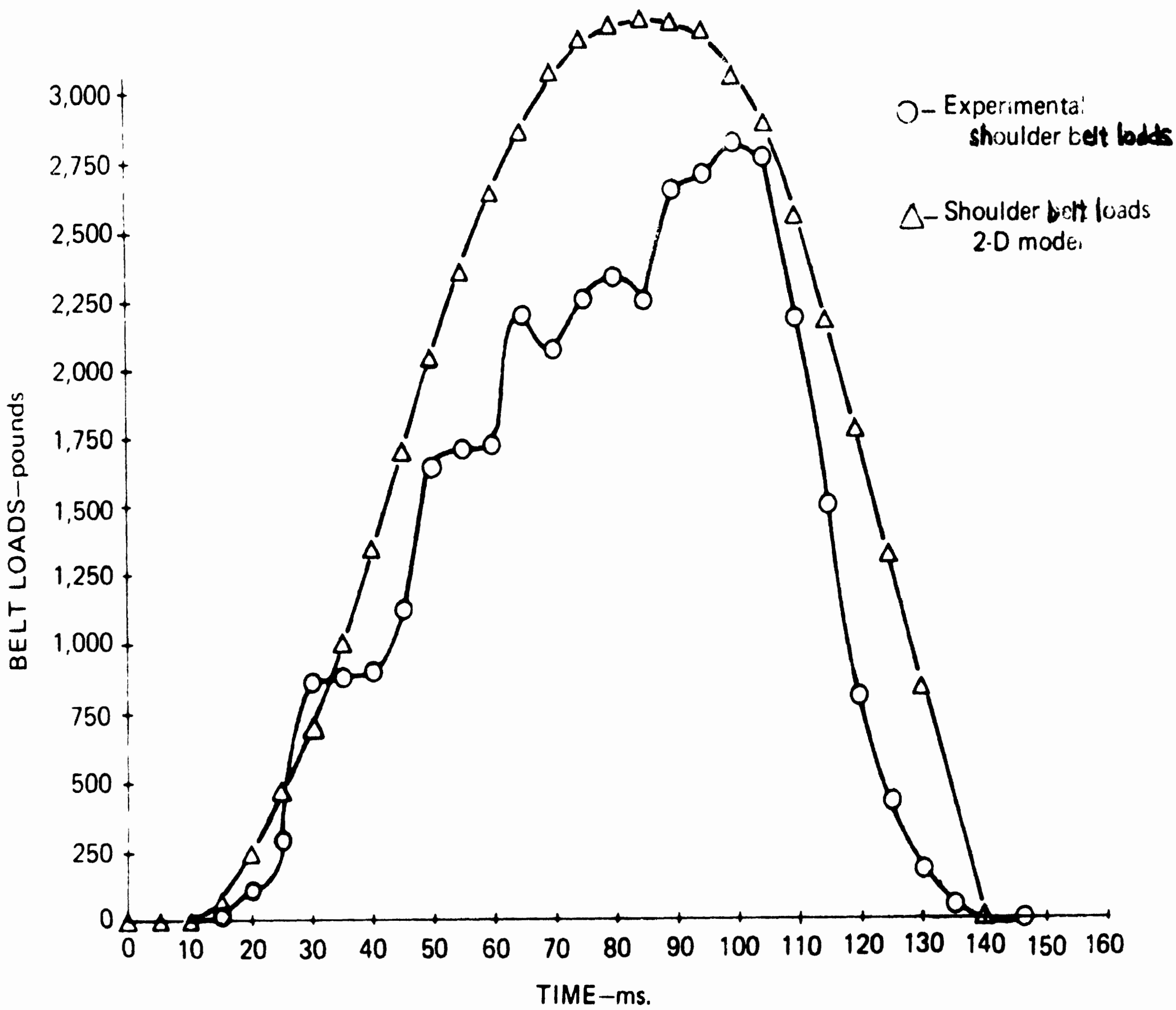


Figure 22. Shoulder harness loads.

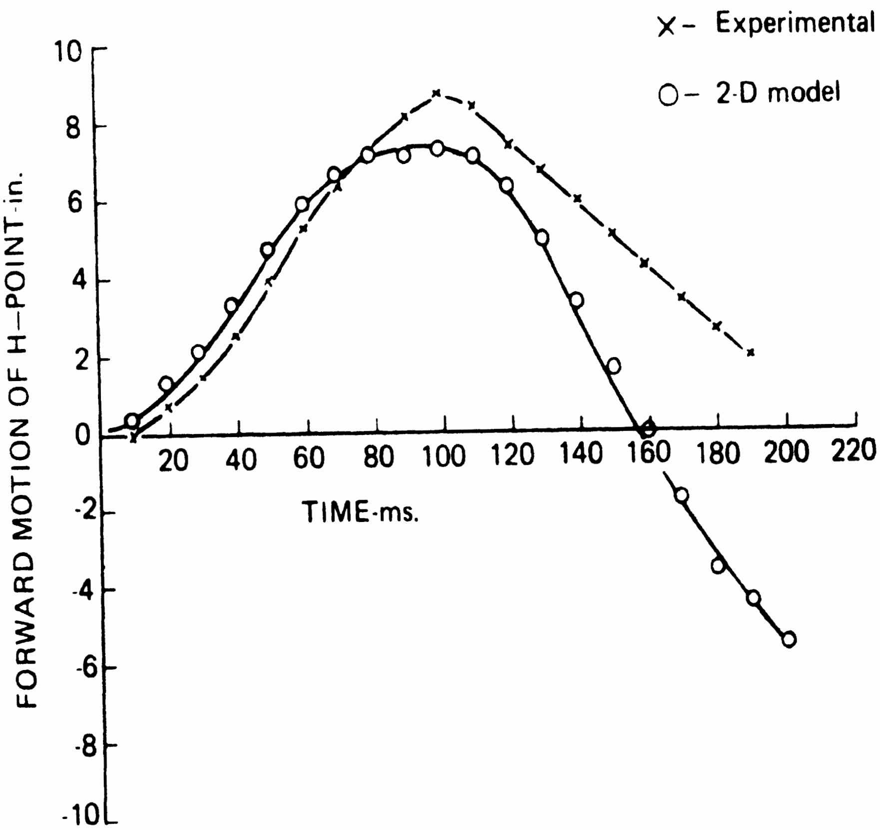


Figure 23. Forward motion of H-point.

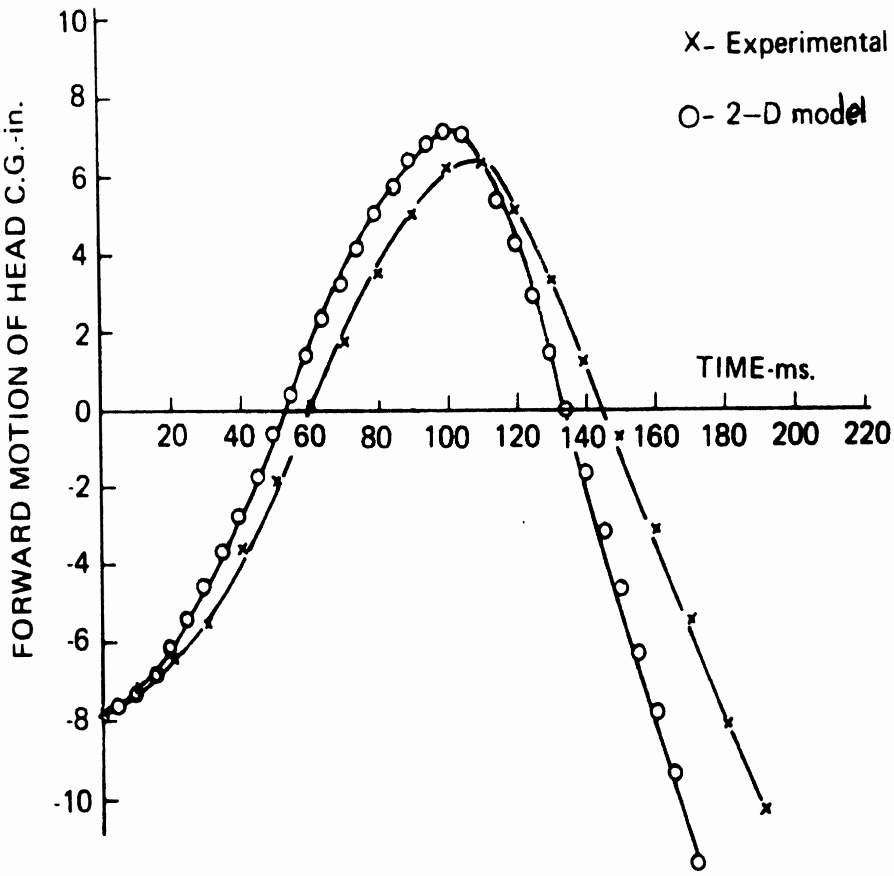


Figure 24. Forward motion of head center-of-gravity.

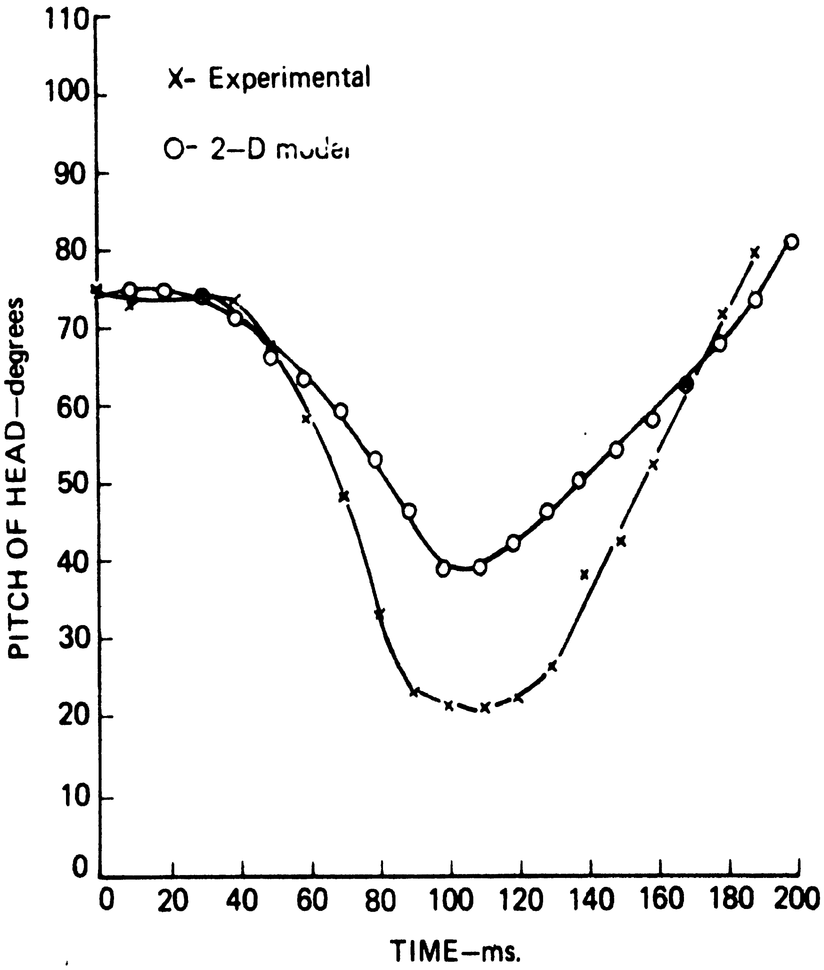


Figure 25. Pitch angle of head.

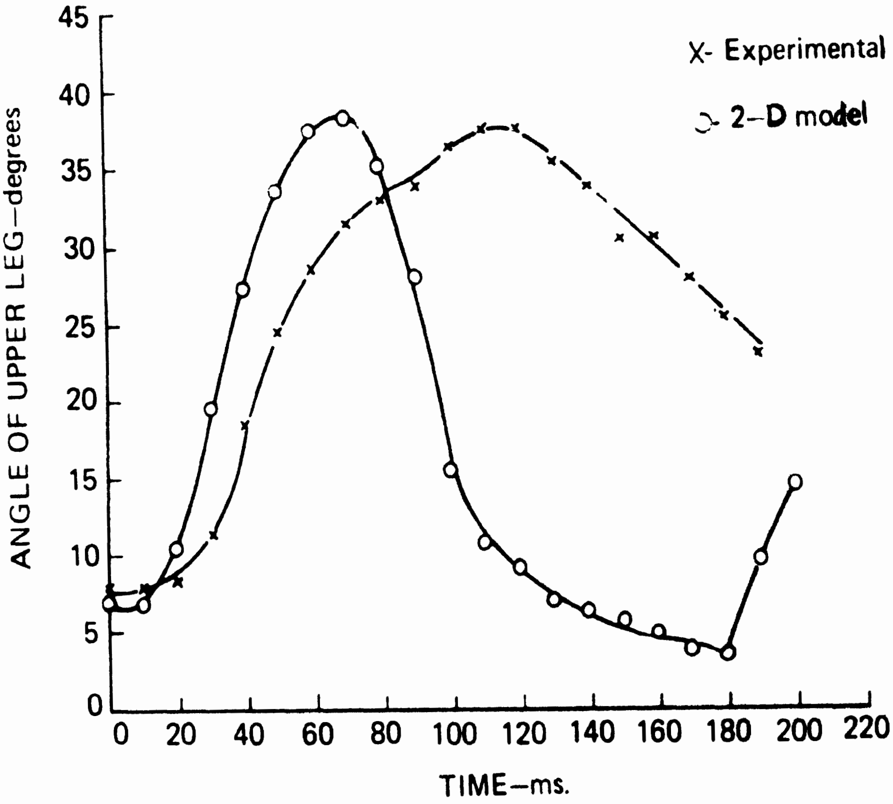
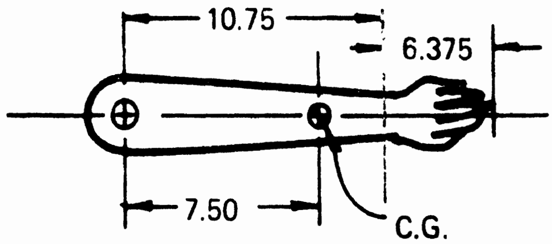
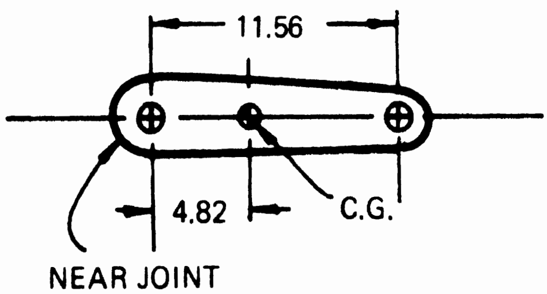


Figure 26. Pitch angle of the upper leg.

Dimensions of Forearms:



Dimensions of Upper Arms



Dimensions of Lower Spine:

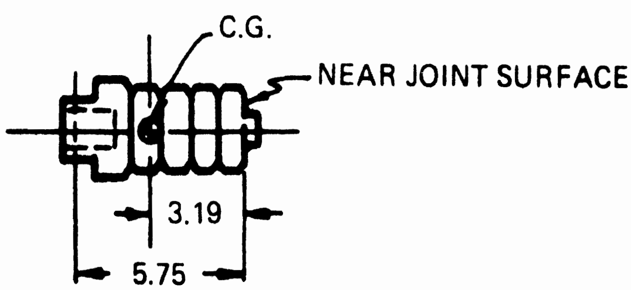
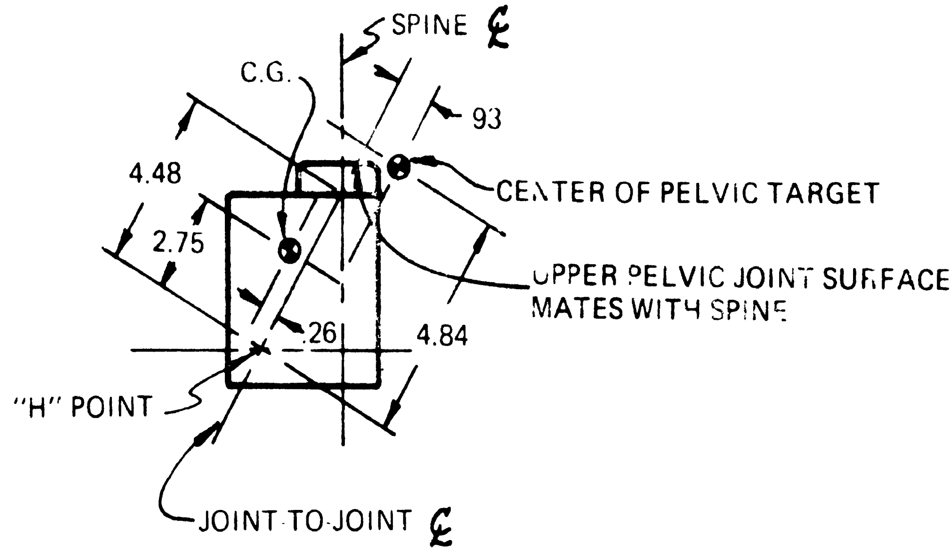
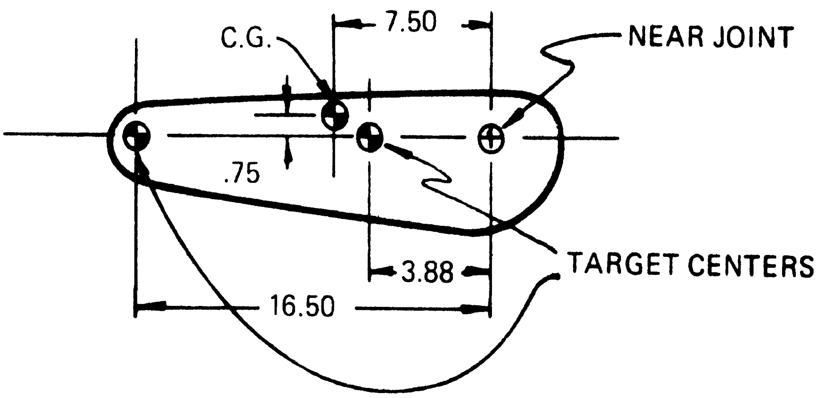


Figure 27. Centers-of-gravity and dimensions of forearms, upper arms, and lower spine.

Dimensions of Lower Torso Pelvic Area:



Dimensions of Upper Leg:



Dimensions of Lower Leg Including Foot:

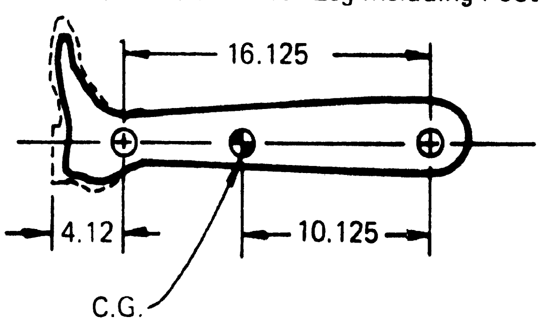
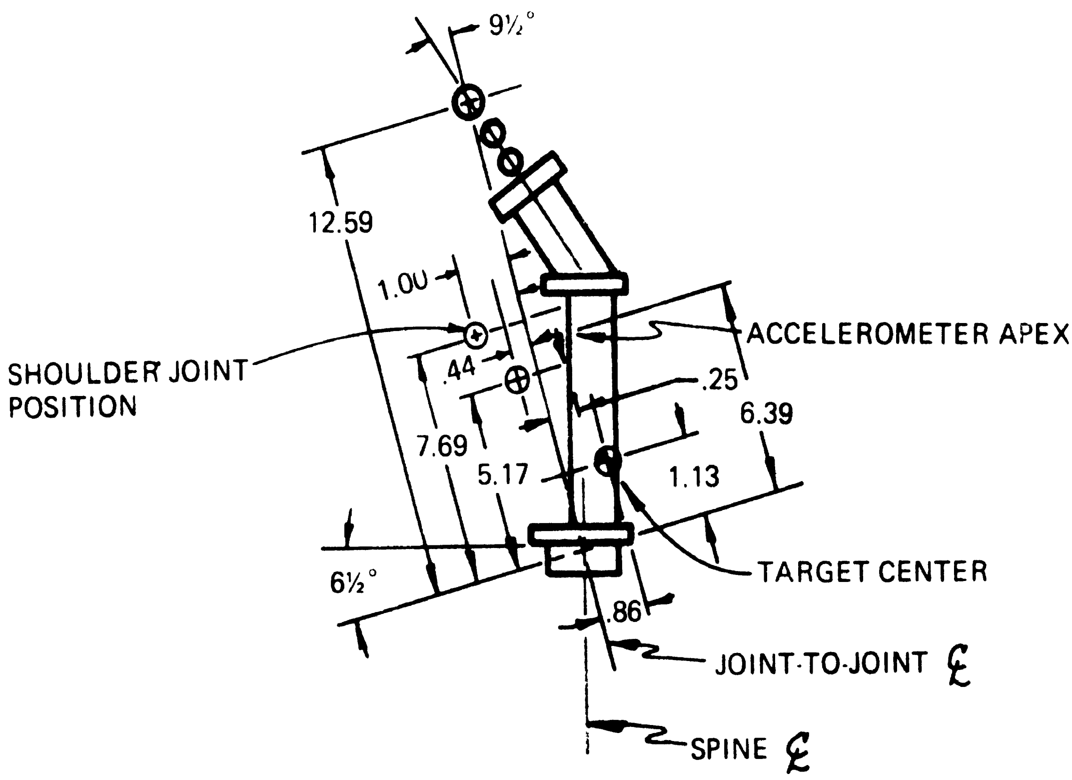


Figure 28. Centers-of-gravity and dimensions of plevic area, upper legs, and lower legs.

Dimensions of Upper Torso Assembly.



Dimensions of Head Assembly:

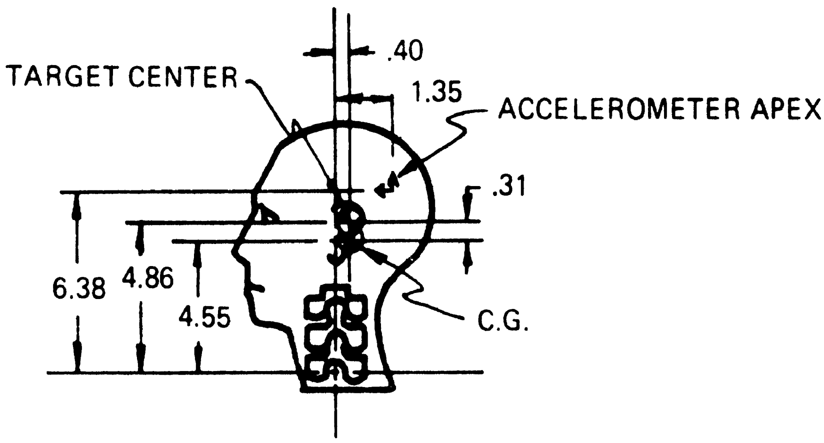


Figure 29. Centers-of-gravity and dimensions of head and upper torso.

C. PREPARATION OF A DATA SET FOR THE COMPUTER SIMULATION

The preparation of a data set for the validation exercise of the model involved determination of the mass and inertial properties of the HSRI 50th percentile male Sierra dummy as well as the force-deformation interactions between the dummy and his seat and restraint system. Various other quantities such as the initial impact velocity, the sled deceleration profile, and the positioning of the dummy at the beginning of the deceleration event were measured directly from the test movies or transducer data.

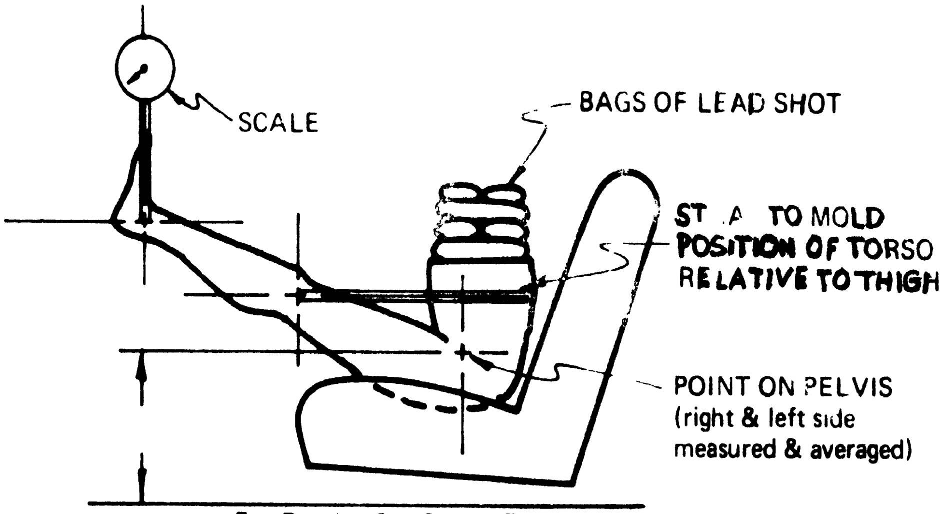
The center of gravity of the various body parts was found by suspending the piece by wires and observing the location of intersecting lines of action. The eight moments of inertia of the body parts for use in the model were found by suspending each piece on a trifilar pendulum. The weights of the body parts were measured on a precision scale. This data, tabulated in Table VI and Figures 27-29, is felt to be accurate within 1% as repeated measurements were taken on the various quantities. A correction to the moments of inertia was made based on the weight and distribution of the body skin element.

Because no impact data is available in a form suitable for use in the computer program, two static tests were carried out. The test configurations are shown in Figure 30 and the results in Figures 31 and 32. In determining the curve for load-deflection under the buttocks, the deflection was measured by taking height readings "h" at points on the pelvis as shown, as weight was added. For determining the load-deflection curve at the front of the seat, the dummy was hung as shown with the legs up, knees locked, and the buttocks just touching the cushion. The hip joint was loose. The legs were lowered gradually, and load scale readings were taken at progressive points until the scale read zero. At this time the seat front is supporting the legs. Weights were then added until the seat front bottomed out of the seat frame. This test has the disadvantages of being static and only applying the load over part of the

TABLE VI. WEIGHTS AND MOMENTS OF INERTIA OF HSRI 50th PERCENTILE SIERRA DUMMY

Body Segment	Segment Weight, lb	Segment Moment of Inertia, in. lb sec^2
Right forearm and hand	5.094	0.300
Left forearm and hand	5.187	0.309
Right upper arm	5.938	0.241
Left upper arm	5.656	0.233
Lower spine	4.531	0.078
Lower torso pelvic area	17.062	1.709
Right upper leg	20.125	1.316
Left upper leg	20.156	1.307
Right lower leg and foot	9.781	1.211
Left lower leg and foot	9.813	1.186
Upper torso (including shoulder and chest mode, plastic "sub-skin" around rib cage and two lower neck vertebrae clamped tight)	37.438	1.344
Head (including two upper neck vertebrae)	15.781	0.436

A) LOAD-DEFLECTION UNDER BUTTOCKS



For Results, See Graph, Fig. I

B) LOAD-DEFLECTION AT FRONT OF SEAT

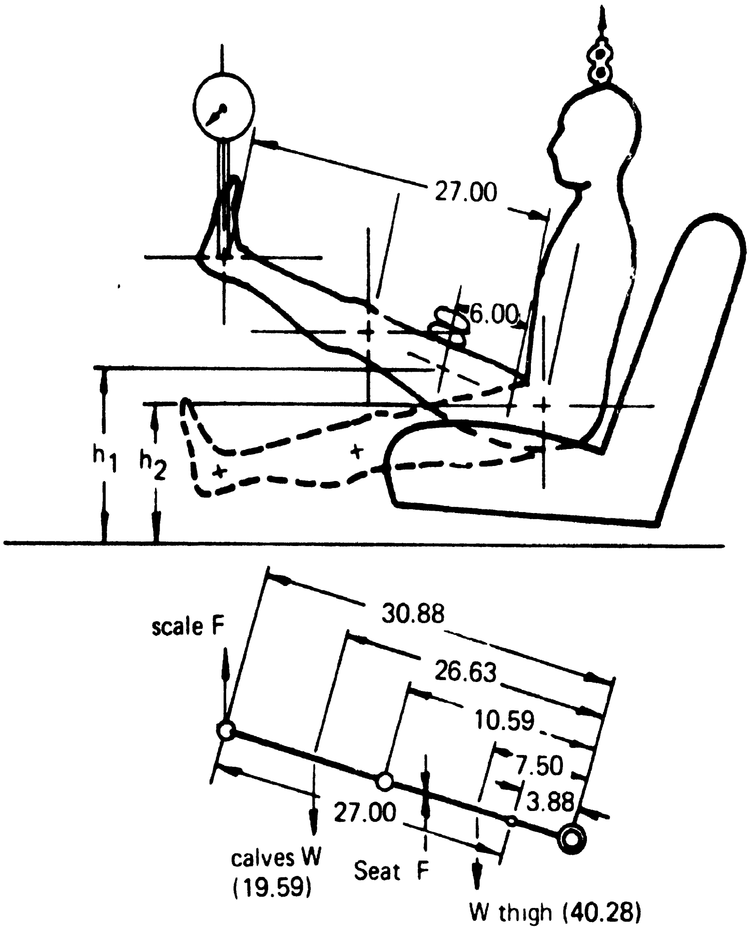


Figure 30. Test configuration for seat property tests.

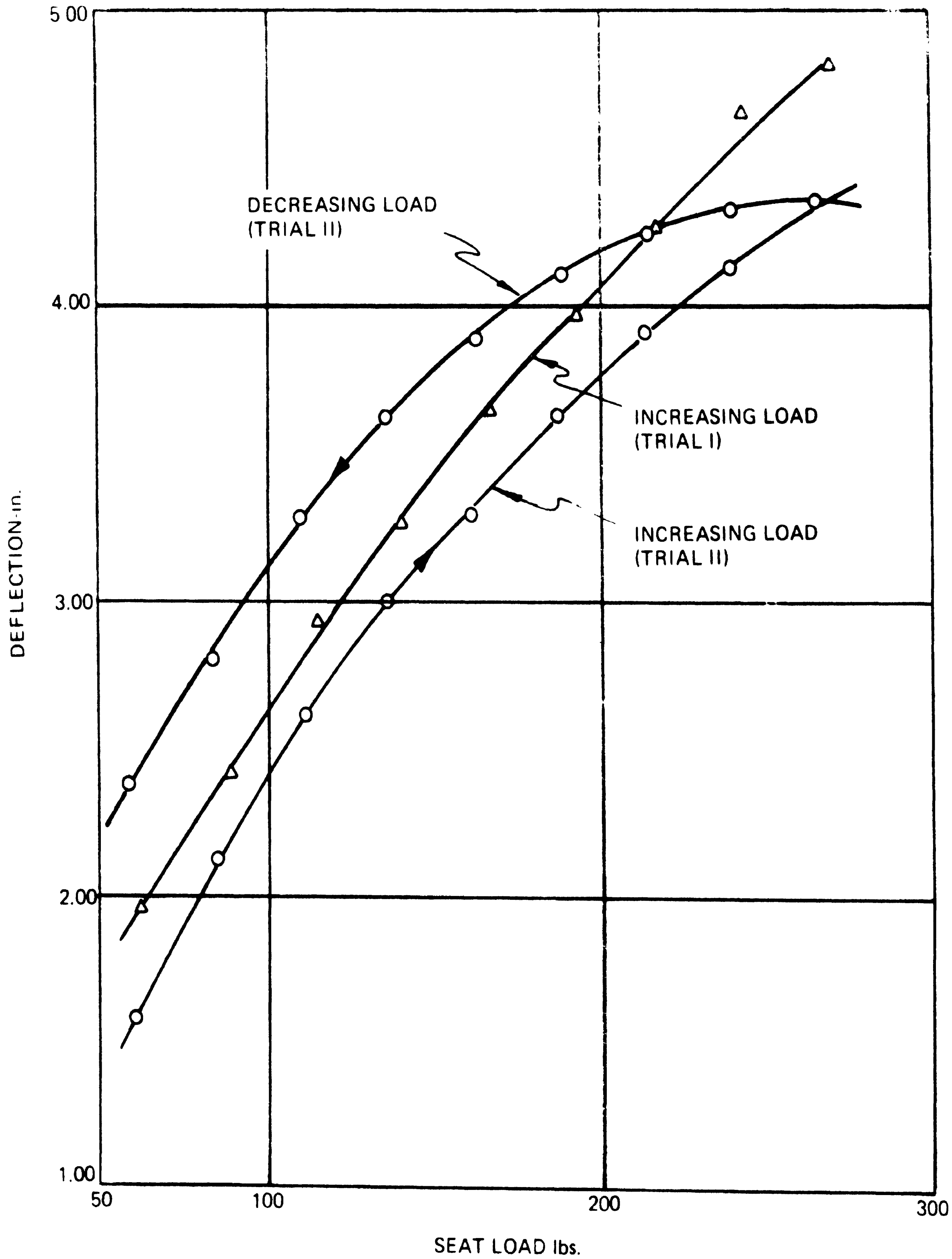


Figure 31. Seat load-deflection characteristics.

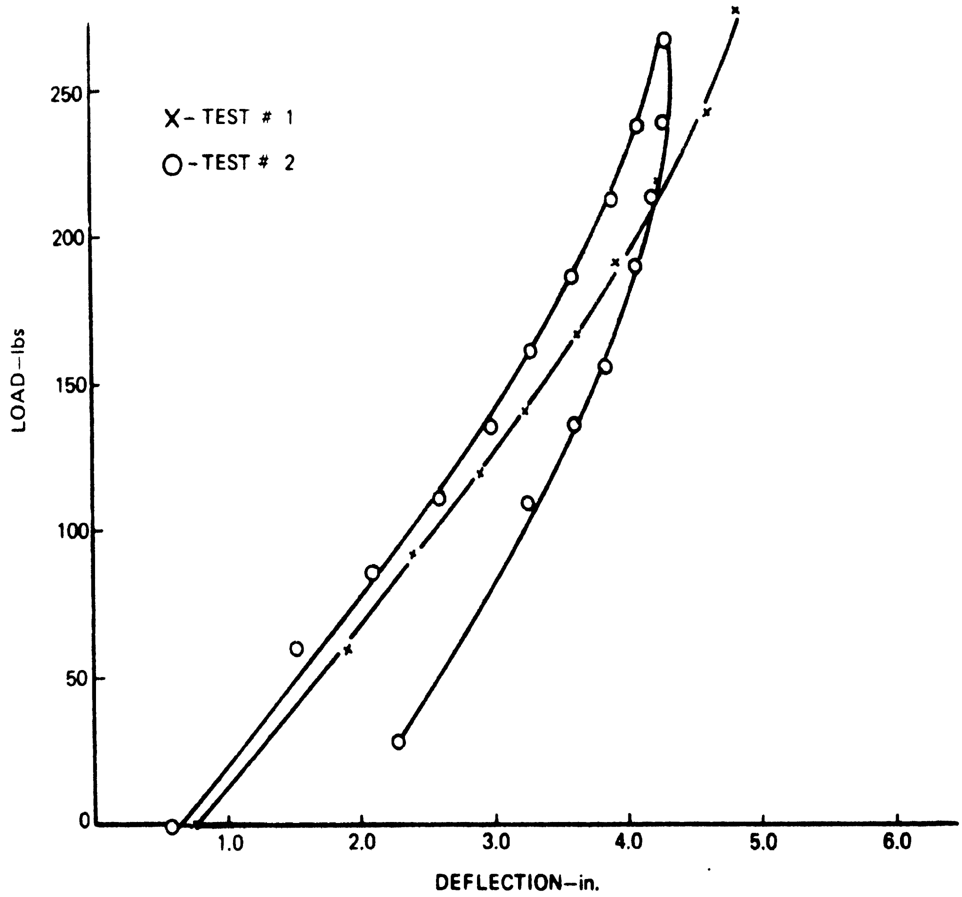


Figure 32. Seat load-deflection characteristics at seat front.

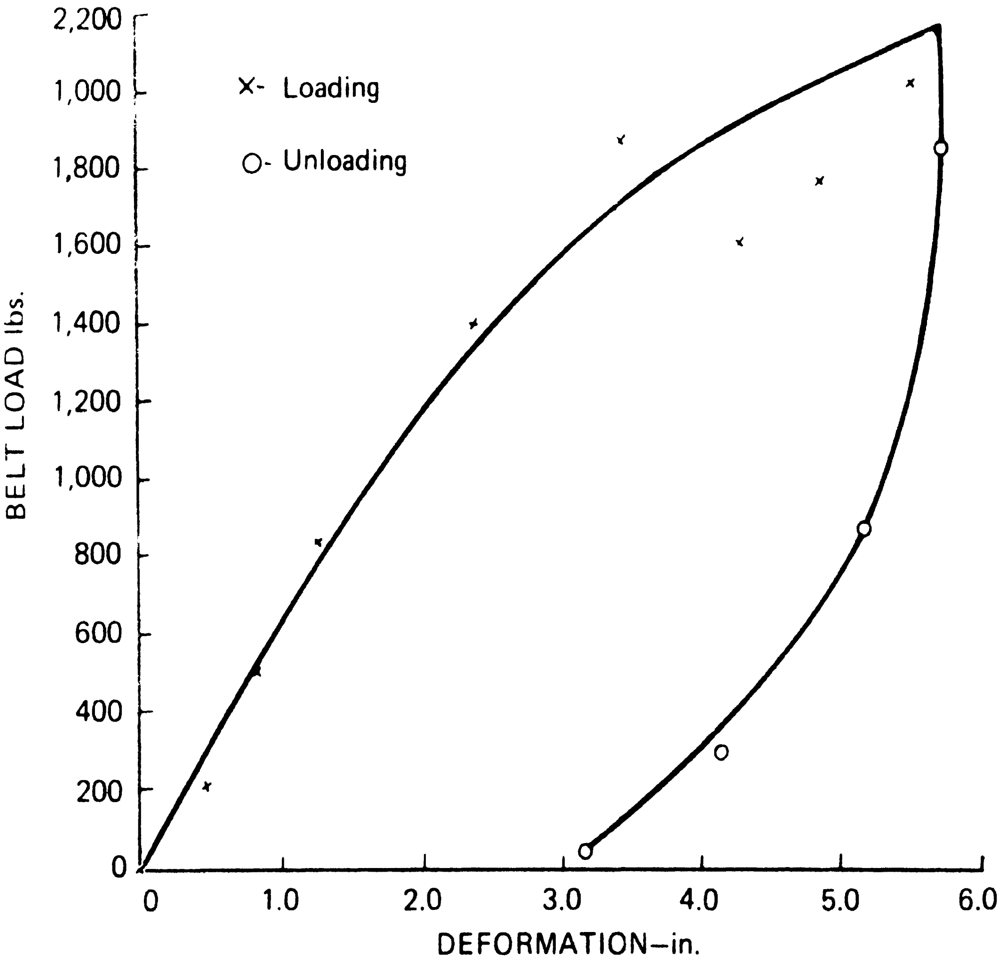


Figure 33. Load-deflection characteristics of seat belts.

seat. However, it does have the advantage of determining a curve which includes deformation properties of both the seat and dummy used in the test.

The seat belt load-deflection characteristic also led to difficulties in measurement. In this case, deformation properties of the belt, buckles, vehicle attachment points, and of the dummy itself must be reflected in the modulus which is used in the model. In addition to this, it is necessary that the deformations be a projection on the two-dimensional plane of events which actually occur in three-space.

Thus, the load-deformation characteristics of the seat belts were measured by making use of data gathered during the test itself. Force transducers were used to record the loads in the belts and high-speed movies recorded a plane view of the action of the belts. Therefore, using the known location of the H-point, the belt angle, and the location of the belt attachment point in the vehicle, it was possible to construct a table of the seat-belt length as a function of time. This, when combined with the data from the load cells, was used to construct Figure 33. Measurement of the deformation characteristics of the shoulder harness elements similarly was carried out using high-speed movies and loads from the force transducers.

D. COMPARISON OF THE SLED TEST DATA WITH THE PREDICTION OF THE MODEL

The comparison between the sled test and the mathematical model was accomplished by measuring the parameters necessary for the operation of the model and then exercising the model based on this set of input data. The only parameters which were not determined experimentally were the stiffnesses of the stops in the various joints. These were given arbitrary high values compatible with the definition of a "stop." In most computer simulations the various body segments do not even interact with the stops making precise definition unnecessary. Also, it has been found in other exercises of the model that variation of these quantities over rather wide ranges does not have a large effect on the body kinematics. Thus, it is felt that the impact data which was measured provides a valid test case.

Two types of comparisons can be made between analysis and experiment. On one hand, the actual dummy body motions are studied; on the other, the forces and accelerations experienced by the body are examined.

The excursion of the head center of gravity and the H-point are shown in Figure 18 as a function of time. It can be noted that both the head and the hip moved down to a greater degree in the test than they did in the simulation. Also, the hip was observed to move further forward in the test. It is felt that this can be explained by an examination of the hip structure of the Sierra dummy in comparison to the model. In the dummy, the seat belt was observed in the test to ride over the pelvic structures into the abdominal area. In the model, the belt was required to stay on a radius which was a fixed distance from the H-point. Thus, in the test submarining was allowed, while in the simulation, it was impossible. The fact that submarining was observed in the test may well explain the substantial nonlinear softening-spring behavior of the seat belt load-deflection curve.

Figures 23 and 24 describe the forward motion of head and hip as a function of time. The prediction of head motion is quite good whereas the motion of the hip differs during rebound possibly as a result of submarining and the fact that the belt is buried in the dummy abdomen after the test.

The pitch angle of the head is plotted in Figure 25. Although the phase is correct, the magnitudes are not. The error in pitch magnitude is about 32%. It is felt at this time that the greater flexibility of the dummy neck (note that this would be even more exaggerated in a living subject) leads to this error. It is possible that this phenomenon can be compensated for by altering the joint stop angle from the values used in this simulation. By increasing their values, greater "flexibility" is introduced to the dummy.

Figure 26 shows the pitch angle for the upper leg. In the model this body element pitched up and down more quickly than in the test. However, the peak values are similar, possibly because the rotation of the pelvic area of the dummy down under the seat belt is in the same direction as the rotation of the upper leg. This seems likely from qualitative observations of the high-speed movies.

Figure 19 shows the resultant chest linear acceleration in G's. Agreement between these curves is remarkably good both with respect to phase and peak G-values. The test data were determined as a combination of the three readings of a triaxial accelerometer pack. The readings for the model were obviously limited to accelerations in the plane. The spike at 180 ms in the model and the rise in the test data reflect rebound into the seat back.

Similarly, in Figure 20 there is fairly good agreement between the predicted and test values of head linear acceleration. The 70 G spike predicted by the model occurred as the head pitched forward sufficiently far to encounter the "stop" briefly. Spikes of this nature are likely to occur in any segmented collection of rigid bodies in which stops are allowed to act. The peaks will be reduced only as flexibility is added to the system.

Figures 21 and 22 show the comparative seat belt and shoulder harness loads. Agreement is quite good both in phase and magnitude in the seat belt loads. The predicted harness loads appear to be low although the peak values are within 15%. The reason for this is unknown at present. It is possible that the error could be experimental in that signal clipping was observed on strain gage channels in several tests conducted near the time of this test. Other reasons could be improper selection of force-deformation curves and slack for the harness system.

The comparisons between theory and experiment which have just been presented represent the beginning of the most important phase of the model development program—the determination of the ability of the model to describe the physical system. Agreement is good on many important quantities discussed above. The differences noted in other quantities reflect both difficulties in mathematically describing a continuous body by lumped masses and also difficulties in determining the input data with which the model can be exercised.

IV. USERS' GUIDE FOR THE TWO-DIMENSIONAL CRASH VICTIM SIMULATOR

This part of the report is intended to serve as a complete Users' Guide for exercising the HSRI Two-Dimensional Crash Victim Simulator. Sections A and B provide information for the preparation of an input data deck or file. Each card (or file line) is defined in Table VII of Section A including references to figures in this report describing the physical nature of the various input data and references to tabular data included in Section B.

Examples of complete data sets are included in Section C. These include significant exercises involving 5th percentile female, 50th and 95th percentile male occupants, and vehicle interior features such as energy-absorbing steering column, energy-absorbing lower instrument panel, belt restraint systems, windshields, etc. Techniques involved in the actual data set preparation are discussed and program printouts for the exercises are included.

The output from the computer program is discussed in Section D. This material is complete with regard to the detailed printout produced in those cases where debugging information is needed.

Section E is of particular interest to Users who wish to exercise the model as it is installed on the COMNET computer (Computer Network Corporation, 5185 MacArthur Blvd., Washington, D.C. 20016). A description of the necessary job control cards (JCL) to be included with each data deck is given. Particular reference is made to remote operation of the model from a Data 100 terminal.

Section F is a technical guide to Users interested in working from teletype terminals. Specific reference is made to the MTS (Michigan Terminal System)[27] and ALPHA[28] command languages. The RUN or EXECUTE statements for using the two systems are described. This is followed by a description of the use of a conversational program (TALK2) which allows the user easy access to desired portions of the output generated in an exercise of the model.

A. DESCRIPTION OF INPUT DATA CARDS

All except the last several input cards have the same format, and are laid out in eight fields of ten columns each. With the exception of the first, each field contains one input datum. The first field contains one input datum in columns two through ten plus an identification letter. This letter, which appears in column one, defines the set of parameters on that card. The order of the data cards is irrelevant up to the "Z" card which precedes the SUMMARY card. If more than one of the same card is included, the last one will be given priority and its data used.

Starting with "Z" card, the following order must be preserved:

1. "Z" card.
2. SUMMARY card.
3. Relabeling cards (if any).
4. "-2" card.
5. Tolerance level reset cards (if any).
6. "-1" card (if injury potential switch is on).
7. 3 cards containing probability data (if injury potential switch and probability switch are on).
8. First field control card.
9. Second field control card.
10. Cards specifying STYX print times if required.

More than one data deck may be submitted at the same time by simply putting them one after another, each with its own full complement of cards ("A" through "STYX"). When the program is finished with the first data deck, it will look for a second. If it finds more data, it will continue, otherwise it will sign off.

The inclusion of the SUMMARY data card at the end of a deck of input data results in the tabular output included at the end of a computer run. This output is the result of a successfully executed program and allows the user to evaluate the physics of the problem.

At present, the contact surface label is chosen according to Table XV. However, the user may alter the labels using the RELABEL card described in Table VII. This card may be inserted after the SUMMARY card in the data deck with the index of the surface to be relabeled in columns one and/or two and the eighteen BCD characters of the new label in columns eleven through twenty-eight suitably centered; e.g.:

-2----------HEAD-REST-----

A graphical output called STYX which is based on the tabular data output is in use at HSRI. The user of STYX has several options available which are fixed both in the input to the main program in the case of the contact surfaces and in the input directly to STYX. Furthermore, there is the option to use STYX or skip it altogether.

The contact surfaces which are specified in the input for a particular run are represented in the STYX output. To this end, each contact must have its reference point fixed, and its length and angle specified on its own S card in the input to the main program. In addition, the third field of the T card for each contact surface desired must contain a nonzero, floating point number. These set up the vector IGNORE (I) which controls the use of the contact surfaces in both the program and the stick figure representation.

Controlling the use of STYX is a switch, NSTICK, read by SUMARY. In the input, this switch is on the card immediately following the Z card. There are 2 floating point fields of 10 spaces each and 4 integer fields of 5 spaces; NSTICK is the third integer field. If it is blank or zero, STYX will be executed; if nonzero, it will be skipped.

If STYX is to be used, its input follows the second SUMARY "go" card. The first card contains seven integer fields, each five columns long. The first field holds the number of horizontal lines, NHL, with restriction: $2 \leq NHL \leq 24$. The second field is used to specify the number of spaces between horizontal lines, NSBH, which must satisfy the inequality: $(NHL-1) * NSBH + NHL \leq 48$. The third field has the number of vertical lines, NVL, with restriction: $2 \leq NVL \leq 53$. The fourth field details the number of spaces between vertical lines, NSBV, which must satisfy the inequality: $(NVL-1) * NSBV + NVL \leq 106$.

The fifth field is the switch that controls the printing of the zero lines. If this field contains a zero, the zero lines print, otherwise they are omitted. The sixth field specifies ISTEP, the number of plots to be printed, subject to the restriction $ISTEP \leq 200$. The seventh field holds METH, the switch controlling the method of generating input. If $METH \neq 0$, the time points are generated automatically; if $METH = 0$, then the time points must be specified by the user.

The next card is divided into six floating point fields, 10.4 wide. The first four of these are the minimum and maximum values of X and Y, respectively, that are to be printed. Care must be exercised so that the entire figure will be contained by these boundaries. For scaling purposes the equation:

$$(XMAX-XMIN)/(\frac{NSVB*(NVL-1)}{10.}) = (YMAX=YMIN)/(\frac{NSBH*(NHL-1) + NHL}{6})$$

must be satisfied. The next two fields are the two parameters necessary when METH ≠ 0. FIRST is the first time step to be printed, and DELTA is the increment between the time points. ISTEP, specified above, is the number of time points that are generated automatically.

If METH = 0, the next ISTEP cards contain the desired time points. If METH ≠ 0, these cards must not be included. Each time point must be in the first 8 columns of its own separate card, and the number of cards specifying time points must be equal to ISTEP. These time points must be at any regular or irregular intervals, but they must be in chronological order. The requested time points need not match exactly the calculated time points. The nearest available time point to the requested time point will be printed. If any requested time points are larger than the last available time point, the last available one will be printed—but only once. The time that is printed in the label is the actual calculated time, not the requested time.

The last card contains 8 integer fields, 5 wide. These are the switches controlling the printing of the contact radii. Each one prints on 0 and is omitted if the field contains anything else. These switches control respectively: the hip, nothing, the chest, nothing, the elbow, the hand, the knee, the foot.

To avoid congestion, only the man is printed out with connecting dots. All of the contact surfaces have only their end points printed out and must be connected by the user. Similarly, only the end points of the lower shoulder

TABLE VII. INPUT DATA CARDS (page 1)

Cards	Field	Table	Figure	Quantity	Units
A	1-7	VIII	10	joint friction coefficients, C_i' (If desire $C_i'=0$, insert small number=0.1)	in. lb.
B	1-8	XI	4	body segment moments of inertia, I_i	in. lb sec^2
C	1-7	VIII		joint elasticity coefficients, K_i	in. lb/rad
D	1-8	IX	4	body element lengths between joints, L_i	in.
E	1-8	IX	4	body segment masses, m_i	lb sec^2/in.
F	1		6	hip contact arc radius, r_1	in.
F	2				
F	3		6	upper torso contact arc radius, r_3	in.
F	4		6	head contact arc radius, r_4	in.
F	5		6	elbow contact arc radius, r_5	in.
F	6		6	hand contact arc radius, r_6	in.
F	7		6	knee contact arc radius, r_7	in.
F	8		6	foot contact arc radius, r_8	in.
G	1		12,34	lower joint stop coefficient, $T_1'\alpha_1$ (See card H, field 1 for α_1. If $\alpha_1 = 0$, then T_1' should be used in place of $T_1'\alpha_1$.)	in. lb (or in. lb/rad)

TABLE VII. INPUT DATA CARDS (page 2)

Cards	Field	Table	Figure	Quantity	Units
G	2-4		11,35	joint stop coefficient, T_i'	in. lb/rad
G	5-7		12,36, 37,38	lower joint stop coefficient, $T_i'\alpha_i$ (See card H, fields 2-4 for α_{5-7}. If $\alpha_i = 0$, then T_i' should be used in place of $T_i'\alpha_i$.)	in. lb (or in. lb/rad)
H	1	VIII	12,34	hip joint lower stop location, α_1	deg
H	2,3,4	VIII	12,36, 37,38	shoulder, elbow, and knee lower stop locations, α_5, α_6, α_7	deg
H	5	VIII	12,34	upper hip stop coefficient, $\hat{T}_1'$	in. lb/rad
H	6-8	VIII	12,36, 37,38	shoulder, elbow, and knee upper stop	in. lb/rad
I	1,6-7	VIII	12,34, 37,38	upper stop locations Ω_1, Ω_6, Ω_7	deg
I	2-5	VIII	11,35	symmetric stop locations, Ω_i	deg
J	1-7	VIII	9	joint angular velocity limits, ξ_i	deg/sec.
K	1-8	IX	10	body segment distance from previous joint to center of gravity, ρ_i	in.
L	1-8	IX	5	body initial angular position, $\theta_i(0)$	deg
M	1	IX	9	initial value of front edge seat force F_s' (FSPRMZ)	lb
M	2		14	hip seat belt contact radius, r_h	in.

TABLE VII. INPUT DATA CARDS (page 3)

Cards	Field	Table	Figure	Quantity	Units
M	3			(blank field)	
M	4		9	initial seat force at hip, W_o	lb
M	5		6	distance to chest center of curvature, ρ_3'	in.
M	6		6	distance to head center of curvature, ρ_4'	in.
M	7		9	effective angle of seat cushion, γ_o	deg
M	8			LCONTL (Set=1.)	
N	1		9	seat linear damper coefficient, c_s	lb sec/in.
N	2		9	seat front linear spring coefficient, s	lb/in.
N	3			seat friction velocity limit, ξ_s	in./sec
N	4			seat friction coefficient, μ_s	
N	5-7		9	seat nonlinear spring coefficients, β_i (β_1, lb/in.), (β_2, lb/in.^{2}), (β_3, lb/in^3)	
N	8		9	initial distance from hip to seat front, z_o	in.
O	1		14	lap belt length from hip to attachment, l_{1o}'	in.

TABLE VII. INPUT DATA CARDS (page 4)

Cards	Field	Table	Figure	Quantity	Units
[illegible]	2		13	initial length of lower shoulder restraint, l_{2_o}	in.
[illegible]	3		13	initial length of upper shoulder restraint, l_{3_o}	in.
[illegible]	4		13	distance from lower spinal joint to lower shoulder restraint, h	in.
[illegible]	5		14	angle from seat belt attachment to H-point ϕ'_{1_o}	deg
[illegible]	6			maximum permissible integration time step, Δt_{max} (usual value is .0005)	sec
O	7-8		9	r_z and s_z; parameters of a linear spring at the front edge of the front seat acting forward on the lower leg. s_z is spring constant, r_z is distance from lower leg centerline to skin	in. lb/in.
*P,Q	1	XII		code for belt parameters on card	
P	2			ratio of permanent to maximum elongation, G	
P	3			ratio of conserved to total energy, R	
P	4		14,13	initial belt angle ϕ_{i_o}	deg

*Cards P, Q, S, T, U, V must be used more than once in specifying several belts, tables, or contact surfaces.

TABLE VII. INPUT DATA CARDS (page 5)

Cards	Field	Table	Figure	Quantity	Units
P	5			belt slack, Δ_i	in.
P	6-8			belt load-deflection coefficients, σ_1, σ_2, σ_3	$lb/(in.)^n$
Q	2-8			load deflection coefficients, σ_i, $i=4,\ldots,10$	$lb/(in.)^n$ for n=1-5 $lb(sec/in.)^{n-5}$ for n=6-10
R	1	XIV		occupant position option, NPASGR	
R	2			occupant initial velocity $\dot{x}_o$(XPACZ)	in./sec
R	3			vehicle initial velocity, $\dot{X}_o$(XVEHZ)	in./sec
R	4			number of belt segments (NBELT = 0, 1, 2, or 3)	
R	5			minimum print-time step, Δt_p	sec
R	6			duration of simulation, t_{max}	sec
R	7			vehicle mass, M_c (not used)	lb sec^2/in.
R	8			number of Δt_p's in one print-time interval	
S,T,U	1	XV		Cards S, T, U specify contact parameters for the various contact surfaces. The surface index is in field 1 in each case.	

TABLE VII. INPUT DATA CARDS (page 5)

Cards	Field	Table	Figure	Quantity	Units
S	2		7	contact surface length, D	in.
S	3			ratio of permanent to maximum deflection, G	in.
S	4			ratio of conserved to total energy, R	
S	5		7	reference coordinate, X'', of contact surface relative to initial position of H-point	in.
S	6		7	reference coordinate, Y''	in.
S	[illegible]		7	tangential velocity limit for friction, ξ	in./sec
S	8		7	reference angle, ψ	deg
T	2			friction coefficient, μ	
T	3-8			load deflection coefficients, σ_i, i=1,...,6	lb/(in.)^n for n=1-5
U	2-5			load deflection coefficients, σ_i, i=7,...,10	lb(sec/in.)$^{n-5}$ for n=6-10
U	6-8				
V				cards V constitute the input tables for vehicle deceleration or debug printout control	

TABLE VII. INPUT DATA CARDS (page)

Cards	Field	Table	Figure	Quantity	Unit
V	1	XVII		number specifying the input table	
V	2			switch indicating whether table is a constant or not (0=yes, 1=no)	
V	3			time of next break point in piecewise linear curve	sec
V	4			value at the inflection point	in./sec^2
V	5-8				
W				table element deleting mechanism (not used)	
X	1	XI		surface index	
	2	XI		saturation force	lbs
	3	XI		slope of unloading curve	lbs/in.
Y				not used	
Z	1	XVIII		debugging switch value (IBUG)	

NOTE: Several additional cards follow the Z-card when the summary table printout, the graphical plot, or the stick drawings are to be produced. These cards are exceptions to the rule governing letters in the first column.

TABLE VII. INPUT DATA CARDS (page 8)

Cards	Field	Table	Figure	Quantity	Unit
SUMMARY*	1			distance along upper spine element centerline from joint specifying accelerometer location (Columns 1-10)	in.
	2			distance along head element centerline from neck joint specifying head accelerometer location (Columns 11-20)	in.
	3	XIV		occupant position option, NPSGR (Columns 21-25 form an integer field)	
	4			control for graphical data printout (blank or zero insure execution) (Columns 26-30 form an integer field)	
	5			control for stick figures (Columns 31-35) (integer) (blank or zero execute)	
	6			control for injury potential predictor printout (Columns 36-40) (integer) (blank or zero execute)	
	7			control for injury potential predictor probability page (Columns 41-45) (integer) (blank or zero execute) (See Table XX and reference 28)	

*NOTE: a. Fields not all 10 columns in length.
b. Integer field contents must be indexed to right side of field.
c. See text following this table.

TABLE VII. INPUT DATA CARDS (page 9)

Cards	Column No.	Table	Figure	Quantity	Unit
RELABEL	1,2			Insert contact surface to be relabeled as an integer in Columns 1 and/or 2. (See text following this table.)	
	3-10				
	11-28			Insert eighteen BCD characters of new label suitably centered.	
"GO"	1,2			Inserting -2 in the first two columns of this card indicates to the program that all input data for the production of summary tables has been read.	
INJ	1-10	XIX		Index of telerance level to be reset.(1.,2.,3.,etc.)	
	11-20	XIX		New value of tolerance level.	
"GO"	1-10			0.or -1.(This card read by injury section. Delete if injury criterion not used)	
PROBABILITY				These three cards provide input for computation of the probability that the simulated event will happed based on type of collision, position of occupant, and chance of restraint system use. If no cards are entered here, probability will not be computed if the probability switch is off.	

TABLE VII. INPUT DATA CARDS (page 10)

Cards	Column No.	Table	Figure	Quantity	Unit
(card 1)	1-10	XX		Probability of particular collision type.	
	11-20	XX		Index defining collision type (0.,1.,2.).	
	21-44	XX		New label describing collision type if index is zero.	
(card 2)	1-10	XX		Probability of the chosen occupant position being used.	
	11-20	XX		Index defining position type (0.,1.,2.,3.,4.)	
	21-44	XX		New label describing occupant position if index is zero.	
(card 3)	1-10	XX		Probability of restraint system use.	
	11-20	XX		Index defining type of restraint if any (0.,1.,2.,3.,4.,5.,6.).	
	21-44	XX		New label describing restraint type if index is zero.	
STYX-1*	1-5			NHL-integer field defining number of horizontal lines.	

*NOTE: A discussion of the application and use of STYX follows this table.

TABLE VII. INPUT DATA CARDS (page 11)

Cards	Column No.	Table	Figure	Quantity	Unit
	6-10			NSBH-integer field defining number of spaces between horizontal lines.*	
	11-15			NVL-integer field defining number of vertical lines.	
	16-20			NSVB-integer field defining number of spaces between vertical lines.	
	21-25			Switch control for zero coordinate lines (0 specified print).	
	26-30			ISTEP-number of plots to be printed.	
	31-35			METH-If METH=0, the time points for producing plots must be specified by the user, otherwise they are generated automatically.	
STYX-2	1-10			XMIN-maximum value for x on plots.	in.
	11-20			XMAX-maximum value for x on plots.	in.
	21-30			YMIN-minimum value for y on plots.	in.
	31-40			YMAX-maximum value for y on plots.	in.
	41-50			FIRST-first time point for production of drawing.	sec

*Note: Index integer quantities to right end of field.

TABLE VII. INPUT DATA CARDS (page 12)

Cards	Column No.	Table	Figure	Quantity	Units
	51-60			DELTA-Time increment between drawings.	sec
METH=0	1-8			If METH=0, a series of cards is entered here. Each one contains a point in time at which a plot is desired. Each time point must be in the first eight columns of its own seperate card. ISTEP=the number of cards included if METH=0. If METH≠0, the cards <u>must</u> <u>not</u> be included.	
CONTACT PRINTS	1-5	X	6	NCNTCT (1)*	
	6-10			NCNTCT (2)	
	11-15			. A switch in each of these	
	16-20			. eight integer fields control the printing of contact radii.	
	21-25			. Printing occurs if zero is entered in the field and is	
	26-30			. omitted if the field contains anything else.	
	31-35			.	
	36-40			NCNTCT (8)	

*Note: Inde[illegible] integer quantities to right end of fiel[illegible] and seat belts are printed, and the upper shoulder belt should be connected to the fifth joint. The contact radii are indicated as unobtrusively as possible.

B. INFORMATION TABLES

The following tables describe the subscripting used in the program. In addition, certain print and tabular indices are given as well as quantities used in the injury criteria model. Certain tables listed earlier in the text are repeated in this section for ease and assessability to the user.

TABLE VIII. SUBSCRIPTS OF BODY JOINTS

Subscript	1	2	3	4	5	6	7
Joint	Hip	Lower Spine	Upper Spine	Neck	Shoulder	Elbow	Knee

TABLE IX. SUBSCRIPTS OF BODY SEGMENTS

Subscript	1	2	3	4	5	6	7	8
Body Segment	Lower Torso	Middle Torso	Upper Torso	Head	Upper Arm	Lower Arm	Upper Leg	Lower Leg

TABLE X. SUBSCRIPTS OF CONTACT ARCS

Subscript	1	2	3	4	5	6	7	8
Contact Arc	Hip	-	Upper Torso	Head	Elbow	Hand	Knee	Foot

TABLE XI. Saturation Indices

Subscript	Surface or Belt
0.	floor
1.	seat back
2.	roof or head rest
3.	upper steering wheel, upper dash, or back of front seat
4.	windshield
5.	lower steering wheel
6.	lower panel
7.	steering column
8.	toeboard
9.	steering wheel
11.	lap belt
12.	lower shoulder belt
13.	upper shoulder belt

TABLE XII. BELT PARAMETER INDEX

Belt parameter index = { 1, lap belt; 2, lower shoulder belt; 3, upper shoulder belt }

Belt parameter index =	1, lap belt
	2, lower shoulder belt
	3, upper shoulder belt

TABLE XIII. NBELT VALUES

NBELT =	0	no belts
	1	lap belt
	2	shoulder belts
	3	lap belt and shoulder belt

TABLE XIV. OCCUPANT POSITION OPTIONS

Occupant position option =	1, driver
	2, front passenger
	3, rear passenger

TABLE XV. NORMAL CONTACT SURFACE INDICES

Index*	Normal Contact Surface
0	floor
1	seat back
2	roof or head rest
3	upper steering wheel, upper dash, back of front seat
4	windshield
5	lower steering wheel
6	lower panel
7	steering column
8	toeboard
9	steering wheel

*It is permissible to use any index for any other contact surface as long as it is compatible with the table of possible contacts in Table XVI. For example, an air bag could be simulated by using the various segments of the steering wheel.

TABLE XVI. OCCUPANT CONTACTS VERSUS VEHICLE CONTACTS (page 1)

Contact Arc Subscript	Driver (1) Contacts	Front Passenger (2) Contacts	Front Passenger (3) Contacts
hip (1)	seat back (1) [5]*	seat back (1) [5]	seat back (1) [5]
upper torso (3)	seat back (1) [6]	seat back (1) [6]	seat back (1) [6]
	upper steering wheel (3) [7]	upper dash (3) [7]	back of front seat (3) [illegible]
	lower steering wheel (5) [8]		
	steering column (7) [9]		
head (4)	seat back (1) [10]	seat back (1) [8]	seat (1) [8]
	roof or head rest (2) [11]	roof or head rest (2) [9]	roof or head rest (2) [9]
	upper steering wheel (3) [12]	upper dash (3) [10]	back of front seat (3) [10]
	windshield (4) [13]	windshield (4) [11]	
	lower steering wheel (5) [14]		

*Numbers in brackets refer to indices 5-18 used in LODFEC and CONTACT printouts. (See flow diagrams and Table XX.)

TABLE XVI. OCCUPANT CONTACTS VERSUS VEHICLE CONTACTS (page 2)

Contact Arc Subscript	Driver (1) Contacts	Front Passenger (2) Contacts	Front Passenger (3) Contacts
elbow (5)	seat back (1) [15]	seat back (1) [12]	seat back (1) [11]
knee (7)	lower panel (6) [16]	lower panel (6) [13]	back of front seat (3) [12]
foot (8)	floorboard (0) [17]	floorboard (0) [14]	floorboard (0) [13]
	toeboard (8) [18]	toeboard (8) [18]	back of front seat (3) [14]

TABLE XVII. INPUT TABLE SWITCHES

Input table =	1 - vehicle deceleration function	
	2 - time-varying debugging switches*	
	3 - (read but not used)	

*Use of this switch is controlled by IBUG value in Table XVIII.

TABLE XVIII. IBUG SWITCHER

IBUG =	negative integer	- Input table 2 is used
	0	- no debugging printout
	1-3	- various levels of debugging (See Debug Section)

TABLE XIX. INDICES FOR THE INJURY CRITERIA QUANTITIES

Index	Quantity	Default Value
1	Severity Index	1000
2	Head Pitch Acceleration (rad/sec^2)	2000
3	Chest Load (lb)	1800
4	Shoulder Belt Load (lb)	1800
5	Pelvic Belt Load (lb)	3000
6	Knee Load (each) (lb)	1500
7	Chest A-P G-Load	45
8	Chest S-I G-Load	25
9	Hip Angle Flexion (deg)	120
10	Lower Spine Angle Flexion (deg)	20
11	Upper Spine Flexion (deg)	20
12	Neck Angle Flexion (deg)	60
13	Shoulder Angle Flexion (deg)	180
14	Elbow Angle Flexion (deg)	135
15	Knee Angle Flexion (deg)	135
16	Hip Angle Hyperextension (deg)	0
17	Lower Spine Angle Hyperextension (deg)	45
18	Upper Spine Angle Hyperextension (deg)	20
19	Neck Angle Hyperextension (deg)	60
20	Shoulder Angle Hyperextension (deg)	60
21	Elbow Angle Hyperextension (deg)	0
22	Knee Angle Hyperextention (deg)	0

Note: See Reference 29 for a discussion of the injury criteria model. The default values are automatically used if no changes are entered in the data set.

TABLE XX. PROBABILITY LABELS

Index	Card 1	Card 2	Card 3
0	(User option)	(User option)	(User option)
1	Front collision	Driver	No restraint
2	Rear collision	Right front passenger	Lap belt only
3	--	Right rear passenger	Shoulder harness only
4	--	Left rear passenger	Shoulder harness and lap belt
5	--	--	Airbag and lap belt use
6	--	--	Inverted y-yoke and lap belt use

C. PREPARATION OF DATA SETS AND SAMPLE MODEL EXERCISES

This section of the report describes the preparation of data sets for use with the model and includes a variety of sample computer outputs. The data cards listed in Table VII serve four basic functions: 1. description of the occupant; 2. description of vehicle geometry and occupant positioning; 3. definition of the deceleration event; and, 4. program control.

Occupant Description

Information on the A through M cards of Table VII describe the occupant. The moments of inertia (B card), body segment lengths (D card), body segment masses (E card), body contact radii (F and L cards), center of gravity locations (K card) can be estimated using standard and non-standard anthropometric data in the case of human subjects. More accurate data can be obtained for dummies as they can be disassembled and subjected to laboratory measurement.

Formulas for estimating these quantities have been developed by Robbins[30], Patten[26], and Hanavan[25] independently. The work of Robbins is specifically applicable to use with the model described in this report while the work of Patten was developed in conjunction with modeling efforts at Cornell Aeronautical Laboratories.

In each case anthropometric data are needed to describe the exterior shape of the subject, his stature, and his weight. Using body weight, the formulas of Barter[31] can be used to estimate the weight of the various body segments. The body segments are then assumed to be simple geometric shapes such as cylinders for the arms, elliptical cylinders for torso elements, ellipsoid for the head, truncated conical sections for the upper legs, etc. The anthropometric and weight data then are combined to locate centers of gravity and compute moments of inertia. Additional research is necessary to validate the accuracy of these procedures.

In the case of a dummy it is possible to measure these quantities more directly. The techniques for doing this are described in Section III C of this report for a Sierra 850 dummy.

Description of Joints

Description of the joints (A,C,G,H,I,J cards) is more difficult because of a lack of experimental data. Both range of motion and stiffness properties are needed.

Angular range of motion is fairly easy to determine for both humans and dummies. The most accurate technique is to target adjacent body segments and take photographs while the subject is extended to the limits of voluntary motion. The precise location of joints such as the neck, shoulder, spine, hip, knee and elbow is still a matter of conjecture however the development of anthropometric techniques for relating body surface landmarks to interior centers of rotation is still relatively incomplete.

Figures 34, 35, 36, 37, and 38 describe the preparation of a specific set of input quantities for use with the model. Consider first the hip joint as shown in Figure 34. If the upper torso is vertical, $\theta_1 = 90.^0$ The α_1 stop is applied when $\theta_1 - \theta_7 < \alpha_1$. (It will be necessary to refer to Figures 5, 10, 11, and 12 in interpreting this discussion.) When θ_7 swings up toward the torso, the stop is applied when $\theta_1 - \theta_7 < \alpha_1$ or in Figure 34 when $\theta_1 - \theta_7 < 60.^0$ On the other hand, when $\dot{\theta}_7$ becomes negative, i.e., when it rotates down from the neutral horizontal position, the α_{L_1} stop is applied when $\theta_1 - \theta_7 > 150.^0$ Because θ_7 is negative, the quantity $\theta_1 - \theta_7$ becomes larger when θ_7 swings down and θ_1 is held constant.

The joint must now be supplied with strength properties. The A card includes frictional forces at the joints resisting relative motions between adjacent body segments. This quantity is most descriptive of dummy joints.

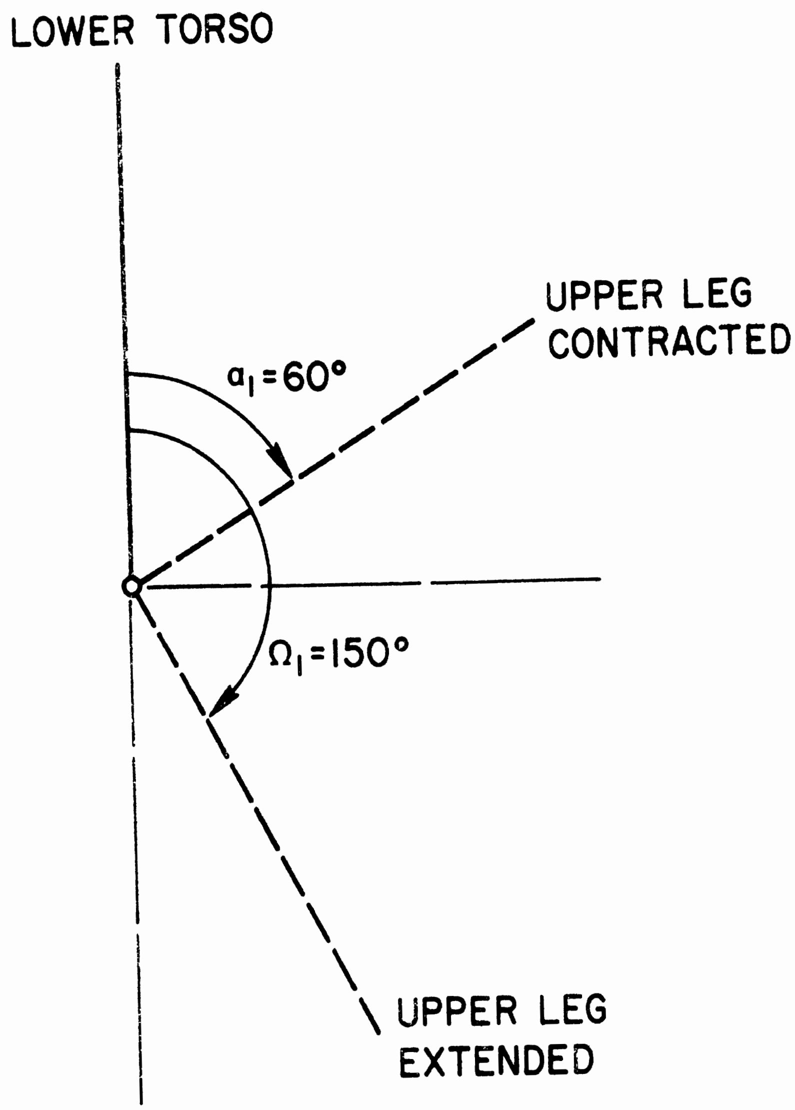


Figure 34. Hip joint structure

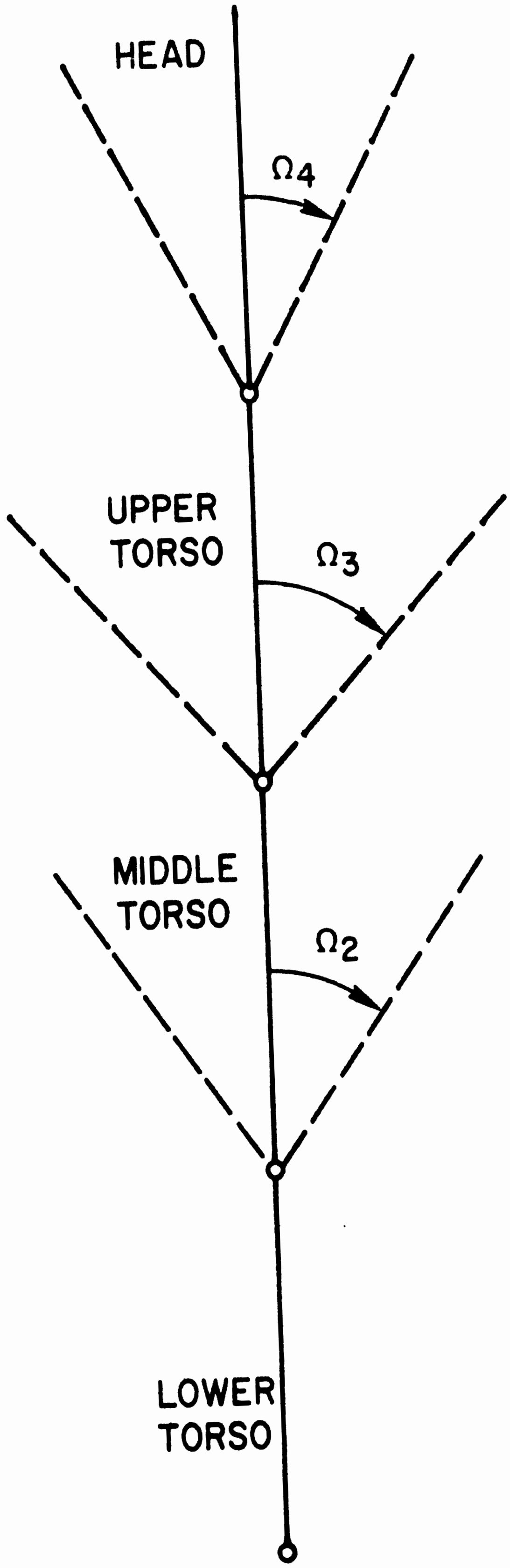


Figure 35. Back joint structures

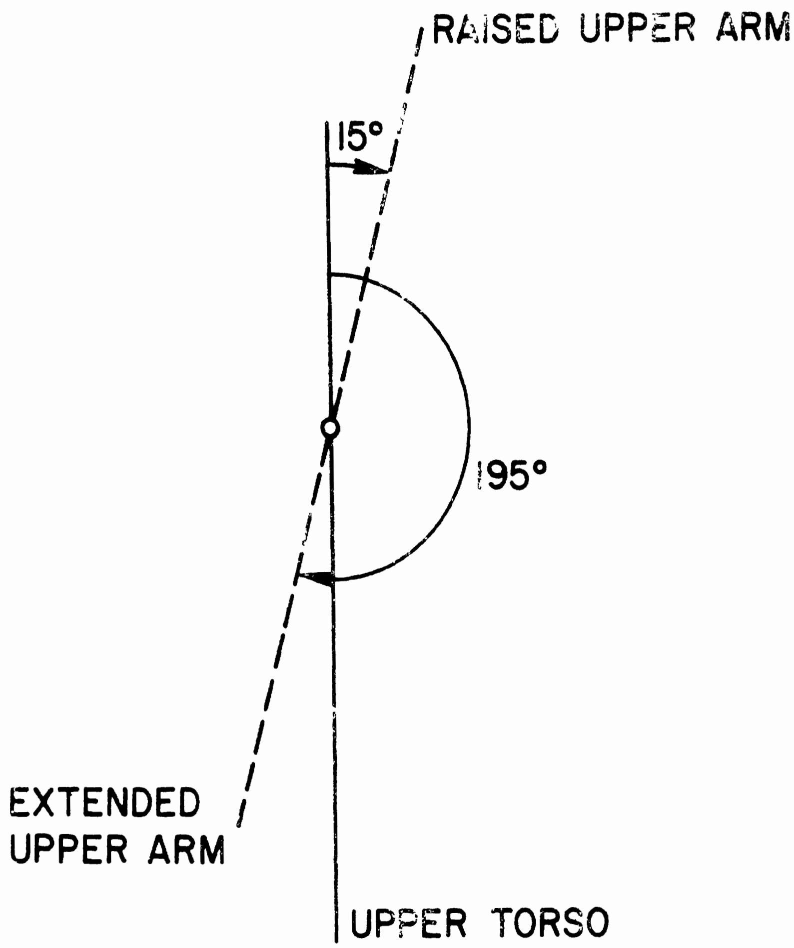


Figure 36. Shculder joint structure

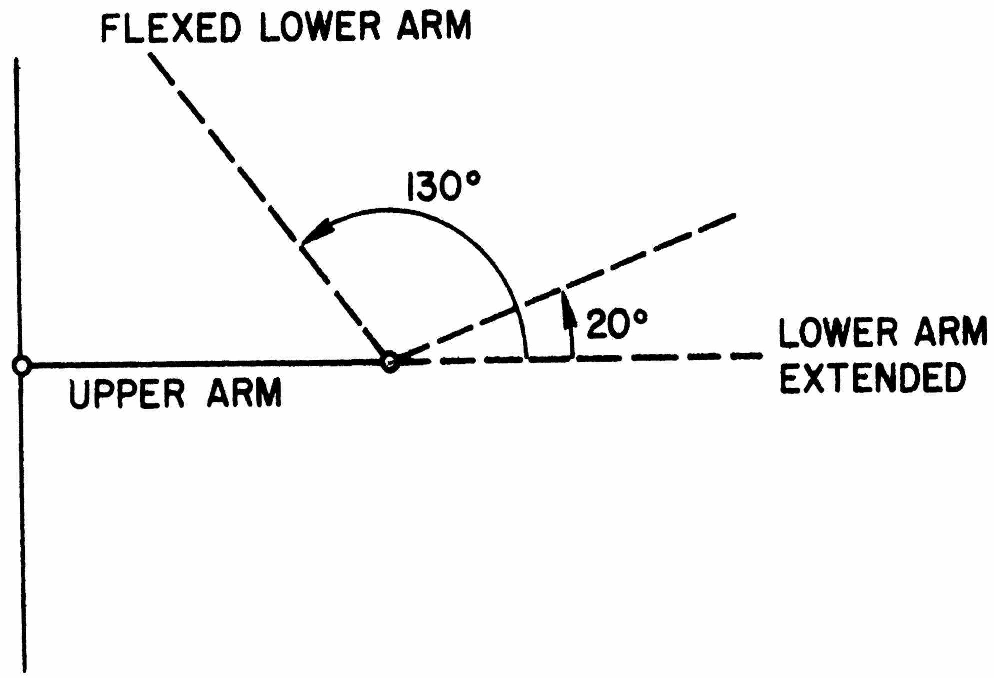


Figure 37. Elbow joint structure

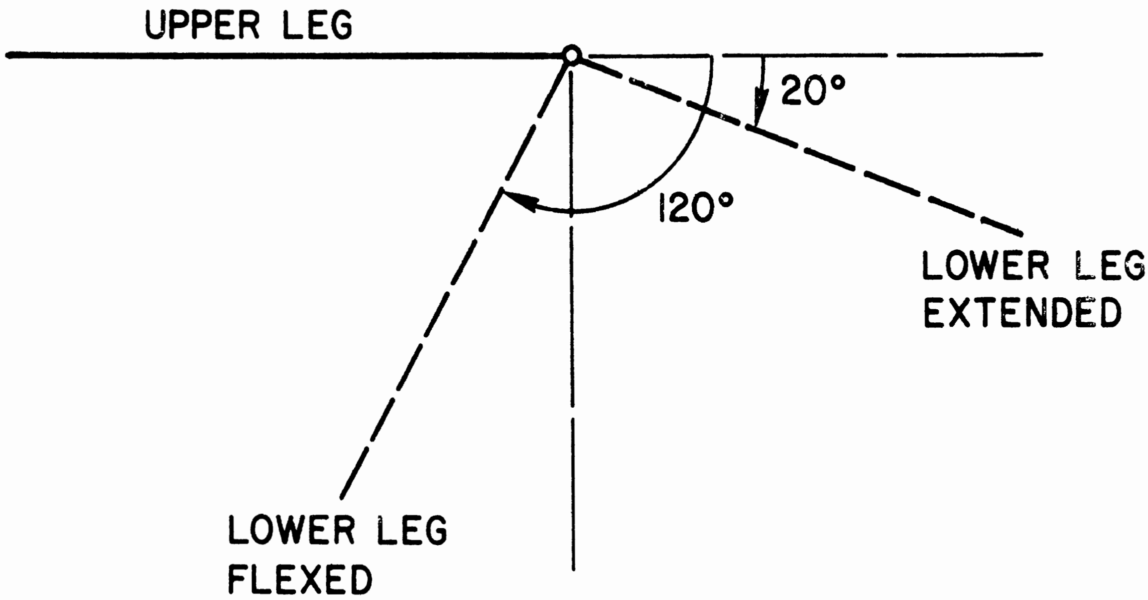


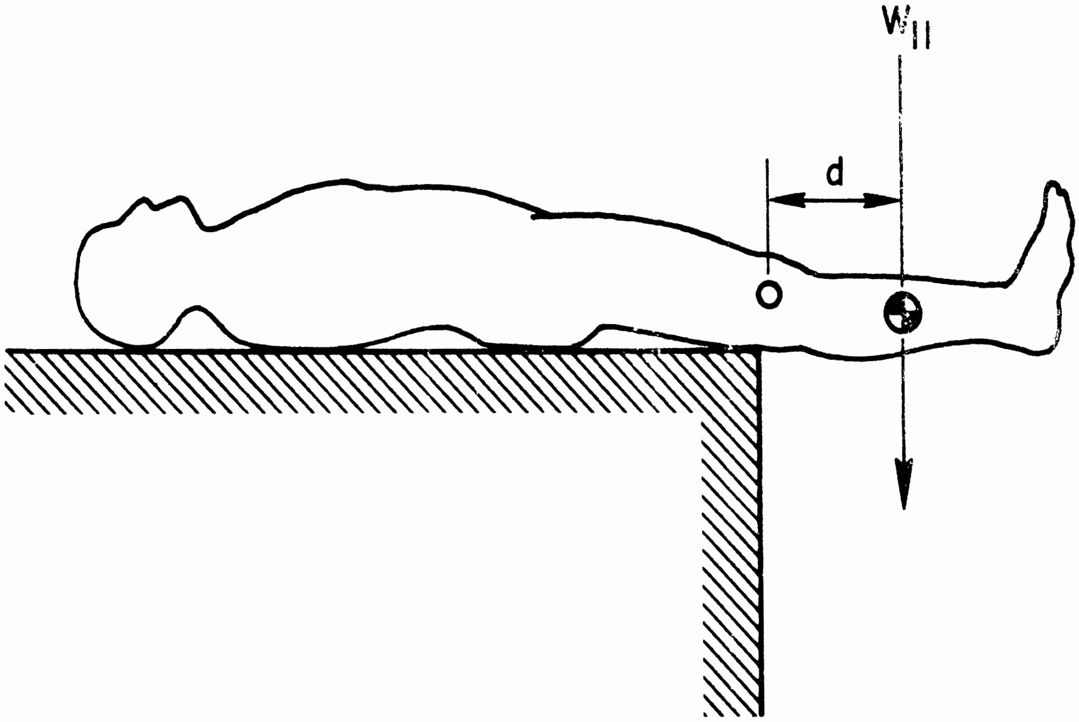
Figure 38. Knee joint structure

If dummy joints are set, for example, at 1-G, the weight of the dummy body segments and the locations of the centers of gravity may be used to estimate this quantity accurately (See Figure 39). For human-like joints or dummy rubber neck structures this quantity should be a small non-zero value such as 0.1 in. lb. (A zero value may cause program malfunction).

It is more difficult to determine the elastic coefficient resisting joint relative motion (C card). For dummies these quantities are near zero. For human-like joints their value depends on the degree of tensing of the muscles. Using the work of Bowman[32] a rough estimate has been made that the maximum value for neck joint stiffness for humans is approximately 1920 in. lb./rad. Insertion of this value in data sets indicates a considerable potential for the subject to influence his crash kinematics. Further research on this subject is necessary.

Because little data has been found in the available literature defining joint stop spring constants, it has been generally assumed at HSRI that the slope of the torque-relative angle curve (G and H cards) is ten times the slope of the human-like joint elastic spring curve (19200 in.lb./rad) for human simulations and about 100,000 in.lb/rad for dummy joints. Recall for the hip joint that $\alpha_1 = 60°$ and $\Omega_1 = 150°$. The slope T' refers to the stop which is entered on the G card in the first field. The definition entered on the card is $T' \alpha_1$ (in.lb.) or T' if $\alpha_1 = 0$ with the units of T' being in.lb./rad. Therefore the quantity entered in G1 would be 20100 in.lb. reflecting the multiplication by α_1 in radians (60/57.3). The quantity $\hat{T}'$ which is the slope of the Ω_1 stop is entered directly in the normal units of in.lb/rad.

The lower spine, upper spine, and neck joints are shown in Figure 35. These three joints are symmetric and are defined by a single Ω_L and the



W_{ll} = WEIGHT OF LOWER LEGS.

d = DISTANCE FROM C.G. OF LOWER LEGS TO KNEE.

C = FRICTION MOMENT = $W_{ll} \times d$ (in.lb.).

Figure 39. Computation of Joint Friction Input Data

associated T'. The following values are typical values which may be used as input data: $\Omega_2 = 70°$, $\Omega_3 = \Omega_4 = 22.5°$, $T'_2 = T'_3 = T'_4 = 20{,}000$ in.lb/rad.

An example of an unsymmetric shoulder joint is shown in Figure 36. The upper torso angle is given by θ_3 and the upper arm angle by θ_5. Similar to the case of the hip, stop locations are defined by $\theta_3 - \theta_5 < \alpha_5$ or $\theta_3 - \theta_5 > \Omega_5$. For example, the stops may be chosen $\alpha_5 = 15°$ and $\Omega_5 = 195°$. The α_5 stop coefficient, T'_5 is again entered into the data set multiplied by a factor while the Ω_5 stop is entered directly.

The elbow joint shown in Figure 37 is also unsymmetric. The upper arm angle is θ_5 with the lower arm given by θ_6. The stop locations are $\theta_6 - \theta_5 < \alpha_6$ and $\theta_6 - \theta_5 > \Omega_6$ with sample values $\alpha_6 = 20°$ and $\Omega_6 = 130°$. The α_6 stop is entered into the data set multiplied by a constant.

The knee joint shown in Figure 38 is unsymmetric. The upper leg angle is θ_7 and the lower leg angle is θ_8. The stops are defined $\theta_7 - \theta_8 < \alpha_7$ and $\theta_7 - \theta_8 > \Omega_7$ with sample values being $\alpha_7 = 20°$ and $\Omega_7 = 120°$. The α_7 stop is entered into the data set multiplied by a constant.

The contents of the J-card defines joint angular velocity limits. This small quantity, usually chosen to be 1.0 deg/sec., is used to turn on the joint frictional forces. When relative velocity between two adjacent body elements is less than this quantity, the friction force is not applied. In other words, the friction force resisting motion is only applied when the actual motion is considered to be significant.

Vehicle and Restraint System Geometry

The position of the occupant within the vehicle (or pedestrian outside the vehicle) and geometric relationships between the vehicle interior components must now be specified. In addition, it is necessary to provide force-deformation data for all potential contacts.

The first step in the development of vehicle-occupant geometric input data is preparation of a scale drawing. As geometry is specified relative to the H-point of the occupant, this point is laid out first on the sketch. As seat back angle is specified on vehicle drawings, the angle of the lower-, middle-, and upper-torso as well as the head elements are usually laid out next.

The location of contact surfaces on the drawing is usually the next step. This is based on an estimate of the number of surfaces which the occupant will contact during the collision event. For a front collision involving a fully belted occupant, these are usually limited to seat back, seat cushion, floor, and toeboard. For a rear-end collision, a head rest, roof, and top of the seat back may be required. For an unrestrained occupant in a frontal collision, the seat, floor, toeboard, windshield, various instrument panel components, etc. may be required. Selection of the appropriate number of surfaces is based on an estimate of the crash event and careful study of Table XVI which is a list of occupant contact-sensing circles versus the allowed vehicle component contacts. Examples for several standard crash events are included in the text and figures which follow.

With the vehicle surface entered it is now possible to specify the location of the lower and upper legs. A circle is usually drawn tangent to the toeboard and floorboard representing foot contact. Given the lengths of upper and lower legs, the angles of these two body elements are then uniquely determined by trigonometry. The arm elements and all other body contact circles are now drawn in.

Given the belt anchor points on a vehicle drawing and the points of tangency where they intersect the body, it is now possible to finish the geometric drawing relating all vehicle and occupant quantities. This final part of the sketch includes belt length and angle which must be specified as input data.

No mention has yet been made of initial equilibrium of the body. The initial seat force at the hip (entered as input data in the fourth field of the M-card) is usually chosen to be the weight of the torso plus the weight of the upper legs. The initial value of the force applied at the front edge of the seat to the upper legs is chosen zero when the angle of the seat cushion is smaller than the initial upper leg angle. In other cases (usually of a child occupant) much of the weight of the legs must be supported at that point. The weight of the lower legs is usually resisted by a force acting at the foot contact circle. This circle is allowed to penetrate the floorboard sufficiently to generate the required force. In rear-end collisions the initial force on the seat back is also chosen to be non-zero. A general rule of thumb is to distribute 20% of torso weight between the hip and upper torso contact circles. This is accomplished by allowing these circles to penetrate the seat back contact surfaces sufficiently to generate the required forces.

It has been found in HSRI experience that setting the hip force equal to torso weight leads to errors of less than 1/2 G in initial body loadings if all other initially applied forces are zero. This simple approximation of equilibrium is felt to be sufficient for most purposes. The additional refinements suggested in the previous paragraph can also be carried out rather easily. Complete equilibrium forces are more difficult to compute.

Vehicle-Occupant Force-Deformation Properties

Specification of the force-deformation properties of the seat cushion, the contact surfaces, and belts must be based on experimental data if it is available. The experimental data can then be simulated by a fifth order polynomial in both deflection and deflection rate possibly supplemented by a perfectly plastic energy absorber. It should be remembered in obtaining or adapting experimental data for this purpose that deflections of the contact surface and the body element are both lumped together. In the case of belts, anchor point deformation, belt stretch, and body compliance are all lumped into the properties chosen for the model exercise. Examples of the determination of contact surfaces and belt strength properties are contained in Section III.C of this report.

Data Cards L Through Q, S Through U, and X

Based on the drawing describing vehicle, occupant, and restraint system geometry as well as selection of force-deformation data, it is possible to prepare the L through Q and S through U cards. Direct measurements from the drawing specify occupant position on the L card, seat length, and seat angle on the M card; initial distance from hip to seat front on the N card, the first five fields relating to belt geometry on the O card, the fourth field of the P card defining initial belt angles, and fields 2, 5, 6, and 8 on the S card defining contact surface end points, length, and angle.

Fields M1 and M4 are based on the simple equilibrium considerations discussed previously completing that card. The first seven fields of the N card define seat cushion force-deformation properties. The third field contains the seat friction velocity limit. This is a control parameter which senses velocity before applying the friction force in the appropriate direction. An appropriate value is 0.1 in/sec. No friction force is applied when the buttocks are sliding along the seat at a lesser velocity.

The seventh and eight fields of the O-card define a thickness of the lower leg and the forward acting force properties of the front edge of the seat. These properties are particularly important in rear-end collisions where the lower leg may swing back toward the seat.

The remaining columns of the P, Q, S, T, U and X cards define belt and contact surface force-deformation properties. For contact surfaces with friction, a lower velocity limit must be provided as a control parameter. It should be remarked that the generation of more than one friction force at the same time can lead to an unstable integration procedure under certain conditions. The program is automatically stopped if this occurs and an appropriate comment printed. The customary procedure at HSRI is to use only one non-zero friction coefficient for a particular simulation until the input data set is thoroughly debugged. If more frictions are desired, they are then added one by one.

Vehicle Deceleration Profile (V Cards)

This is one of the simpler parts of data preparation. Given experimental data, it must be digitized. The acceleration curve is broken up into connected straight line segments. The end points of the straight lines are then entered onto the V cards. It should be remembered that the deceleration should be specified for the total real-time duration of the simulation even though it has dropped to zero.

Control Cards

The first control quantity is entered in the sixth field of the O card, the maximum permissible integration time step. This puts a boundary on the fineness of the integration scheme. A usual value is .0005 sec. This is the largest time interval which can be employed to model an event with a 500 cps content (four points per cycle). When required by the dynamics of the situation, this time step is automatically reduced. The minimum possible reduction is to 1 μsec.

The R card contains several parameters such as occupant position, initial vehicle and occupant velocity, number of belts, print times, and real time duration of the simulation. The quantity NPASGR is usually selected as 1. because the largest number of potential vehicle-occupant contacts is available for that option. The print time step controls storage of important output variables and will be the time step in tabular output. The most convenient table size occurs for a value of .005 sec. although additional detail is often required.

When the program senses the Z card, execution of the model occurs. The results are then stored for use by the output subroutines controlled by the cards following the Z card.

The SUMARY card selects the output options desired specifies accelerometer location for computation of head and chest resultant G levels. The fourth through seventh field contain integers for executing output options such as graphical output, stick drawings of occupant motions, an injury potential monitor, and an event probability predictor. These options will execute if a 1 is entered in the field.

RELABEL cards may be entered to change the names of contact surfaces in the tabular printout of data. For instance, the "steering column" contact surface may be used to represent an airbag. Relabeling of this surface should be carried out.

Following RELABEL cards a -2 card is entered which causes tabular printout to occur. Injury criterion and probability control cards follow if these options have been selected.

The final three cards are used by the stick figure printer plot subroutine, STYX. Basically these set up a series of printer plot drawings of the occupant and vehicle position as a function of time. Sample inputs and outputs are included in the text which follows.

Example No. 1. 30 mph Front Collision. Belts. 50th Percentile Male

A 50th percentile male wearing a lap belt and shoulder harness in a 30 mph front collision is simulated using the data set in Table XXI. The data describing the occupant, the vehicle interior and belts are derived from information included in Part III of this report. Human joint properties have been chosen. A "half-tensed" state has been chosen for the musculature of the neck. Other joint structures are given the same value because of a lack of other experimental data. Only three contact surfaces are included with friction only in the seat cushion. The deceleration is a 25 G trapezoid.

The cards after the Z card include execution of all options. All tolerance indicators are reset for the example. The complete printout from this run is included in Table XXII.

The occupant is observed to move forward into the belts and then to rebound. The chest and head G-loadings are probably acceptable except for rebound.

The injury criteria printout indicates potential problems due to head-neck flexion (the tolerance value used was derived for the case of whiplash and thus may not be accurate), shoulder belt loads, vertical spinal loadings, and excessive relative motions between adjacent body segments.

The plots of output variables and the stick drawings of the occupant can be used to study the vvent further. The stick drawings are particularly useful in ascertaining the accuracy of the input geometric data and whether sufficient contact surfaces have been included.

```
$SIGNON SCGH T=4M P=50 'DHF'
**LAST SIGNON WAS: 10:21.25    08-09-72
 USER "SCGH" SIGNED ON AT  11:02.48 ON 08-09-72
$LIST DOTIN(1,75)
    1     A1.        1.       1.       1.       1.       1.       1.
    2     B2.041     .54      2.996    .436     .474     .600     2.623    2.397
    3     C960.      960.     960.     960.     960.     960.     960.
    4     D4.48      5.75     12.59    7.53     11.56    10.75    16.5     16.125
    5     E.04976    .01896   .11258   .04084   .03      .0266    .10424   .056
    6     F3.76      0.       3.76     4.       1.25     2.       2.18     3.75
    7     G21000.    20000.   20000.   20000.   5240.    7000.    7000.
    8     H60.       15.      20.      20.      20000.   20000.   20000.   20000.
    9     I150.      22.5     22.5     70.      195.     130.     120.
   10     J1.        1.       1.       1.       1.       1.       1.
   11     K2.75      3.19     5.17     4.66     4.82     7.5      7.5      10.135
   12     L103.      103.     103.     75.      -77.     0.       6.       -33.
   13     M0.        2.       0.       145.     7.17     6.       5.       1.
   14     N1.        92.      .1       .34      37.21    5.31     1.57     13.
   15     O12.1      13.5     16.8     2.55     50.      .0005    2.       1000.
   16     P1.        .315     1.       50.      0.       625.     -12.     -12.
   17     P2.        .315     1.       77.      .5       350.
   18     P3.        .315     1.       -39.     .5       350.
   19     Q1.        .5       .078
   20     Q2.
   21     Q3.
   22     R1.        528.     528.     3.       .005     .2       5.       1.
   23     S0.        45.      .5       .5       45.      -10.     .1       3.
   24     T0.        0.       800.
   25     U0.
   26     S1.        28.      .01      .95      -3.      -5.      .1       283.
   27     T1.        0.       800.
   28     U1.
   29     S8.        36.      .5       .5       18.5     10.      .1       135.
   30     T8.        0.       800.
   31     U8.
   32     U2.
   33     U3.
   34     U4.
   35     U5.
   36     U6.
   37     U7.
   38     U9.
   39     V1.        1.       0.       0.
   40     V1.        1.       .02      -9650.
   41     V1.        1.       .0547    -9650.
   42     V1.        1.       .0747    0.
   43     V1.        1.       2.       0.
   44     Z
   45     7.5        2.3
   46     -2
   47     1.         1500.
   48     2.         1800.
   49     3.         2000.
   50     4.         2000.
   51     5.         4000.
   52     6.         1400.
   53     7.         60.
   54     8.         26.
   55     9.         10.
   56     10.        20.
```

Table XXI. Data Set. Example No. 1 (page 1 of 2)

```
  57      11.       20.
  58      12.       70.
  59      13.       55.
  60      14.       5.
  61      15.       3.
  62      16.       130.
  63      17.       22.5
  64      18.       22.5
  65      19.       70.
  66      20.       190.
  67      21.       140.
  68      22.       140.
  69      -1.
  70      .443      1.
  71      1.        1.
  72      .046      4.
  73         2    44    2   100    0    11    1
  74      -30.      42.3     -13.      41.1      0.         .02
  75         0     0    0     0    0     0    0    0
END OF FILE
```


Table XXI. Data Set. Example No. 1 (page 2 of 2)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 1, 1972 PAGE 1

TIME (SEC.)	BELT FORCES (POUNDS) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	BELT ANGLES (DEGREES) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	RELATIVE HIP POSITION (INCHES) HORIZONTAL	RELATIVE HIP POSITION (INCHES) VERTICAL	RELATIVE HEAD POSITION (INCHES) HORIZONTAL	RELATIVE HEAD POSITION (INCHES) VERTICAL
0.0	0.	0.	0.	59.5	77.0	-39.0	0.0	0.0	-3.88	26.93
0.005	3.	0.	0.	59.5	77.0	-39.0	0.01	0.00	-3.87	26.93
0.010	25.	0.	0.	59.2	76.7	-38.8	0.07	0.00	-3.79	26.93
0.015	84.	0.	0.	58.5	76.0	-38.4	0.25	0.01	-3.60	26.93
0.020	197.	0.	0.	57.1	74.5	-37.7	0.59	0.01	-3.23	26.93
0.025	377.	0.	156.	55.0	72.3	-36.5	1.15	-0.00	-2.63	26.92
0.030	618.	12.	390.	52.2	69.2	-35.1	1.91	-0.03	-1.79	26.89
0.035	902.	121.	688.	49.1	65.7	-33.5	2.84	-0.09	-0.74	26.84
0.040	1194.	258.	1042.	45.7	61.8	-31.8	3.89	-0.17	0.52	26.73
0.045	1454.	417.	1439.	42.5	57.8	-30.3	5.01	-0.28	1.95	26.56
0.050	1656.	587.	1863.	39.4	54.0	-29.0	6.16	-0.42	3.53	26.29
0.055	1794.	756.	2292.	36.5	50.4	-28.0	7.32	-0.59	5.22	25.90
0.060	1880.	909.	2701.	33.9	47.2	-27.2	8.45	-0.76	6.96	25.37
0.065	1943.	1025.	3054.	31.7	44.5	-26.7	9.50	-0.96	8.65	24.67
0.070	2007.	1081.	3326.	29.8	42.4	-26.6	10.40	-1.17	10.15	23.81
0.075	2066.	1038.	3519.	28.5	41.1	-26.7	11.04	-1.33	11.37	22.79
0.080	2080.	876.	3627.	28.0	40.8	-27.1	11.32	-1.38	12.27	21.69
0.085	1986.	601.	3626.	28.4	41.7	-27.7	11.21	-1.27	12.75	20.63
0.090	1772.	233.	3489.	29.7	43.7	-28.6	10.72	-1.04	12.79	19.79
0.095	1455.	0.	3201.	31.6	46.7	-29.7	9.91	-0.75	12.38	19.20
0.100	1047.	0.	2769.	34.0	50.6	-30.8	8.82	-0.50	11.53	18.99
0.105	610.	0.	2193.	36.8	55.3	-32.0	7.56	-0.31	10.31	19.08
0.110	177.	0.	1508.	40.1	60.9	-33.4	6.20	-0.11	8.82	19.38
0.115	0.	0.	751.	44.1	67.2	-34.9	4.78	0.12	7.13	19.84
0.120	0.	0.	0.	48.7	73.9	-36.7	3.35	0.37	5.34	20.41
0.125	0.	0.	0.	53.8	80.5	-38.8	1.93	0.61	3.51	21.04
0.130	0.	0.	0.	59.4	86.9	-41.3	0.53	0.83	1.65	21.74
0.135	0.	0.	0.	65.4	92.9	-44.1	-0.86	1.05	-0.24	22.50
0.140	0.	0.	0.	71.7	98.0	-47.1	-2.19	1.26	-2.02	23.34
0.145	0.	0.	0.	77.6	101.7	-49.5	-3.36	1.52	-3.60	24.28
0.150	0.	0.	0.	82.2	104.0	-50.9	-4.24	1.85	-4.87	25.36
0.155	0.	0.	0.	85.1	104.6	-50.7	-4.78	2.29	-5.84	26.59
0.160	0.	201.	0.	86.0	103.9	-48.5	-4.93	2.83	-6.55	27.95
0.165	0.	399.	0.	85.0	102.0	-44.6	-4.67	3.43	-7.11	29.35
0.170	0.	596.	0.	82.7	99.1	-38.9	-4.04	4.10	-7.58	30.61
0.175	353.	825.	0.	79.6	95.6	-32.3	-3.15	4.84	-7.99	31.49
0.180	912.	1084.	0.	76.3	91.7	-25.8	-2.09	5.61	-8.24	31.79
0.185	1336.	1335.	0.	73.2	87.7	-20.7	-1.00	6.23	-8.26	31.64
0.190	1588.	1541.	0.	70.2	83.8	-17.3	0.05	6.59	-8.07	31.23
0.195	1714.	1678.	0.	67.4	80.0	-15.6	1.03	6.66	-7.74	30.70
0.200	1765.	1733.	0.	64.5	76.3	-15.5	1.93	6.43	-7.30	30.11

Table XXII. Printout. Example No. 1 (page 1 of 27)

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	LOWER TORSO POSITION	LOWER TORSO VELOCITY	LOWER TORSO ACCEL.	CENTER TORSO POSITION	CENTER TORSO VELOCITY	CENTER TORSO ACCEL.	UPPER TORSO POSITION	UPPER TORSO VELOCITY	UPPER TORSO ACCEL.	HEAD POSITION	HEAD VELOCITY	HEAD ACCEL.
0.0	103.00	0.0	0.6625E 03	103.00	0.0	0.7102E 03	103.00	0.0	0.5780E 03	75.00	0.0	-0.2594E 04
0.0050	103.00	-1.76	-0.4215E 03	102.99	-2.50	-0.7438E 03	103.00	2.21	0.3913E 03	74.97	-13.00	-0.2533E 04
0.0100	102.98	-3.02	0.1205E 03	102.97	-7.63	-0.1611E 04	103.02	3.80	0.1868E 03	74.87	-24.85	-0.2083E 04
0.0150	102.97	0.53	0.1641E 04	102.90	-20.41	-0.4064E 04	103.04	3.76	-0.3085E 03	74.72	-33.22	-0.1047E 04
0.0200	103.00	14.04	0.4154E 04	102.74	-50.76	-0.9104E 04	103.05	0.22	-0.1309E 04	74.55	-34.32	0.9702E 03
0.0250	103.14	42.20	0.7472E 04	102.35	-108.11	-0.1452E 05	103.04	-3.95	0.4151E 02	74.37	-40.53	-0.5081E 04
0.0300	103.45	86.58	0.1071E 05	101.60	-195.32	-0.2104E 05	103.02	0.63	0.1774E 04	74.08	-86.95	-0.1478E 05
0.0350	104.04	150.59	0.1523E 05	100.34	-312.61	-0.2575E 05	103.05	8.56	0.1103E 04	73.42	-183.95	-0.2541E 05
0.0400	104.99	235.42	0.1893E 05	98.46	-441.59	-0.2426E 05	103.10	9.54	-0.1271E 04	72.14	-337.95	-0.3758E 05
0.0450	106.42	337.20	0.2204E 05	95.98	-541.17	-0.1262E 05	103.12	-5.76	-0.5581E 04	69.93	-564.41	-0.5026E 05
0.0500	108.39	454.42	0.2526E 05	93.18	-560.16	0.8225E 04	103.00	-46.18	-0.1133E 05	66.49	-832.88	-0.6194E 05
0.0550	110.99	589.64	0.2942E 05	90.57	-465.16	0.3174E 05	102.60	-117.13	-0.1774E 05	61.52	-1162.42	-0.6961E 05
0.0600	114.28	704.40	0.1737E 04	88.76	-204.61	0.9270E 05	101.76	-232.32	-0.3294E 05	54.83	-1513.86	-0.6962E 05
0.0650	117.70	640.11	-0.2389E 05	89.11	381.08	0.1334E 06	100.12	-435.25	-0.4819E 05	46.42	-1835.45	-0.5365E 05
0.0700	120.96	730.74	0.3478E 05	92.15	729.74	0.3478E 05	97.42	-632.51	-0.3656E 05	36.70	-2022.28	-0.1832E 05
0.0750	124.98	859.95	0.1051E 05	96.17	858.95	0.1051E 05	93.78	-827.00	-0.3575E 05	26.47	-2048.34	0.9662E 03
0.0800	129.33	872.72	0.6862E 04	100.51	871.72	0.6862E 04	89.22	-978.54	-0.2357E 05	16.18	-2041.25	0.4946E 05
0.0850	133.79	908.12	0.1667E 04	104.97	907.12	0.1667E 04	84.07	-1070.84	-0.1072E 05	6.95	-1573.70	0.1350E 06
0.0900	138.22	828.79	-0.2682E 05	109.37	781.81	-0.8198E 05	78.77	-982.45	0.6354E 05	0.76	-983.45	0.6354E 05
0.0950	142.06	712.35	-0.2411E 05	112.04	254.17	-0.1174E 06	74.77	-592.02	0.8944E 05	-3.23	-593.02	0.8944E 05
0.1000	145.22	492.36	-0.1050E 06	111.97	-171.42	0.4340E 05	72.93	-172.42	0.4340E 05	-5.09	-173.42	0.4340E 05
0.1050	146.34	12.81	-0.1161E 05	111.66	11.81	-0.1161E 05	72.63	48.76	0.3628E 05	-5.40	47.76	0.3628E 05
0.1100	146.21	-69.00	-0.1933E 05	111.66	3.02	0.6933E 04	73.30	210.83	0.2771E 05	-4.74	209.83	0.2771E 05
0.1150	145.62	-167.10	-0.1853E 05	111.79	48.72	0.5451E 04	74.67	329.26	0.1920E 05	-3.38	328.26	0.1920E 05
0.1200	144.57	-248.39	-0.1397E 05	112.07	59.88	0.3861E 03	76.51	399.10	0.7030E 04	-1.48	440.29	0.3089E 05
0.1250	143.15	-319.96	-0.1407E 05	112.38	68.16	0.3164E 04	78.60	435.07	0.7422E 04	1.11	597.56	0.3209E 05
0.1300	141.38	-390.35	-0.1478E 05	112.77	88.30	0.2723E 04	80.87	473.17	0.7522E 04	4.50	760.35	0.3263E 05
0.1350	139.23	-472.07	-0.1452E 05	113.09	3.70	-0.3331E 05	83.30	495.18	0.1642E 04	8.69	908.60	0.2795E 05
0.1400	136.74	-511.44	0.2728E 03	112.66	-178.33	-0.3931E 05	85.79	497.71	-0.1198E 04	13.59	1057.79	0.3384E 05
0.1450	134.23	-477.48	0.1459E 05	111.27	-378.19	-0.3947E 05	88.25	481.56	-0.6134E 04	19.35	1255.75	0.4783E 05
0.1500	132.05	-393.33	0.1935E 05	108.94	-540.93	-0.2066E 05	90.55	431.74	-0.1458E 05	26.29	1538.58	0.6832E 05
0.1550	130.32	-297.91	0.1671E 05	106.11	-558.82	0.1763E 05	92.49	335.79	-0.2579E 05	34.93	1936.41	0.9325E 05
0.1600	129.02	-230.33	0.9249E 04	103.64	-402.26	0.4450E 05	93.80	175.76	-0.3986E 05	45.89	2472.12	0.1241E 06
0.1650	127.96	-182.47	0.2274E 05	102.22	-183.47	0.2274E 05	94.13	-44.36	-0.4264E 05	59.89	3148.08	0.1428E 06
0.1700	127.23	-124.34	0.4550E 04	101.48	-125.34	0.4550E 04	93.39	-242.64	-0.2702E 05	77.39	3827.54	0.1125E 06
0.1750	126.61	-139.05	-0.1425E 05	100.85	-140.05	-0.1425E 05	92.00	-264.70	0.2789E 05	97.59	4162.39	-0.9397E 03
0.1800	125.66	-255.73	-0.3262E 05	99.90	-256.73	-0.3262E 05	91.24	-0.57	0.7600E 05	117.90	3851.66	-0.1284E 06
0.1850	123.94	-437.21	-0.3599E 05	98.17	-438.21	-0.3599E 05	92.22	390.60	0.7214E 05	135.30	3074.74	-0.1720E 06
0.1900	121.33	-596.08	-0.2512E 05	95.56	-597.08	-0.2512E 05	94.39	695.90	0.4581E 05	148.46	2175.06	-0.1880E 06
0.1950	118.09	-684.50	-0.7907E 04	92.32	-685.50	-0.7907E 04	98.93	955.34	0.1500E 05	156.96	1217.57	-0.1931E 06
0.2000	114.64	-682.43	0.1011E 05	88.86	-683.44	0.1011E 05	103.29	867.85	-0.1113E 05	160.65	270.19	-0.1821E 06

Table XXII. Printout. Example No. 1 (page 2 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 1, 1972 PAGE 3

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	UPPER ARM POSITION	UPPER ARM VELOCITY	UPPER ARM ACCEL.	LOWER ARM POSITION	LOWER ARM VELOCITY	LOWER ARM ACCEL.	UPPER LEG POSITION	UPPER LEG VELOCITY	UPPER LEG ACCEL.	LOWER LEG POSITION	LOWER LEG VELOCITY	LOWER LEG ACCEL.
0.0	-77.00	0.0	0.5724E 03	0.0	0.0	-0.2683E 04	6.00	0.0	-0.1820E 04	-33.00	0.0	0.1524E 04
0.0050	-76.99	3.01	0.5906E 03	-0.03	-13.90	-0.2742E 04	5.97	-10.17	-0.2032E 04	-32.97	11.44	0.2403E 04
0.0100	-76.97	5.74	0.4847E 03	-0.14	-26.94	-0.2372E 04	5.90	-19.90	-0.1784E 04	-32.88	23.83	0.2631E 04
0.0150	-76.93	7.78	0.2950E 03	-0.30	-37.06	-0.1486E 04	5.78	-27.59	-0.1154E 04	-32.73	38.31	0.3317E 04
0.0200	-76.89	8.56	-0.3690E 02	-0.50	-40.82	0.3099E 03	5.64	-25.56	0.2825E 04	-32.56	9.53	-0.1909E 05
0.0250	-76.84	16.02	0.4009E 04	-0.70	-38.67	0.3446E 03	5.56	-2.63	0.6682E 04	-32.83	-133.44	-0.3723E 05
0.0300	-76.69	49.86	0.1058E 05	-0.89	-38.11	-0.9966E 02	5.64	39.80	0.1083E 05	-33.98	-322.88	-0.3444E 05
0.0350	-76.27	122.21	0.1967E 05	-1.08	-37.87	0.7697E 02	6.00	105.72	0.1614E 05	-35.96	-454.07	-0.1479E 05
0.0400	-75.38	245.32	0.3108E 05	-1.27	-39.47	-0.1225E 04	6.75	198.86	0.2156E 05	-38.35	-486.15	0.1182E 04
0.0450	-73.72	429.86	0.4429E 05	-1.49	-54.40	-0.6020E 04	8.03	316.23	0.2529E 05	-40.75	-478.98	-0.2204E 04
0.0500	-70.96	682.60	0.5818E 05	-1.87	-106.05	-0.1694E 05	9.93	444.97	0.2561E 05	-43.24	-530.35	-0.2169E 05
0.0550	-66.78	1003.43	0.7107E 05	-2.67	-229.86	-0.3565E 05	12.47	566.77	0.2220E 05	-46.23	-683.04	-0.3900E 05
0.0600	-60.83	1387.06	0.8407E 05	-4.36	-467.03	-0.6385E 05	15.56	670.60	0.2092E 05	-50.15	-883.21	-0.3561E 05
0.0650	-52.80	1828.23	0.9112E 05	-7.60	-850.72	-0.8909E 05	19.18	775.13	0.1933E 05	-54.89	-976.95	0.6881E 04
0.0700	-42.57	2248.25	0.7073E 05	-12.94	-1271.53	-0.6984E 05	23.20	814.06	-0.2711E 04	-59.51	-838.07	0.4751E 05
0.0750	-30.78	2279.66	-0.1889E 06	-19.69	-1149.17	0.3167E 06	27.16	745.54	-0.3355E 05	-63.06	-574.82	0.5205E 05
0.0800	-22.94	898.45	-0.7335E 05	-19.68	1084.27	0.1383E 06	30.30	483.64	-0.5632E 05	-65.33	-335.22	0.5408E 05
0.0850	-19.35	540.87	-0.6637E 05	-12.55	1762.22	0.1258E 06	32.04	216.88	-0.5071E 05	-66.38	-93.68	0.4481E 05
0.0900	-17.43	235.17	-0.5608E 05	-2.31	2290.82	0.7404E 05	32.53	-6.87	-0.3591E 05	-66.29	129.66	0.4540E 05
0.0950	-16.86	19.63	-0.2532E 05	9.82	2504.01	0.6034E 04	32.11	-148.84	-0.2000E 05	-65.07	358.34	0.4563E 05
0.1000	-16.97	-37.87	0.1014E 05	22.24	2424.24	-0.3957E 05	31.15	-224.43	-0.1131E 05	-62.72	569.14	0.3024E 05
0.1050	-17.03	14.30	0.9245E 04	33.83	2211.40	-0.3760E 05	29.92	-272.10	-0.2058E 05	-59.52	703.79	0.1973E 05
0.1100	-16.85	53.76	0.5752E 04	44.44	2036.78	-0.3014E 05	28.33	-363.22	-0.1562E 05	-55.78	785.30	0.1221E 05
0.1150	-16.52	76.28	0.4171E 04	54.29	1912.81	-0.1770E 05	26.33	-430.74	-0.1073E 05	-51.72	835.32	0.9350E 04
0.1200	-16.08	106.07	0.9217E 04	63.68	1857.13	-0.3826E 04	24.06	-471.63	-0.5269E 04	-47.43	881.94	0.9170E 04
0.1250	-15.42	158.24	0.1164E 05	72.91	1831.52	-0.6519E 04	21.64	-498.42	-0.5091E 04	-42.93	905.37	-0.3467E 04
0.1300	-14.48	219.33	0.1199E 05	81.98	1794.10	-0.7403E 04	19.09	-520.18	-0.3271E 04	-38.50	859.96	-0.1421E 05
0.1350	-13.28	250.36	0.1470E 04	90.94	1814.91	0.1872E 05	16.45	-530.45	-0.2364E 03	-34.38	786.43	-0.1485E 05
0.1400	-12.01	256.39	0.2641E 04	100.35	1969.34	0.4541E 05	13.81	-525.08	0.2705E 04	-30.63	713.33	-0.1913E 05
0.1450	-10.67	291.12	0.1384E 05	110.85	2251.28	0.6901E 05	11.23	-506.35	0.4375E 04	-27.36	580.86	-0.3438E 05
0.1500	-8.98	401.29	0.3604E 05	123.04	2633.65	0.6787E 05	8.75	-485.23	0.4092E 04	-24.93	386.25	-0.4327E 05
0.1550	-6.42	633.82	0.5002E 05	136.70	2738.17	-0.4339E 05	6.38	-460.46	0.6207E 04	-23.55	159.22	-0.4714E 05
0.1600	-2.69	840.35	0.2601E 05	149.38	2224.22	-0.1731E 06	4.18	-416.11	0.1194E 05	-23.35	-79.54	-0.4774E 05
0.1650	1.73	901.40	-0.1381E 04	157.96	1138.39	-0.2559E 06	2.25	-352.92	0.1068E 05	-24.34	-309.46	-0.4219E 05
0.1700	6.07	818.19	-0.2380E 05	162.42	819.19	-0.2380E 05	0.52	-355.28	-0.5635E 04	-26.35	-485.59	-0.2861E 05
0.1750	9.82	675.27	-0.3197E 05	166.11	630.28	-0.5756E 05	-1.33	-377.60	0.2157E 04	-29.10	-603.29	-0.1793E 05
0.1800	12.79	517.42	-0.2827E 05	168.41	259.60	-0.9225E 05	-3.11	-313.66	0.2696E 05	-32.31	-674.00	-0.9780E 04
0.1850	15.09	418.50	-0.6910E 04	168.49	-233.48	-0.1002E 06	-4.26	-130.87	0.4456E 05	-35.78	-711.93	-0.6899E 04
0.1900	17.18	439.49	0.1720E 05	166.08	-728.49	-0.9661E 05	-4.33	105.42	0.4879E 05	-39.42	-740.30	-0.3420E 04
0.1950	19.67	572.98	0.3725E 05	161.25	-1194.64	-0.8851E 05	-3.20	346.07	0.4669E 05	-43.14	-743.18	0.3321E 04
0.2000	23.06	792.30	0.5051E 05	154.20	-1617.40	-0.8037E 05	-0.90	571.46	0.4306E 05	-46.78	-708.08	0.1171E 05

Table XXII. Printout. Example No. 1 (page 3 of 27)

	VEHICULAR MOTION			BODY MOTION AT HIP JOINT					
TIME	POSITION	VELOCITY	ACCEL.	RELATIVE DISPL.	HORIZONTAL VELOCITY	ACCEL.	RELATIVE DISPL.	VERTICAL VELOCITY	ACCEL.
	(IN.)	(IN./SEC.)	(G-UNITS)	(IN.)	(IN./SEC.)	(G-UNITS)	(IN.)	(IN./SEC.)	(G-UNITS)
0.0	0.0	528.00	0.0	0.0	529.00	0.092	0.0	0.0	0.329
0.0050	2.630	521.97	-6.244	0.008	527.05	-0.579	0.001	0.50	0.228
0.0100	5.200	503.88	-12.487	0.071	525.84	-0.714	0.005	0.82	0.050
0.0150	7.649	473.72	-18.731	0.247	524.18	-1.094	0.009	0.57	-0.418
0.0200	9.917	431.50	-24.974	0.594	521.40	-2.003	0.008	-1.02	-1.421
0.0250	11.954	383.25	-24.974	1.152	515.85	-4.172	-0.005	-4.19	-1.846
0.0300	13.749	335.00	-24.974	1.911	504.92	-7.733	-0.035	-8.05	-2.238
0.0350	15.304	286.75	-24.974	2.837	485.91	-12.589	-0.087	-13.14	-3.066
0.0400	16.617	238.50	-24.974	3.885	457.03	-17.774	-0.168	-19.46	-3.393
0.0450	17.689	190.25	-24.974	5.006	418.75	-22.032	-0.282	-25.79	-3.014
0.0500	18.519	142.00	-24.974	6.159	373.61	-24.715	-0.424	-30.89	-2.126
0.0550	19.109	93.77	-24.600	7.315	324.41	-26.243	-0.587	-34.03	-0.963
0.0600	19.469	52.28	-18.356	8.449	273.03	-26.646	-0.762	-36.05	-2.387
0.0650	19.651	22.84	-12.113	9.502	221.08	-27.570	-0.957	-42.41	-3.339
0.0700	19.717	5.47	-5.869	10.399	162.32	-32.854	-1.168	-38.56	5.418
0.0750	19.726	0.14	0.0	11.038	95.54	-37.462	-1.329	-24.39	12.029
0.0800	19.727	0.14	0.0	11.322	16.50	-42.579	-1.376	7.44	15.006
0.0850	19.728	0.14	0.0	11.209	-60.43	-38.402	-1.267	35.36	13.326
0.0900	19.728	0.14	0.0	10.725	-131.33	-34.188	-1.036	54.49	4.768
0.0950	19.729	0.14	0.0	9.910	-192.13	-28.039	-0.753	55.55	-4.089
0.1000	19.730	0.14	0.0	8.824	-238.56	-15.569	-0.502	44.41	-4.271
0.1050	19.731	0.14	0.0	7.564	-263.32	-11.844	-0.306	35.90	3.673
0.1100	19.731	0.14	0.0	6.200	-280.01	-4.920	-0.109	42.66	3.434
0.1150	19.732	0.14	0.0	4.783	-295.07	-0.973	0.120	48.52	1.737
0.1200	19.733	0.14	0.0	3.355	-285.06	1.093	0.367	49.04	-1.419
0.1250	19.733	0.14	0.0	1.934	-282.63	1.482	0.605	46.50	-1.190
0.1300	19.734	0.14	0.0	0.527	-279.55	1.704	0.932	44.29	-1.121
0.1350	19.735	0.14	0.0	-0.862	-275.20	5.540	1.048	42.06	-0.256
0.1400	19.736	0.14	0.0	-2.194	-253.02	18.441	1.263	45.50	4.221
0.1450	19.736	0.14	0.0	-3.355	-207.73	29.032	1.517	57.40	8.512
0.1500	19.737	0.14	0.0	-4.243	-144.47	36.662	1.850	76.93	11.530
0.1550	19.738	0.14	0.0	-4.781	-69.09	41.225	2.291	98.97	10.747
0.1600	19.739	0.14	0.0	-4.925	12.16	42.212	2.832	115.83	6.074
0.1650	19.739	0.14	0.0	-4.665	90.73	37.545	3.434	124.56	3.984
0.1700	19.740	0.14	0.0	-4.044	154.97	28.181	4.095	141.43	9.727
0.1750	19.741	0.14	0.0	-3.149	199.83	16.456	4.844	155.69	1.536
0.1800	19.741	0.14	0.0	-2.090	219.52	2.352	5.607	143.96	-15.875
0.1850	19.742	0.14	0.0	-0.998	215.15	-4.876	6.229	100.98	-27.423
0.1900	19.743	0.14	0.0	0.049	203.54	-7.140	6.595	44.04	-31.054
0.1950	19.744	0.14	0.0	1.030	188.76	-8.029	6.664	-16.62	-31.519
0.2000	19.744	0.14	0.0	1.934	173.33	-7.757	6.429	-77.30	-31.229

Table XXII. Printout. Example No. 1 (page 4 of 27)

TIME	ACCELEROMETER READINGS HEAD RESULTANT (G-UNITS)	HEAD ANGLE (DEG.)	CHEST RESULTANT (G-UNITS)	CHEST ANGLE (DEG.)	BELT FORCES (LBS) LAP	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	SEAT FORCES (LBS) AT HIP	AT FRONT EDGE
0.0	0.3	-8.2	0.4	138.7	0.0	0.0	0.0	145.00	0.0
0.0050	0.3	3.2	0.4	141.0	3.3	0.0	0.0	144.92	0.0
0.0100	0.3	-16.7	0.4	159.1	25.4	0.0	0.0	146.16	0.0
0.0150	0.3	-68.9	0.4	-144.9	84.4	0.0	0.0	149.33	0.0
0.0200	0.9	-97.1	1.1	-109.6	197.5	0.0	0.0	155.51	0.0
0.0250	1.9	-99.3	2.4	-143.5	377.0	0.0	155.7	164.66	0.0
0.0300	3.5	-100.3	5.0	-157.9	618.5	12.3	389.7	175.23	7.02
0.0350	6.1	-102.6	9.5	-160.7	902.3	121.1	687.7	187.51	14.43
0.0400	9.2	-105.4	15.6	-163.3	1193.6	258.2	1041.8	201.32	20.92
0.0450	13.2	-109.2	22.9	-166.1	1453.8	416.9	1439.3	215.40	26.85
0.0500	18.3	-114.2	30.8	-169.3	1656.3	586.9	1863.0	228.47	33.49
0.0550	25.0	-120.8	36.1	-172.6	1794.3	756.1	2291.8	239.78	43.07
0.0600	32.4	-129.0	47.1	-176.1	1880.5	909.2	2700.9	249.55	58.10
0.0650	40.4	-139.1	52.3	-177.9	1942.7	1025.4	3053.6	263.28	80.72
0.0700	47.3	-150.6	43.0	-176.3	2007.5	1081.4	3326.2	265.74	109.50
0.0750	40.9	-164.4	36.1	173.5	2065.6	1037.7	3519.1	254.14	134.34
0.0800	58.7	172.3	41.2	170.8	2079.9	875.6	3626.8	218.11	141.03
0.0850	64.4	142.8	35.6	171.8	1985.8	601.1	3626.5	178.99	118.11
0.0900	59.6	149.0	18.4	142.4	1772.4	232.9	3488.6	143.84	66.40
0.0950	67.8	132.3	12.5	110.6	1454.9	0.0	3201.2	125.65	0.0
0.1000	46.6	140.0	19.9	151.2	1047.2	0.0	2767.8	121.75	0.0
0.1050	36.4	136.3	13.8	145.3	609.8	0.0	2193.5	118.50	0.0
0.1100	27.3	134.4	9.9	136.7	176.9	0.0	1508.3	100.25	0.0
0.1150	16.8	131.6	5.0	114.6	0.0	0.0	750.5	82.19	0.0
0.1200	10.8	102.3	2.1	16.2	0.0	0.0	0.0	68.26	0.0
0.1250	11.1	111.6	1.9	10.6	0.0	0.0	0.0	56.39	0.0
0.1300	11.2	119.3	2.5	6.7	0.0	0.0	0.0	42.94	0.0
0.1350	14.1	52.6	16.4	15.7	0.0	0.0	0.0	28.12	0.0
0.1400	24.6	35.9	29.5	13.5	0.0	0.0	0.0	7.11	0.0
0.1450	32.5	35.3	38.8	12.7	0.0	0.0	0.0	0.0	0.0
0.1500	33.3	40.9	42.0	11.9	0.0	0.0	0.0	0.0	0.0
0.1550	22.7	54.2	37.9	8.5	0.0	0.0	0.0	0.0	0.0
0.1600	6.5	116.3	34.0	2.6	0.0	200.8	0.0	0.0	0.0
0.1650	31.3	-126.9	32.7	-0.0	0.0	398.6	0.0	0.0	0.0
0.1700	68.6	-102.1	30.5	16.9	0.0	595.7	0.0	0.0	0.0
0.1750	101.0	-78.3	19.9	10.4	352.5	824.7	0.0	0.0	0.0
0.1800	86.8	-52.8	14.0	-53.3	911.6	1083.8	0.0	0.0	0.0
0.1850	56.3	-25.7	24.3	-81.8	1336.0	1335.3	0.0	0.0	0.0
0.1900	36.2	3.4	31.7	-90.3	1587.8	1540.8	0.0	0.0	0.0
0.1950	26.6	31.7	36.2	-98.0	1713.9	1678.0	0.0	0.0	0.0
0.2000	23.9	44.1	38.1	-105.5	1764.9	1732.8	0.0	0.0	0.0

Table XXII. Printout. Example No. 1 (page 5 of 27)

CONTACT FORCES (LBS.)

TIME	FOOT ON FLOOR	FOOT ON TOE BOARD	UPPER TORSO ON SEAT BACK	HIP ON SEAT BACK
0.0	18.5	0.0	0.0	0.0
0.0050	18.5	0.0	0.0	0.0
0.0100	19.8	0.0	0.0	0.0
0.0150	23.7	0.0	0.0	0.0
0.0200	40.4	202.1	0.0	0.0
0.0250	141.3	439.6	0.0	0.0
0.0300	385.3	611.9	0.0	0.0
0.0350	736.5	718.1	0.0	0.0
0.0400	1083.3	841.0	0.0	0.0
0.0450	1326.2	1051.2	0.0	0.0
0.0500	1447.8	1321.9	0.0	0.0
0.0550	1501.9	1534.6	0.0	0.0
0.0600	1541.1	1548.0	0.0	0.0
0.0650	1524.3	1177.0	0.0	0.0
0.0700	1210.1	666.8	0.0	0.0
0.0750	525.8	293.0	0.0	0.0
0.0800	0.0	2.7	0.0	0.0
0.0850	0.0	0.0	0.0	0.0
0.0900	0.0	0.0	0.0	0.0
0.0950	0.0	0.0	0.0	0.0
0.1000	0.0	0.0	0.0	0.0
0.1050	0.0	0.0	0.0	0.0
0.1100	0.0	0.0	0.0	0.0
0.1150	0.0	0.0	0.0	0.0
0.1200	0.0	0.0	0.0	0.0
0.1250	0.0	107.2	0.0	0.0
0.1300	0.0	190.9	53.6	0.0
0.1350	0.0	134.7	1243.2	252.9
0.1400	0.0	0.0	2317.7	1252.4
0.1450	0.0	0.0	3171.5	2112.0
0.1500	0.0	0.0	3723.0	2743.9
0.1550	0.0	0.0	3932.4	3084.4
0.1600	0.0	0.0	3789.3	3094.9
0.1650	0.0	0.0	3287.4	2747.1
0.1700	0.0	0.0	2454.0	2095.1
0.1750	0.0	0.0	1384.7	1241.6
0.1800	0.0	0.0	280.9	323.3
0.1850	0.0	0.0	0.0	0.0
0.1900	0.0	0.0	0.0	0.0
0.1950	0.0	0.0	0.0	0.0
0.2000	0.0	0.0	0.0	0.0

Table XXII. Printout. Example No. 1 (page 6 of 27)

SUMMARY OF TOLERANCE DATA USED IN INJURY CRITERIA

QUANTITY	MAXIMUM ACCEPTABLE VALUE	NATURE OF INJURY OR DATA	WEIGHTING CODE
1. SEVERITY INDEX	1. 1500	1. INTERNAL HEAD INJURY. DANGEROUS TO LIFE.	1. 22/26
2. HEAD PITCH ACCELERATION	2. 1800 RAD/SEC/SEC	2. 50% CHANCE OF CEREBRAL CONCUSSION.	2. 12/26
3. CHEST LOAD	3. 2000 LB	3. RIB FRACTURE OF CADAVER,	3. 1[illegible]/26
4. SHOULDER BELT LOAD	4. 2000 LB COMBINED	4. PREDICTED TOLERANCE LEVEL WITHOUT INJURY.	4. 1/26
5. PELVIC BELT LOAD	5. 4000 LB	5. MAXIMUM VOLUNTARY LOAD.	5. 1/26
6. KNEE LOAD (EACH)	6. 1400 LB	6. COMMINUTED PATELLA FRACTURE.	6. 12/26
7. CHEST A-P G-LOAD	7. 60 G-PEAK	7. VOLUNTEER DATA WITH NO INJURY. (DURATION=.09 SEC, RISE TIME=500 G/SEC) HIGHER RISE TIMES OR LONGER DURATIONS CAN DECREASE THIS VALUE SIGNIFICANTLY.	7. 4/26
8. CHEST S-I G-LOAD	8. 26 G-PEAK	8. VOLUNTEER DATA. FRACTURED VERTEBRAE	8. 16/26

LIST OF REFERENCES

1. GADD, C.W., "USE OF A WEIGHTED-IMPULSE CRITERION FOR ESTIMATING INJURY HAZARD", PROC. 10TH. STAPP CAR CRASH CONF., NOV. 1966, P.95-100.
2. OMMAYA, A.K. ET AL, "COMPARATIVE TOLERANCES FOR CEREBRAL CONCUSSION BY HEAD IMPACT AND WHIPLASH INJURY IN PRIMATES", 1970 INTERNATIONAL AUTOMOBILE SAFETY CONFERENCE COMPENDIUM, SAE PUB. NO. P-30, P.808-817.
3. GADD, C.W. AND PATRICK, L.M., "SYSTEM VERSUS LABORATORY IMPACT TESTS FOR ESTIMATING INJURY HAZARD", SAE PAPER NO. 680053, JAN. 1968.
4. -, ESTIMATED PROBABLE THRESHOLD OF INJURY BY BIOMECHANICS TASK FORCE OF SAE OCCUPANT RESTRAINT SYSTEMS SUBCOMMITTEE.
5. STAPP, J.P. AND ENFIELD, D.L., "EVALUATION OF THE LAP-TYPE AUTOMOBILE SAFETY BELT WITH REFERENCE TO HUMAN TOLERANCE", SAE PAPER NO. 62A, 1958.
6. SNYDER, R.G., "HUMAN IMPACT TOLERANCE", 1970 INTERNATIONAL AUTOMOBILE SAFETY CONFERENCE COMPENDIUM, SAE PUB. NO. P-30, P.712-782.
7. IBID.
8. IBID.

NOTE: THE WEIGHTING CODE IS BASED ON VAN KIRK, D.J. AND LANGE, W.A., "A DETAILED INJURY SCALE FOR ACCIDENT INVESTIGATION", PROC. OF THE 12TH. STAPP CAR CRASH CONFERENCE, OCT. 1968, P.240-259.
MINOR INJURY = 1-4/26, MODERATE INJURY = 8-10/26, MODERATELY SEVERE INJURY = 12-14/26,
SEVERE INJURY = 16-18/26, CRITICAL INJURY = 20-22/26, FATAL INJURY = 24-26/26.

Table XXII. Printout. Example No. 1 (page 7 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR   OUTPUT DATA   SEP 1, 197[illegible]   PAGE 8

SUMMARY OF ANGULAR MOTION LIMITS USED IN INJURY CRITERIA

JOINT	FLEXION	HYPEREXTENSION
1. HIP	10 DEG	130 DEG
2. LOWER SPINE	20 DEG	22 DEG
3. UPPER SPINE	20 DEG	22 DEG
4. NECK	70 DEG	70 DEG
5. SHOULDER	55 DEG	190 DEG
6. ELBOW	5 DEG	140 DEG
7. KNEE	5 DEG	140 DEG

NOTE: ALL QUANTITIES MEASURED FROM AN ERECT STANDING POSITION WITH ARMS AT SIDES.

Table XXII. Printout. Example No. 1 (page 8 of 27)

SUMMARY OF QUANTITIES EXCEEDING TOLERANCES

QUANTITY	PEAK	TIME OF OCCURRENCE	DURATION	TIME START	TIME END	WEIGHTING CODE
HEAD PITCH ACCELERATION	2356.	0.085000	0.004091	0.083138	0.087229	12/26
HEAD PITCH ACCELERATION	2492.	0.165000	0.013817	0.156602	0.170419	12/26
SHOULDER BELT LOAD	4557.	0.075000	0.060201	0.046211	0.106412	1/26
CHEST S-I G-LOAD	-42.	0.065000	0.013752	0.061860	0.075612	16/26
CHEST S-I G-LOAD	27.	0.085000	0.000600	0.084848	0.085448	16/26
CHEST S-I G-LOAD	39.	0.145000	0.010357	0.141249	0.151605	16/26
CHEST S-I G-LOAD	38.	0.165000	0.009508	0.158032	0.167540	16/26
CHEST S-I G-LOAD	38.	0.195000	0.009015	0.187876	0.196891	16/26
UPPER SPINE HYPEREXTENSION	39.	0.100000	0.059738	0.085828	0.145565	-----
NECK HYPEREXTENSION	78.	0.115000	0.065984	0.077347	0.143331	-----
ELBOW FLEXION	3.	0.080000	0.003568	0.078888	0.082456	-----
ELBOW HYPEREXTENSION	156.	0.170000	0.042160	0.153596	0.195756	-----

Table XXII. Printout. Example No. 1 (page 9 of 27)

PROBABILITY OF OCCURRENCE

THE PROBABILITY OF OCCURRENCE IS BASED ON:

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1. PROBABILITY OF FRONT COLLISION               =  0.4430
2. PROBABILITY OF DRIVER                        =  1.0000
3. PROBABILITY OF SHOULDER & LAP BELT USE       =  0.0460

          PROBABILITY OF OCCURRENCE =   0.0204
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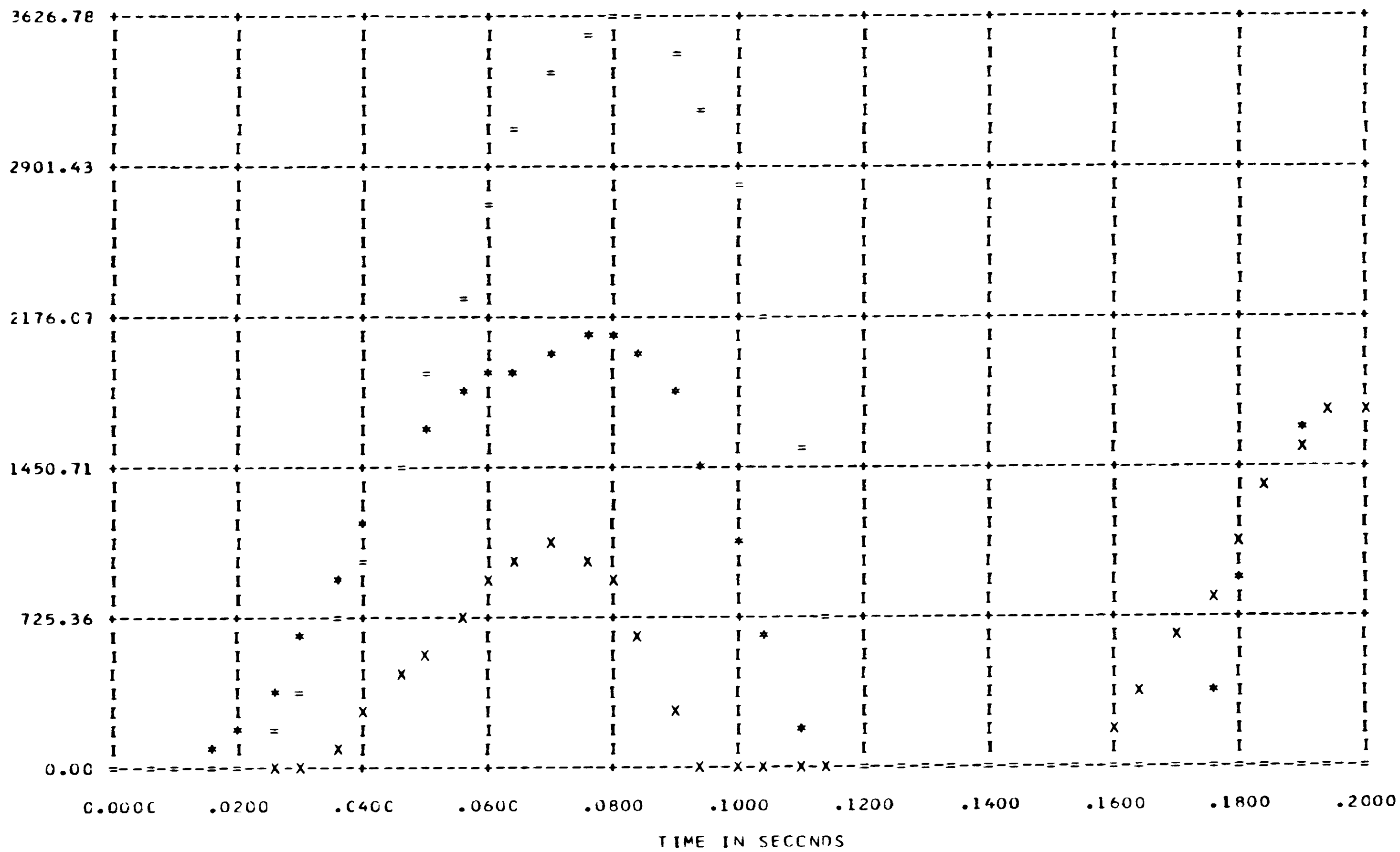
Table XXII. Printout. Example No. 1 (page 10 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR   PLOT OF OUTPUT DATA

BELT FORCES IN LBS.

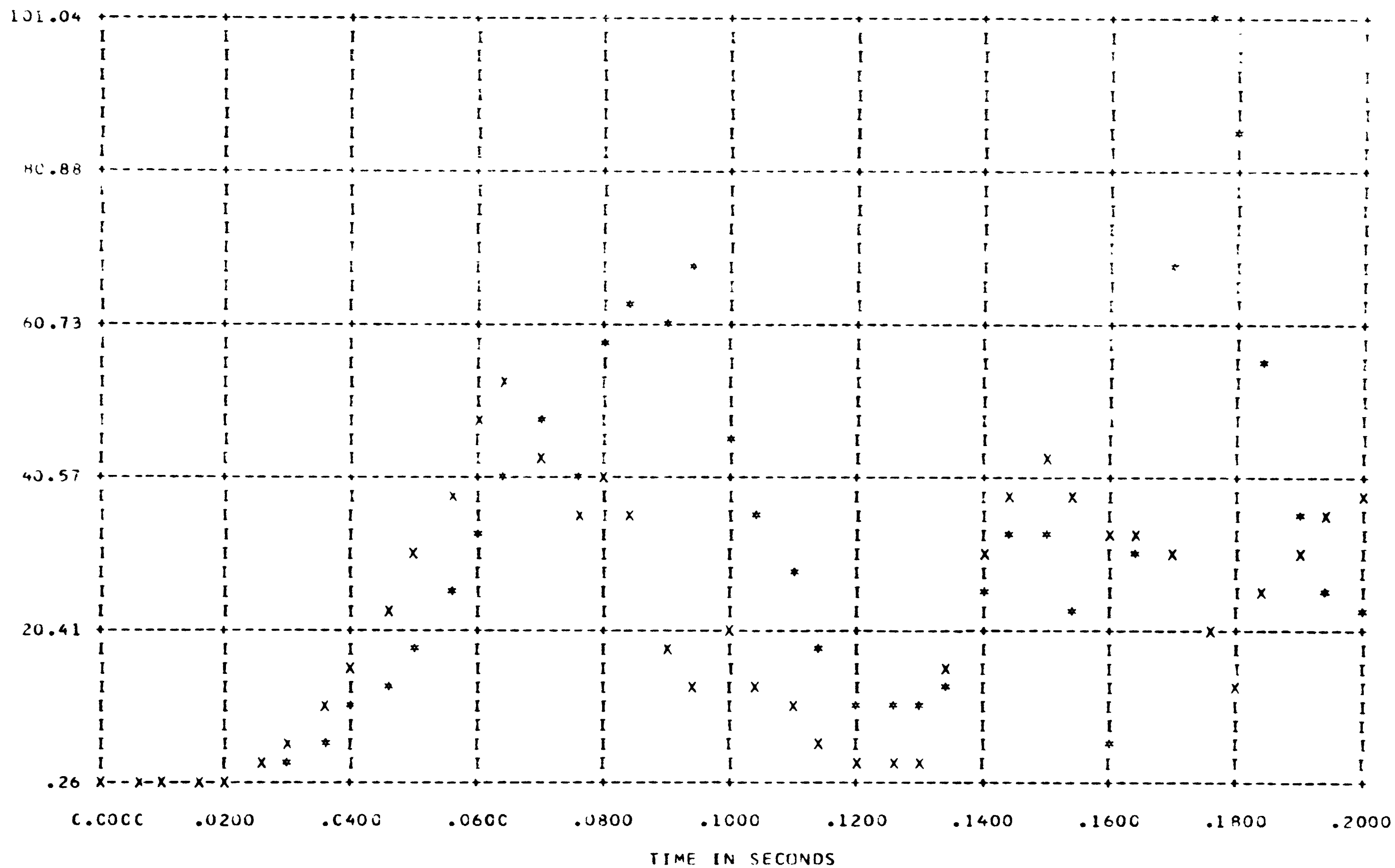


* IS LAP BELT
X IS LOWER SHOULDER RESTRAINT
= IS UPPER SHOULDER RESTRAINT

Table XXII. Printout. Example No. 1 (page 11 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR   PLOT OF OUTPUT DATA

ACCELERATION, IN G-UNITS

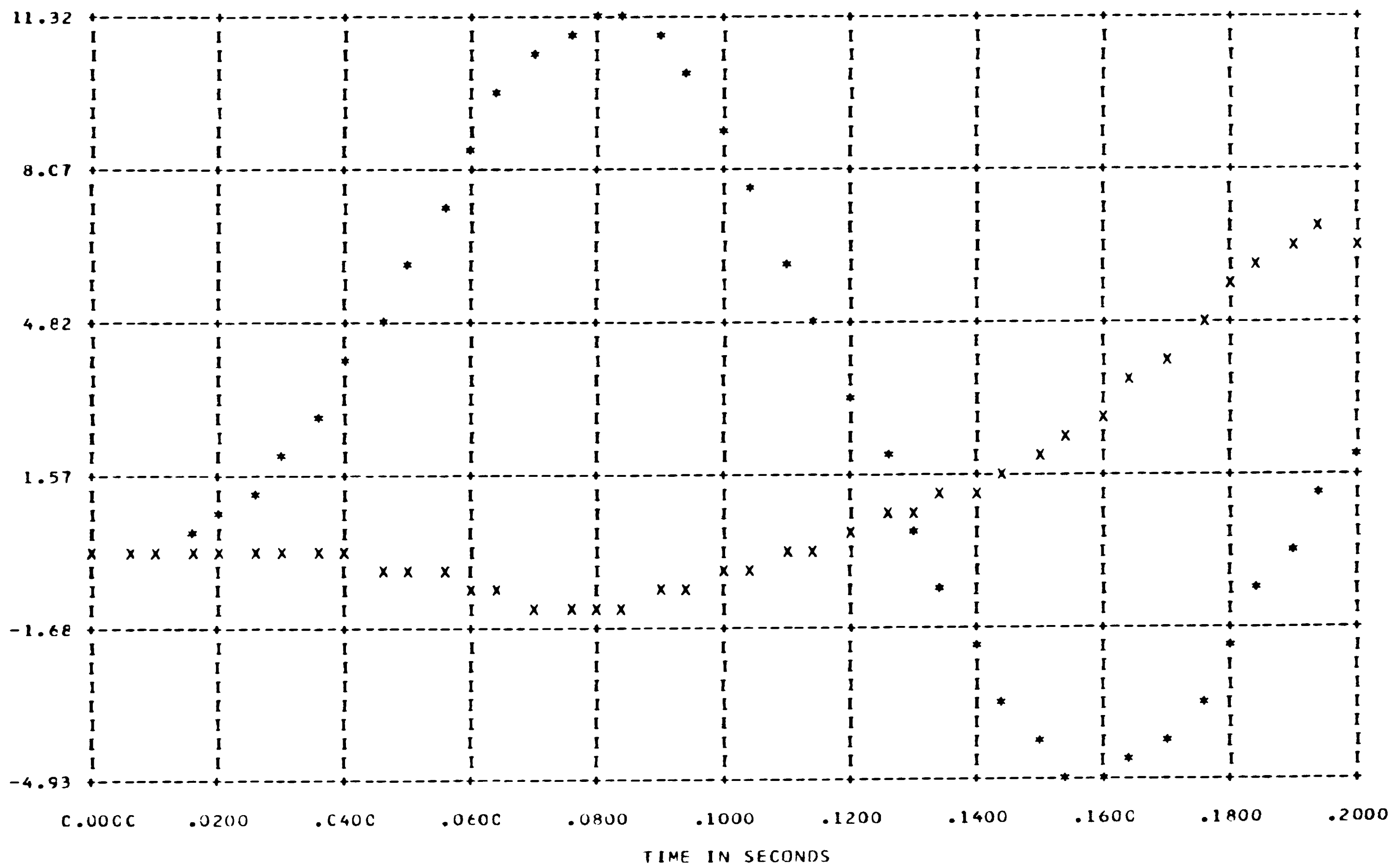


* IS HEAD ACCELERATION
X IS CHEST ACCELERATION

Table XXII. Printout. Example No. 1 (page 12 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR   PLOT OF OUTPUT DATA

HIP POSITION IN INCHES



* IS HORIZONTAL HIP POSITION
X IS VERTICAL HIP POSITION

Table XXII. Printout. Example No. 1 (page 13 of 27)

VEHICLE INPUT PULSE IN G-UNITS

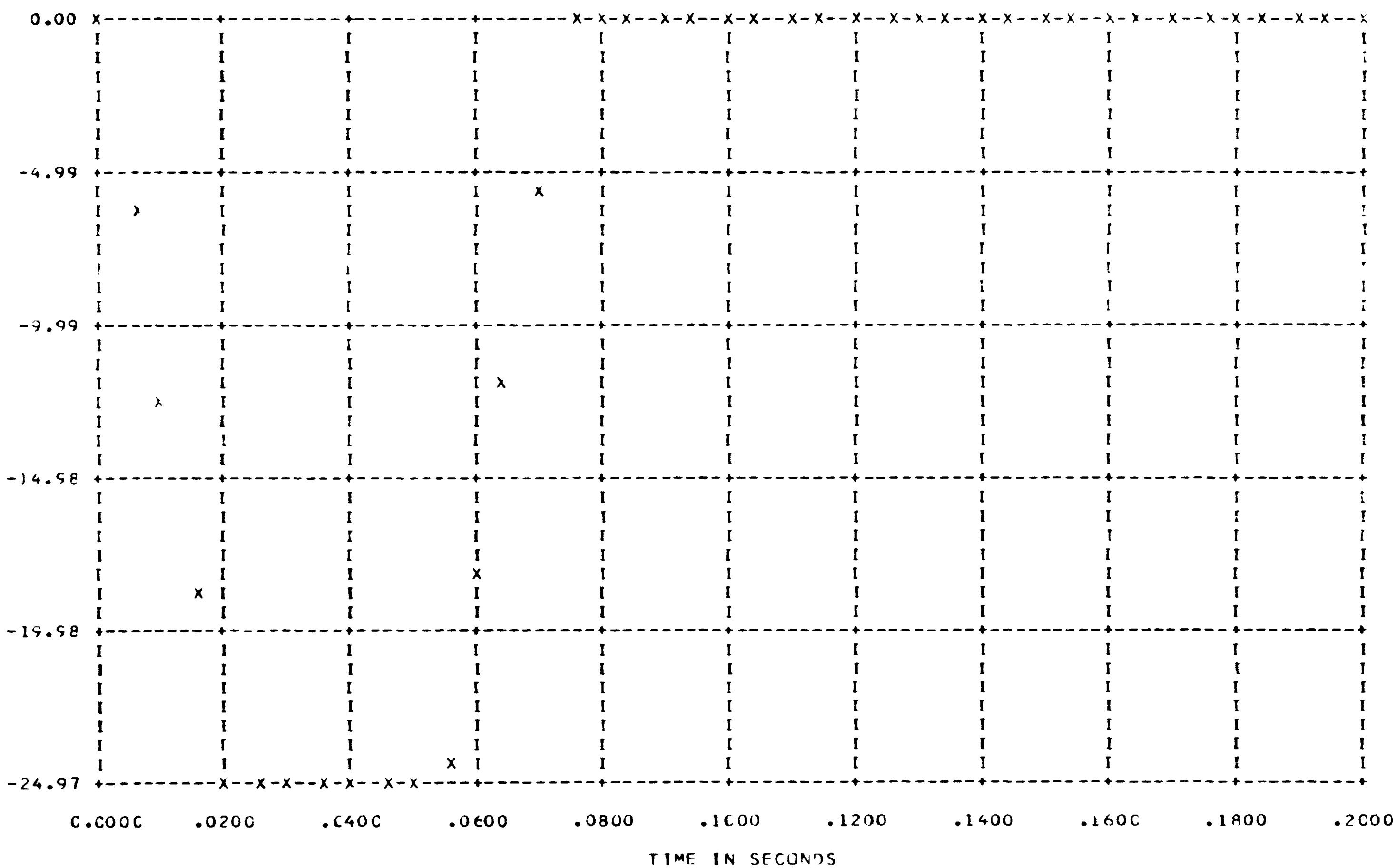


Table XXII. Printout. Example No. 1 (page 14 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR PLOT OF OUTPUT DATA

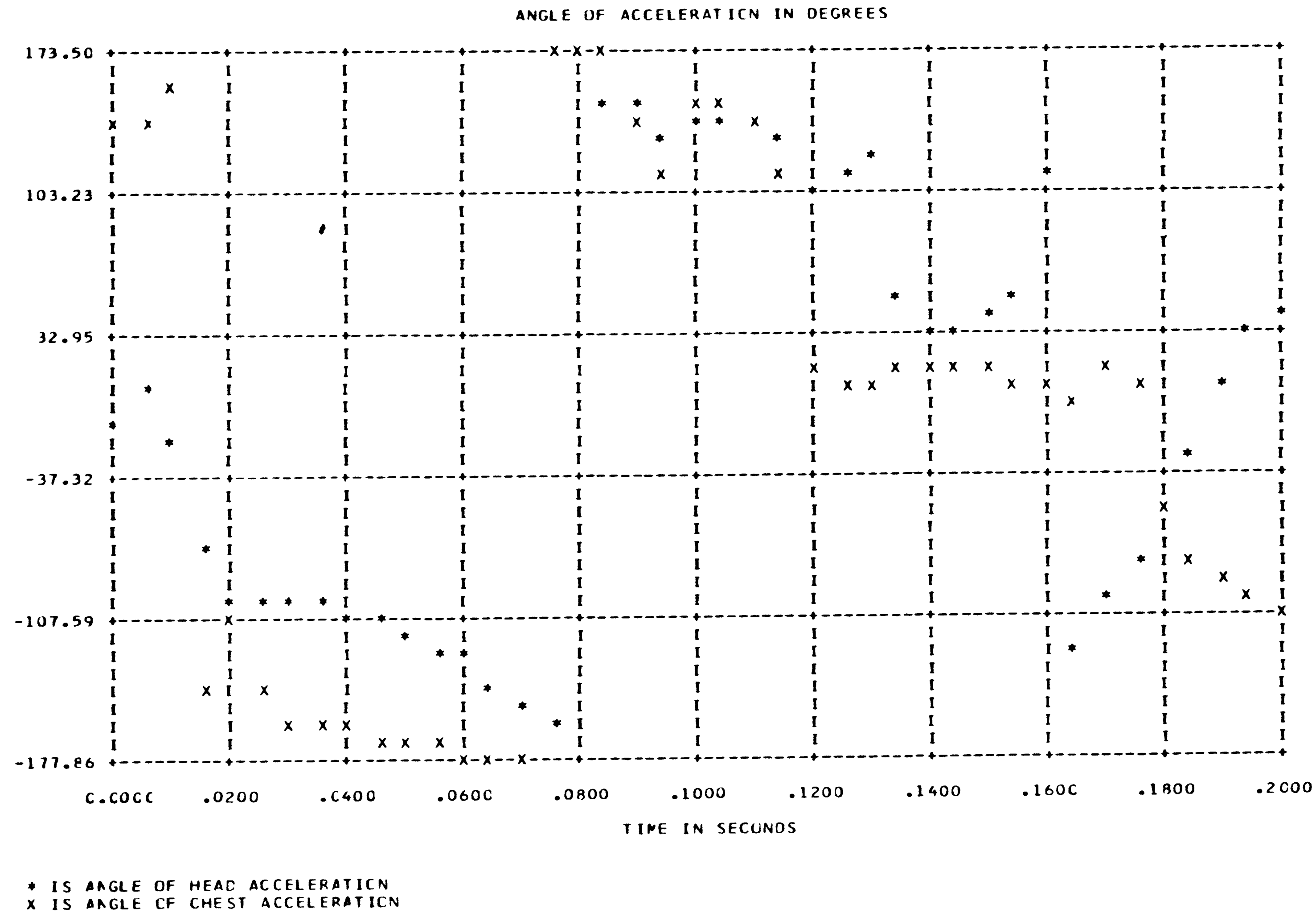
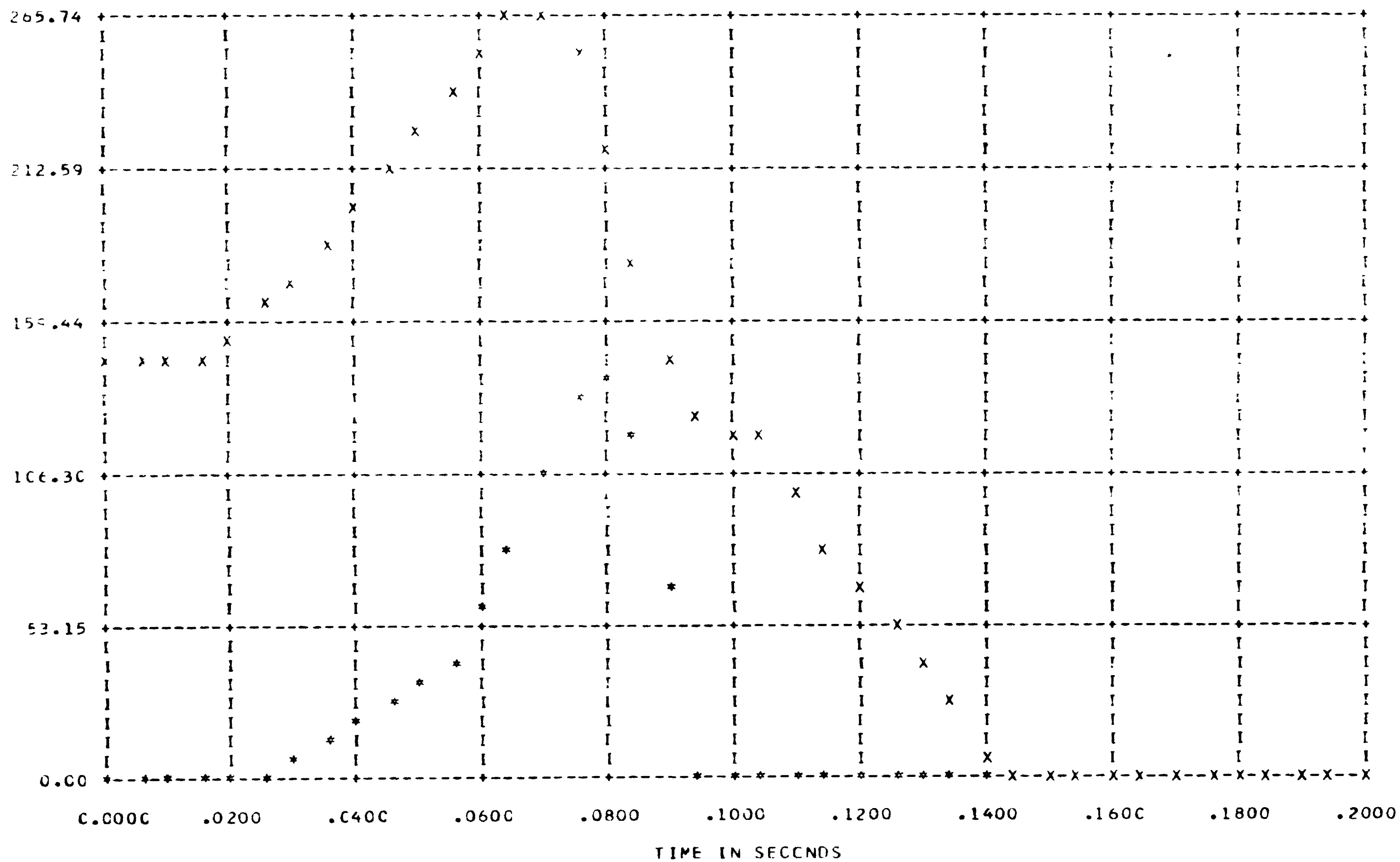


Table XXII. Printout. Example No. 1 (page 15 of 27)

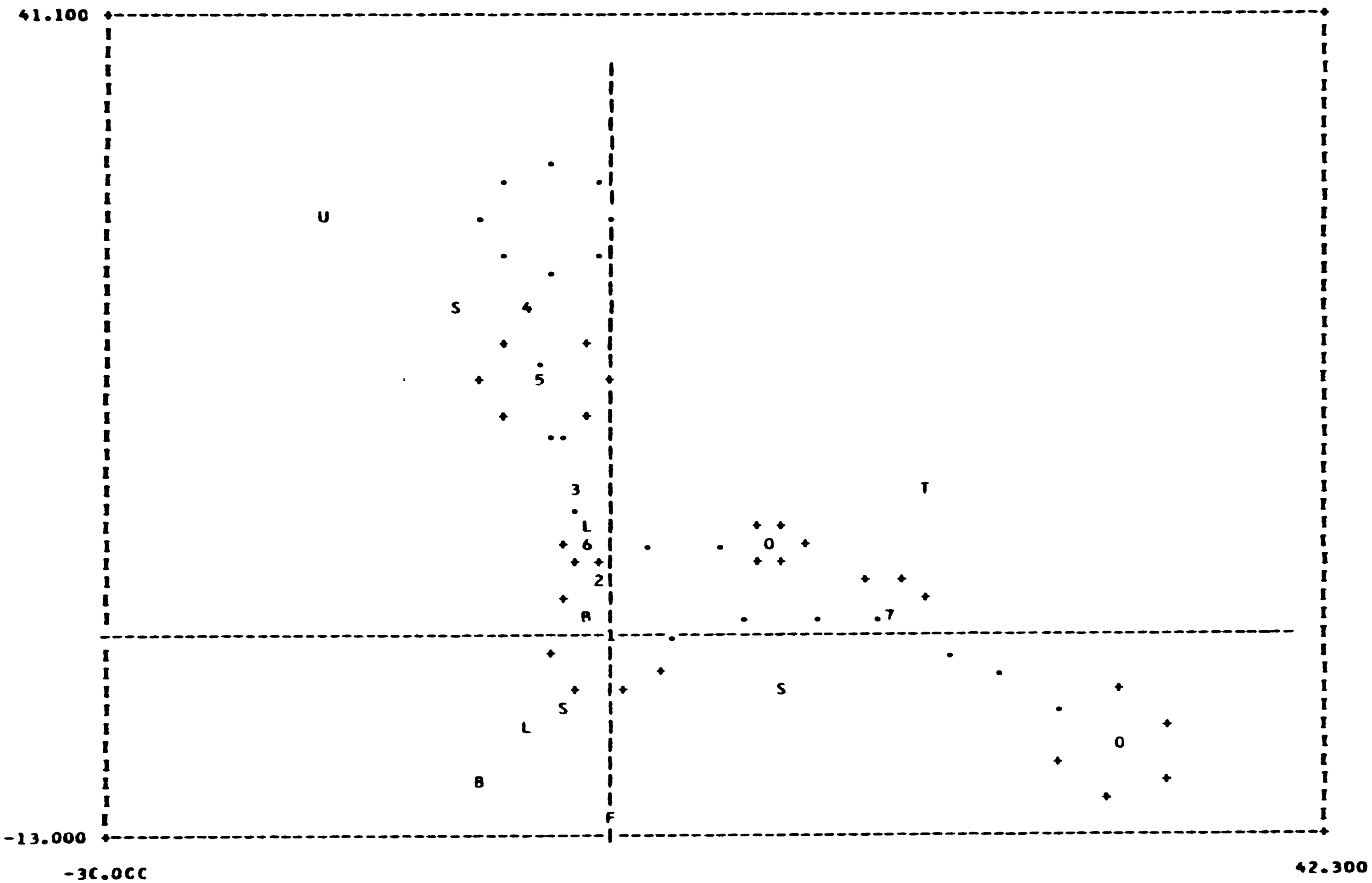
SEAT FORCES IN LBS.



* IS SEAT FORCE AT FRONT OF SEAT
X IS SEAT FORCE AT HIP

Table XXII. Printout. Example No. 1 (page 16 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 1, 1972
STICK FIGURE REPRESENTATION FOR TIME = 0.0 SECONDS

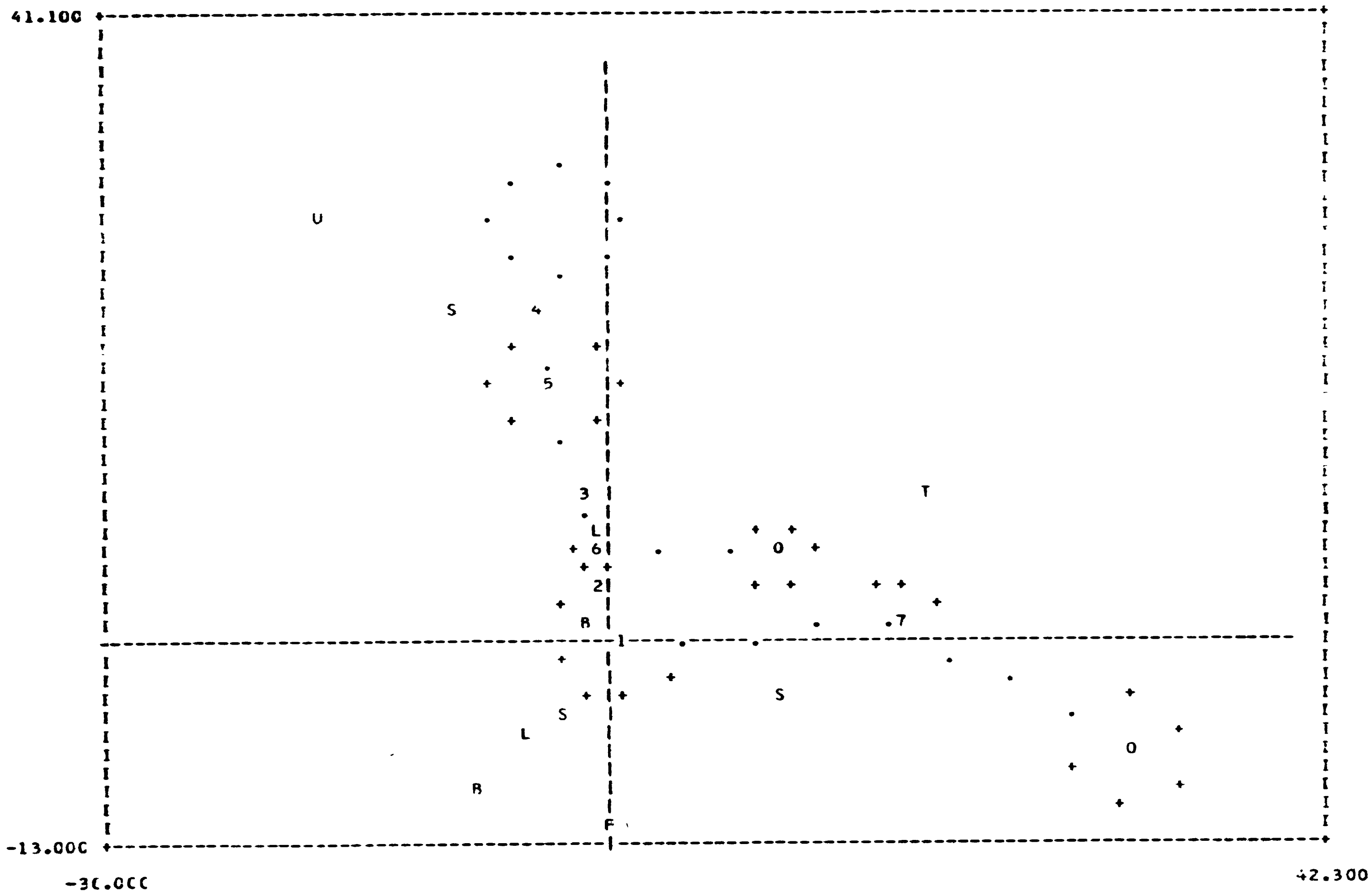


INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 17 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR   OUTPUT DATA   SEP 1, 1972   PAGE 18

STICK FIGURE REPRESENTATION FOR TIME = 0.020 SECONDS

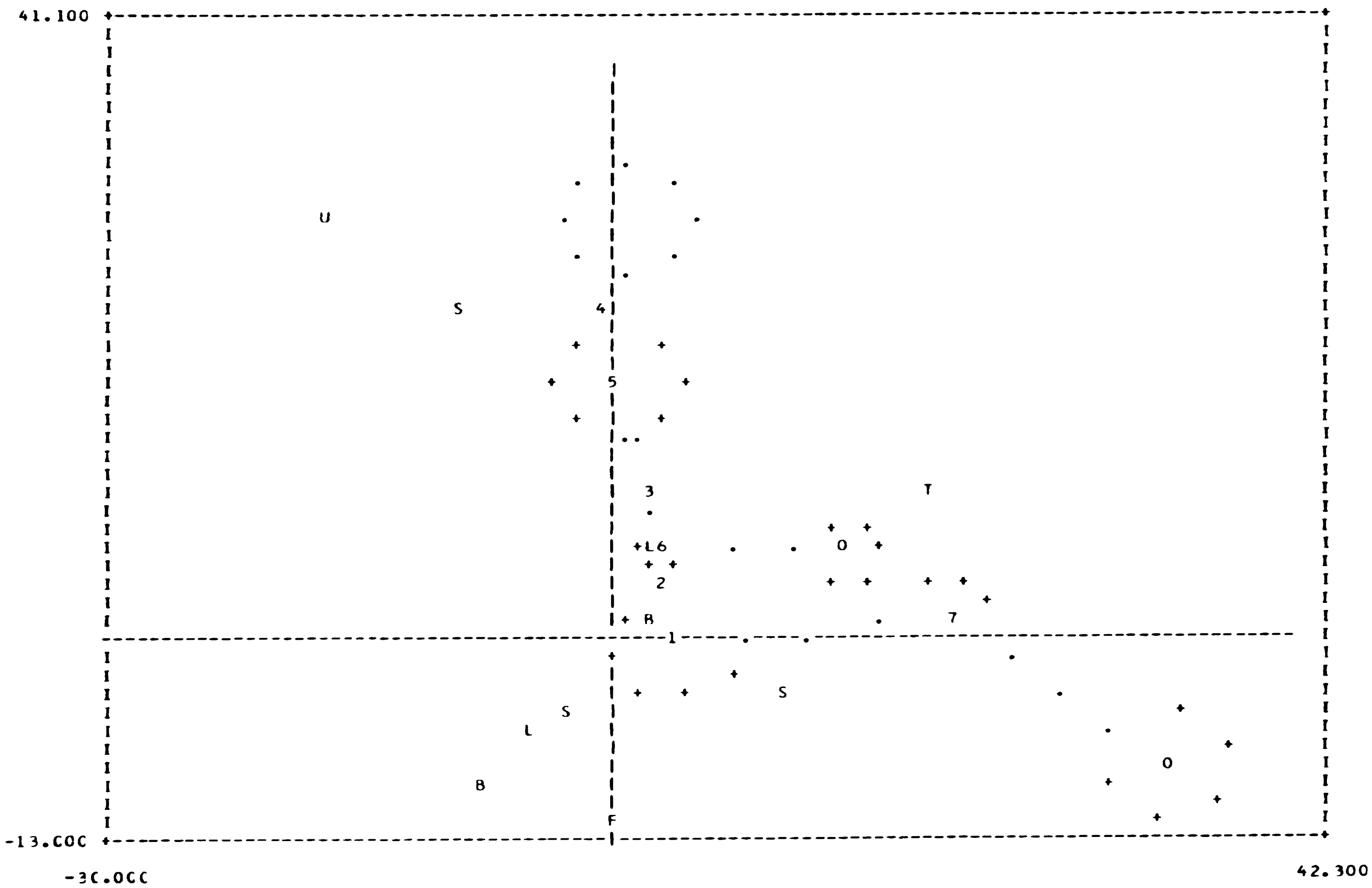


INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 18 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 1, 1972

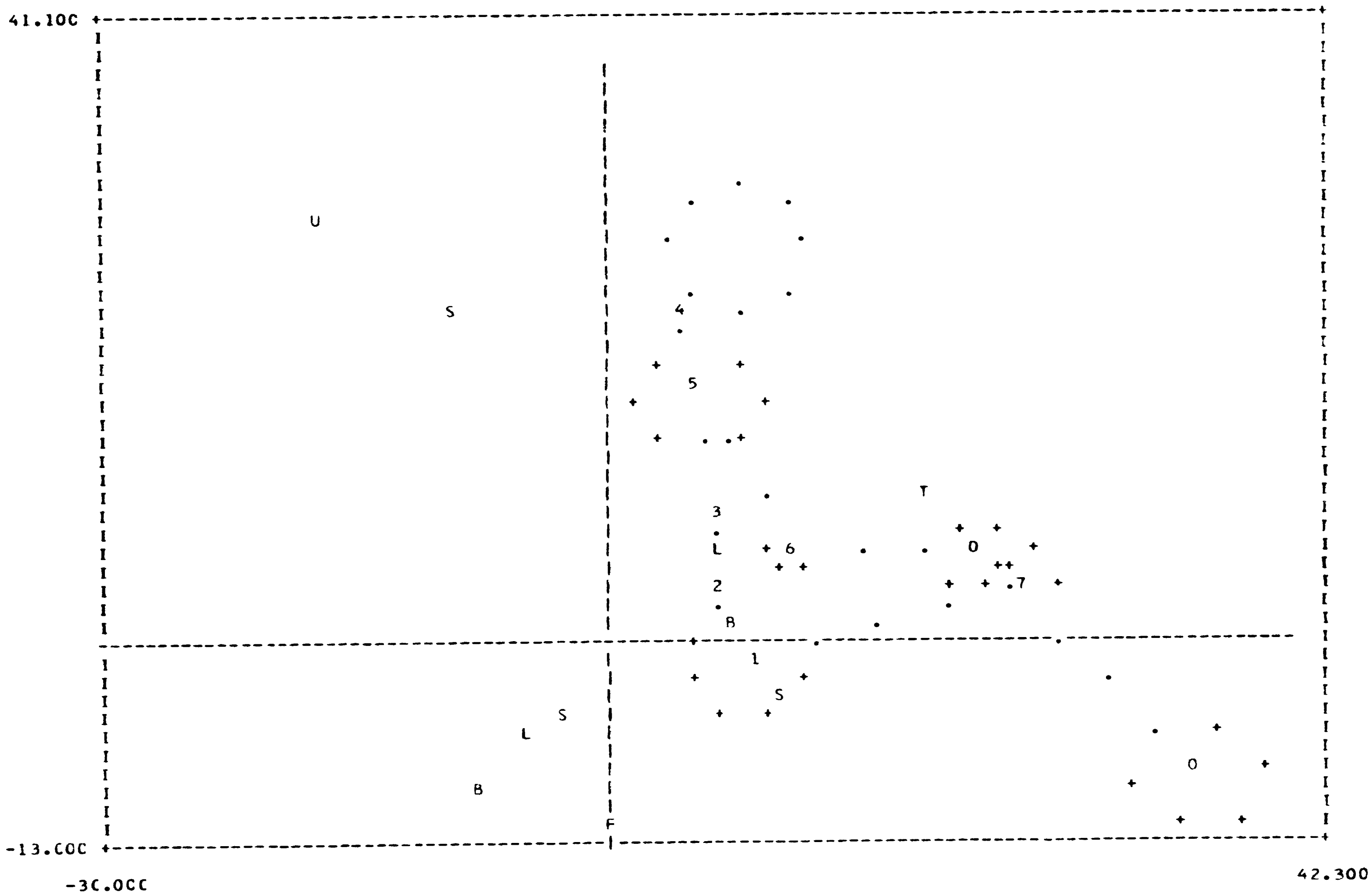
STICK FIGURE REPRESENTATION FOR TIME = 0.040 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 19 of 27)

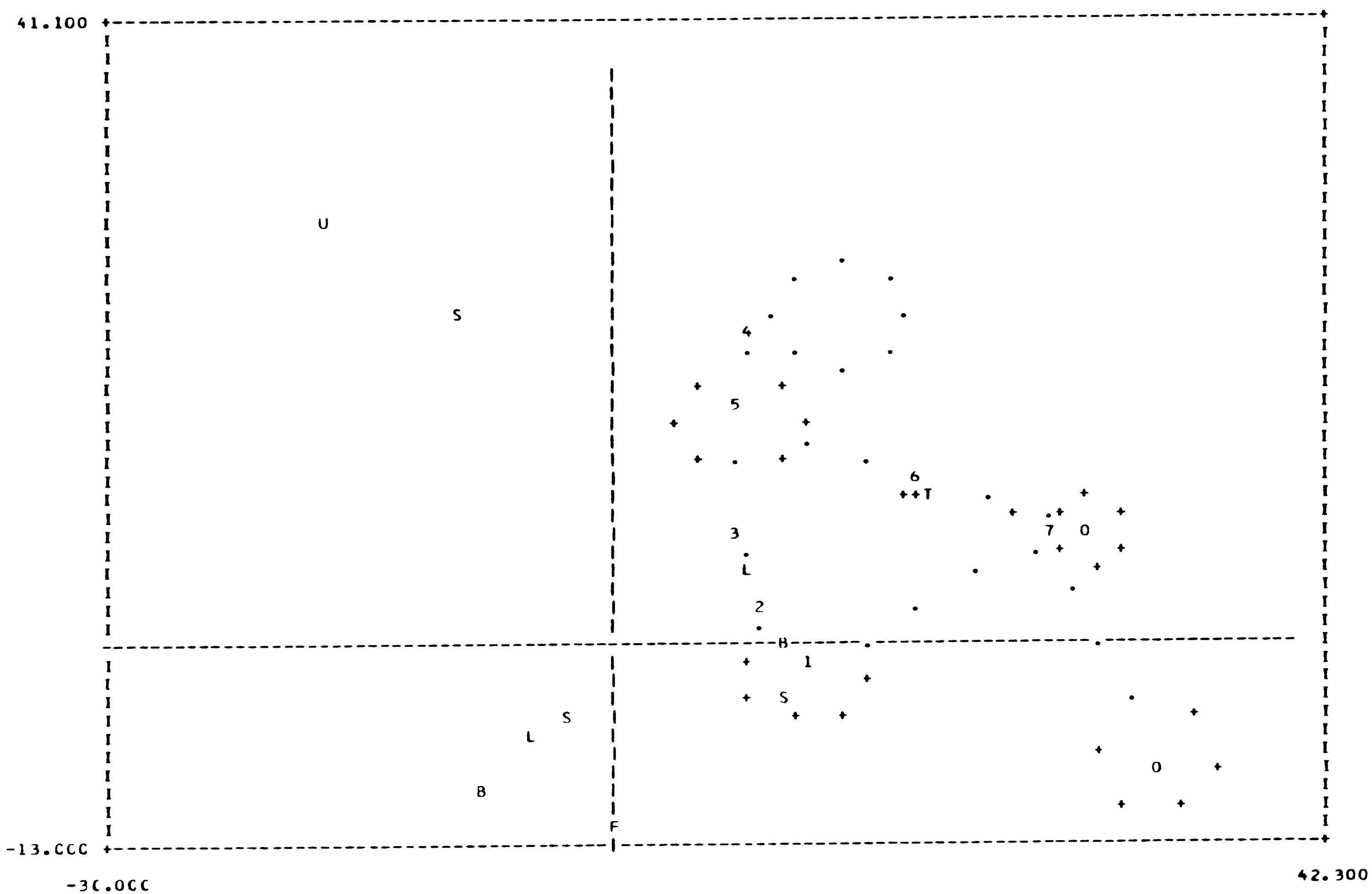
STICK FIGURE REPRESENTATION FOR TIME = 0.060 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALINC FACTORS: 1 TO 7.09 IN THE X CIRECTICN
1 TO 7.C6 IN THE Y CIRECTION

Table XXII. Printout. Example No. 1 (page 20 of 27)

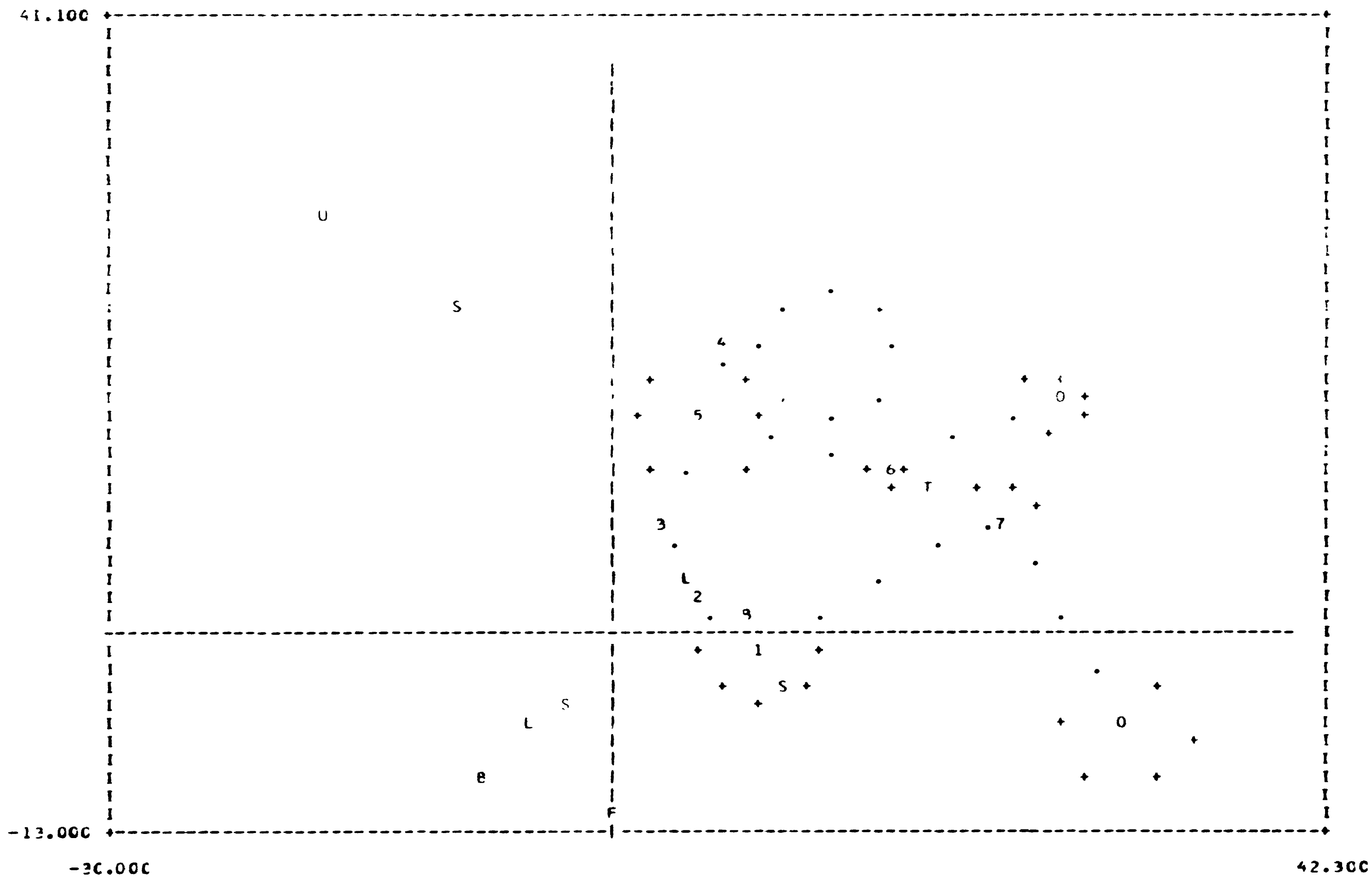
STICK FIGURE REPRESENTATION FOR TIME = 0.080 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 21 of 27)

STICK FIGURE REPRESENTATION FOR TIME = 0.100 SECONDS

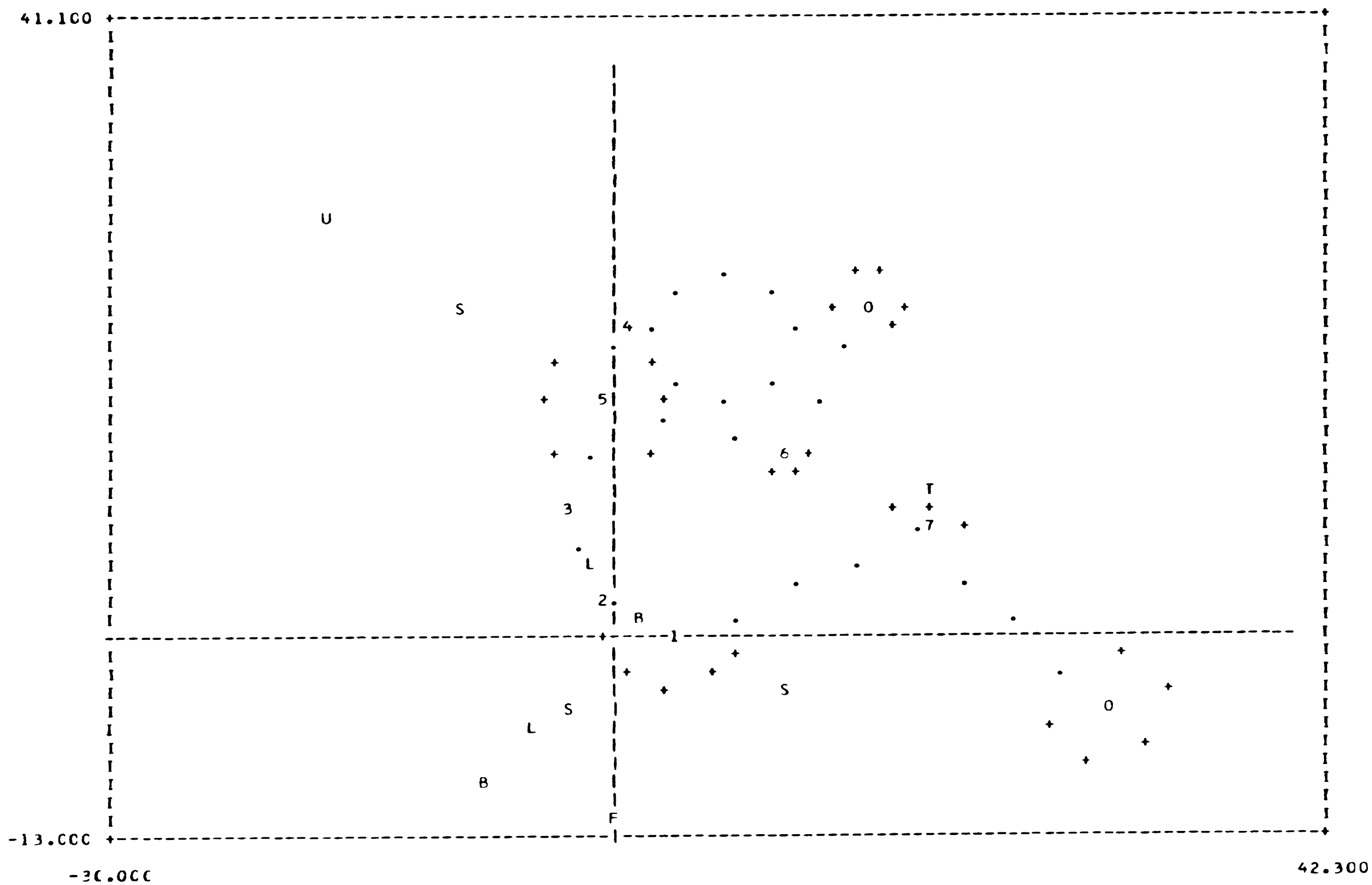


INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 22 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA
STICK FIGURE REPRESENTATION FOR TIME = 0.120 SECONDS

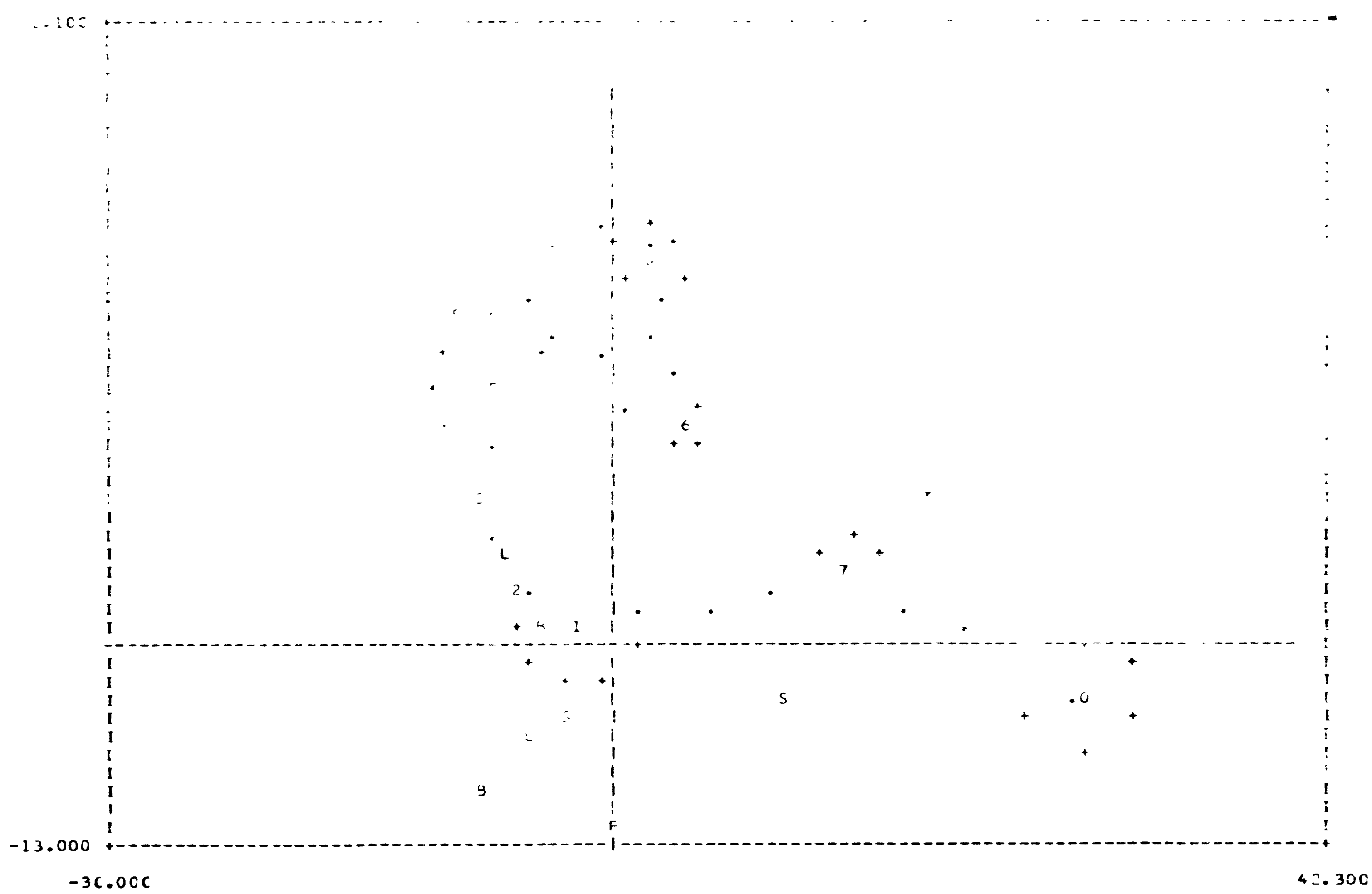
SEP 1, 1972



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 23 of 27)

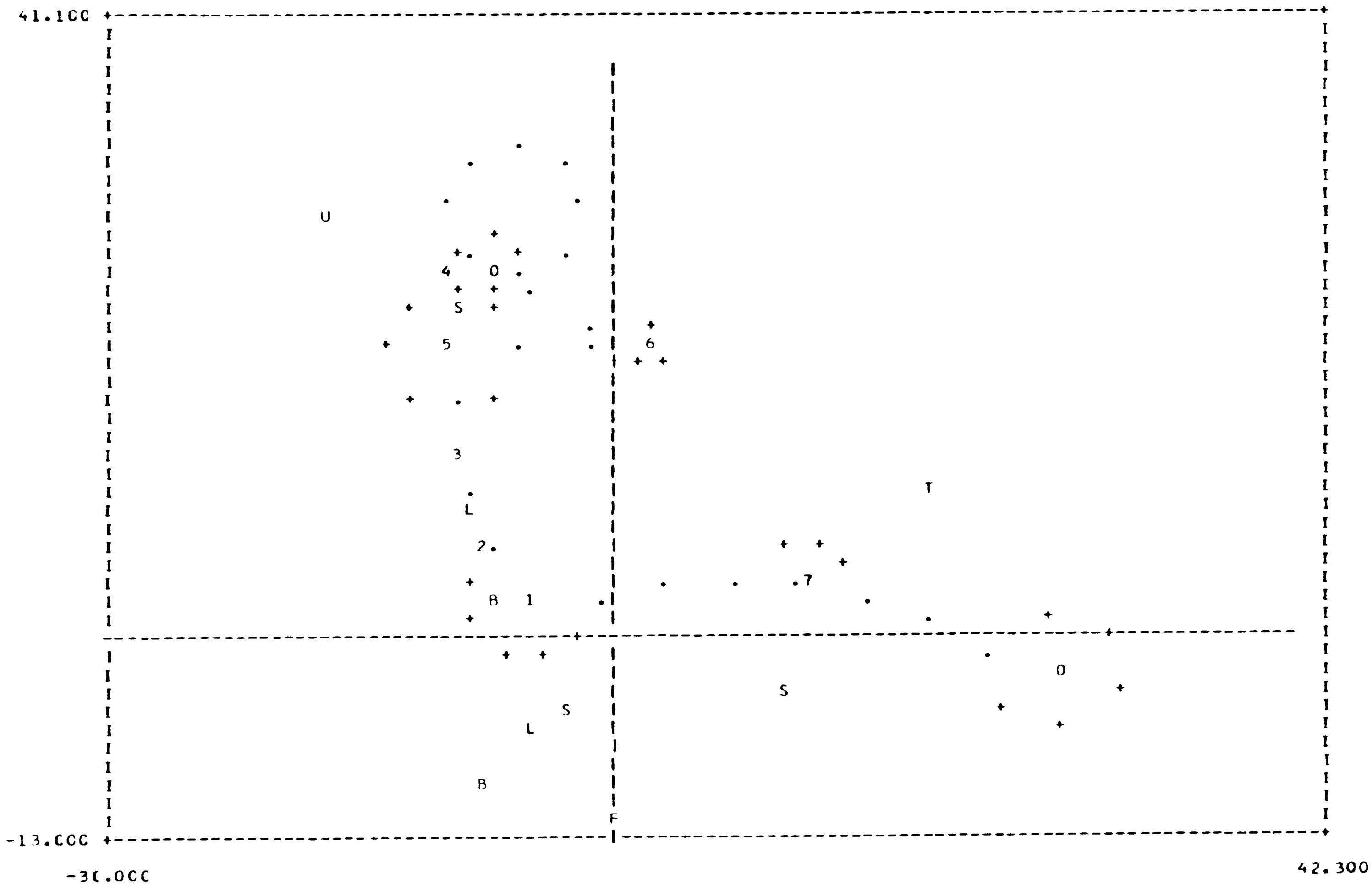
TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA
STICK FIGURE REPRESENTATION FOR TIME = 0.140 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 24 of 27)

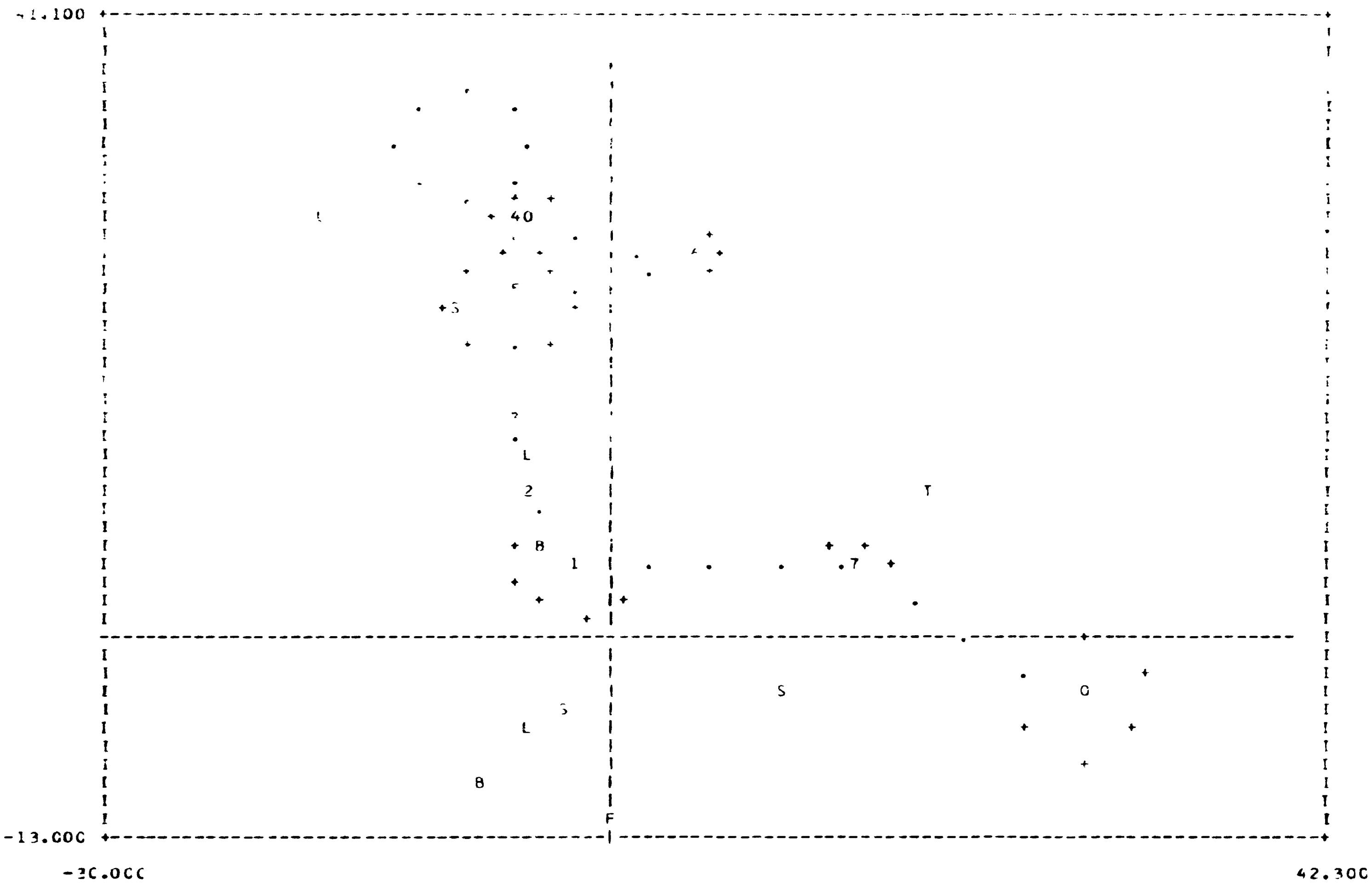
STICK FIGURE REPRESENTATION FOR TIME = 0.160 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 25 of 27)

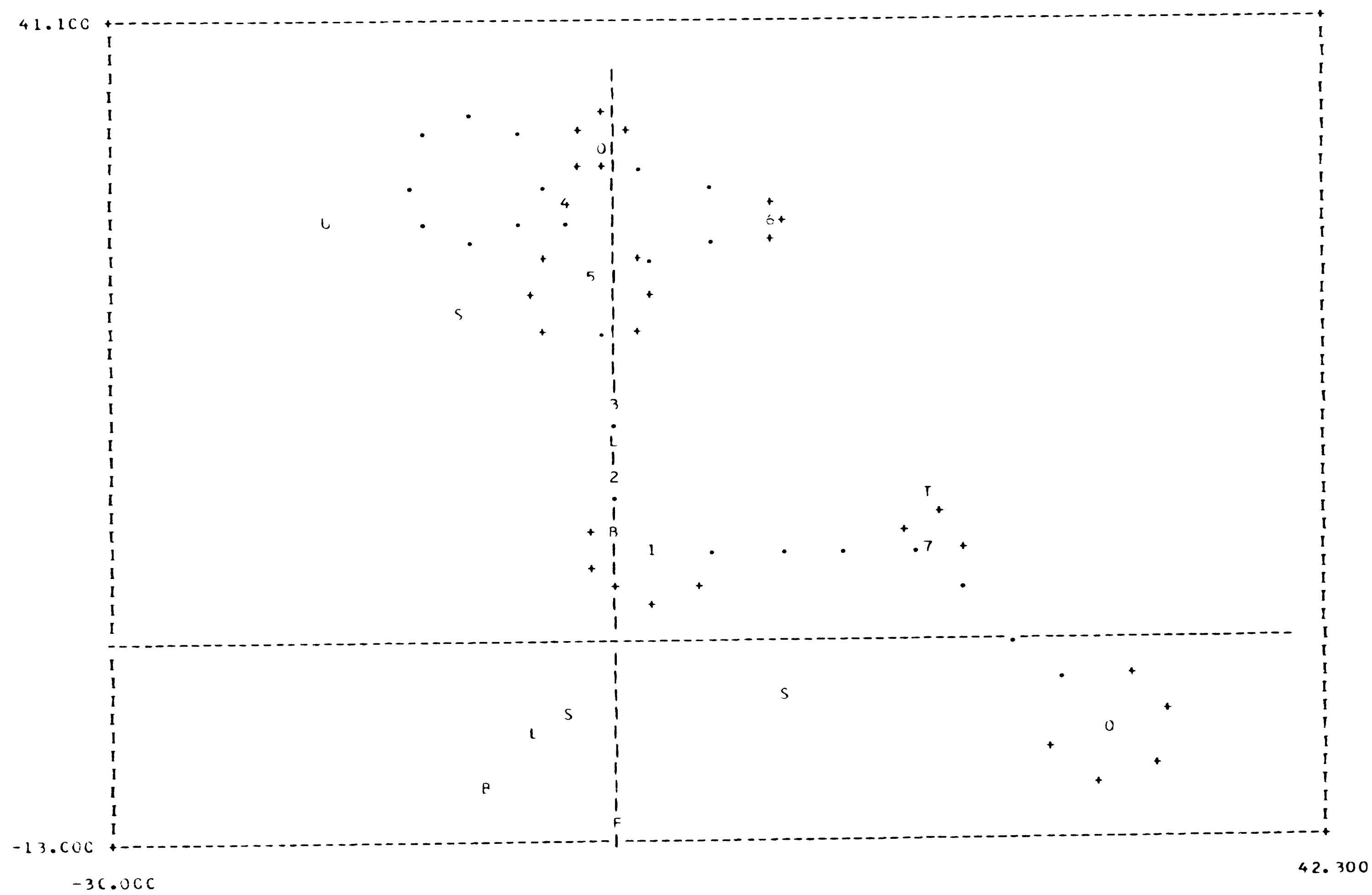
TWO DIMENSIONAL CRASH VICTIM SIMULATOR   OUTPUT DATA
STICK FIGURE REPRESENTATION FOR TIME = 0.180 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
                  1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 26 of 27)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 1, 1972 PAGE 27
STICK FIGURE REPRESENTATION FOR TIME = 0.200 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXII. Printout. Example No. 1 (page 27 of 27)

Example No. 2. 30 mph Front Collision. Lap Belt and EA Steering Column. 50th Percentile Male.

The same occupant, vehicle, and crash event have been modeled with the exception that the upper torso belts have been removed. This data set is given in Table XXIII. The belts have been replaced by the EA column and airbag combination specified as Figure 60 of the report, "Passive Protection at 50 Miles Per Hour" by Carter.[33] The complex force-deformation profile was modeled by three independent contact surfaces placed one behind the other. The cumulative effect of these three surfaces is shown in Figure 40. These surfaces have been relabeled as required. An upper instrument panel has also been added to restrain the motion of the head as it pitches downward after the upper torso has begun to interact with the EA column elements.

The tabular output for this exercise is included in Table XXIV. Although the steering column produces acceptable G-loadings on the chest, the head G-loadings caused by upper instrument panel contact may be excessive. To save space only the tabular output and three stick diagrams have been included in this table.

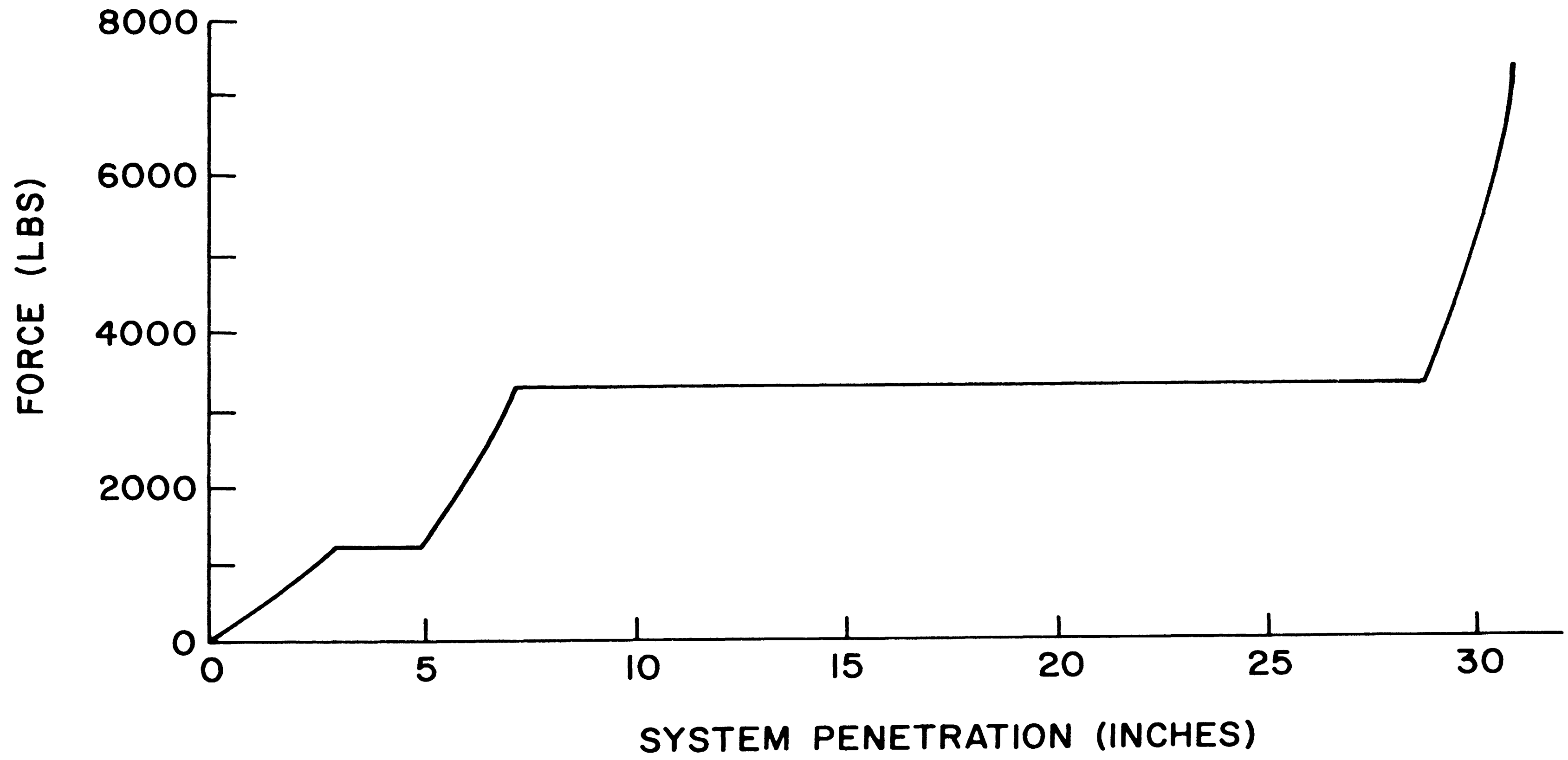


Figure 40. Static Force-Deflection Characteristics of EA Column-Airbag Combination

*LIST DATIN(76,142)

76	A1.	1.	1.	1.	1.	1.	1.	
77	[illegible]	[illegible]	[illegible]	[illegible]	.47.	[illegible]	[illegible]	[illegible]
78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
79	[illegible]	3.75	[illegible]	[illegible]	11. [illegible]	[illegible]	[illegible]	[illegible]
80	[illegible]	[illegible]	.11253	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
81	23.76	.	3.76	[illegible]	1.2	[illegible]	2.13	3.75
82	[illegible]	[illegible]	22000.	[illegible]	524.	[illegible]	7000.	
83	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
84	[illegible]	[illegible]	22.5	[illegible]	[illegible]	[illegible]	[illegible]	
85	J1.	1.	1.	1.	1.	1.	1.	
86	[illegible]	[illegible]	[illegible].17	[illegible]	4.32	[illegible]	7.5	[illegible]
87	[illegible]	[illegible]	[illegible]	75.	-77.	[illegible]	[illegible]	-33.
88	[illegible]	[illegible]	[illegible]	[illegible]	7.17	[illegible]	[illegible]	1.
89	N1.	[illegible]	[illegible]	.34	37.[illegible]	[illegible].31	1.57	15.
90	O12.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.	[illegible]
91	P1.	[illegible]	1.	[illegible]	[illegible]	[illegible]	-12.	-12.
92	[illegible]	[illegible]	1.	[illegible]	[illegible]	[illegible]		
93	B3.	.315	1.	[illegible]	.5	[illegible]		
94	[illegible]	[illegible]	[illegible]					
95	[illegible]							
96	[illegible]							
97	R1.	[illegible]	528.	1.	[illegible]	[illegible]	5.	1.
98	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1	[illegible]
99	[illegible]	[illegible]	800.					
100	[illegible]							
101	S1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1	283.
102	I1.	[illegible]	800.					
103	U1.							
104	S8.	[illegible]	.5	.5	[illegible]	[illegible]	.1	135.
105	[illegible]	.	[illegible]					
106	[illegible]							
107	[illegible]							
108	[illegible]	16.	[illegible]	[illegible]	11.5	[illegible]	.1	[illegible]
109	I3.	[illegible]	[illegible]					
110	U3.							
111	X3.	[illegible]	400.					
112	S4.	24.	[illegible]	[illegible]	[illegible]	[illegible]	.1	[illegible]
113	I4.	[illegible]	[illegible]					
114	X4.	[illegible]	[illegible]					
115	U4.							
116	S5.	26.4	[illegible]	[illegible]	41.[illegible]	[illegible]	.1	[illegible]
117	I5.	[illegible]	[illegible]					
118	U5.							
119	U6.							
120	S7.	17.8[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.1	[illegible]
121	I7.	[illegible]	[illegible]					
122	U7.							
123	X7.	[illegible]	[illegible]					
124	U9.							
125	V1.	1.	[illegible]	C.				
126	V1.	1.	.02	[illegible]				
127	V1.	1.	.[illegible]547	[illegible]				
128	V1.	1.	.[illegible]747	[illegible]				
129	V1.	1.	2.	[illegible]				
130	Z							
131	7.5	2.3	1	[illegible]	[illegible]	[illegible]		
132	03	STEERING WHEEL						
133	04	UPPER I. P.						

Table XXIII. Data Set. Example No. 2. (page 1 of 2)

```
134      05         S. C. BOTTOM OUT
135      -2
136      -1.
137      .443        1.
138      1.          1.
139      .2          0.       LAP BELT + EA COLUMN
140          2    44    2  100    0   11    1
141      -30.       42.3      -13.      41.1      0.         .02
142          0     0     0     0     0     0     0     0
END OF FILE
```


Table XXIII. Data Set. Example No. 2. (page 2 of 2)

	TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA									SEP 7, 1972	PAGE 1
	BELT FORCES (POUNDS)			BELT ANGLES (DEGREES)			RELATIVE HIP POSITION (INCHES)		RELATIVE HEAD POSITION (INCHES)		
TIME (SEC.)	LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	HORIZONTAL	VERTICAL	HORIZONTAL	VERTICAL	
0.0	0.	0.	0.	59.5	0.0	0.0	0.0	0.0	-3.88	26.93	
0.005	3.	0.	0.	59.5	0.0	0.0	0.01	0.00	-3.87	26.93	
0.010	25.	0.	0.	59.2	0.0	0.0	0.07	0.00	-3.79	26.93	
0.015	84.	0.	0.	58.5	0.0	0.0	0.25	0.01	-3.60	26.93	
0.020	197.	0.	0.	57.1	0.0	0.0	0.59	0.01	-3.23	26.93	
0.025	377.	0.	0.	55.0	0.0	0.0	1.15	-0.01	-2.63	26.92	
0.030	614.	0.	0.	52.2	0.0	0.0	1.91	-0.05	-1.78	26.89	
0.035	889.	0.	0.	48.9	0.0	0.0	2.85	-0.13	-0.69	26.84	
0.040	1172.	0.	0.	45.3	0.0	0.0	3.92	-0.28	0.64	26.75	
0.045	1432.	0.	0.	41.7	0.0	0.0	5.08	-0.49	2.21	26.60	
0.050	1646.	0.	0.	38.1	0.0	0.0	6.31	-0.76	4.04	26.39	
0.055	1800.	0.	0.	34.7	0.0	0.0	7.59	-1.07	6.11	26.10	
0.060	1902.	0.	0.	31.4	0.0	0.0	8.91	-1.43	8.43	25.73	
0.065	2010.	0.	0.	28.2	0.0	0.0	10.24	-1.87	10.92	25.31	
0.070	2258.	0.	0.	25.4	0.0	0.0	11.50	-2.31	13.47	24.84	
0.075	2768.	0.	0.	23.3	0.0	0.0	12.58	-2.69	15.96	24.30	
0.080	3392.	0.	0.	21.8	0.0	0.0	13.30	-2.97	18.27	23.64	
0.085	3681.	0.	0.	21.2	0.0	0.0	13.54	-3.14	20.29	22.73	
0.090	3534.	0.	0.	21.5	0.0	0.0	13.21	-3.17	21.93	21.48	
0.095	3124.	0.	0.	22.6	0.0	0.0	12.32	-3.05	23.08	20.09	
0.100	2529.	0.	0.	25.0	0.0	0.0	10.99	-2.73	23.77	19.05	
0.105	1842.	0.	0.	28.6	0.0	0.0	9.33	-2.23	23.96	18.68	
0.110	1163.	0.	0.	33.4	0.0	0.0	7.50	-1.61	23.65	19.01	
0.115	600.	0.	0.	39.4	0.0	0.0	5.62	-0.86	22.73	19.80	
0.120	256.	0.	0.	46.5	0.0	0.0	3.82	0.03	21.18	20.59	
0.125	168.	0.	0.	54.1	0.0	0.0	2.14	1.02	19.27	21.14	
0.130	296.	0.	0.	61.5	0.0	0.0	0.64	2.04	17.29	21.49	
0.135	501.	0.	0.	67.6	0.0	0.0	-0.60	2.88	15.40	21.77	
0.140	448.	0.	0.	70.9	0.0	0.0	-1.37	3.10	13.64	22.12	
0.145	167.	0.	0.	72.4	0.0	0.0	-1.79	2.97	12.13	22.75	
0.150	0.	0.	0.	72.7	0.0	0.0	-1.94	2.74	10.71	23.58	
0.155	0.	0.	0.	72.0	0.0	0.0	-1.85	2.49	9.34	24.57	
0.160	0.	0.	0.	70.4	0.0	0.0	-1.54	2.25	8.01	25.70	
0.165	0.	0.	0.	68.0	0.0	0.0	-1.03	2.08	6.71	26.90	
0.170	0.	0.	0.	65.3	0.0	0.0	-0.38	2.03	5.48	28.08	
0.175	0.	0.	0.	63.0	0.0	0.0	0.30	2.15	4.29	29.06	
0.180	0.	0.	0.	61.3	0.0	0.0	0.94	2.47	3.08	29.63	
0.185	0.	0.	0.	60.4	0.0	0.0	1.49	2.97	1.77	29.67	
0.190	330.	0.	0.	60.1	0.0	0.0	1.95	3.64	0.32	29.34	
0.195	828.	0.	0.	60.4	0.0	0.0	2.32	4.44	-1.24	28.80	
0.200	1199.	0.	0.	61.0	0.0	0.0	2.59	5.31	-2.91	28.30	

Table XXIV. Selected Printout. Example No. 2 (page 1 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 2

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	LOWER TORSO			CENTER TORSO			UPPER TORSO			HEAD		
	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.
0.0	103.00	0.0	0.6625E 03	103.00	0.0	0.7102E 03	103.00	0.0	0.5780E 03	75.00	0.0	-0.2594E 04
0.0050	103.00	-1.76	-0.4215E 03	102.99	-2.50	-0.7438E 03	103.00	2.21	0.3913E 03	74.97	-13.60	-0.2533E 04
0.0100	102.98	-3.02	0.1205E 03	102.97	-7.63	-0.1611E 04	103.02	3.80	0.1868E 03	74.87	-24.85	-0.2083E 04
0.0150	102.97	0.53	0.1641E 04	102.90	-20.41	-0.4064E 04	103.04	3.76	-0.3085E 03	74.72	-33.22	-0.1047E 04
0.0200	103.00	14.04	0.4154E 04	102.74	-50.76	-0.9104E 04	103.05	0.22	-0.1309E 04	74.55	-34.32	0.9702E 03
0.0250	103.14	41.49	0.7104E 04	102.34	-114.29	-0.1775E 05	103.03	-9.83	-0.2997E 04	74.40	-23.24	0.3863E 04
0.0300	103.44	82.87	0.9493E 04	101.51	-228.72	-0.2947E 05	102.93	-29.97	-0.5451E 04	74.34	3.26	0.7157E 04
0.0350	103.98	133.25	0.1046E 05	99.95	-404.67	-0.4181E 05	102.70	-64.63	-0.8886E 04	74.46	47.25	0.1077E 05
0.0400	104.77	184.19	0.9516E 04	97.37	-635.80	-0.5056E 05	102.25	-118.75	-0.1339E 05	74.84	102.14	0.1427E 05
0.0450	105.80	226.49	0.6883E 04	93.54	-894.58	-0.5155E 05	101.47	-197.75	-0.1890E 05	75.58	186.97	0.1690E 05
0.0500	107.01	252.20	0.2757E 04	88.44	-1138.54	-0.4412E 05	100.23	-305.69	-0.2488E 05	76.73	273.87	0.1748E 05
0.0550	108.26	219.08	-0.3962E 05	82.27	-1285.24	0.1818E 05	98.36	-451.76	-0.3952E 05	78.31	357.53	0.1533E 05
0.0600	108.61	-130.60	-0.9672E 05	76.51	-922.79	0.1318E 06	95.57	-663.04	-0.3840E 05	80.16	335.34	-0.4132E 05
0.0650	106.88	-437.65	0.7038E 04	73.48	-438.65	0.7038E 04	91.87	-777.92	-0.2338E 04	81.12	19.97	-0.7512E 05
0.0700	104.77	-397.59	0.1678E 05	71.36	-398.59	0.1678E 05	87.98	-755.50	0.2653E 05	80.18	-464.38	-0.1631E 06
0.0750	103.03	-300.10	0.1261E 05	69.62	-301.10	0.1261E 05	84.66	-561.63	0.3676E 05	75.40	-1491.46	-0.2136E 06
0.0800	101.60	-292.42	-0.1109E 05	68.18	-293.42	-0.1109E 05	82.22	-436.52	0.7850E 04	65.40	-2477.20	-0.1701E 06
0.0850	99.94	-383.31	-0.2213E 05	66.52	-384.31	-0.2213E 05	80.00	-484.95	-0.3327E 05	51.13	-3163.45	-0.9197E 05
0.0900	97.76	-484.99	-0.1751E 05	64.33	-485.99	-0.1751E 05	77.00	-754.23	-0.7775E 05	34.56	-3334.67	0.7216E 05
0.0950	95.13	-564.67	-0.1464E 05	61.70	-565.87	-0.1464E 05	72.19	-1174.91	-0.7742E 05	19.59	-2477.85	0.2703E 06
0.1000	92.11	-645.56	-0.7557E 04	58.76	-579.59	0.8677E 04	65.62	-1388.15	-0.1176E 05	10.86	-936.42	0.3702E 06
0.1050	88.80	-670.41	-0.5794E 04	56.05	-501.19	0.2005E 05	58.62	-1399.29	0.3629E 04	10.80	904.32	0.3616E 06
0.1100	85.33	-717.76	-0.1296E 05	53.77	-418.02	0.8281E 04	51.66	-1388.23	0.1037E 04	19.68	2597.49	0.2935E 06
0.1150	81.53	-807.42	-0.2244E 05	51.67	-451.66	-0.2973E 05	44.78	-1340.01	0.2925E 05	35.84	3731.35	0.1297E 06
0.1200	77.23	-903.41	-0.9748E 04	48.90	-679.97	-0.5436E 05	38.64	-1071.58	0.8048E 05	55.43	3948.08	-0.4992E 05
0.1250	72.69	-897.93	-0.2758E 04	44.88	-898.93	-0.2758E 04	34.36	-633.65	0.8230E 05	74.21	3513.32	-0.1070E 06
0.1300	68.26	-849.36	0.2441E 05	40.45	-850.36	0.2441E 05	32.18	-248.80	0.7000E 05	90.45	2988.23	-0.9911E 05
0.1350	64.84	-427.74	0.1144E 06	37.12	-314.21	0.1912E 06	31.90	164.50	0.1019E 06	104.07	2406.55	-0.1824E 06
0.1400	64.24	196.97	0.1083E 06	37.38	262.86	0.6428E 04	33.99	656.52	0.8917E 05	113.53	1336.40	-0.2358E 06
0.1450	66.03	484.68	0.4636E 05	39.18	483.68	0.4636E 05	38.07	918.98	0.3103E 05	117.88	603.32	-0.7694E 05
0.1500	69.03	726.96	0.6189E 05	42.16	694.61	0.3188E 05	43.01	1048.76	0.2341E 05	119.92	205.24	-0.8984E 05
0.1550	73.53	1085.42	0.7700E 05	45.98	825.64	0.2434E 05	48.54	1162.40	0.2159E 05	119.74	-298.65	-0.1131E 06
0.1600	79.83	1450.76	0.6401E 05	51.46	986.20	0.4657E 05	54.61	1264.11	0.1885E 05	116.77	-897.20	-0.1255E 06
0.1650	87.42	1481.15	-0.2079E 05	56.27	1377.70	0.8571E 05	61.13	1336.64	0.1105E 05	110.84	-1450.92	-0.1069E 06
0.1700	94.66	1411.89	-0.2248E 05	63.46	1417.68	-0.1217E 05	68.23	1529.72	0.4664E 05	102.09	-2073.58	-0.1317E 06
0.1750	101.35	1240.05	-0.4812E 05	71.46	1393.78	0.2895E 04	76.44	1746.45	0.3381E 05	90.11	-2695.91	-0.1033E 06
0.1800	106.92	980.38	-0.5407E 05	77.54	1455.84	0.2410E 05	85.47	1830.17	-0.7463E 04	75.63	-3017.76	-0.9351E 04
0.1850	111.17	729.42	-0.4102E 05	85.16	1600.97	0.3139E 05	94.38	1707.52	-0.3918E 05	60.76	-2861.62	0.6879E 05
0.1900	114.42	599.50	-0.7686E 04	93.55	1747.00	0.2455E 05	102.39	1493.98	-0.4363E 05	47.44	-2445.50	0.9502E 05
0.1950	117.41	617.81	0.1651E 05	102.51	1818.17	0.4373E 04	109.34	1286.88	-0.4901E 05	36.43	-1940.34	0.1494E 06
0.2000	120.76	729.32	0.2452E 05	111.64	1824.21	-0.7262E 04	115.01	955.44	-0.7930E 05	29.41	-703.00	0.3408E 06

Table XXIV. Selected Printout. Example No. 2 (page 2 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	UPPER ARM			LOWER ARM			UPPER LEG			LOWER LEG		
	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.
0.0	-77.00	0.0	0.5724E 03	0.0	0.0	-0.2683E 04	6.00	0.0	-0.1820E 04	-33.00	0.0	0.1524E 04
0.0050	-76.99	3.01	0.5906E 03	-0.03	-13.90	-0.2742E 04	5.97	-10.17	-0.2032E 04	-32.97	11.44	0.2403E 04
0.0100	-76.97	5.74	0.4847E 03	-0.14	-26.94	-0.2372E 04	5.90	-19.90	-0.1784E 04	-32.88	23.83	0.2631E 04
0.0150	-76.93	7.78	0.2950E 03	-0.30	-37.06	-0.1486E 04	5.78	-27.59	-0.1154E 04	-32.73	38.31	0.3317E 04
0.0200	-76.89	8.56	-0.3690E 02	-0.50	-40.82	0.3099E 03	5.64	-25.56	0.2825E 04	-32.56	9.53	-0.1909E 05
0.0250	-76.85	7.51	-0.4154E 03	-0.69	-33.71	0.2890E 04	5.57	1.22	0.8645E 04	-32.84	-134.48	-0.3775E 05
0.0300	-76.82	4.80	-0.6665E 03	-0.81	-12.49	0.5935E 04	5.70	59.11	0.1522E 05	-33.99	-327.75	-0.3557E 05
0.0350	-76.80	1.45	-0.6102E 03	-0.79	24.38	0.9133E 04	6.21	150.44	0.2190E 05	-36.02	-465.66	-0.1664E 05
0.0400	-76.80	-0.72	-0.1081E 03	-0.54	77.57	0.1246E 05	7.26	274.18	0.2794E 05	-38.49	-508.41	-0.1211E 04
0.0450	-76.80	1.22	0.1168E 04	0.02	146.81	0.1542E 05	9.00	422.62	0.3106E 05	-41.03	-513.55	-0.4663E 04
0.0500	-76.77	11.81	0.3473E 04	0.95	228.70	0.1729E 05	11.50	576.43	0.2952E 05	-43.72	-576.83	-0.2400E 05
0.0550	-76.66	39.05	0.9635E 04	2.31	313.43	0.1405E 05	14.73	718.05	0.3017E 05	-46.98	-742.27	-0.4226E 05
0.0600	-76.26	146.74	0.4064E 05	3.99	340.22	-0.8237E 04	18.73	883.94	0.3540E 05	-51.23	-957.15	-0.3688E 05
0.0650	-74.95	378.66	0.4442E 05	5.54	283.24	-0.8523E 04	23.55	1021.44	0.1284E 05	-56.35	-1058.99	0.2253E 04
0.0700	-72.46	644.79	0.8260E 05	6.60	197.40	-0.3990E 05	28.79	1060.38	-0.2722E 04	-61.45	-943.64	0.4476E 05
0.0750	-68.02	1152.79	0.1059E 06	7.09	-122.80	-0.8617E 05	33.96	982.57	-0.3279E 05	-65.53	-673.74	0.6009E 05
0.0800	-60.96	1664.83	0.9796E 05	5.27	-630.34	-0.1187E 06	38.32	733.40	-0.6417E 05	-68.14	-370.17	0.6425E 05
0.0850	-51.44	2135.73	0.8960E 05	0.55	-1272.58	-0.1361E 06	41.13	381.40	-0.7673E 05	-69.20	-58.10	0.5848E 05
0.0900	-39.69	2543.68	0.6285E 05	-7.47	-1912.88	-0.1004E 06	42.06	-13.34	-0.8007E 05	-68.80	212.18	0.4866E 05
0.0950	-26.61	2456.28	-0.2622E 06	-17.58	-1757.00	0.4165E 06	41.01	-407.32	-0.8010E 05	-67.16	432.02	0.3531E 05
0.1000	-18.95	710.88	-0.1102E 06	-13.04	1017.31	0.1379E 06	37.99	-776.05	-0.5630E 05	-64.59	601.44	0.3922E 05
0.1050	-16.78	159.98	-0.1044E 06	-11.64	1925.72	0.1649E 06	33.48	-1016.20	-0.3954E 05	-61.10	792.86	0.3651E 05
0.1100	-17.17	-282.69	-0.6393E 05	-0.15	2614.58	0.3942E 05	27.94	-1194.03	-0.3256E 05	-56.69	962.70	0.3033E 05
0.1150	-19.21	-495.95	-0.2028E 05	13.90	2348.95	0.3033E 05	21.56	-1356.43	-0.3296E 05	-51.52	1101.04	0.2569E 05
0.1200	-21.85	-539.97	0.2234E 04	28.64	2980.12	-0.1953E 05	14.36	-1520.41	-0.3117E 05	-45.69	1237.95	0.3134E 05
0.1250	-24.48	-502.72	0.1125E 05	43.40	2828.80	-0.3719E 05	6.39	-1660.37	-0.2163E 05	-39.07	1413.66	0.3829E 05
0.1300	-26.83	-434.19	0.1667E 05	57.09	2651.16	-0.3229E 05	-2.14	-1739.93	-0.6680E 04	-31.54	1595.22	0.3026E 05
0.1350	-28.71	-283.27	0.5343E 05	63.95	2488.14	-0.3927E 05	-8.66	-169.46	0.7110E 06	-25.71	-99.48	-0.8223E 06
0.1400	-29.60	-112.80	0.1335E 05	81.95	2320.42	-0.2947E 05	-2.73	1921.85	0.4143E 05	-33.57	-2257.71	0.1070E 05
0.1450	-30.08	-92.15	-0.3643E 04	93.17	2175.22	-0.3014E 05	6.92	1896.25	-0.2031E 05	-44.35	-2029.16	0.5175E 05
0.1500	-30.63	-132.55	-0.7301E 04	103.59	1957.66	-0.8635E 05	16.12	1778.57	-0.2338E 05	-53.87	-1787.17	0.4219E 05
0.1550	-31.39	-179.12	-0.1477E 05	111.89	1265.58	-0.1986E 06	24.73	1669.51	-0.2037E 05	-62.32	-1604.03	0.3019E 05
0.1600	-32.52	-279.58	-0.2407E 05	115.43	93.82	-0.2649E 06	32.83	1570.03	-0.1991E 05	-69.88	-1361.31	0.9899E 05
0.1650	-34.31	-448.85	-0.3225E 05	113.56	-652.91	-0.9652E 05	40.46	1482.15	-0.2079E 05	-74.99	-560.05	0.2676E 06
0.1700	-36.82	-532.16	-0.4410E 04	109.19	-1092.59	-0.8194E 05	47.59	1363.28	-0.3309E 05	-73.71	1137.47	0.3164E 06
0.1750	-39.46	-503.54	0.1692E 05	102.76	-1460.38	-0.6009E 05	53.92	1144.65	-0.5832E 05	-65.05	2117.37	0.4073E 05
0.1800	-41.71	-339.50	0.2883E 05	94.83	-1679.87	-0.2215E 05	58.87	831.79	-0.6464E 05	-54.46	2087.07	-0.1530E 05
0.1850	-43.23	-234.71	0.3165E 05	86.29	-1710.42	0.9436E 04	62.23	512.53	-0.6117E 05	-44.22	1985.09	-0.8584E 05
0.1900	-44.06	-72.53	0.3379E 05	77.92	-1624.64	0.2445E 05	64.15	293.38	-0.1737E 05	-36.36	952.08	-0.3287E 06
0.1950	-43.99	98.27	0.3288E 05	70.14	-1488.12	0.3177E 05	65.50	252.37	-0.1360E 05	-36.12	-914.91	-0.3819E 06
0.2000	-43.10	257.06	0.3143E 05	63.11	-1310.52	0.3737E 05	66.39	60.06	-0.6339E 05	-44.71	-2276.16	-0.7234E 05

Table XXIV. Selected Printout. Example No. 2 (page 3 of 9)

TWO DIMENSIONAL CRASH [illegible] OUTPUT DATA [illegible]

	VEHICULAR MOTION			BODY MOTION AT HIP JOINT					
TIME	POSITION	VELOCITY	ACCEL.	RELATIVE DISPL.	HORIZONTAL VELOCITY	ACCEL.	RELATIVE DISPL.	VERTICAL VELOCITY	ACCEL.
	(IN.)	(IN./SEC.)	(G-UNITS)	(IN.)	(IN./SEC.)	(G-UNITS)	(IN.)	(IN./SEC.)	(G-UNITS)
0.0	0.0	528.00	0.0	0.0	528.00	0.092	0.0	[illegible]	[illegible]
0.0050	2.639	521.97	-6.244	0.000	527.05	-0.579	0.00[illegible]	[illegible]	[illegible]
0.0100	5.200	503.39	-12.467	[illegible]	525.84	-0.714	0.00[illegible]	0.[illegible]	[illegible]
0.0150	7.649	473.72	-18.73[illegible]	0.247	524.18	-1.094	0.00[illegible]	0.5[illegible]	-[illegible].41[illegible]
0.0200	9.917	431.50	-24.374	0.594	521.40	-2.003	0.006	-1.[illegible]	-1.421
0.0250	11.954	383.25	-24.374	1.152	516.03	-3.931	-0.0[illegible]	-5.[illegible]	[illegible]
0.0300	13.745	335.00	-24.374	1.913	505.66	-7.092	-0.044	-12.[illegible]	-4.762
0.0350	15.304	286.75	-24.374	2.843	486.63	-11.217	-0.135	-22.[illegible]	-6.[illegible]
0.0400	16.617	238.50	-24.374	3.718	463.21	-15.435	-0.28[illegible]	-35.[illegible]	-5.593
0.0450	17.689	190.25	-24.374	5.[illegible]	430.42	-18.560	-0.493	-48.[illegible]	-6.03[illegible]
0.0500	18.51[illegible]	142.00	-24.37[illegible]	[illegible].212	393.04	-20.014	-0.[illegible]7	[illegible]	[illegible]
0.0550	19.105	93.77	-24.600	7.[illegible]	[illegible]4.42	-19.181	-1.072	-64.[illegible]	-4.[illegible]15
0.0600	19.4[illegible]	52.28	-18.356	[illegible].91[illegible]	3[illegible]3.32	-17.298	-1.42[illegible]	-79.[illegible]	[illegible]
0.0650	19.651	22.34	-12.113	1[illegible]	[illegible]	-19.371	-1.67	-9[illegible]	[illegible].45[illegible]
0.0700	19.717	3.47	-5.864	[illegible]	243.75	-25.135	-[illegible].31	-83.[illegible]	[illegible]
0.0750	19.726	0.14	0.0	[illegible]	185.60	-36.902	[illegible]	-67.[illegible]	[illegible]
0.0800	19.727	0.14	0.0	13.[illegible]	1[illegible].65	-52.095	-2.37[illegible]	-45.[illegible]	[illegible]
0.0850	19.726	0.14	0.0	1[illegible]	-[illegible].73	-59.917	-[illegible].14[illegible]	-19.[illegible]	[illegible]
0.0900	19.728	0.14	0.0	1[illegible]	-[illegible]3.43	-57.169	-3.17	[illegible]	[illegible]
0.0950	19.729	0.14	0.0	[illegible]	[illegible].65	-46.622	[illegible]	[illegible]	[illegible]
0.1000	19.730	0.14	0.0	10.[illegible]	-304.41	-[illegible].812	-2.72[illegible]	85.[illegible]	[illegible]
0.1050	19.731	0.14	0.0	9.3[illegible]	-3[illegible].58	-16.912	-2.2[illegible]	113.[illegible]	[illegible]
0.1100	19.731	0.14	0.0	7.497	-374.28	-3.466	-1.6[illegible]	136.[illegible]	[illegible]
0.1150	19.732	0.14	0.0	5.625	-370.75	7.712	-0.85[illegible]	162.[illegible]	14.[illegible]
0.1200	19.733	0.14	0.0	3.818	-349.33	14.260	0.027	190.4	11.49[illegible]
0.1250	19.733	0.14	0.0	2.144	-318.62	17.652	1.02[illegible]	204.[illegible]	0.[illegible]
0.1300	19.734	0.14	0.0	0.640	-281.61	20.924	2.036	197.1	-9.961
0.1350	19.735	0.14	0.0	-0.600	-201.65	51.019	2.877	112.43	-81.867
0.1400	19.736	0.14	0.0	-1.372	-110.74	33.835	3.099	-5.[illegible]	-27.919
0.1450	19.736	0.14	0.0	-1.786	-55.68	26.980	2.967	-40.[illegible]	-8.728
0.1500	19.737	0.14	0.0	-1.939	-5.64	24.813	2.735	-48.99	-1.692
0.1550	19.738	0.14	0.0	-1.851	40.48	22.479	2.489	-49.5[illegible]	1.535
0.1600	19.739	0.14	0.0	-1.543	82.84	2[illegible].612	2.254	-43.07	5.9[illegible]
0.1650	19.739	0.14	0.0	-1.031	120.44	15.669	2.076	-25.[illegible]	12.93[illegible]
0.1700	19.740	0.14	0.0	-0.381	135.57	2.001	2.025	7.3[illegible]	18.874
0.1750	19.741	0.14	0.0	0.298	133.94	-4.961	2.152	43.6[illegible]	19.460
0.1800	19.741	0.14	0.0	0.937	120.63	-9.131	2.467	82.57	2[illegible]
0.1850	19.742	0.14	0.0	1.491	100.76	-10.578	2.972	118.5[illegible]	16.966
0.1900	19.743	0.14	0.0	1.947	82.99	-7.608	3.64[illegible]	148.35	13.3[illegible]
0.1950	19.744	0.14	0.0	2.324	66.90	-10.816	4.443	179.5[illegible]	7.644
0.2000	19.744	0.14	0.0	2.592	37.76	-20.509	5.31[illegible]	172.[illegible]	-7.250

Table XXIV. Selected Printout. Example No. 2 (page 4 of 9)

TIME	ACCELEROMETER READINGS HEAD RESULTANT (G-UNITS)	HEAD ANGLE (DEG.)	CHEST RESULTANT (G-UNITS)	CHEST ANGLE (DEG.)	BELT FORCES (LBS), LAP	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	SEAT FORCES (LBS) AT HIP	AT FRONT EDGE
0.0	0.3	-8.2	0.4	138.7	0.0	0.0	0.0	145.00	0.0
0.0050	0.3	3.2	0.4	141.0	3.3	0.0	0.0	144.92	0.0
0.0100	0.3	-16.7	0.4	159.1	25.4	0.0	0.0	146.16	0.0
0.0150	0.3	-68.9	0.4	-144.9	84.4	0.0	0.0	149.33	0.0
0.0200	0.9	-97.1	1.1	-109.6	197.5	0.0	0.0	155.51	0.0
0.0250	1.7	-104.2	2.4	-102.5	376.5	0.0	0.0	165.56	0.0
0.0300	2.7	-105.4	3.9	-102.6	613.9	0.0	0.0	180.06	4.90
0.0350	3.8	-105.4	5.7	-105.5	888.8	0.0	0.0	199.23	11.44
0.0400	5.1	-103.8	7.8	-109.8	1171.8	0.0	0.0	222.06	16.71
0.0450	6.5	-101.1	10.0	-115.5	1432.1	0.0	0.0	246.22	21.67
0.0500	8.0	-97.0	12.1	-123.1	1645.6	0.0	0.0	268.92	28.38
0.0550	7.7	-89.3	15.9	-145.4	1799.8	0.0	0.0	289.54	40.10
0.0600	5.9	-60.4	23.9	-179.4	1902.3	0.0	0.0	321.08	62.32
0.0650	9.7	-64.9	22.3	-180.0	2009.5	0.0	0.0	354.69	101.35
0.0700	11.5	-56.9	35.8	171.6	2257.6	0.0	0.0	371.97	156.53
0.0750	22.6	-82.2	47.4	168.4	2767.7	0.0	0.0	378.59	219.09
0.0800	49.3	-107.3	49.4	167.2	3391.6	0.0	0.0	373.94	271.07
0.0850	74.6	-127.1	48.3	167.2	3680.9	0.0	0.0	352.80	292.32
0.0900	78.8	-165.0	43.3	167.4	3533.6	0.0	0.0	314.25	263.47
0.0950	94.3	136.2	36.4	159.3	3124.0	0.0	0.0	257.67	187.26
0.1000	133.6	118.8	36.1	161.6	2529.0	0.0	0.0	176.84	83.49
0.1050	131.2	117.4	24.9	156.9	1842.4	0.0	0.0	109.32	0.0
0.1100	115.7	138.5	10.1	122.7	1162.6	0.0	0.0	51.01	0.0
0.1150	99.7	-176.1	14.4	26.4	599.9	0.0	0.0	0.0	0.0
0.1200	78.4	-130.6	18.1	8.3	256.0	0.0	0.0	0.0	0.0
0.1250	48.9	-89.3	9.3	8.6	167.9	0.0	0.0	0.0	0.0
0.1300	34.2	-52.0	5.1	-19.5	295.8	0.0	0.0	0.0	0.0
0.1350	36.9	-3.7	25.1	-104.2	500.9	0.0	0.0	0.0	74.58
0.1400	73.4	37.3	12.3	-55.6	448.1	0.0	0.0	0.0	0.0
0.1450	27.3	53.6	7.9	35.4	167.0	0.0	0.0	0.0	0.0
0.1500	27.3	57.4	6.5	70.6	0.0	0.0	0.0	1.83	0.0
0.1550	25.7	53.9	5.3	133.9	0.0	0.0	0.0	32.82	0.0
0.1600	22.1	37.3	8.8	153.1	0.0	0.0	0.0	54.69	0.0
0.1650	20.5	-2.9	10.2	128.6	0.0	0.0	0.0	59.90	137.94
0.1700	32.7	-48.8	0.6	112.0	0.0	0.0	0.0	36.76	153.14
0.1750	60.9	-79.3	4.4	128.0	0.0	0.0	0.0	0.0	0.0
0.1800	75.9	-101.1	8.3	133.8	0.0	0.0	0.0	0.0	0.0
0.1850	59.3	-121.3	7.2	160.8	0.0	0.0	0.0	0.0	0.0
0.1900	37.0	-143.7	7.3	-143.7	390.0	0.0	0.0	0.0	0.0
0.1950	29.5	157.6	12.3	-115.2	828.3	0.0	0.0	0.0	0.0
0.2000	90.8	110.0	24.2	-110.1	1199.4	0.0	0.0	0.0	0.0

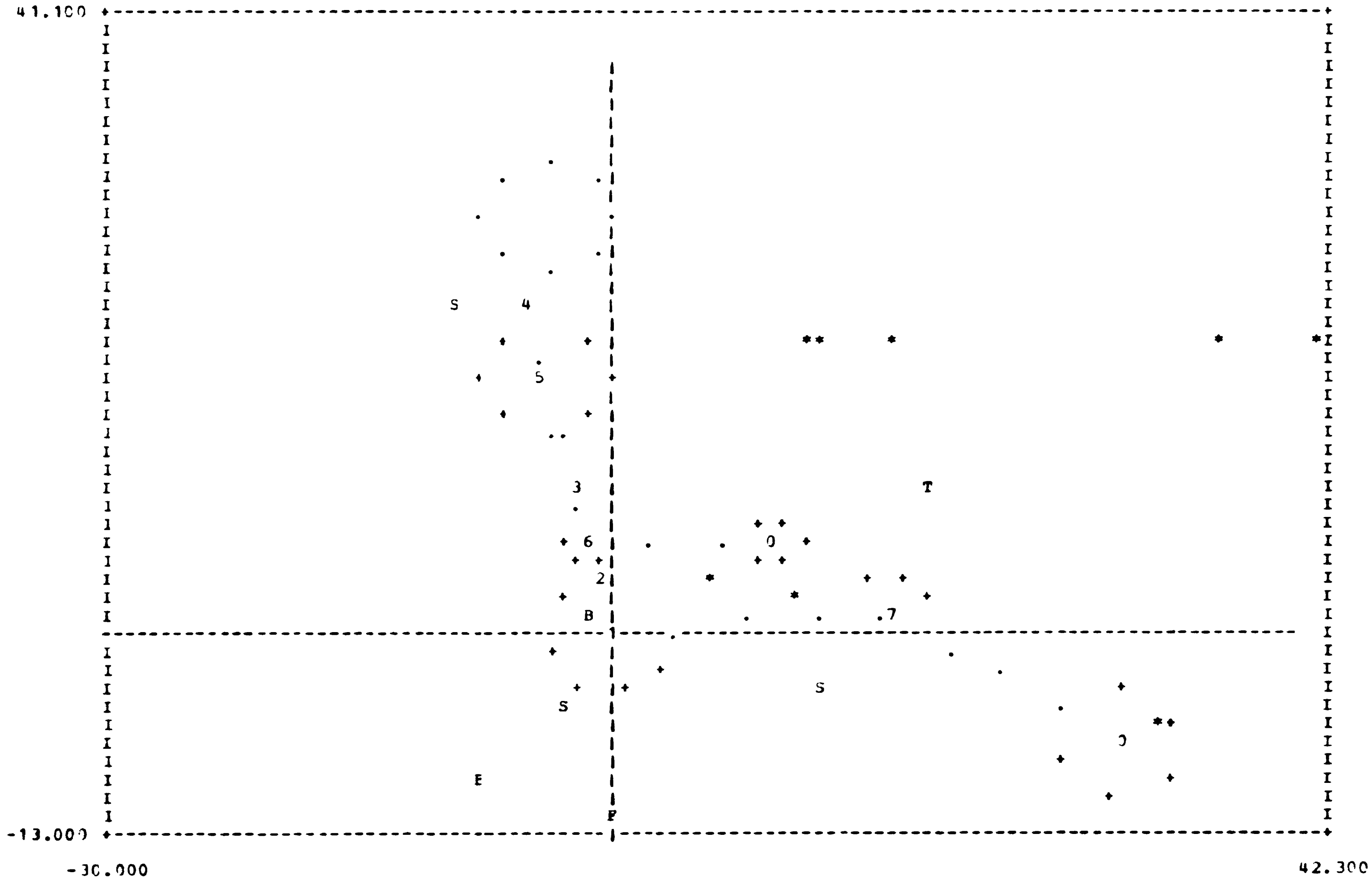
Table XXIV. Selected Printout. Example No. 2 (page 5 of 9)

CONTACT FORCES (LBS.)

TIME	FOOT ON FLOOR	FOOT ON TOE BOARD	UPPER TORSO ON STEERING WHEEL	UPPER TORSO ON STEERING COLUMN	HEAD ON UPPER I. P.	HIP ON SEAT BACK
0.0	18.5	0.0	0.0	0.0	0.0	0.0
0.0050	18.5	0.0	0.0	0.0	0.0	0.0
0.0100	19.8	0.0	0.0	0.0	0.0	0.0
0.0150	23.7	0.0	0.0	0.0	0.0	0.0
0.0200	40.4	202.1	0.0	0.0	0.0	0.0
0.0250	141.3	439.6	0.0	0.0	0.0	0.0
0.0300	335.0	611.3	0.0	0.0	0.0	0.0
0.0350	735.2	716.5	0.0	0.0	0.0	0.0
0.0400	1080.2	837.6	0.0	0.0	0.0	0.0
0.0450	1321.6	1044.7	0.0	0.0	0.0	0.0
0.0500	1442.2	1311.5	0.0	0.0	0.0	0.0
0.0550	14[illegible]	1520.6	0.0	0.0	0.0	0.0
0.0600	1530.5	1530.7	709.7	0.0	0.0	0.0
0.0650	1491.4	1157.9	1000.0	0.0	0.0	0.0
0.0700	1165.8	635.4	1000.0	1146.6	0.0	0.0
0.0750	499.9	240.5	1000.0	2000.0	0.0	0.0
0.0800	0.0	0.0	1000.0	2000.0	0.0	0.0
0.0850	0.0	0.0	1000.0	2000.0	0.0	0.0
0.0900	0.0	0.0	1000.0	2000.0	351.0	0.0
0.0950	0.0	0.0	1000.0	2000.0	1010.5	0.0
0.1000	0.0	0.0	977.3	1943.2	1434.9	0.0
0.1050	0.0	0.0	836.3	1590.8	1498.4	0.0
0.1100	0.0	0.0	591.2	978.1	1297.8	0.0
0.1150	0.0	0.0	300.4	250.9	869.3	0.0
0.1200	0.0	0.0	8.2	0.0	442.6	0.0
0.1250	0.0	0.0	0.0	0.0	160.4	0.0
0.1300	0.0	0.0	0.0	0.0	1.9	0.0
0.1350	0.0	0.0	0.0	0.0	0.0	0.0
0.1400	0.0	0.0	0.0	0.0	0.0	281.8
0.1450	0.0	0.0	0.0	0.0	0.0	628.3
0.1500	0.0	0.0	0.0	0.0	0.0	788.3
0.1550	0.0	0.0	0.0	0.0	0.0	759.6
0.1600	0.0	0.0	0.0	0.0	0.0	544.0
0.1650	0.0	0.0	0.0	0.0	0.0	176.0
0.1700	0.0	0.0	0.0	0.0	0.0	0.0
0.1750	0.0	0.0	0.0	0.0	0.0	0.0
0.1800	0.0	0.0	0.0	0.0	0.0	0.0
0.1850	0.0	621.5	0.0	0.0	0.0	0.0
0.1900	0.0	2883.0	0.0	0.0	0.0	0.0
0.1950	0.0	3450.1	0.0	0.0	0.0	0.0
0.2000	0.0	738.9	0.0	0.0	0.0	0.0

Table XXIV. Selected Printout. Example No. 2 (page 6 of 9)

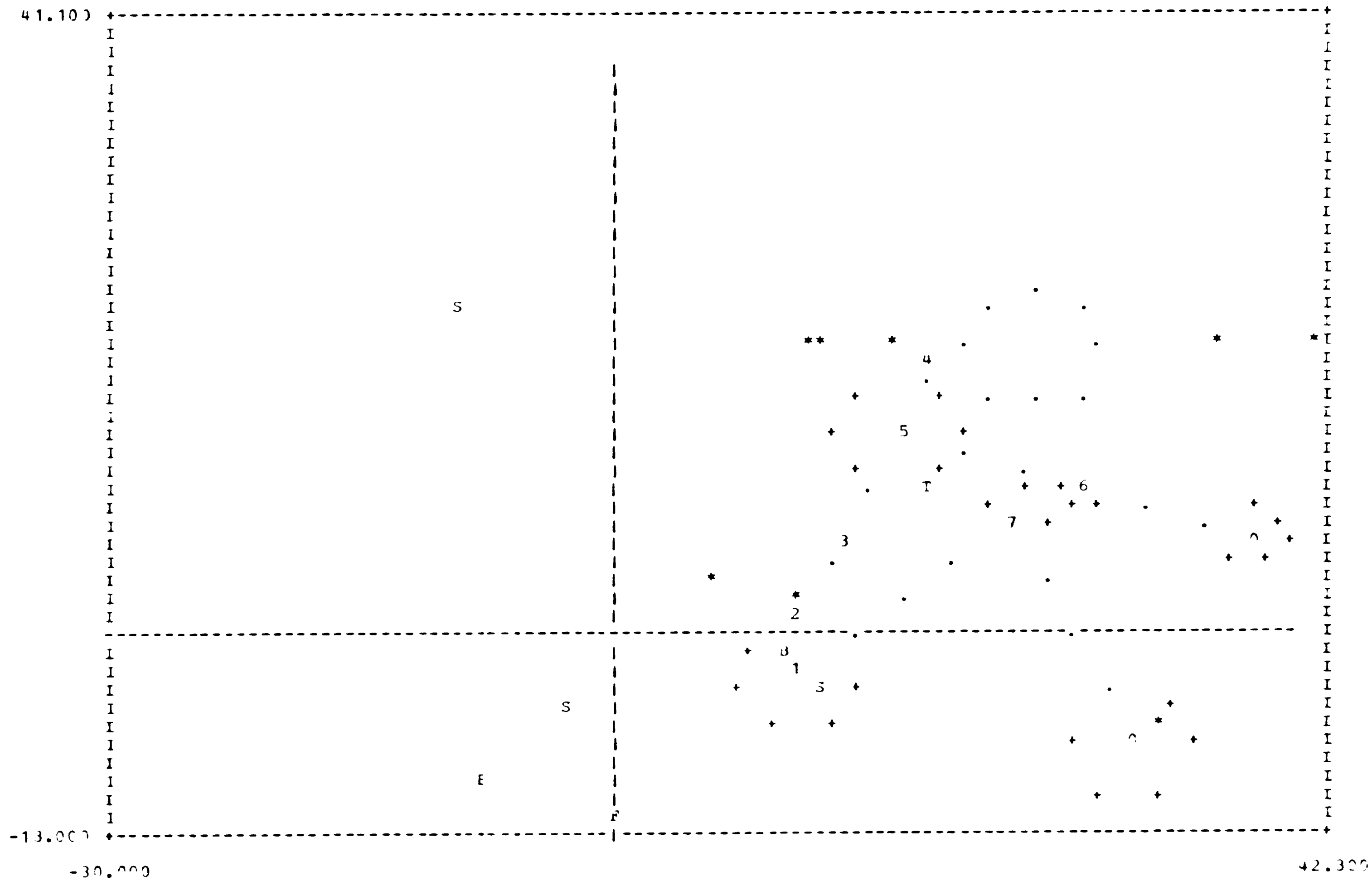
STICK FIGURE REPRESENTATION FOR TIME = 0.0 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXIV. Selected Printout. Example No. 2 (page 7 of 9)

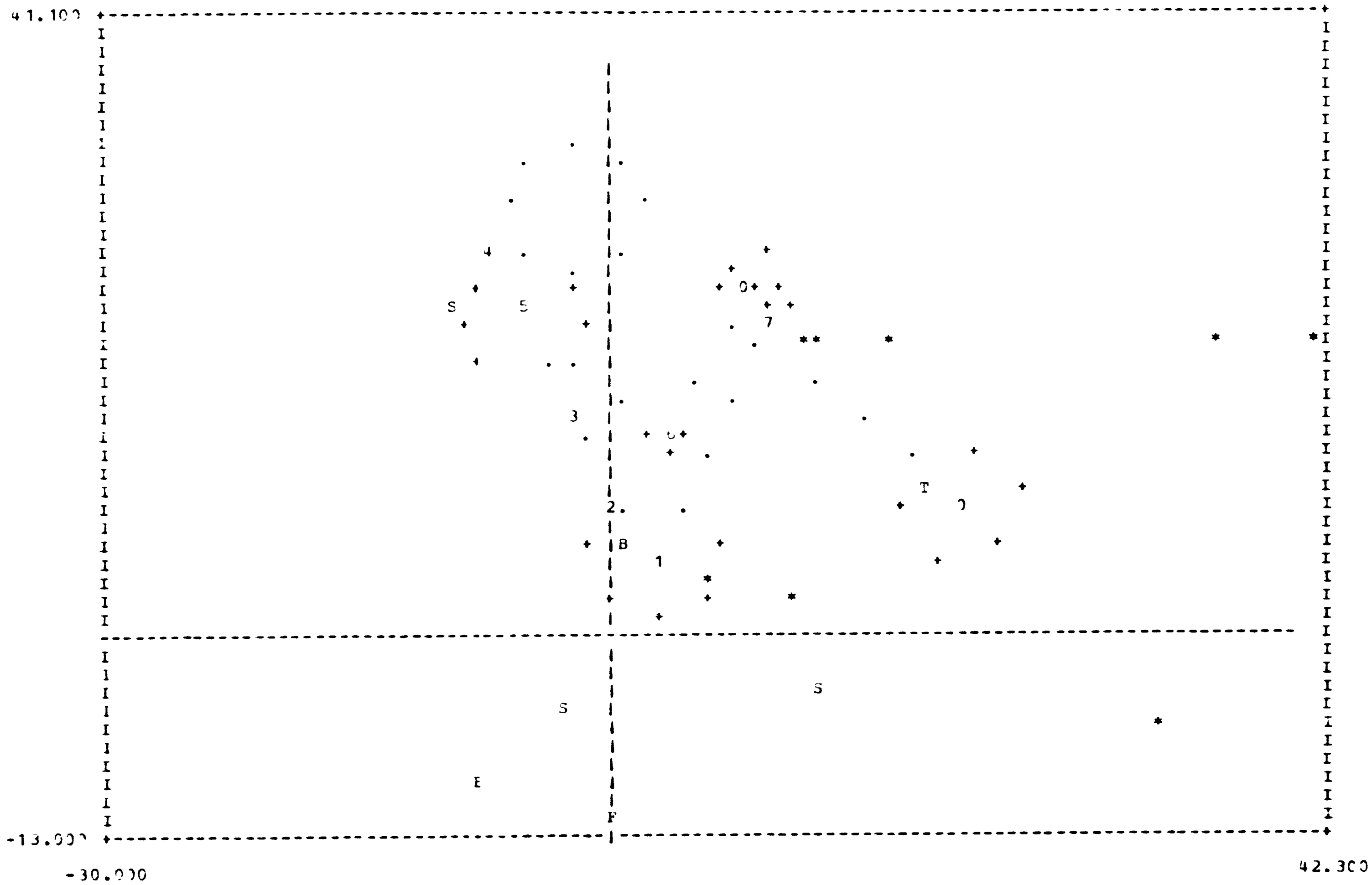
TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 22
STICK FIGURE REPRESENTATION FOR TIME = 0.100 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.00 IN THE X DIRECTION
1 TO 7.00 IN THE Y DIRECTION

Table XXIV. Selected Printout. Example No. 2 (page 8 of 9)

STICK FIGURE REPRESENTATION FOR TIME = 0.200 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.09 IN THE Y DIRECTION

Table XXIV. Selected Printout. Example No. 2 (page 9 of 9)

Example No. 3. Unrestrained 5th Percentile Female Right Front Passenger in a 30 mph Frontal Impact.

This event has been modeled using the data in Table XXV. A complete description of the properties of a 5th percentile female were not available. Values were obtained by scaling the data describing the 50th percentile male down based on stature and weight for a 5th percentile female (105 lbs. and 5 ft. approximately). Joint range of motion and stiffness properties were not changed because of the lack of available data. Besides the usual seat cushion, seat back, toeboard, and floor, four other contact surfaces have been specified. These are the windshield (Surface 4) to indicate head contact, an upper instrument panel element (Surface 2) also to indicate head contact (Surface 7), and a knee-catching lower instrument panel (Surface 6).

The exaggerated extent of these surfaces as specified by the input data should be observed in the annotations to the stick figure section of the abbreviated program output included as Table XXVI. This procedure is based on the fact that each contact surface generates forces only on selected body elements. As an example, it does not matter how long the windshield (Surface 4) is or whether it intersects with the body. A force is generated only on the head. Surfaces 2, 6, and 7 also only produce forces on a single body segment (head, knee, and chest).

The philosophy behind this procedure is to ensure a successful program execution even though the input data is not highly refined. This is made necessary in many exercises, such as the present one, where one cannot predict with any accuracy the kinematics of the occupant. If surfaces are too short, body contact circles may slide unrealistically by their ends. In other words, it is usually better in beginning a series of exercises to have the occupant hit something rather than to fly off into space.

The kinematics of the occupant are interesting and the body loadings are severe. The small occupant is directed generally downward under the instrument panel. The head contacts the windshield and upper instrument panel, the chest the front panel, the knees the lower panel, while the legs are trapped under the panel. The buttocks rebound into the front of the seat cushion generating high loads and flexing the back to the rear. The head finally contacts the seat back.

$LIST DUTIN(143,208)

143	A1.	1.	1.	1.	1.	1.	1.	
144	B.9	.238	1.32	.192	.209	.268	1.158	1.058
145	C960.	960.	960.	960.	960.	960.	960.	
146	D3.83	4.92	10.76	6.59	9.88	9.2	14.1	13.78
147	E.03	.01144	.068	.0246	.0181	.01606	.063	.0338
148	F3.76	0.	3.76	4.	1.25	2.	2.18	3.75
149	G21000.	20000.	20000.	20000.	5240.	7000.	7000.	
150	H60.	15.	20.	20.	20000.	20000.	20000.	20000.
151	I150.	22.5	22.5	70.	195.	130.	120.	
152	J1.	1.	1.	1.	1.	1.	1.	
153	K2.35	2.73	4.42	4.16	4.12	6.42	6.42	8.67
154	L103.	103.	103.	75.	-77.	0.	6.	-40.
155	M0.	2.	0.	145.	6.14	6.	5.	1.
156	N1.	92.	.1	.34	37.21	5.31	1.57	15.
157	O12.1	13.5	16.8	2.55	50.	.0005	2.	1000.
158	P1.	.315	1.	50.	0.	625.	-12.	-12.
159	P2.	.315	1.	77.	.5	350.		
160	P3.	.315	1.	-39.	.5	350.		
161	Q1.	.5	.078					
162	Q2.							
163	Q3.							
164	R1.	528.	528.	0.	.005	.2	5.	1.
165	S0.	45.	.5	.5	45.	-10.	.1	3.
166	T0.	0.	800.					
167	U0.							
168	S1.	28.	.01	.95	-3.	-5.	.1	283.
169	T1.	0.	800.					
170	U1.							
171	S8.	36.	.5	.5	13.5	10.	.1	135.
172	T8.	0.	800.					
173	U8.							
174	S2.	29.	.01	.95	35.85	19.36	.1	15.
175	T2.	0.	500.					
176	X2.	1500.	500.					
177	U2.							
178	U3.							
179	S4.	30.	.01	.95	10.	30.	.1	144.
180	T4.	0.	4000.	-4000.				
181	U4.							
182	U5.							
183	S6.	20.	.01	.95	18.5	15.	.1	106.5
184	T6.	0.	1400.					
185	U6.							
186	X6.	2100.	1400.					
187	S7.	30.	.88	.12	15.	25.	.1	90.
188	T7.	0.	500.					
189	U7.							
190	X7.	1500.	500.					
191	U9.							
192	V1.	1.	0.	0.				
193	V1.	1.	.02	-9650.				
194	V1.	1.	.0547	-9650.				
195	V1.	1.	.0747	0.				
196	V1.	1.	2.	0.				
197	Z							
198	7.5	2.3	1	0	0	0	0	
199	07	UPPER I. P.						
200	02	UPPER I. P..						

Table XXV. Data Set. Example No. 3 (page 1 of 2)

```
 201    -2
 202    -1.
 203    .443      1.
 204    .275      2.
 205    .8        1.
 206        2   44    2  100    0    11    1
 207    -30.      42.3     -13.      41.1      0.        .02
 208        0    0    0    0    0    0    0    0
END OF FILE
```

Table XXV. Data Set. Example No. 3 (page 2 of 2)

1	A	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0
2	B	0.9000	0.2380	1.3200	0.1923	0.2090	0.2680	1.1580	1.0580
3	C	960.0000	960.0000	960.0000	960.0000	960.0000	960.0000	960.0000	0.0
4	D	3.3300	4.9200	10.7600	6.5800	9.8800	9.2000	14.1000	13.7800
5	E	0.0300	0.0114	0.0680	0.0246	0.0181	0.0161	0.0630	0.0338
6	F	3.7600	0.0	3.7600	4.0000	1.2500	2.0000	2.1800	3.7500
7	G	21000.0000	20000.0000	20000.0000	20000.0000	5240.0000	7000.0000	7000.0000	0.0
8	H	60.0000	15.0000	20.0000	20.0000	20000.0000	20000.0000	20000.0000	20000.0000
9	I	150.0000	22.5000	22.5000	70.0000	195.0000	130.0000	120.0000	0.0
10	J	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0
11	K	2.3500	2.7300	4.4200	4.1600	4.1200	6.4200	6.4200	8.6700
12	L	103.0000	103.0000	103.0000	75.0000	-77.0000	0.0	6.0000	-40.0000
13	M	0.0	2.0000	0.0	145.0000	6.1400	6.0000	5.0000	1.0000
14	N	1.0000	92.0000	0.1000	0.3400	37.2100	5.3100	1.5700	15.0000
15	O	12.1000	13.5000	16.8000	2.5500	50.0000	0.3005	2.0000	1000.0000
16	P	1.0000	0.3150	1.0000	50.0000	0.0	625.0000	-12.0000	-12.0000
17	P	2.0000	0.3150	1.0000	77.0000	0.5000	350.0000	0.0	0.0
18	P	3.0000	0.3150	1.0000	-39.0000	0.5000	350.0000	0.0	0.0
19	Q	1.0000	0.5000	0.0780	0.0	0.0	0.0	0.0	0.0
20	Q	2.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Q	3.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	R	1.0000	528.0000	528.0000	0.0	0.0050	0.2000	5.0000	1.0000
23	S	0.0	45.0000	2.5000	0.5000	45.0000	-10.0000	0.1000	3.0000
24	T	0.0	0.0	800.0000	0.0	0.0	0.0	0.0	0.0
25	U	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	S	1.0000	28.0000	0.0100	0.9500	-3.0000	-5.0000	0.1000	283.0000
27	T	1.0000	0.0	800.0000	0.0	0.0	0.0	0.0	0.0
28	U	1.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	S	8.0000	36.0000	0.5000	0.5000	18.5000	10.0000	0.1000	135.0000
30	T	8.0000	0.0	800.0000	0.0	0.0	0.0	0.0	0.0
31	U	8.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	S	2.0000	29.0000	0.0100	0.9500	35.8500	19.3600	0.1000	15.0000
33	T	2.0000	0.0	500.0000	0.0	0.0	0.0	0.0	0.0
34	X	2.0000	1500.0000	500.0000	0.0	0.0	0.0	0.0	0.0
35	U	2.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	U	3.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	S	4.0000	30.0000	0.0100	0.9500	10.0000	30.0000	0.1000	144.0000
38	T	4.0000	0.0	4000.0000	-4000.0000	0.0	0.0	0.0	0.0
39	U	4.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	U	5.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	S	6.0000	20.0000	0.0100	0.9500	18.5000	15.0000	0.1000	106.5000
42	T	6.0000	0.0	1400.0000	0.0	0.0	0.0	0.0	0.0
43	U	6.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	X	6.0000	2100.0000	1400.0000	0.0	0.0	0.0	0.0	0.0
45	S	7.0000	30.0000	0.6800	0.1200	15.0000	25.0000	0.1000	90.0000
46	T	7.0000	0.0	500.0000	0.0	0.0	0.0	0.0	0.0
47	U	7.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	X	7.0000	1500.0000	500.0000	0.0	0.0	0.0	0.0	0.0
49	U	9.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	V	1.0000	1.0000	0.0	0.0	0.0	0.0	0.0	0.0
51	V	1.0000	1.0000	0.0200	-9650.0000	0.0	0.0	0.0	0.0
52	V	1.0000	1.0000	0.0547	-9650.0000	0.0	0.0	0.0	0.0
53	V	1.0000	1.0000	0.0747	0.0	0.0	0.0	0.0	0.0
54	V	1.0000	1.0000	2.0000	0.0	0.0	0.0	0.0	0.0
55	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NS= 14

I=	1	3	3	3	3	4	4	4	4	4	5	7	3	8
A=	1	1	3	5	7	1	2	3	4	5	1	6	0	8

Table XXVI. Selected Printout. Example No. 3 (page 1 of 12)

NO.	M	I	L	RHO	F	THETA
1	0.29999997E-01	0.89999993E 00	0.33299999E 01	0.23499994E 01	0.37599993E 01	0.10299998E 03
2	0.11439998E-01	0.23799999E 00	0.49199991E 01	0.27299995E 01	0.0	0.10299998E 03
3	0.67999959E-01	0.13199997E 01	0.10759999E 02	0.44199991E 01	0.37599993E 01	0.10299998E 03
4	0.24599999E-01	0.19199997E 00	0.65799999E 01	0.41599998E 01	0.40000000E 01	0.74999969E 02
5	0.18099997E-01	0.20899999E 00	0.98799992E 01	0.41199999E 01	0.12500000E 01	-0.74999964E 02
6	0.16059998E-01	0.26799995E 00	0.91999998E 01	0.64199991E 01	0.20000000E 01	0.0
7	0.62999964E-01	0.11580000E 01	0.14099999E 02	0.64199991E 01	0.21799994E 01	0.59999981E 01
8	0.33799998E-01	0.10579996E 01	0.13780000E 02	0.86699991E 01	0.37500000E 01	-0.39999985E 02

NO.	TPRIME	ALPHA	OMEGA	K	CPRIME	XI
1	0.21000000E 05	0.59999999E 02	0.14999995E 03	0.96000000E 03	0.10000000E 01	0.10000000E 01
2	0.20000000E 05	-0.40050991E-74	0.22499985E 02	0.96000000E 03	0.10000000E 01	0.10000000E 01
3	0.20000000E 05	-0.40050991E-74	0.22499985E 02	0.96000000E 03	0.10000000E 01	0.10000000E 01
4	0.20000000E 05	-0.40050991E-74	0.69999954E 02	0.96000000E 03	0.10000000E 01	0.10000000E 01
5	0.52400000E 04	0.14999998E 02	0.19499998E 03	0.96000000E 03	0.10000000E 01	0.10000000E 01
6	0.70000000E 04	0.19999985E 02	0.12999995E 03	0.96000000E 03	0.10000000E 01	0.10000000E 01
7	0.70000000E 04	0.19999985E 02	0.11999995E 03	0.96000000E 03	0.10000000E 01	0.10000000E 01

RZ= 0.20000000E 01,SZ= 0.10000000E 04,DELTA T PRINT=0.005000,NO. PER PRINT INTERVAL= 0.100E 01,LCONTL= 1
PSPRMZ= 0.0 ,RH= 0.20000000E 01,THATP5= 0.20000000E 05,MC= 0.14500000E 03,RHOP3= 0.61399994E 01
RHOP4= 0.60000000E 01,PHIP1= 50.000,CS= 0.10000000E 01,S= 0.92000000E 02,XIS= 0.99999964E-01,MUS= 0.33999997E 00
ZO= 0.15000000E 02,LE1= 0.12099999E 02,L22= 0.13500000E 02,L23= 0.16799988E 02,H= 0.25499992E 01
GAMMAO= 5.000,VC= 0.52800000E 03,NEASSR= 1,NBELT= 0,DELTA T= 0.0005
MAX TIME= 0.2000,MC= 0.50000000E 01

M	G	B	PHI	DELTA	BETA
1	0.31500000E 00	0.10000000E 01	0.49999985E 02	0.0	0.37209991E 02
2	0.31500000E 00	0.10000000E 01	0.76999969E 02	0.50000000E 00	0.53099995E 01
3	0.31500000E 00	0.10000000E 01	-0.38999985E 02	0.50000000E 00	0.15699997E 01

SIGMA

M					
1	0.62500000E 03	-0.12000000E 02	-0.12000000E 02	0.50000000E 03	0.77999949E-01
	0.0	0.0	0.0	0.0	0.0
2	0.35000000E 03	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0
3	0.35000000E 03	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0

A	C	G	B	X	Y	MUA
1	0.45000000E 02	0.50000000E 00	0.50000000E 00	0.45000000E 02	-0.10000000E 02	0.0
2	0.28000000E 02	0.99999973E-02	0.94999999E 00	-0.30000000E 01	-0.50000000E 01	0.0
3	0.29000000E 02	0.99999973E-02	0.94999999E 00	0.35849991E 02	0.19359985E 02	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.30000000E 02	0.99999973E-02	0.94999999E 00	0.10000000E 02	0.30000000E 02	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.28000000E 02	0.99999973E-02	0.94999999E 00	0.18500000E 02	0.15000000E 02	0.0
8	0.30000000E 02	0.88000000E 00	0.11999995E 00	0.15000000E 02	0.25000000E 02	0.0
9	0.36000000E 02	0.50000000E 00	0.50000000E 00	0.18500000E 02	0.10000000E 02	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0

A	XI	PSI
1	0.100	3.000
2	0.100	283.000
3	0.100	15.000

Table XXVI. Selected Printout. Example No. 3 (page 2 of 12)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 1

TIME (SEC.)	BELT FORCES (POUNDS) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	BELT ANGLES (DEGREES) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	RELATIVE HIP POSITION (INCHES) HORIZONTAL	VERTICAL	RELATIVE HEAD POSITION (INCHES) HORIZONTAL	VERTICAL
0.0	0.	0.	0.	0.0	0.0	0.0	0.0	0.0	-3.31	23.03
0.005	0.	0.	0.	0.0	0.0	0.0	0.41	0.04	-3.30	22.97
0.010	0.	0.	0.	0.0	0.0	0.0	1.37	0.19	-3.24	22.86
0.015	0.	0.	0.	0.0	0.0	0.0	2.54	0.45	-3.06	22.72
0.020	0.	0.	0.	0.0	0.0	0.0	3.90	0.80	-2.71	22.57
0.025	0.	0.	0.	0.0	0.0	0.0	5.47	1.24	-2.14	22.41
0.030	0.	0.	0.	0.0	0.0	0.0	7.23	1.73	-1.35	22.22
0.035	0.	0.	0.	0.0	0.0	0.0	9.03	2.09	-0.34	22.00
0.040	0.	0.	0.	0.0	0.0	0.0	10.74	2.15	0.88	21.77
0.045	0.	0.	0.	0.0	0.0	0.0	12.41	1.94	2.32	21.52
0.050	0.	0.	0.	0.0	0.0	0.0	14.07	1.50	3.98	21.26
0.055	0.	0.	0.	0.0	0.0	0.0	15.79	0.95	5.87	21.03
0.060	0.	0.	0.	0.0	0.0	0.0	17.62	0.49	7.96	20.91
0.065	0.	0.	0.	0.0	0.0	0.0	19.37	0.12	10.20	20.90
0.070	0.	0.	0.	0.0	0.0	0.0	20.87	-0.22	12.55	20.90
0.075	0.	0.	0.	0.0	0.0	0.0	21.96	-0.71	14.76	20.74
0.080	0.	0.	0.	0.0	0.0	0.0	22.59	-1.45	16.60	20.31
0.085	0.	0.	0.	0.0	0.0	0.0	22.87	-2.36	18.31	19.65
0.090	0.	0.	0.	0.0	0.0	0.0	23.08	-3.25	19.90	18.77
0.095	0.	0.	0.	0.0	0.0	0.0	23.30	-4.08	21.31	17.59
0.100	0.	0.	0.	0.0	0.0	0.0	23.55	-4.83	22.24	16.29
0.105	0.	0.	0.	0.0	0.0	0.0	23.75	-5.48	22.34	15.54
0.110	0.	0.	0.	0.0	0.0	0.0	23.79	-6.10	21.34	15.35
0.115	0.	0.	0.	0.0	0.0	0.0	23.62	-6.67	19.40	14.98
0.120	0.	0.	0.	0.0	0.0	0.0	23.33	-7.16	17.11	14.31
0.125	0.	0.	0.	0.0	0.0	0.0	22.93	-7.59	14.78	13.73
0.130	0.	0.	0.	0.0	0.0	0.0	22.39	-7.90	12.60	13.25
0.135	0.	0.	0.	0.0	0.0	0.0	21.63	-7.98	10.77	12.52
0.140	0.	0.	0.	0.0	0.0	0.0	20.73	-7.86	9.12	11.68
0.145	0.	0.	0.	0.0	0.0	0.0	19.82	-7.62	7.37	11.24
0.150	0.	0.	0.	0.0	0.0	0.0	18.84	-7.33	5.54	10.94
0.155	0.	0.	0.	0.0	0.0	0.0	17.80	-7.10	3.69	10.60
0.160	0.	0.	0.	0.0	0.0	0.0	16.69	-6.94	1.83	10.19
0.165	0.	0.	0.	0.0	0.0	0.0	15.56	-6.84	-0.06	9.74
0.170	0.	0.	0.	0.0	0.0	0.0	14.37	-6.71	-1.99	9.27
0.175	0.	0.	0.	0.0	0.0	0.0	12.92	-6.43	-3.74	9.01
0.180	0.	0.	0.	0.0	0.0	0.0	11.38	-6.00	-4.22	9.09
0.185	0.	0.	0.	0.0	0.0	0.0	9.85	-5.45	-3.64	8.86
0.190	0.	0.	0.	0.0	0.0	0.0	8.55	-4.99	-3.98	9.26
0.195	0.	0.	0.	0.0	0.0	0.0	7.37	-4.54	-4.49	10.27
0.200	0.	0.	0.	0.0	0.0	0.0	6.28	-4.08	-4.59	11.61

Table XXVI. Selected Printout. Example No. 3 (page 3 of 12)

TWO DIMENSIONAL HEAD VICTIM SIMULATOR OUTPUT DATA SEP ?-72 PAGE ?

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	LOWER TORSO POSITION	LOWER TORSO VELOCITY	LOWER TORSO ACCEL.	CENTER TORSO POSITION	CENTER TORSO VELOCITY	CENTER TORSO ACCEL.	UPPER TORSO POSITION	UPPER TORSO VELOCITY	UPPER TORSO ACCEL.	HEAD POSITION	HEAD VELOCITY	HEAD ACCEL.
0.0	103.00	0.0	0.1817E 06	103.00	0.0	0.2236E 06	103.00	0.0	0.1432E 06	75.00	0.0	0.2648E [illegible]
0.0050	105.11	783.93	0.1080E 06	105.56	944.34	0.1218E 06	103.15	71.42	0.1323E 06	75.27	-1.49	0.5490E 04
0.0100	109.98	1088.29	0.2389E 05	111.27	1231.39	0.4160E 04	103.64	123.32	0.8563E 04	75.74	57.04	-0.5272E 04
0.0150	115.71	1202.98	0.2175E 05	117.42	1214.43	-0.1154E 05	104.41	175.02	0.1236E 05	76.11	56.82	-0.6784E 04
0.0200	121.99	1305.73	0.1906E 05	123.30	1131.92	-0.2171E 05	105.45	243.27	0.1498E 05	76.30	22.21	-0.6742E 04
0.0250	128.74	1392.64	0.1499E 05	128.67	1010.02	-0.2663E 05	106.86	321.25	0.1604E 05	76.34	-7.33	-0.4424E 04
0.0300	135.87	1427.08	-0.3086E 05	133.16	675.31	-0.1569E 06	108.75	459.31	0.4117E 05	76.20	-63.69	-0.1954E 05
0.0350	142.16	1031.33	-0.9579E 05	134.71	-36.91	-0.1334E 06	111.26	510.32	-0.9171E 03	75.87	-37.76	0.1619E 05
0.0400	146.15	571.01	-0.8735E 05	132.98	-626.39	-0.9759E 05	113.79	489.69	-0.8032E 04	75.92	63.65	0.2561E 05
0.0450	147.93	147.11	-0.8353E 05	128.75	-1036.49	-0.6839E 05	116.10	431.25	-0.1773E 05	76.59	215.10	0.3413E 05
0.0500	147.63	-285.80	-0.1091E 06	122.84	-1245.22	0.4848E 05	117.96	301.85	-0.4458E 05	78.10	387.32	0.3098E 05
0.0550	144.90	-717.30	0.2590E 05	117.86	-718.30	0.2590E 05	118.65	51.92	-0.2833E 05	80.31	465.60	-0.1002E 05
0.0600	141.65	-551.05	0.8519E 05	114.58	-619.04	-0.4029E 05	118.65	-168.79	-0.6837E 05	82.44	366.89	-0.6298E 04
0.0650	140.53	190.84	0.1534E 06	110.65	-864.55	-0.4763E 05	116.84	-583.69	-0.1007E 06	84.48	450.62	-0.1004E 04
0.0700	142.82	595.34	-0.5488E 04	106.57	-642.96	0.1947E 06	112.57	-1141.98	-0.1188E 06	86.35	202.41	-0.1143E 06
0.0750	144.42	6.97	-0.1160E 06	106.19	142.50	-0.3793E 05	105.97	-1271.99	0.6021E 05	86.64	89.47	-0.6288E 05
0.0800	142.89	-613.94	-0.1117E 06	106.35	-111.14	-0.7338E 05	100.22	-1030.21	0.4900E 05	85.14	-764.30	-0.1862E 06
0.0850	139.43	-700.40	0.3014E 04	106.03	31.77	0.2780E 05	95.77	-752.44	0.5066E 05	79.07	-1631.86	-0.1486E 06
0.0900	135.98	-637.28	0.1341E 06	105.59	164.02	-0.6922E 05	92.63	-503.26	0.5261E 05	69.25	-2236.55	-0.8959E 05
0.0950	134.76	166.75	0.1524E 06	105.71	-1.69	0.4677E 05	90.82	-278.71	-0.9694E 04	56.92	-2569.43	0.1177E 06
0.1000	137.20	724.46	0.4242E 05	107.50	376.91	0.1191E 06	89.09	-453.86	-0.5857E 05	47.42	-811.51	0.6037E 06
0.1050	140.85	660.44	-0.3218E 05	110.63	669.90	-0.9630E 05	86.20	-610.69	0.3515E 05	51.64	2524.53	0.6156E 06
0.1100	143.22	265.10	-0.8335E 05	112.98	224.54	-0.1430E 06	83.76	-292.11	0.1357E 06	70.69	4722.74	0.1523E 06
0.1150	143.60	-82.43	-0.5121E 05	113.06	-83.43	-0.5121E 05	83.98	400.51	0.1828E 06	94.67	4534.02	-0.2607E 06
0.1200	142.53	-316.21	-0.4471E 05	112.04	-317.21	-0.4471E 05	88.41	1385.48	0.1970E 06	113.12	2664.52	-0.4725E 06
0.1250	140.42	-555.58	-0.5364E 05	109.86	-556.58	-0.5364E 05	97.67	2283.71	0.1523E 06	120.27	171.42	-0.4914E 06
0.1300	136.93	-848.60	-0.6476E 05	106.39	-829.01	-0.1416E 05	110.72	2853.73	0.4565E 05	115.62	-1831.49	-0.2430E 06
0.1350	131.89	-1159.21	-0.5047E 05	102.81	-446.84	0.1607E 06	124.86	2652.97	-0.1274E 06	104.86	-2147.82	0.1349E 06
0.1400	125.72	-1250.05	0.8491E 04	103.65	1032.56	0.3973E 06	135.65	1510.05	-0.2991E 06	96.82	-910.22	0.3116E 06
0.1450	119.50	-1225.94	0.4923E 05	111.66	1831.33	0.2090E 05	140.68	645.90	-0.5127E 05	95.76	328.03	0.6218E 05
0.1500	114.15	-887.46	0.7923E 05	120.63	1779.14	-0.4559E 05	143.26	388.54	-0.4657E 05	98.21	654.50	0.6408E 05
0.1550	110.65	-531.26	0.5856E 05	129.01	1474.52	-0.7076E 05	144.69	206.36	-0.2220E 05	102.22	935.35	0.4317E 05
0.1600	108.89	-80.57	0.1711E 06	135.33	948.36	-0.1944E 06	145.59	201.72	0.3843E 05	107.30	1059.50	-0.2336E 04
0.1650	110.48	573.37	0.6810E 05	137.89	259.86	-0.5831E 05	147.08	356.35	0.1349E 05	112.50	1025.28	-0.5648E 04
0.1700	113.59	468.65	-0.6423E 05	133.46	-21.04	-0.4249E 05	149.19	544.33	0.5900E 05	117.28	777.58	-0.1888E 06
0.1750	115.50	365.60	0.1855E 05	137.90	-182.66	-0.1604E 05	152.69	859.61	0.4978E 05	115.72	-2020.60	-0.8976E 06
0.1800	117.72	553.39	0.5230E 05	137.06	-72.81	0.7569E 05	157.03	694.06	-0.1713E 06	94.31	-6343.03	-0.6124E 06
0.1850	121.10	778.58	0.2931E 05	138.13	620.94	0.1929E 06	157.33	-747.47	-0.3216E 06	59.96	-5968.37	0.9685E 06
0.1900	125.32	916.45	0.3139E 05	143.41	1243.91	-0.5034E 05	150.41	-1718.86	-0.3157E 05	43.88	-1385.45	0.1773E 06
0.1950	130.27	1052.46	0.2214E 05	148.62	877.52	-0.9823E 05	141.34	-1931.19	-0.5440E 05	39.02	-579.16	0.1548E 06
0.2000	135.78	1145.65	0.1521E 05	151.82	290.90	-0.1384E 06	130.98	-2210.61	-0.4922E 05	38.21	305.61	0.2215E 06

Table XXVI. Selected Printout. Example No. 3 (page 4 of 12)

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	UPPER ARM POSITION	UPPER ARM VELOCITY	UPPER ARM ACCEL.	LOWER ARM POSITION	LOWER ARM VELOCITY	LOWER ARM ACCEL.	UPPER LEG POSITION	UPPER LEG VELOCITY	UPPER LEG ACCEL.	LOWER LEG POSITION	LOWER LEG VELOCITY	LOWER LEG ACCEL.
0.0	-77.00	0.0	-0.1300E 05	0.0	0.0	0.3306E 05	6.00	0.0	0.3438E 06	-40.00	0.0	-0.3603E 06
0.0050	-77.14	-51.11	-0.5353E 04	0.35	121.96	0.1018E 05	9.70	1268.11	0.9676E 05	-43.78	-1253.14	-0.6191E 05
0.0100	-77.43	-59.16	0.1300E 04	1.02	133.82	-0.2671E 04	16.52	1334.77	-0.3566E 05	-50.14	-1204.26	0.3568E 05
0.0150	-77.71	-50.55	0.2210E 04	1.65	118.64	-0.3497E 04	22.76	1165.64	-0.3154E 05	-55.73	-1036.05	0.3132E 05
0.0200	-77.93	-37.55	0.3043E 04	2.20	99.29	-0.4285E 04	28.21	1017.23	-0.2747E 05	-60.53	-867.16	0.2817E 05
0.0250	-78.08	-20.75	0.3710E 04	2.64	76.78	-0.4659E 04	32.96	888.42	-0.2373E 05	-64.62	-750.67	0.2649E 05
0.0300	-78.13	3.09	0.6813E 04	2.96	45.94	-0.7498E 04	37.17	830.07	0.2830E 05	-67.99	-551.68	0.8884E 05
0.0350	-78.03	34.18	0.6114E 04	3.14	35.11	-0.2591E 03	41.98	1150.94	0.8813E 05	-69.26	104.07	0.1569E 06
0.0400	-77.78	65.59	0.6215E 04	3.32	34.47	0.4269E 03	48.77	1540.92	0.6434E 05	-67.50	385.57	-0.8461E 05
0.0450	-77.38	94.99	0.6634E 04	3.51	41.57	0.1271E 04	57.25	1848.73	0.6095E 05	-67.26	-381.15	-0.1723E 06
0.0500	-76.81	141.40	0.1723E 05	3.72	38.22	-0.6258E 04	67.32	2204.05	0.9248E 05	-70.57	-692.18	0.1327E 06
0.0550	-75.81	268.67	0.2838E 05	3.73	-54.91	-0.3616E 05	79.55	2648.91	0.2008E 05	-71.12	653.94	0.2985E 06
0.0600	-74.05	447.49	0.3915E 05	2.94	-262.84	-0.3670E 05	92.62	2496.42	-0.9731E 05	-64.37	1993.83	0.1969E 06
0.0650	-71.37	621.79	0.5299E 05	1.32	-358.62	-0.6283E 04	103.62	1850.29	-0.1842E 06	-53.82	1849.29	-0.1842E 06
0.0700	-67.30	1080.08	0.1388E 06	-0.54	-390.24	-0.1580E 05	110.28	782.40	-0.2219E 06	-47.35	607.08	-0.3301E 06
0.0750	-60.03	1808.95	0.1194E 06	-2.79	-503.70	-0.3324E 05	111.88	-68.38	-0.1441E 06	-48.02	-743.45	-0.1696E 06
0.0800	-49.66	2318.07	0.8691E 05	-5.88	-752.25	-0.5695E 05	109.77	-760.46	-0.1242E 06	-52.80	-907.20	0.1355E 06
0.0850	-37.22	2592.03	0.3993E 04	-10.22	-924.71	0.1990E 05	105.30	-966.81	-0.2512E 05	-57.17	-852.42	0.2078E 05
0.0900	-25.15	1815.52	-0.4696E 06	-13.22	363.45	0.7529E 06	100.87	-636.28	0.1341E 06	-60.48	-313.80	0.1698E 06
0.0950	-19.42	810.00	-0.1088E 06	-5.76	2124.48	0.2109E 06	99.65	167.75	0.1524E 06	-59.66	648.83	0.1781E 06
0.1000	-16.61	353.94	-0.5753E 05	7.26	3011.55	0.1226E 06	102.10	725.46	0.4242E 05	-54.48	1342.13	0.7289E 05
0.1050	-15.38	155.60	-0.2997E 05	23.49	3406.65	0.3295E 05	105.74	635.37	-0.6317E 05	-47.44	1336.18	-0.8588E 05
0.1100	-14.87	66.45	-0.9596E 04	40.56	3335.72	-0.7084E 05	108.06	266.10	-0.8335E 05	-42.20	671.90	-0.1678E 06
0.1150	-14.50	111.66	0.1782E 05	56.06	2809.71	-0.1369E 06	108.45	-81.43	-0.5121E 05	-40.82	-34.07	-0.6051E 05
0.1200	-13.68	220.43	0.2561E 05	68.32	2093.93	-0.1376E 06	107.44	-315.21	-0.4471E 05	-41.35	-142.37	-0.1254E 05
0.1250	-12.22	370.17	0.3512E 05	77.22	1504.88	-0.8675E 05	105.28	-554.58	-0.5364E 05	-42.24	-224.09	-0.2267E 05
0.1300	-9.93	544.53	0.3118E 05	83.95	1257.07	-0.9017E 04	101.80	-847.60	-0.6476E 05	-43.68	-355.63	-0.2981E 05
0.1350	-6.96	601.71	-0.2051E 05	92.27	1298.38	0.1958E 05	96.75	-1158.21	-0.5047E 05	-45.80	-474.85	-0.7590E 04
0.1400	-4.49	327.56	-0.8307E 05	96.88	1306.09	-0.2431E 05	90.60	-1249.05	0.8491E 04	-48.11	-421.93	0.2384E 05
0.1450	-3.66	74.08	0.2293E 05	103.25	1243.55	-0.1913E 05	84.28	-1224.94	0.4923E 05	-49.82	-199.57	0.8411E 05
0.1500	-2.98	202.03	0.2565E 05	109.23	1148.21	-0.2079E 05	78.93	-886.46	0.7923E 05	-49.64	296.35	0.1074E 06
0.1550	-1.68	308.45	0.1393E 05	114.68	1022.64	-0.3202E 05	75.44	-530.78	0.5115E 05	-46.87	784.54	0.6127E 05
0.1600	-0.05	321.92	-0.1477E 05	119.33	821.72	-0.4937E 05	73.22	-397.54	0.2611E 04	-42.78	722.94	-0.8930E 05
0.1650	1.35	242.11	-0.1282E 05	122.77	548.18	-0.5834E 05	71.19	-422.63	-0.8840E 04	-40.50	169.31	-0.9885E 05
0.1700	2.18	14.50	-0.6150E 05	124.57	97.99	-0.1076E 06	68.67	-684.29	-0.6264E 05	-40.42	-23.95	0.1230E 05
0.1750	1.72	-156.72	-0.1638E 05	123.87	-348.39	-0.7110E 05	64.73	-845.65	-0.1315E 05	-40.37	40.41	0.1079E 05
0.1800	0.52	-401.01	-0.1107E 06	121.31	-656.73	-0.4934E 05	60.31	-929.90	-0.2007E 05	-40.06	82.31	0.8014E 04
0.1850	-3.10	-1029.19	-0.6940E 05	117.64	-742.56	0.2710E 05	55.62	-875.89	0.5671E 05	-39.50	154.54	0.1980E 05
0.1900	-8.51	-1081.66	-0.1200E 05	114.43	-562.40	0.1324E 05	51.93	-673.38	-0.7145E 04	-38.52	220.77	0.5154E 04
0.1950	-14.17	-1207.69	-0.4086E 05	111.95	-411.74	0.3825E 05	48.53	-677.28	0.5698E 04	-37.35	248.94	0.5648E 04
0.2000	-20.80	-1456.39	-0.5329E 05	110.35	-244.76	-0.2754E 03	45.24	-635.12	0.1010E 05	-36.04	274.75	0.4631E 04

Table XXVI. Selected Printout. Example No. 3 (page 5 of 12)

	VEHICULAR MOTION			BODY MOTION AT HIP JOINT					
TIME	POSITION (IN.)	VELOCITY (IN./SEC.)	ACCEL. (G-UNITS)	RELATIVE DISPL. (IN.)	HORIZONTAL VELOCITY (IN./SEC.)	ACCEL. (G-UNITS)	RELATIVE DISPL. (IN.)	VERTICAL VELOCITY (IN./SEC.)	ACCEL. (G-UNITS)
0.0	0.0	528.00	0.0	0.0	528.00	89.875	0.0	0.0	6.041
0.0050	2.630	521.97	-6.244	0.408	675.12	49.403	0.036	17.24	13.322
0.0100	5.200	503.88	-12.487	1.372	721.67	3.915	0.187	41.73	10.628
0.0150	7.649	473.72	-18.731	2.544	725.74	0.177	0.446	61.71	9.839
0.0200	9.917	431.50	-24.974	3.902	723.70	-2.368	0.800	79.57	8.455
0.0250	11.954	383.25	-24.974	5.469	717.51	-4.110	1.237	94.53	6.848
0.0300	13.749	335.07	-24.974	7.233	700.29	-24.314	1.731	96.55	-16.670
0.0350	15.304	286.75	-24.974	9.027	635.60	-34.185	2.094	42.32	-33.049
0.0400	16.617	238.50	-24.974	10.736	575.21	-28.087	2.151	-17.74	-28.050
0.0450	17.689	190.25	-24.974	12.411	524.35	-26.357	1.935	-66.94	-22.968
0.0500	18.519	142.00	-24.974	14.074	474.64	-19.816	1.499	-104.43	-11.984
0.0550	19.109	93.77	-24.600	15.792	452.77	-11.701	0.952	-106.16	14.199
0.0600	19.469	52.28	-18.356	17.618	415.72	-32.839	0.483	-30.99	8.012
0.0650	19.651	22.84	-12.113	19.369	359.07	-40.958	0.124	-65.09	1.618
0.0700	19.717	5.47	-5.869	20.866	263.48	-49.262	-0.222	-77.27	-12.113
0.0750	19.726	0.14	0.0	21.962	176.79	-50.676	-0.708	-123.23	-27.759
0.0800	19.727	0.14	0.0	22.532	75.12	-53.322	-1.454	-174.61	-24.797
0.0850	19.728	0.14	0.0	22.871	46.19	-8.870	-2.356	-180.51	0.895
0.0900	19.728	0.14	0.0	23.080	42.41	-0.248	-3.250	-175.47	10.003
0.0950	19.729	0.14	0.0	23.300	47.51	3.809	-4.084	-158.35	10.029
0.1000	19.730	0.14	0.0	23.546	49.19	-3.728	-4.827	-138.75	9.455
0.1050	19.731	0.14	0.0	23.752	27.42	-20.845	-5.482	-125.80	3.376
0.1100	19.731	0.14	0.0	23.787	-14.37	-23.192	-6.098	-119.91	3.152
0.1150	19.732	0.14	0.0	23.622	-46.95	-12.525	-6.666	-105.13	7.200
0.1200	19.733	0.14	0.0	23.331	-68.42	-10.529	-7.161	-93.54	6.100
0.1250	19.733	0.14	0.0	22.934	-91.44	-14.810	-7.593	-76.68	13.269
0.1300	19.734	0.14	0.0	22.391	-128.29	-24.043	-7.896	-41.15	24.440
0.1350	19.735	0.14	0.0	21.633	-173.26	-19.249	-7.980	6.92	21.712
0.1400	19.736	0.14	0.0	20.727	-177.77	12.003	-7.860	36.61	9.572
0.1450	19.736	0.14	0.0	19.815	-189.16	-4.039	-7.622	56.56	4.047
0.1500	19.737	0.14	0.0	18.844	-199.88	-7.515	-7.334	55.33	-6.168
0.1550	19.738	0.14	0.0	17.804	-216.35	-8.886	-7.096	38.59	-9.469
0.1600	19.739	0.14	0.0	16.686	-227.57	0.639	-6.941	24.42	-5.437
0.1650	19.739	0.14	0.0	15.557	-224.68	0.008	-6.838	19.62	0.225
0.1700	19.740	0.14	0.0	14.372	-268.77	-32.012	-6.714	39.44	18.880
0.1750	19.741	0.14	0.0	12.921	-302.65	-6.437	-6.433	71.68	15.291
0.1800	19.741	0.14	0.0	11.381	-312.18	-2.586	-5.998	102.60	15.214
0.1850	19.742	0.14	0.0	9.847	-289.08	30.970	-5.446	106.55	-16.174
0.1900	19.743	0.14	0.0	8.546	-242.39	5.122	-4.993	85.27	6.061
0.1950	19.744	0.14	0.0	7.366	-227.84	9.883	-4.545	92.22	0.997
0.2000	19.744	0.14	0.0	6.276	-207.27	10.806	-4.083	91.67	-1.321

Table XXVI. Selected Printout. Example No. 3 (page 6 of 12)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972

TIME	ACCELEROMETER READINGS HEAD RESULTANT (G-UNITS)	HEAD ANGLE (DEG.)	CHEST RESULTANT (G-UNITS)	CHEST ANGLE (DEG.)	BELT FORCES (LBS), LAP	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	SEAT FORCES (LBS) AT HIP	AT FRONT EDGE
0.0	12.3	-111.9	15.7	-53.2	0.0	0.0	0.0	145.00	60.58
0.0050	5.2	-105.2	6.8	-38.4	0.0	0.0	0.0	141.13	0.0
0.0100	1.6	-81.9	1.7	-6.8	0.0	0.0	0.0	119.82	0.0
0.0150	1.9	-88.0	2.4	-0.0	0.0	0.0	0.0	96.74	0.0
0.0200	2.2	-99.2	2.3	6.4	0.0	0.0	0.0	72.65	0.0
0.0250	2.4	-117.1	3.2	11.2	0.0	0.0	0.0	47.76	0.0
0.0300	4.5	-109.1	7.5	29.5	0.0	0.0	0.0	31.03	0.0
0.0350	4.8	-159.9	1.5	-96.1	0.0	0.0	0.0	72.18	0.0
0.0400	6.0	-174.5	2.6	-112.4	0.0	0.0	0.0	136.50	0.0
0.0450	7.1	177.6	4.6	-120.7	0.0	0.0	0.0	204.77	0.0
0.0500	7.2	149.2	12.2	-155.6	0.0	0.0	0.0	268.18	0.0
0.0550	10.2	101.1	16.0	155.7	0.0	0.0	0.0	0.0	0.0
0.0600	12.9	95.5	25.3	176.5	0.0	0.0	0.0	0.0	0.0
0.0650	1.7	165.9	39.7	-159.8	0.0	0.0	0.0	0.0	0.0
0.0700	18.2	-66.1	80.0	-163.1	0.0	0.0	0.0	0.0	0.0
0.0750	46.5	-137.0	33.6	-159.2	0.0	0.0	0.0	0.0	0.0
0.0800	31.5	-60.3	30.3	-164.4	0.0	0.0	0.0	0.0	0.0
0.0850	35.4	-76.3	13.5	-169.0	0.0	0.0	0.0	0.0	0.0
0.0900	45.7	-100.4	7.3	-147.3	0.0	0.0	0.0	0.0	0.0
0.0950	78.3	-162.8	26.5	-153.8	0.0	0.0	0.0	0.0	0.0
0.1000	202.8	140.9	27.2	-167.4	0.0	0.0	0.0	0.0	0.0
0.1050	228.4	151.0	12.4	87.0	0.0	0.0	0.0	0.0	0.0
0.1100	161.1	-152.6	23.2	88.1	0.0	0.0	0.0	0.0	0.0
0.1150	88.1	-81.8	25.8	127.5	0.0	0.0	0.0	0.0	0.0
0.1200	75.3	20.1	20.3	143.3	0.0	0.0	0.0	0.0	0.0
0.1250	95.7	33.5	15.7	134.3	0.0	0.0	0.0	0.0	0.0
0.1300	79.6	-18.5	17.3	126.2	0.0	0.0	0.0	0.0	0.0
0.1350	36.0	-85.1	23.5	154.0	0.0	0.0	0.0	0.0	0.0
0.1400	79.5	138.8	46.4	-178.3	0.0	0.0	0.0	0.0	0.0
0.1450	11.7	-162.0	15.0	-108.5	0.0	0.0	0.0	0.0	0.0
0.1500	13.0	-144.7	15.6	-93.5	0.0	0.0	0.0	0.0	0.0
0.1550	12.4	-125.7	8.7	-84.3	0.0	0.0	0.0	0.0	0.0
0.1600	8.7	-103.6	10.4	71.6	0.0	0.0	0.0	0.0	0.0
0.1650	6.5	-92.7	4.1	125.6	0.0	0.0	0.0	0.0	0.0
0.1700	42.9	44.4	30.2	126.6	0.0	0.0	0.0	836.41	590.57
0.1750	290.7	20.5	13.4	125.8	0.0	0.0	0.0	703.69	307.39
0.1800	281.8	-31.8	19.6	134.9	0.0	0.0	0.0	552.57	88.55
0.1850	332.5	167.7	26.7	-58.7	0.0	0.0	0.0	430.64	0.0
0.1900	43.2	99.1	20.3	18.0	0.0	0.0	0.0	374.09	0.0
0.1950	61.1	61.0	34.5	22.7	0.0	0.0	0.0	302.30	0.0
0.2000	68.7	68.7	40.4	25.9	0.0	0.0	0.0	249.64	0.0

Table XXVI. Selected Printout. Example No. 3 (page 7 of 12)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 5

CONTACT FORCES (LBS.)

TIME	FOOT ON FLOOR	KNEE ON LOWER PANEL	FOOT ON TOE BOARD	UPPER TORSO ON UPPER I. P.	HEAD ON WINDSHIELD	HEAD ON UPPER I. P..
0.0	54.9	0.0	0.0	0.0	0.0	0.0
0.0050	0.0	0.0	0.0	0.0	0.0	0.0
0.0100	0.0	0.0	0.0	0.0	0.0	0.0
0.0150	0.0	0.0	0.0	0.0	0.0	0.0
0.0200	0.0	0.0	0.0	0.0	0.0	0.0
0.0250	0.0	0.0	0.0	0.0	0.0	0.0
0.0300	0.0	1121.6	0.0	0.0	0.0	0.0
0.0350	0.0	2100.0	0.0	0.0	0.0	0.0
0.0400	0.0	2100.0	1204.7	0.0	0.0	0.0
0.0450	0.0	2100.0	1839.9	0.0	0.0	0.0
0.0500	0.0	1675.2	887.4	0.0	0.0	0.0
0.0550	0.0	240.2	0.0	0.0	0.0	0.0
0.0600	0.0	0.0	148.0	0.0	0.0	0.0
0.0650	0.0	0.0	1168.9	324.3	0.0	0.0
0.0700	0.0	0.0	1902.2	1497.4	0.0	0.0
0.0750	0.0	0.0	1673.0	1500.0	488.5	0.0
0.0800	0.0	0.0	470.1	1500.0	0.0	0.0
0.0850	0.0	0.0	0.0	1500.0	0.0	0.0
0.0900	0.0	1341.0	0.0	1500.0	0.0	0.0
0.0950	0.0	1720.0	0.0	1500.0	0.0	357.0
0.1000	0.0	908.0	0.0	1500.0	0.0	1228.5
0.1050	0.0	0.0	345.4	1500.0	0.0	1499.1
0.1100	0.0	0.0	619.5	1495.2	0.0	1251.5
0.1150	0.0	0.0	188.0	1390.7	0.0	1032.2
0.1200	0.0	0.0	0.0	1069.0	0.0	1054.7
0.1250	0.0	0.0	0.0	507.1	0.0	1054.4
0.1300	0.0	0.0	0.0	0.0	0.0	985.6
0.1350	0.0	0.0	0.0	0.0	0.0	1088.2
0.1400	0.0	0.0	0.0	0.0	0.0	1290.9
0.1450	0.0	733.5	0.0	0.0	0.0	0.0
0.1500	0.0	1215.7	0.0	0.0	0.0	0.0
0.1550	0.0	959.9	79.2	0.0	0.0	0.0
0.1600	0.0	159.6	534.6	0.0	0.0	0.0
0.1650	0.0	0.0	522.3	0.0	0.0	0.0
0.1700	0.0	0.0	0.0	0.0	0.0	0.0
0.1750	0.0	0.0	0.0	0.0	0.0	0.0
0.1800	0.0	0.0	0.0	0.0	0.0	0.0
0.1850	0.0	0.0	0.0	0.0	0.0	0.0
0.1900	0.0	0.0	0.0	0.0	0.0	0.0
0.1950	0.0	0.0	0.0	0.0	0.0	0.0
0.2000	0.0	0.0	0.0	0.0	0.0	0.0

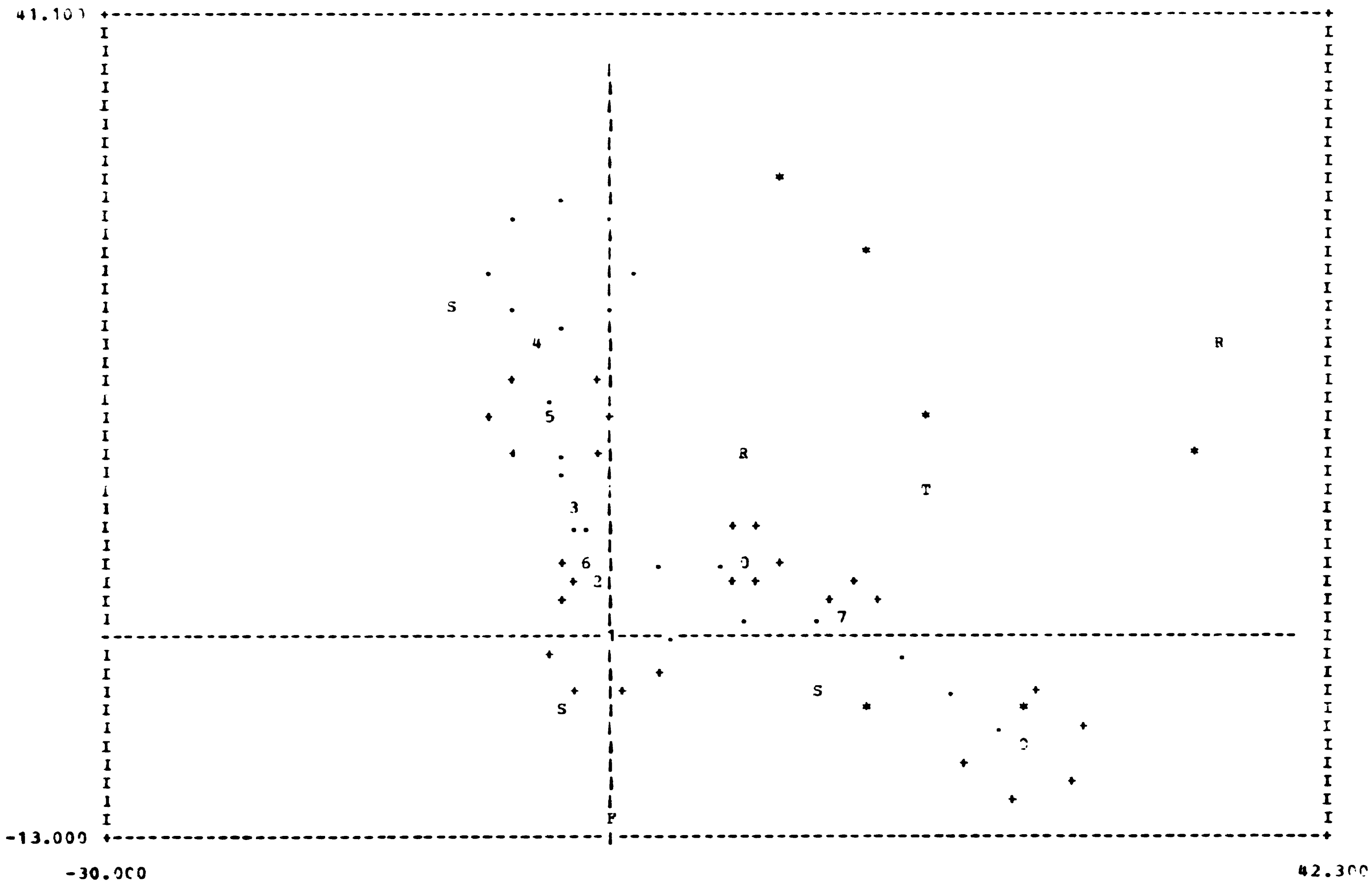
Table XXVI. Selected Printout. Example No. 3 (page 8 of 12)

CONTACT FORCES (LBS.)

TIME	HEAD ON SEAT BACK	UPPER TORSO ON SEAT BACK
0.0	0.0	0.0
0.0050	0.0	0.0
0.0100	0.0	0.0
0.0150	0.0	0.0
0.0200	0.0	0.0
0.0250	0.0	0.0
0.0300	0.0	0.0
0.0350	0.0	0.0
0.0400	0.0	0.0
0.0450	0.0	0.0
0.0500	0.0	0.0
0.0550	0.0	0.0
0.0600	0.0	0.0
0.0650	0.0	0.0
0.0700	0.0	0.0
0.0750	0.0	0.0
0.0800	0.0	0.0
0.0850	0.0	0.0
0.0900	0.0	0.0
0.0950	0.0	0.0
0.1000	0.0	0.0
0.1050	0.0	0.0
0.1100	0.0	0.0
0.1150	0.0	0.0
0.1200	0.0	0.0
0.1250	0.0	0.0
0.1300	0.0	0.0
0.1350	0.0	0.0
0.1400	0.0	0.0
0.1450	0.0	0.0
0.1500	0.0	0.0
0.1550	0.0	0.0
0.1600	0.0	0.0
0.1650	0.0	0.0
0.1700	208.1	0.0
0.1750	1583.8	0.0
0.1800	1345.9	0.0
0.1850	1[illegible]1.5	282.1
0.1900	113.0	1338.4
0.1950	271.2	2118.9
0.2000	100.1	2537.8

Table XXVI. Selected Printout. Example No. 3 (page 9 of 12)

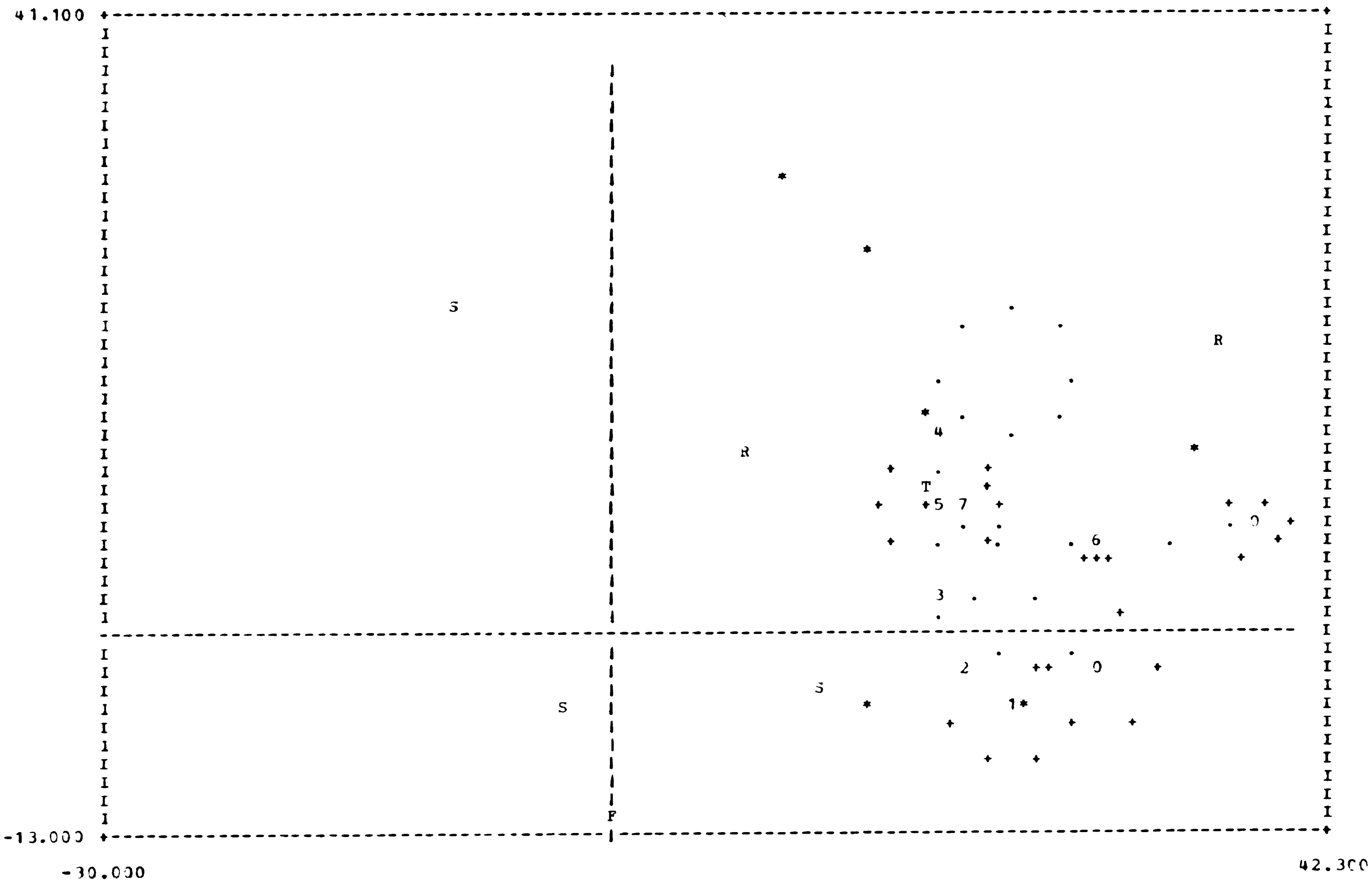
STICK FIGURE REPRESENTATION FOR TIME = 0.0 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXVI. Selected Printout. Example No. 3 (page 10 of 12)

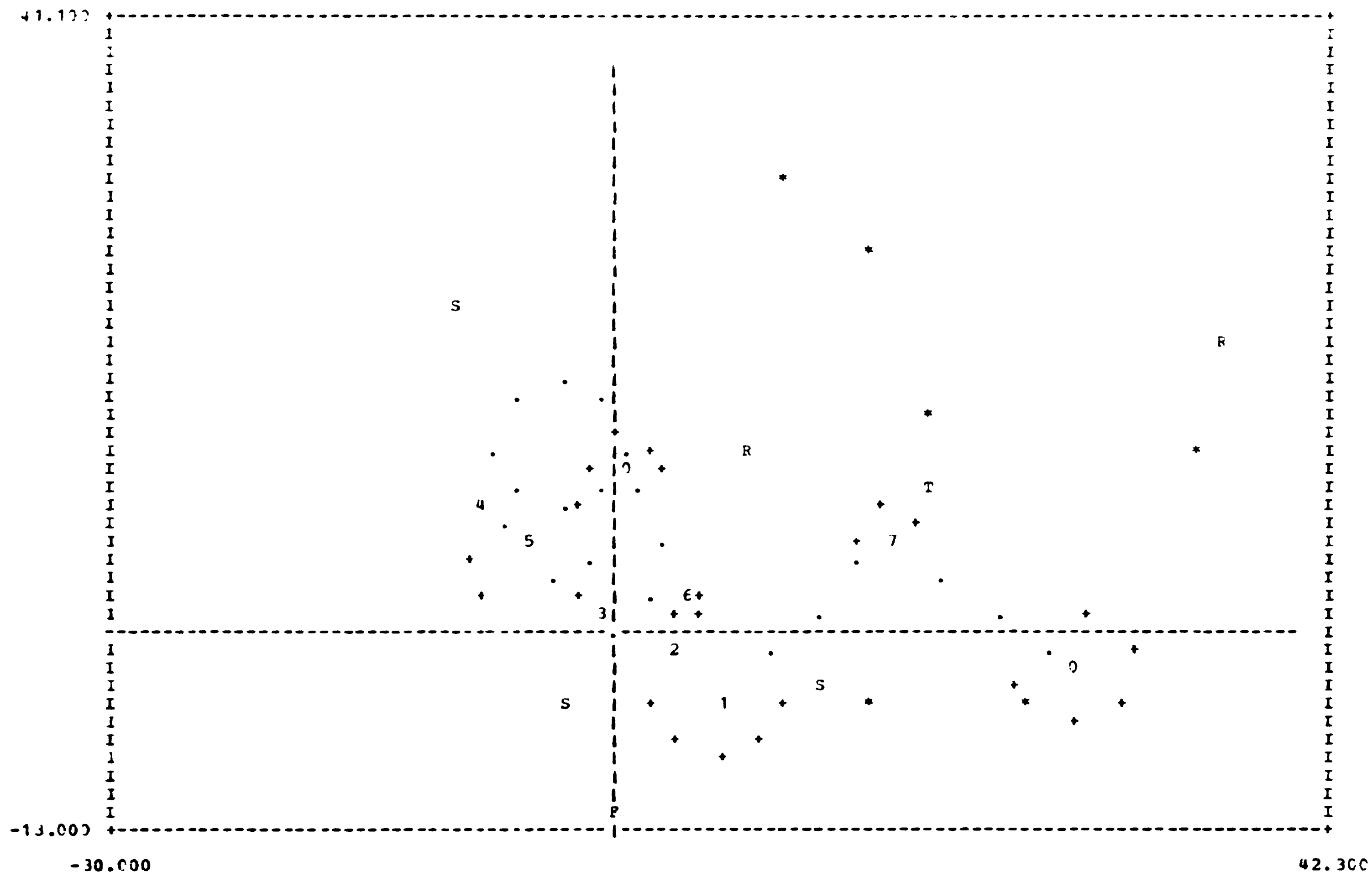
TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972
STICK FIGURE REPRESENTATION FOR TIME = 0.100 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXVI. Selected Printout. Example No. 3 (page 11 of 12)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA
STICK FIGURE REPRESENTATION FOR TIME = 0.200 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXVI. Selected Printout. Example No. 3 (page 12 of 12)

Example No. 4. Unrestrained 95th Percentile Driver (EA Column and Lower Instrument Panel) in 30 mph Frontal Collision.

The occupant description used in this data set (Table XXVII) was derived by scaling the 50th percentile dummy data upward to reflect the stature and weight of the larger subject. The vehicle geometry and properties were the same as Example No. 2 except that the lap belt was removed and replaced by an energy-absorbing lower instrument panel (See Figure 45 of "Passive Protection at 50 Miles per Hour by Carter.[33]). This surface (No. 6) had the energy absorbing properties shown in Figure 41 as specified on the proper S, T, V, and X cards. A windshield contact surface was also added because of the extreme penetration of the large occupant into the steering column. This was considerably more pronounced than for the smaller occupant although the occupant loadings may be tolerable.

In early versions of this exercise it was observed that the center torso mass element moved forward so far that the lower edge of the steering wheel passed entirely through the body. This occurred because no contact sensing circles are attached to this element. To avoid this problem and in a sense to simulate the restraining effect of the lower part of the steering wheel on the torso, the stop angles for joints 2 and 3 were decreased. In later simulations this provided restraining torques at these joints to eliminate the unrealistic kinematics. For comparison purposes, see fields 2 and 3 of the I card for Example No. 1 (Table XXI) and this example (Table XXVII).

The output from this exercise is included as Table XXVIII. The occupant moves forward and contacts all surfaces. Penetration of the column by the chest is approximately 8 inches before rebound.

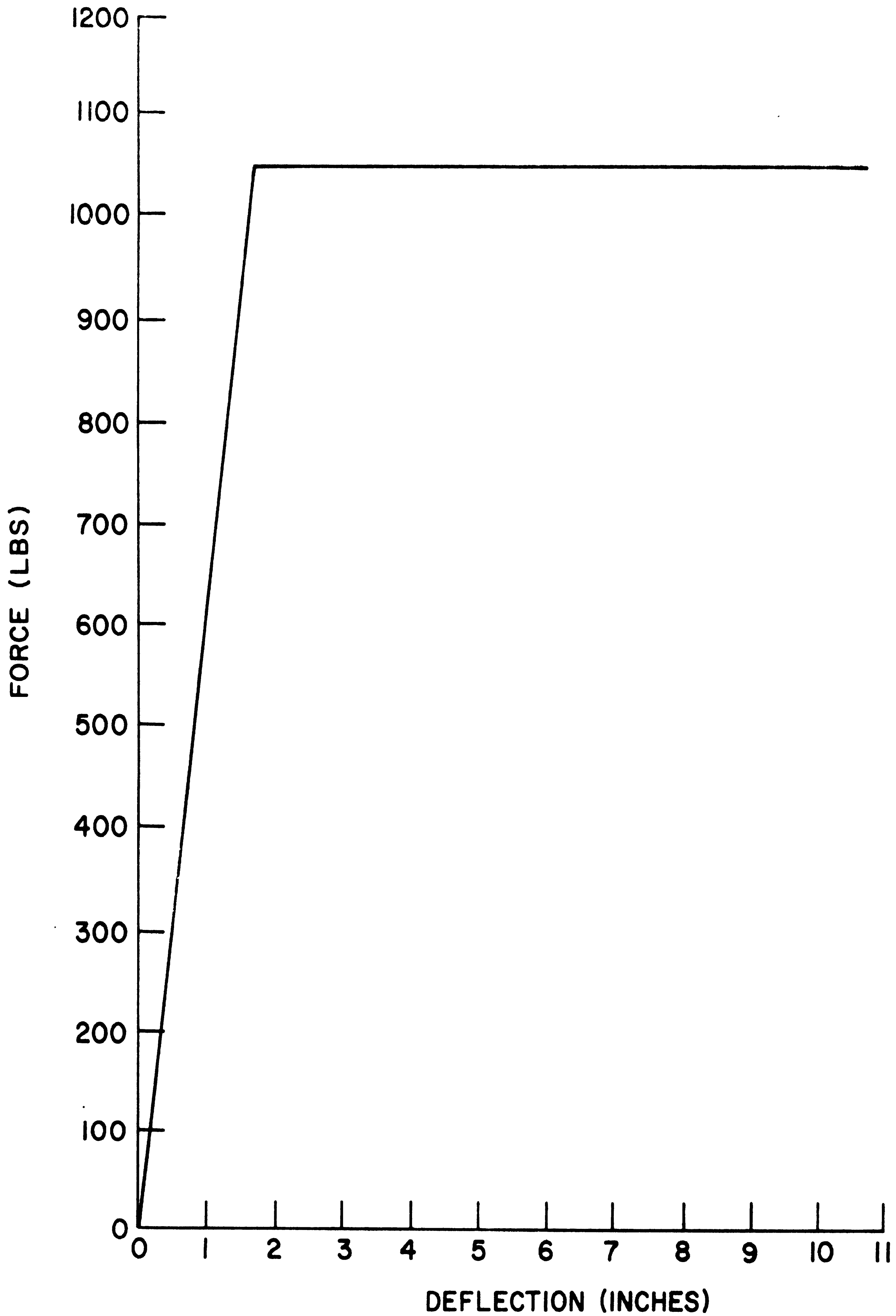


Figure 41. Force-Deflection Characteristics of Knee Restraint

$LIST DOTIN(209,278)

209	A1.	1.	1.	1.	1.	1.	1.	
210	B2.83	.75	4.16	.606	.658	.845	3.64	3.33
211	C960.	960.	960.	960.	960.	960.	960.	
212	D4.77	6.12	13.39	8.13	12.24	11.39	17.47	17.08
213	E.061	.0232	.138	.05	.0368	.0326	.128	.0687
214	F3.76	0.	3.76	4.	1.25	2.	2.18	3.75
215	G21000.	100000.	100000.	20000.	5240.	7000.	7000.	
216	H60.	15.	20.	20.	20000.	20000.	20000.	20000.
217	I150.	5.	5.	70.	195.	130.	120.	
218	J1.	1.	1.	1.	1.	1.	1.	
219	K2.93	3.4	5.51	5.13	5.14	7.99	7.99	10.8
220	L103.	103.	103.	75.	-77.	0.	13.5	-39.8
221	M0.	2.	0.	145.	5.51	6.	5.	1.
222	N1.	92.	.1	.34	37.21	5.31	1.57	15.
223	O12.1	13.5	16.8	2.55	50.	.0005	2.	1000.
224	P1.	.315	1.	50.	0.	625.	-12.	-12.
225	P2.	.315	1.	77.	.5	350.		
226	P3.	.315	1.	-39.	.5	350.		
227	Q1.	.5	.078					
228	Q2.							
229	Q3.							
230	R1.	528.	528.	0.	.005	.2	5.	1.
231	S0.	45.	.5	.5	45.	-10.	.1	3.
232	T0.	0.	800.					
233	U0.							
234	S1.	28.	.01	.95	-3.	-5.	.1	283.
235	T1.	0.	800.					
236	U1.							
237	S8.	36.	.5	.5	18.5	10.	.1	135.
238	T8.	0.	800.					
239	U8.							
240	U2.							
241	S3.	16.	.01	.95	12.	21.	.1	70.
242	T3.	0.	400.					
243	U3.							
244	X3.	1000.	400.					
245	S4.	43.8	.01	.95	0.	38.	.1	144.
246	T4.	0.	2000.					
247	X4.	2000.	2000.					
248	U4.							
249	S5.	26.4	.01	.95	41.3	19.	.1	70.
250	T5.	0.	4000.					
251	S6.	20.	.01	.95	18.5	15.	.1	106.5
252	T6.	0.	1400.					
253	U5.							
254	X6.	2100.	1400.					
255	U6.							
256	S7.	30.3	.01	.95	20.8	31.4	.1	70.
257	T7.	0.	1000.					
258	U7.							
259	X7.	2000.	1000.					
260	U9.							
261	V1.	1.	0.	0.				
262	V1.	1.	.02	-9650.				
263	V1.	1.	.0547	-9650.				
264	V1.	1.	.0747	0.				
265	V1.	1.	2.	0.				
266	Z							

Table XXVII. Data Set. Example No. 4 (page 1 of 2)

```
 267     7.        2.
 268     .         STEERING WHEEL
 269     04        WINDSHIELD
 270     05        S. C. BOTTOM OUT
 271     -2
 272     -1.
 273     .443      1.
 274     1.        1.
 275     1.        1.        EA COLUMN, -- EA...
 276          2   40    2  100   0
 277     -30.      42.0      -13.      -4.
 278          0    1     0     0    0           0
END OF FILE
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Table XXVII. Data Set. Example No. 4 (page 2 of 2)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA — SEP 7, 1972 — PAGE 1

TIME (SEC.)	BELT FORCES (POUNDS) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	BELT ANGLES (DEGREES) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	RELATIVE HIP POSITION (INCHES) HORIZONTAL	VERTICAL	RELATIVE HEAD POSITION (INCHES) HORIZONTAL	VERTICAL
0.0	0.	0.	0.	0.0	0.0	0.0	0.0	0.0	-4.12	28.66
0.005	0.	0.	0.	0.0	0.0	0.0	0.01	0.00	-4.11	28.66
0.010	0.	0.	0.	0.0	0.0	0.0	0.07	0.00	-4.04	28.66
0.015	0.	0.	0.	0.0	0.0	0.0	0.25	0.00	-3.85	28.66
0.020	0.	0.	0.	0.0	0.0	0.0	0.61	0.00	-3.48	28.65
0.025	0.	0.	0.	0.0	0.0	0.0	1.20	0.01	-2.87	28.65
0.030	0.	0.	0.	0.0	0.0	0.0	2.01	0.01	-2.03	28.65
0.035	0.	0.	0.	0.0	0.0	0.0	3.05	-0.00	-0.94	28.64
0.040	0.	0.	0.	0.0	0.0	0.0	4.23	-0.03	0.38	28.63
0.045	0.	0.	0.	0.0	0.0	0.0	5.40	-0.11	1.95	28.62
0.050	0.	0.	0.	0.0	0.0	0.0	6.55	-0.23	3.77	28.60
0.055	0.	0.	0.	0.0	0.0	0.0	7.68	-0.39	5.84	28.58
0.060	0.	0.	0.	0.0	0.0	0.0	8.81	-0.60	7.99	28.52
0.065	0.	0.	0.	0.0	0.0	0.0	9.91	-0.89	9.92	28.31
0.070	0.	0.	0.	0.0	0.0	0.0	10.95	-1.26	11.56	27.96
0.075	0.	0.	0.	0.0	0.0	0.0	11.92	-1.72	12.78	27.46
0.080	0.	0.	0.	0.0	0.0	0.0	12.74	-2.24	13.41	26.74
0.085	0.	0.	0.	0.0	0.0	0.0	13.39	-2.77	13.64	25.78
0.090	0.	0.	0.	0.0	0.0	0.0	13.89	-3.27	13.79	24.76
0.095	0.	0.	0.	0.0	0.0	0.0	14.21	-3.72	13.93	23.77
0.100	0.	0.	0.	0.0	0.0	0.0	14.42	-4.06	14.12	22.84
0.105	0.	0.	0.	0.0	0.0	0.0	14.45	-4.20	14.26	22.06
0.110	0.	0.	0.	0.0	0.0	0.0	14.19	-4.19	14.20	21.66
0.115	0.	0.	0.	0.0	0.0	0.0	13.64	-4.11	13.85	21.74
0.120	0.	0.	0.	0.0	0.0	0.0	12.94	-3.96	13.39	22.03
0.125	0.	0.	0.	0.0	0.0	0.0	12.16	-3.78	12.94	22.45
0.130	0.	0.	0.	0.0	0.0	0.0	11.36	-3.58	12.52	22.99
0.135	0.	0.	0.	0.0	0.0	0.0	10.54	-3.39	12.15	23.62
0.140	0.	0.	0.	0.0	0.0	0.0	9.72	-3.18	11.83	24.32
0.145	0.	0.	0.	0.0	0.0	0.0	8.89	-2.96	11.57	25.06
0.150	0.	0.	0.	0.0	0.0	0.0	8.05	-2.73	11.37	25.79
0.155	0.	0.	0.	0.0	0.0	0.0	7.20	-2.45	11.24	26.43
0.160	0.	0.	0.	0.0	0.0	0.0	6.37	-2.12	11.16	26.85
0.165	0.	0.	0.	0.0	0.0	0.0	5.60	-1.78	11.13	27.05
0.170	0.	0.	0.	0.0	0.0	0.0	4.83	-1.38	11.04	27.01
0.175	0.	0.	0.	0.0	0.0	0.0	4.05	-0.92	10.83	26.77
0.180	0.	0.	0.	0.0	0.0	0.0	3.28	-0.43	10.45	26.35
0.185	0.	0.	0.	0.0	0.0	0.0	2.55	0.05	9.93	25.85
0.190	0.	0.	0.	0.0	0.0	0.0	1.83	0.50	9.24	25.35
0.195	0.	0.	0.	0.0	0.0	0.0	1.13	0.90	8.50	25.11
0.200	0.	0.	0.	0.0	0.0	0.0	0.45	1.24	7.81	25.25

Table XXVIII. Selected Printout. Example No. 4 (page 1 of 9)

[illegible]

TIME	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.
0.0	[illegible]	[illegible]	0.6174	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0050	103.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0150	[illegible]	[illegible]	-0.2977	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	74.77	[illegible]	[illegible]
0.0200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	74.60	-38.34	-0.1586E 04
0.0250	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.09	[illegible]	[illegible]	74.39	-45.32	-0.1138E 04
0.0300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	74.15	-48.79	-0.5853E 03
0.0350	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.14	1.29	[illegible]	73.90	-51.25	0.1284E 03
0.0400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73.55	-47.89	0.1521E 04
0.0450	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73.43	-35.67	0.3719E 04
0.0500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73.31	-3.29	0.2181E 05
0.0550	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.33	-416.21	[illegible]	73.77	236.30	0.8641E 05
0.0600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75.43	567.34	0.6414E 05
0.0650	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	973.70	0.1027E 06
0.0700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0750	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-477.[illegible]	[illegible]	[illegible]	[illegible]	0.8422E 05
0.0800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0850	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.0950	[illegible]	[illegible]	[illegible]	75.5[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.1000	[illegible]	[illegible]	-0.2044	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	144.57	1347.75	[illegible]
0.1050	82.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	150.37	644.41	-0.1457E 06
0.1100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	152.80	70.64	-0.1668E 06
0.1150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	151.92	-301.88	[illegible]
0.1200	[illegible]	[illegible]	[illegible]	[illegible]	-103.41	[illegible]	[illegible]	-56.87	[illegible]	149.81	-543.94	-0.4843E 05
0.1250	[illegible]	[illegible]	-0.1449E 05	[illegible]	[illegible]	[illegible]	[illegible]	-0.57	[illegible]	146.49	-782.81	-0.4786E 05
0.1300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67.13	0.1967E 05	141.97	-1027.17	-0.5037E 05
0.1350	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70.42	174.71	[illegible]	136.19	-1286.30	-0.5359E 05
0.1400	[illegible]	[illegible]	-0.6331E 04	[illegible]	[illegible]	[illegible]	71.46	282.59	0.2401E 05	129.07	-1564.58	-0.5835E 05
0.1450	[illegible]	[illegible]	[illegible]	77.[illegible]	[illegible]	[illegible]	73.19	412.70	[illegible]	120.50	-1869.55	-0.6439E 05
0.1500	[illegible]	-411.01	-0.1064E 05	[illegible]	-412.01	-0.1064E 05	75.62	[illegible]	0.3193E 05	110.32	-2204.57	-0.6959E 05
0.1550	[illegible]	[illegible]	-0.1147E 05	73.42	[illegible]	[illegible]	78.84	725.48	0.2042E 05	98.43	-2551.56	-0.5868E 05
0.1600	[illegible]	[illegible]	[illegible]	72.19	[illegible]	[illegible]	[illegible]	427.35	[illegible]	85.45	-2530.26	0.6241E 05
0.1650	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.4421E 04	[illegible]	[illegible]	0.4421E 04	72.71	-2609.46	-0.1941E 05
0.1700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	371.67	[illegible]	59.49	-2660.44	0.5460E 03
0.1750	[illegible]	[illegible]	[illegible]	77.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.1221E 05	46.23	-2633.44	[illegible]
0.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.23	-2555.92	0.2807E 05
0.1850	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	114.31	[illegible]	20.82	-2411.55	[illegible]
0.1900	[illegible]	[illegible]	[illegible]	81.13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.49	[illegible]	[illegible]
0.1950	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.63	[illegible]	[illegible]
0.2000	76.47	[illegible]	[illegible]	[illegible]	433.54	-0.4753E 04	[illegible]	-363.56	0.2048E 04	-1.05	-234.33	0.3386E 05

Table XXVIII. Selected Printout. Example No. 4 (page 2 of 9)

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	UPPER ARM POSITION	UPPER ARM VELOCITY	UPPER ARM ACCEL.	LOWER ARM POSITION	LOWER ARM VELOCITY	LOWER ARM ACCEL.	UPPER LEG POSITION	UPPER LEG VELOCITY	UPPER LEG ACCEL.	LOWER LEG POSITION	LOWER LEG VELOCITY	LOWER LEG ACCEL.
0.0	-77.00	0.0	0.4277E 03	0.0	0.0	-0.2017E 04	13.50	0.0	-0.1273E 04	-39.80	0.0	-0.3290E 04
0.0050	-76.99	2.34	0.4681E 03	-0.03	-10.76	-0.2168E 04	13.48	-7.96	-0.1665E 04	-39.83	-11.11	-0.1608E 04
0.0100	-76.98	4.61	0.4314E 03	-0.11	-21.55	-0.2143E 04	13.42	-16.26	-0.1620E 04	-39.91	-20.10	-0.2588E 04
0.0150	-76.95	6.67	0.3828E 03	-0.24	-32.18	-0.2096E 04	13.32	-23.85	-0.1347E 04	-40.05	-42.36	-0.7599E 04
0.0200	-76.91	8.42	0.3060E 03	-0.43	-42.41	-0.1934E 04	13.19	-28.35	0.2800E 03	-40.39	-96.45	-0.1367E 05
0.0250	-76.86	9.72	0.1976E 03	-0.66	-51.40	-0.1610E 04	13.06	-19.32	0.3906E 04	-41.06	-175.19	-0.1838E 05
0.0300	-76.81	10.42	0.6528E 02	-0.94	-58.55	-0.1198E 04	13.03	10.55	0.8649E 04	-42.18	-277.69	-0.2295E 05
0.0350	-76.76	11.01	0.4659E 03	-1.25	-63.87	-0.1059E 04	13.20	60.97	0.9510E 04	-43.86	-386.68	-0.1311E 05
0.0400	-76.69	15.27	0.1120E 04	-1.58	-68.69	-0.5566E 03	13.62	101.74	0.7752E 04	-45.87	-401.00	0.5165E 04
0.0450	-76.60	19.78	0.6183E 03	-1.92	-67.19	0.1519E 04	14.24	151.18	0.1198E 05	-47.84	-393.99	-0.3509E 04
0.0500	-76.50	21.88	0.7068E 03	-2.23	-53.22	0.4168E 04	15.15	216.63	0.1583E 05	-49.89	-433.58	-0.1497E 05
0.0550	-76.36	47.48	0.2128E 05	-2.43	-19.97	0.1664E 05	16.48	325.93	0.3217E 05	-52.30	-535.99	-0.2639E 05
0.0600	-75.72	232.62	0.4849E 05	-2.27	84.30	0.1744E 05	18.49	481.73	0.3022E 05	-55.28	-652.98	-0.2146E 05
0.0650	-73.94	470.65	0.3805E 05	-1.66	155.47	0.1229E 05	21.29	647.29	0.3972E 05	-58.90	-747.01	-0.1185E 05
0.0700	-71.12	678.34	0.6100E 05	-0.77	178.58	-0.1353E 05	25.05	858.35	0.4159E 05	-62.63	-774.86	0.1856E 04
0.0750	-66.79	1074.88	0.8281E 05	-0.19	27.85	-0.4571E 05	29.73	992.58	0.1879E 05	-66.36	-697.66	0.2598E 05
0.0800	-60.41	1467.91	0.7424E 05	-0.72	-263.41	-0.7467E 05	34.88	1049.88	-0.1796E 03	-69.47	-538.48	0.3757E 05
0.0850	-52.15	1832.84	0.7190E 05	-3.07	-699.10	-0.9820E 05	40.06	1013.54	-0.1062E 05	-71.66	-334.29	0.3983E 05
0.0900	-42.10	2182.50	0.6110E 05	-7.78	-1178.02	-0.8824E 05	45.04	995.89	0.1033E 04	-72.81	-115.52	0.4510E 05
0.0950	-30.58	2360.95	-0.5770E 05	-14.61	-1477.77	0.6918E 05	49.98	953.32	-0.2563E 05	-72.89	60.19	0.2027E 05
0.1000	-20.80	1291.53	-0.3465E 06	-19.15	70.74	0.5216E 06	54.28	732.41	-0.5281E 05	-72.44	101.09	0.8536E 04
0.1050	-17.00	495.74	-0.8571E 05	-14.82	1251.32	0.1203E 06	57.29	471.62	-0.5922E 05	-71.79	167.77	0.2080E 05
0.1100	-15.67	30.23	-0.5186E 05	-7.17	1783.18	0.8611E 05	58.97	207.56	-0.5299E 05	-70.61	295.47	0.1437E 05
0.1150	-16.41	-289.63	-0.4258E 05	2.61	2087.77	0.3470E 05	59.33	-61.59	-0.5140E 05	-69.17	260.62	-0.1224E 05
0.1200	-18.22	-410.26	-0.6861E 04	13.43	2211.68	0.9161E 04	58.75	-160.16	-0.1349E 05	-67.83	277.47	0.4672E 04
0.1250	-20.32	-413.97	0.6057E 04	24.55	2224.80	-0.4300E 04	57.81	-209.75	-0.6834E 04	-66.38	302.60	0.4927E 04
0.1300	-22.24	-346.08	0.1817E 05	35.58	2183.47	-0.1247E 05	56.68	-239.78	-0.5810E 04	-64.81	325.10	0.4331E 04
0.1350	-23.73	-244.14	0.2240E 05	46.32	2107.09	-0.1672E 05	55.38	-279.15	-0.7991E 04	-63.15	337.37	0.2533E 04
0.1400	-24.67	-130.54	0.2269E 05	56.64	2020.55	-0.1795E 05	53.89	-319.68	-0.8330E 04	-61.43	350.33	0.2593E 04
0.1450	-25.04	-20.09	0.2105E 05	66.51	1927.71	-0.1944E 05	52.18	-363.03	-0.9189E 04	-59.65	362.65	0.2218E 04
0.1500	-24.89	78.54	0.1783E 05	75.90	1826.05	-0.2142E 05	50.25	-412.01	-0.1064E 05	-57.81	372.01	0.1371E 04
0.1550	-24.29	157.91	0.1296E 05	84.76	1716.33	-0.2190E 05	48.05	-470.54	-0.1147E 05	-55.96	355.97	-0.1093E 05
0.1600	-23.40	179.64	-0.4987E 04	93.07	1606.01	-0.2111E 05	45.62	-485.80	0.5736E 04	-54.39	263.27	-0.2403E 05
0.1650	-22.50	184.60	-0.4747E 02	100.85	1512.49	-0.1728E 05	43.11	-528.20	-0.1084E 05	-53.32	166.75	-0.1647E 05
0.1700	-21.59	176.16	-0.3527E 04	108.21	1430.36	-0.1563E 05	40.33	-584.44	-0.1112E 05	-52.65	116.10	-0.1061E 03
0.1750	-20.74	167.41	-0.6254E 03	115.03	1267.12	-0.5467E 05	37.28	-632.52	-0.7814E 04	-52.02	137.87	0.6515E 04
0.1800	-19.91	160.91	-0.3422E 04	120.56	915.17	-0.8739E 05	34.03	-659.56	0.2376E 04	-51.24	176.78	0.8058E 04
0.1850	-19.16	135.74	-0.5682E 04	123.94	416.45	-0.1138E 06	30.79	-640.14	-0.1033E 04	-50.26	218.83	0.9796E 04
0.1900	-18.57	94.12	-0.9321E 04	124.87	67.43	-0.2279E 05	27.59	-636.56	0.3112E 04	-49.03	270.94	0.1110E 05
0.1950	-18.18	67.74	-0.1198E 04	124.92	-46.51	-0.2389E 05	24.47	-610.05	0.6943E 04	-47.54	328.32	0.1129E 05
0.2000	-17.88	39.18	-0.1285E 05	124.36	-193.14	-0.3530E 05	21.48	-599.09	-0.4051E 04	-45.77	373.12	0.6542E 04

Table XXVIII. Selected Printout. Example No. 4 (page 3 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR – OUTPUT DATA SEP 7, 1972 PAGE 4

TIME	VEHICULAR MOTION POSITION (IN.)	VEHICULAR MOTION VELOCITY (IN./SEC.)	VEHICULAR MOTION ACCEL. (G-UNITS)	BODY MOTION AT HIP JOINT HORIZONTAL RELATIVE DISPL. (IN.)	HORIZONTAL VELOCITY (IN./SEC.)	HORIZONTAL ACCEL. (G-UNITS)	VERTICAL RELATIVE DISPL. (IN.)	VERTICAL VELOCITY (IN./SEC.)	VERTICAL ACCEL. (G-UNITS)
0.0	0.0	524.00	0.0	0.0	523.00	0.144	0.0	0.0	0.080
0.0050	2.630	521.77	-6.244	0.003	527.29	-0.435	0.000	0.09	0.042
0.0100	5.200	503.84	-12.487	0.073	525.45	-0.428	0.001	0.17	0.051
0.0150	7.649	473.72	-18.731	0.254	525.65	-0.381	0.002	0.29	0.069
0.0200	9.917	431.50	-24.974	0.613	524.80	-0.523	0.004	0.40	-0.003
0.0250	11.954	383.25	-24.974	1.197	523.50	-0.991	0.005	0.22	-0.223
0.0300	13.749	335.00	-24.974	2.014	521.08	-1.586	0.005	-0.45	-0.505
0.0350	15.304	286.75	-24.974	3.053	513.74	-11.192	-0.001	-2.46	-2.654
0.0400	16.617	238.50	-24.974	4.228	475.81	-27.452	-0.031	-10.89	-5.745
0.0450	17.689	190.25	-24.974	5.402	422.14	-28.074	-0.112	-20.99	-4.366
0.0500	18.512	142.00	-24.974	6.545	367.91	-26.613	-0.235	-27.46	-2.553
0.0550	19.103	93.77	-24.500	7.676	322.10	-20.589	-0.388	-35.40	-8.532
0.0600	19.469	52.08	-18.356	8.615	277.39	-23.179	-0.604	-50.70	-6.134
0.0650	19.651	22.84	-12.113	9.612	236.44	-13.379	-0.886	-63.36	-9.560
0.0700	19.717	5.47	-5.869	10.551	208.76	-3.766	-1.257	-85.29	-11.532
0.0750	19.726	0.14	0.0	11.918	173.23	-16.239	-1.721	-93.16	-5.728
0.0800	19.727	0.14	0.0	12.736	144.20	-16.531	-2.237	-107.27	-2.047
0.0850	19.728	0.14	0.0	13.394	115.33	-16.652	-2.773	-104.88	4.605
0.0900	19.728	0.14	0.0	13.885	80.66	-17.622	-3.273	-94.76	5.506
0.0950	19.729	0.14	0.0	14.212	53.16	-10.385	-3.717	-81.82	9.292
0.1000	19.730	0.14	0.0	14.423	27.75	-21.116	-4.059	-48.37	24.580
0.1050	19.731	0.14	0.0	14.452	-13.06	-32.169	-4.195	-8.91	16.761
0.1100	19.731	0.14	0.0	14.189	-57.14	-35.147	-4.189	7.02	3.529
0.1150	19.732	0.14	0.0	13.638	-123.83	-16.962	-4.115	24.07	8.819
0.1200	19.733	0.14	0.0	12.937	-142.06	-7.233	-3.965	34.80	3.478
0.1250	19.733	0.14	0.0	12.163	-153.66	-2.675	-3.778	38.65	0.644
0.1300	19.734	0.14	0.0	11.359	-161.91	-1.312	-3.584	39.01	0.077
0.1350	19.735	0.14	0.0	10.544	-163.65	-0.886	-3.386	40.13	0.731
0.1400	19.736	0.14	0.0	9.721	-165.37	-0.894	-3.181	41.93	1.252
0.1450	19.736	0.14	0.0	8.889	-167.10	-0.906	-2.964	45.14	2.277
0.1500	19.737	0.14	0.0	8.048	-169.90	-0.977	-2.726	50.95	4.061
0.1550	19.738	0.14	0.0	7.198	-170.98	-0.092	-2.448	61.04	6.300
0.1600	19.739	0.14	0.0	6.366	-155.60	13.745	-2.124	65.18	-2.939
0.1650	19.739	0.14	0.0	5.597	-153.62	-0.539	-1.781	74.25	6.296
0.1700	19.740	0.14	0.0	4.826	-154.77	-0.104	-1.379	86.59	6.083
0.1750	19.741	0.14	0.0	4.053	-154.12	0.462	-0.920	96.24	3.588
0.1800	19.741	0.14	0.0	3.285	-152.18	3.975	-0.425	99.81	-2.570
0.1850	19.742	0.14	0.0	2.545	-144.31	1.328	0.054	92.41	-1.813
0.1900	19.743	0.14	0.0	1.830	-141.40	1.645	0.503	86.20	-5.096
0.1950	19.744	0.14	0.0	1.130	-133.16	1.704	0.903	73.04	-8.079
0.2000	19.744	0.14	0.0	0.446	-134.85	1.720	1.237	64.40	0.217

Table XXVIII. Selected Printout. Example No. 4 (page 4 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 5

TIME	HEAD RESULTANT (G-UNITS)	HEAD ANGLE (DEG.)	CHEST RESULTANT (G-UNITS)	CHEST ANGLE (DEG.)	BELT FORCES (LBS). LAP	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	SEAT FORCES (LBS) AT HIP	AT FRONT EDGE
0.0	0.3	-47.4	0.2	-179.2	0.0	0.0	0.0	145.00	0.0
0.0050	0.3	-32.8	0.3	164.7	0.0	0.0	0.0	145.40	0.0
0.0100	0.2	-31.6	0.3	163.3	0.0	0.0	0.0	147.01	0.0
0.0150	0.2	-30.4	0.3	162.1	0.0	0.0	0.0	150.01	0.0
0.0200	0.2	-38.3	0.3	170.1	0.0	0.0	0.0	154.61	0.0
0.0250	0.2	-61.1	0.3	-167.5	0.0	0.0	0.0	160.70	0.0
0.0300	0.3	-82.5	0.4	-145.5	0.0	0.0	0.0	167.95	0.0
0.0350	0.1	-81.8	1.1	-159.2	0.0	0.0	0.0	176.93	0.0
0.0400	0.1	-89.8	2.4	158.5	0.0	0.0	0.0	190.82	0.0
0.0450	0.8	-103.1	2.9	-141.0	0.0	0.0	0.0	206.53	0.0
0.0500	1.3	68.7	10.7	-154.0	0.0	0.0	0.0	219.63	0.0
0.0550	24.8	-177.2	28.7	-152.2	0.0	0.0	0.0	235.70	0.0
0.0600	50.3	-164.1	23.9	-142.5	0.0	0.0	0.0	260.60	0.0
0.0650	55.0	-165.6	22.3	-143.6	0.0	0.0	0.0	284.42	19.81
0.0700	64.2	-163.7	49.8	-170.6	0.0	0.0	0.0	321.51	62.25
0.0750	77.5	-156.9	38.3	-176.8	0.0	0.0	0.0	354.24	117.10
0.0800	61.4	-141.5	38.5	175.0	0.0	0.0	0.0	389.39	181.36
0.0850	16.2	-27.0	38.8	169.7	0.0	0.0	0.0	420.51	251.65
0.0900	11.6	23.9	29.2	174.5	0.0	0.0	0.0	448.74	319.13
0.0950	13.7	28.3	45.6	159.0	0.0	0.0	0.0	476.99	376.39
0.1000	18.5	91.1	31.1	142.2	0.0	0.0	0.0	479.93	420.29
0.1050	56.8	106.9	7.6	53.9	0.0	0.0	0.0	452.65	428.17
0.1100	89.4	110.7	28.6	7.9	0.0	0.0	0.0	427.19	382.09
0.1150	29.3	115.3	16.3	138.3	0.0	0.0	0.0	392.34	287.95
0.1200	18.4	80.3	4.8	132.1	0.0	0.0	0.0	356.68	172.71
0.1250	16.8	62.5	3.0	13.4	0.0	0.0	0.0	326.42	53.74
0.1300	16.0	53.9	3.2	-1.1	0.0	0.0	0.0	301.47	0.0
0.1350	15.0	40.8	1.1	21.2	0.0	0.0	0.0	277.87	0.0
0.1400	14.4	20.3	0.9	43.2	0.0	0.0	0.0	255.20	0.0
0.1450	15.9	-10.5	1.2	56.9	0.0	0.0	0.0	232.39	0.0
0.1500	22.6	-43.2	2.1	74.5	0.0	0.0	0.0	207.76	0.0
0.1550	36.0	-69.1	4.4	110.9	0.0	0.0	0.0	178.97	0.0
0.1600	32.7	-85.1	39.3	159.1	0.0	0.0	0.0	157.95	0.0
0.1650	38.0	-102.6	4.3	93.7	0.0	0.0	0.0	132.79	0.0
0.1700	38.1	-119.3	4.2	96.3	0.0	0.0	0.0	103.86	0.0
0.1750	36.9	-136.2	3.2	121.9	0.0	0.0	0.0	77.31	0.0
0.1800	29.5	-154.2	4.2	162.8	0.0	0.0	0.0	56.26	0.0
0.1850	30.7	-170.3	2.5	-166.0	0.0	0.0	0.0	46.08	0.0
0.1900	45.8	110.3	6.2	-148.6	0.0	0.0	0.0	32.98	0.0
0.1950	71.4	85.5	10.3	-140.2	0.0	0.0	0.0	25.67	0.0
0.2000	9.3	100.1	1.2	-102.6	0.0	0.0	0.0	13.89	0.0

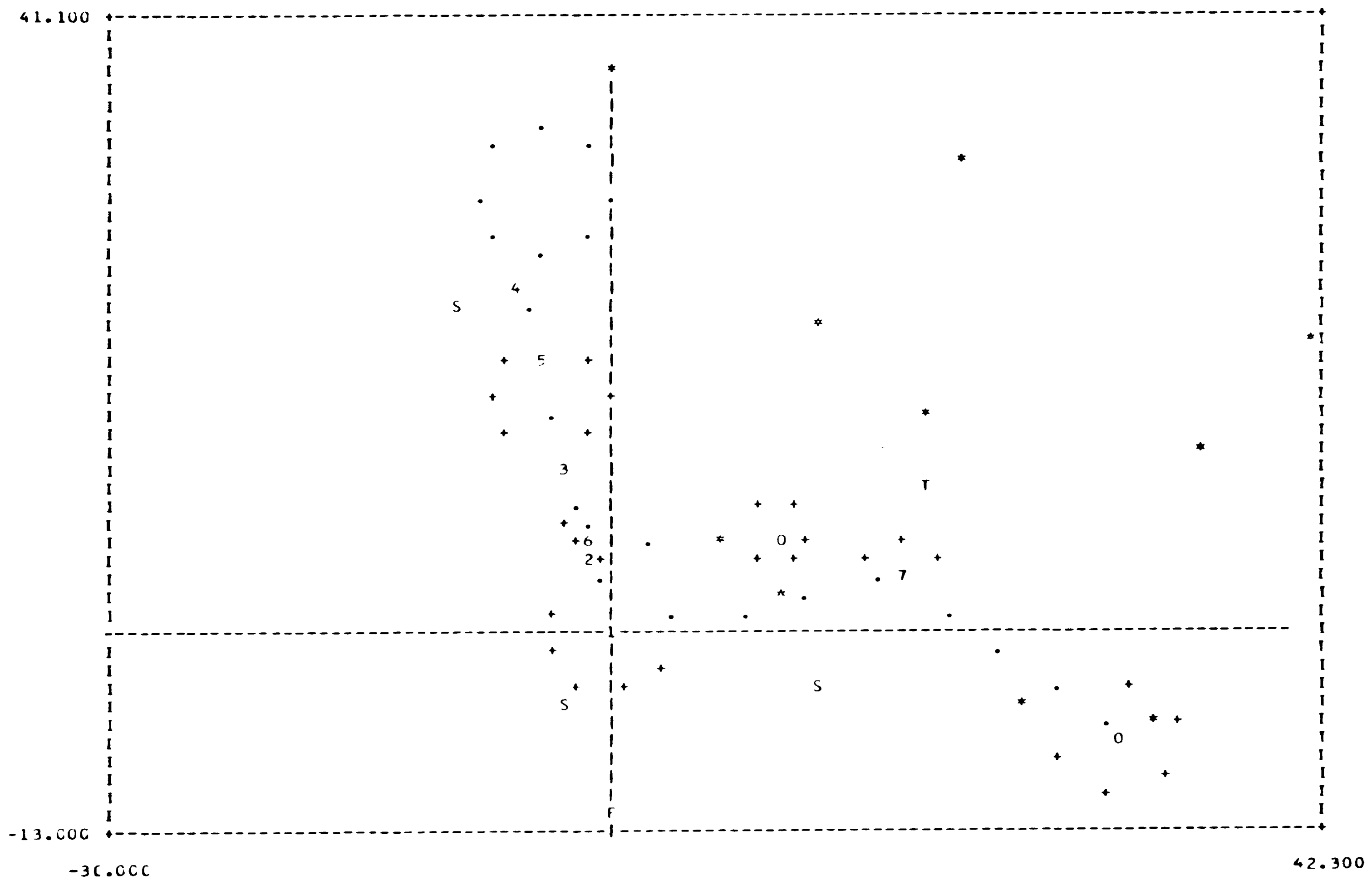
Table XXVIII. Selected Printout. Example No. 4 (page 5 of 9)

CONTACT FORCES (LBS.)

TIME	FEET ON TOE BOARD	FEET ON FLOOR	KNEE ON LOWER PANEL	HEAD ON WINDSHIELD	UPPER TORSO ON STEERING WHEEL	UPPER TORSO ON STEERING COLUMN
0.0	32.9	0.0	0.0	0.0	0.0	0.0
0.0050	23.2	0.0	0.0	0.0	0.0	0.0
0.0100	34.2	0.0	0.0	0.0	0.0	0.0
0.0150	89.7	0.0	0.0	0.0	0.0	0.0
0.0200	176.9	64.2	0.0	0.0	0.0	0.0
0.0250	353.0	233.0	0.0	0.0	0.0	0.0
0.0300	543.2	465.7	0.0	0.0	0.0	0.0
0.0350	750.7	749.4	769.7	0.0	0.0	0.0
0.0400	970.7	1046.3	2100.0	0.0	0.0	0.0
0.0450	1197.9	1313.5	2100.0	0.0	0.0	0.0
0.0500	1400.8	1542.3	2100.0	0.0	0.0	0.0
0.0550	1540.3	1734.2	2100.0	1176.0	0.0	0.0
0.0600	1585.1	1563.3	2100.0	2000.0	722.7	0.0
0.0650	1447.1	1701.1	2100.0	2000.0	1000.0	0.0
0.0700	1123.0	1667.1	2100.0	2000.0	1000.0	1095.6
0.0750	709.2	1032.8	2100.0	1999.0	1000.0	2000.0
0.0800	233.7	234.6	2100.0	1349.4	1000.0	2000.0
0.0850	0.0	0.0	1972.9	0.0	1000.0	2000.0
0.0900	0.0	0.0	1499.2	0.0	1000.0	2000.0
0.0950	0.0	0.0	676.9	0.0	1000.0	2000.0
0.1000	0.0	0.0	0.0	0.0	999.1	1997.8
0.1050	0.0	0.0	0.0	0.0	932.2	1830.4
0.1100	0.0	0.0	0.0	0.0	794.2	1485.5
0.1150	0.0	0.0	0.0	0.0	611.9	1029.6
0.1200	0.0	0.0	0.0	0.0	371.3	428.2
0.1250	0.0	0.0	0.0	0.0	108.8	0.0
0.1300	0.0	0.0	0.0	0.0	0.0	0.0
0.1350	0.0	0.0	0.0	0.0	0.0	0.0
0.1400	0.0	0.0	0.0	0.0	0.0	0.0
0.1450	0.0	0.0	0.0	0.0	0.0	0.0
0.1500	0.0	0.0	0.0	0.0	0.0	0.0
0.1550	124.2	0.0	0.0	0.0	0.0	0.0
0.1600	225.7	0.0	0.0	0.0	0.0	0.0
0.1650	217.6	0.0	0.0	0.0	0.0	0.0
0.1700	40.5	0.0	0.0	0.0	0.0	0.0
0.1750	0.0	0.0	0.0	0.0	0.0	0.0
0.1800	0.0	0.0	0.0	0.0	0.0	0.0
0.1850	0.0	0.0	0.0	0.0	0.0	0.0
0.1900	0.0	0.0	0.0	0.0	0.0	0.0
0.1950	0.0	0.0	0.0	0.0	0.0	0.0
0.2000	0.0	0.0	0.0	0.0	0.0	0.0

Table XXVIII. Selected Printout. Example No. 4 (page 6 of 9)

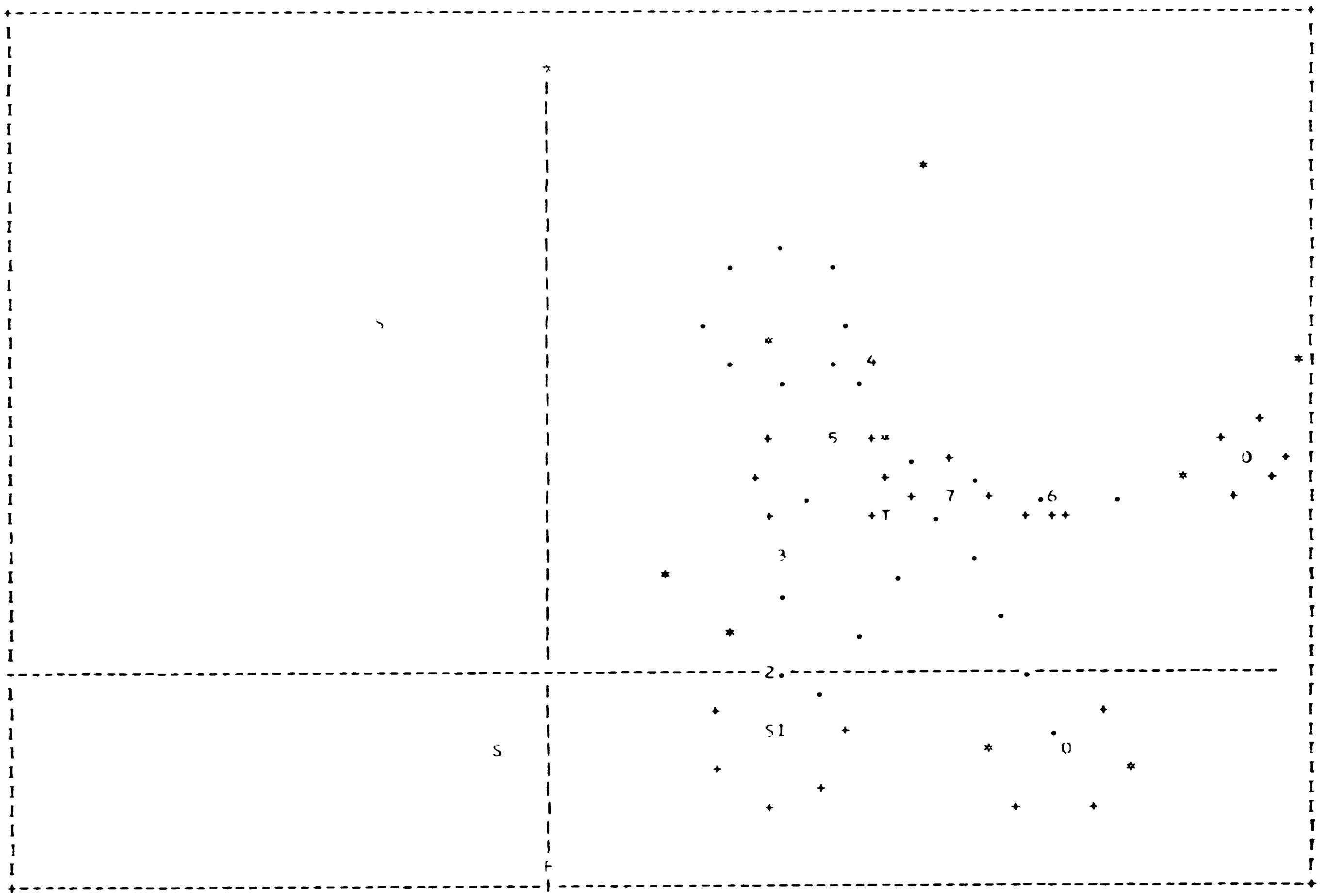
TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 17
STICK FIGURE REPRESENTATION FOR TIME = 0.0 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXVIII. Selected Printout. Example No. 4 (page 7 of 9)

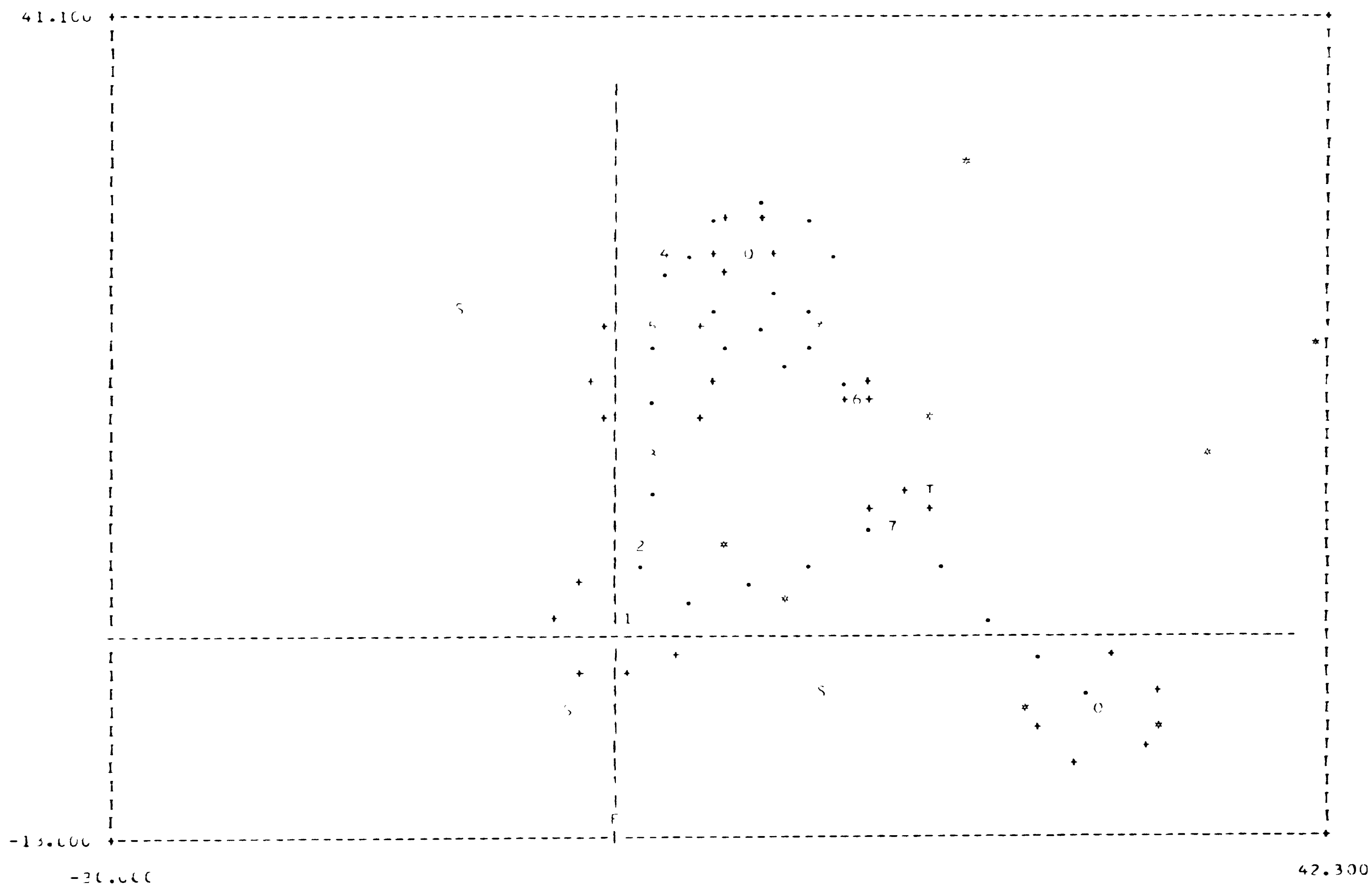
STICK FIGURE REPRESENTATION FOR TIME = 0.120 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXVIII. Selected Printout. Example No. 4 (page 8 of 9)

STICK FIGURE REPRESENTATION FOR TIME = 0.200 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.03 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXVIII. Selected Printout. Example No. 4 (page 9 of 9)

Example No. 5. Unrestrained 95th Percentile Occupant in 30 mph Rear-End Collision.

The occupant description used in this data set (Table XXIX) was the same as that used in Example 4. The contact surfaces consisted of toeboard, floor, seat cushion, and seat back. The seat back was made up of two segments - one to restrain the hip and one for the upper torso.

The reason for two surfaces is based on the friction options available with the HSRI model. It should be recalled that the presence of more than one friction force during computation can lead to instabilities. If one surface is used for the seat back (e.g. surface No. 1 - seat back) which interacts with the hip and the upper torso contact circles, then the possibility for generation to two simultaneous friction forces is very high especially since ramping usually is observed in rear impacts. This being the case, two surfaces have been used in this example. Surface No. 1 has non-zero friction and interacts with the hip while surface no. 7 interacts with the upper torso.

Two options are available to model the knees and lower legs as they swing back toward the front seat. One of these is contained in fields 7-8 of the O-card and the other involves restriction of the relative motion between the upper and lower legs. Field 7 of the O-card contains a "thickness" for the lower leg while field 8 contains a stiffness factor which generates a forward acting force on the lower leg if contact is sensed. In this example flexion of the knee was limited to model a similar effect.

Table XXX contains output generated using this data set. The only obvious aspect of body loadings and kinematics which should be of concern is the head-neck hyperextension caused by a lack of head restraint. The addition of a head restraint, possibly by use of surface No. 4, would lead to a gentle ride for the occupant.

```
$LIST DATIN(279,335)
   279      A1.        1.         1.         1.         1.         1.         1.
   280      B2.83      .75        4.16       .636       .653       .845       3.64       3.36
   281      C360.      360.       360.       360.       360.       360.       360.
   282      D4.77      6.12       13.39      9.13       12.24      11.39      17.47      17.03
   283      E.061      .0232      .138       .05        .0368      .0326      .128       .0687
   284      F3.76      0.         3.76       4.         1.25       2.         2.16       3.75
   285      G21000.    20000.     25000.     20000.     5240.      7000.      20000.
   286      H60.       15.        20.        20.        20000.     20000.     20000.     100000.
   287      I150.      22.5       22.5       70.        135.       130.       80.
   288      J1.        1.         1.         1.         1.         1.         1.
   289      K2.93      3.4        5.51       5.13       5.14       7.99       7.99       10.5
   290      L103.      103.       103.       75.        -77.       0.         13.5       -39.5
   291      M0.        2.         0.         145.       7.67       5.         5.         1.
   292      N1.        92.        .1         0.         37.21      5.31       1.57       13.
   293      O12.1      13.5       16.8       2.55       50.        .0005      2.         0.
   294      P1.        .315       1.         50.        0.         625.       -12.       -12.
   295      P2.        .315       1.         77.        .5         355.
   296      P3.        .315       1.         -39.       .5         355.
   297      Q1.        .5         .078
   298      Q2.
   299      Q3.
   300      R1.        0.         0.         0.         .005       .2         5.         1.
   301      S0.        45.        .5         .5         45.        -10.       .1         3.
   302      T0.        0.         800.
   303      U0.
   304      S1.        15.        .01        .95        -3.        -5.        .1         283.
   305      T1.        1.         800.
   306      U1.
   307      S4.        36.        .5         .5         13.5       10.        .1         135.
   308      T8.        0.         800.
   309      U8.
   310      U2.
   311      U3.
   312      U4.
   313      U5.
   314      U6.
   315      S7.        27.76      .01        .95        -3.        -5.        .1         283.
   316      T7.        0.         800.
   317      U7.
   318      U9.
   319      V1.        1.         0.         0.
   320      V1.        1.         .015       36E4.
   321      V1.        1.         .03        0.
   322      V1.        1.         .06        5E16.
   323      V1.        1.         .1922      0.
   324      V1.        1.         2.         0.
   325      Z
   326      7.5        2.3                1    0    0    0    0
   327      07         UE. SEAT BACK
   328      -2
   329      -1.
   330      .07        0          REAR REGION COLLISION
   331      .034       0          REAR CENTER PASSENGER
   332      1.         0          SEAT BACK RESTRAINT
   333            2    44    2  100    0    11    1
   334      -30.        42.3      -13.       41.1       0.        .0
   335            0    0    0    0    0    0    0    0
END OF FILE
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Table XXIX. Data Set. Example No. 5

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 1

TIME (SEC.)	BELT FORCES (POUNDS) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	BELT ANGLES (DEGREES) LAP BELT	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	RELATIVE HIP POSITION (INCHES) HORIZONTAL	VERTICAL	RELATIVE HEAD POSITION (INCHES) HORIZONTAL	VERTICAL
0.0	0.	0.	0.	0.0	0.0	0.0	0.0	0.0	-4.12	28.66
0.005	0.	0.	0.	0.0	0.0	0.0	-0.00	0.00	-4.13	28.66
0.010	0.	0.	0.	0.0	0.0	0.0	-0.04	0.00	-4.16	28.66
0.015	0.	0.	0.	0.0	0.0	0.0	-0.14	0.00	-4.26	28.65
0.020	0.	0.	0.	0.0	0.0	0.0	-0.32	0.01	-4.45	28.65
0.025	0.	0.	0.	0.0	0.0	0.0	-0.56	0.01	-4.70	28.64
0.030	0.	0.	0.	0.0	0.0	0.0	-0.80	-0.00	-4.97	28.64
0.035	0.	0.	0.	0.0	0.0	0.0	-1.01	-0.00	-5.21	28.66
0.040	0.	0.	0.	0.0	0.0	0.0	-1.18	0.01	-5.44	28.71
0.045	0.	0.	0.	0.0	0.0	0.0	-1.33	0.04	-5.67	28.80
0.050	0.	0.	0.	0.0	0.0	0.0	-1.47	0.08	-5.92	28.91
0.055	0.	0.	0.	0.0	0.0	0.0	-1.61	0.14	-6.21	29.03
0.060	0.	0.	0.	0.0	0.0	0.0	-1.76	0.23	-6.56	29.14
0.065	0.	0.	0.	0.0	0.0	0.0	-1.93	0.33	-7.00	29.20
0.070	0.	0.	0.	0.0	0.0	0.0	-2.09	0.45	-7.50	29.19
0.075	0.	0.	0.	0.0	0.0	0.0	-2.24	0.64	-8.05	29.13
0.080	0.	0.	0.	0.0	0.0	0.0	-2.35	0.88	-8.60	28.99
0.085	0.	0.	0.	0.0	0.0	0.0	-2.41	1.17	-9.14	28.76
0.090	0.	0.	0.	0.0	0.0	0.0	-2.41	1.47	-9.63	28.44
0.095	0.	0.	0.	0.0	0.0	0.0	-2.33	1.74	-10.03	28.03
0.100	0.	0.	0.	0.0	0.0	0.0	-2.20	1.95	-10.35	27.57
0.105	0.	0.	0.	0.0	0.0	0.0	-2.14	2.15	-10.57	27.09
0.110	0.	0.	0.	0.0	0.0	0.0	-2.14	2.32	-10.68	26.63
0.115	0.	0.	0.	0.0	0.0	0.0	-2.11	2.40	-10.70	26.26
0.120	0.	0.	0.	0.0	0.0	0.0	-2.06	2.43	-10.67	26.13
0.125	0.	0.	0.	0.0	0.0	0.0	-1.97	2.46	-10.58	26.18
0.130	0.	0.	0.	0.0	0.0	0.0	-1.85	2.46	-10.44	26.32
0.135	0.	0.	0.	0.0	0.0	0.0	-1.71	2.43	-10.23	26.56
0.140	0.	0.	0.	0.0	0.0	0.0	-1.57	2.36	-9.95	26.86
0.145	0.	0.	0.	0.0	0.0	0.0	-1.43	2.28	-9.60	27.25
0.150	0.	0.	0.	0.0	0.0	0.0	-1.29	2.17	-9.21	27.69
0.155	0.	0.	0.	0.0	0.0	0.0	-1.17	2.05	-8.79	28.19
0.160	0.	0.	0.	0.0	0.0	0.0	-1.05	1.92	-8.34	28.72
0.165	0.	0.	0.	0.0	0.0	0.0	-0.95	1.79	-7.85	29.25
0.170	0.	0.	0.	0.0	0.0	0.0	-0.87	1.67	-7.31	29.72
0.175	0.	0.	0.	0.0	0.0	0.0	-0.82	1.59	-6.70	30.05
0.180	0.	0.	0.	0.0	0.0	0.0	-0.79	1.55	-6.04	30.16
0.185	0.	0.	0.	0.0	0.0	0.0	-0.79	1.55	-5.35	30.03
0.190	0.	0.	0.	0.0	0.0	0.0	-0.80	1.59	-4.67	29.72
0.195	0.	0.	0.	0.0	0.0	0.0	-0.82	1.67	-4.01	29.32
0.200	0.	0.	0.	0.0	0.0	0.0	-0.84	1.77	-3.40	28.86

Table XXX. Selected Printout. Example No. 5 (page 1 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA [illegible] 7, 1972 PAGE [illegible]

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	LOWER TORSO POSITION	LOWER TORSO VELOCITY	LOWER TORSO ACCEL.	CENTER TORSO POSITION	CENTER TORSO VELOCITY	CENTER TORSO ACCEL.	UPPER TORSO POSITION	UPPER TORSO VELOCITY	UPPER TORSO ACCEL.	HEAD POSITION	HEAD VELOCITY	HEAD ACCEL.
0.0	103.00	0.0	0.6174E 03	103.00	0.0	0.6732E 03	103.00	0.0	0.4475E 03	75.00	0.0	-0.1950E 04
0.0050	103.01	2.96	0.5631E 03	103.01	3.36	0.6162E 03	103.00	2.15	0.4342E 03	74.93	[illegible]	-0.1885E 04
0.0100	103.03	5.70	0.5378E 03	103.03	6.42	0.6220E 03	103.02	4.27	0.4056E 03	74.80	-13.73	-0.1795E 04
0.0150	103.06	8.38	0.5348E 03	103.07	9.52	0.6180E 03	103.05	6.21	0.3664E 03	74.73	-27.39	-0.1645E 04
0.0200	103.11	11.20	0.2014E 04	103.13	12.06	-0.7458E 03	103.08	7.55	-0.5218E 03	74.63	-34.06	0.1132E 04
0.0250	103.24	53.51	0.1640E 05	103.15	-6.40	-0.7331E 04	103.10	-3.70	-0.4357E 04	74.52	-0.43	0.1352E 05
0.0300	103.74	130.88	-0.1805E 05	103.02	-40.37	0.9275E 04	103.01	-31.14	-0.3872E 04	74.72	86.34	0.1409E 05
0.0350	104.40	138.60	0.4108E 05	102.81	-41.99	-0.1915E 05	102.78	-64.58	-0.1137E 05	75.42	198.76	0.3569E 05
0.0400	105.14	151.56	0.4978E 05	102.59	-44.02	-0.2269E 05	102.35	-107.75	-0.1357E 05	76.76	342.34	0.4254E 05
0.0450	106.01	198.90	0.1053E 05	102.33	-57.74	-0.2436E 04	101.68	-160.25	-0.1104E 05	78.30	515.77	0.3616E 05
0.0500	107.12	251.17	0.1175E 05	102.03	-65.16	-0.3228E 03	100.74	-216.19	-0.1135E 05	81.93	698.59	0.3730E 05
0.0550	108.53	318.35	0.1384E 05	101.70	-66.45	0.2271E 04	99.52	-272.08	-0.1014E 05	85.39	883.80	0.3473E 05
0.0600	110.27	381.22	0.1576E 05	101.44	-35.20	0.8432E 04	98.05	-312.74	-0.5764E 04	90.70	1032.65	0.2397E 05
0.0650	112.31	433.43	0.9743E 04	101.41	30.90	0.1515E 05	96.42	-332.10	-0.2145E 04	96.12	1128.37	0.1504E 05
0.0700	114.70	504.77	-0.5137E 05	101.65	19.41	0.3157E 05	94.74	-344.89	-0.9504E 04	101.99	1241.27	0.4013E 05
0.0750	118.04	752.09	-0.5096E 05	101.48	-69.56	0.3296E 05	93.01	-342.50	-0.8479E 04	108.53	1365.20	0.3991E 05
0.0800	122.15	867.63	0.6520E 05	101.01	-103.79	-0.3368E 05	91.34	-320.47	0.1592E 05	115.53	1429.45	-0.8938E 04
0.0850	126.74	931.95	-0.2722E 05	100.43	-90.20	0.3374E 05	89.34	-287.77	-0.1911E 04	122.74	1449.53	0.9296E 04
0.0900	131.23	832.13	-0.1080E 06	100.46	138.15	0.1090E 06	88.44	-276.62	-0.2543E 05	129.39	1401.85	0.3433E 05
0.0950	134.82	604.31	-0.4677E 05	102.00	466.40	0.5207E 05	87.02	-291.32	-0.5948E 04	136.69	1309.67	-0.1062E 05
0.1000	137.49	491.03	-0.1772E 05	104.56	490.03	-0.1772E 05	85.53	-300.99	-0.4620E 04	143.00	1217.33	-0.1525E 05
0.1050	139.69	384.99	-0.2493E 05	106.76	383.99	-0.2493E 05	83.94	-341.75	-0.1005E 05	148.90	1144.17	-0.1562E 05
0.1100	141.32	264.31	-0.2336E 05	108.39	263.31	-0.2836E 05	82.34	-270.33	0.2740E 05	154.24	964.35	-0.6340E 05
0.1150	142.26	107.02	-0.3366E 05	109.32	106.02	-0.3366E 05	81.35	-124.98	0.2982E 05	158.11	562.68	-0.9693E 05
0.1200	142.62	57.86	-0.6655E 04	109.68	56.86	-0.6655E 04	80.99	-24.57	0.1775E 05	159.53	-18.70	-0.1202E 06
0.1250	142.79	-21.62	-0.2775E 05	109.84	-22.62	-0.2775E 05	80.96	34.95	0.1519E 05	159.11	-145.95	-0.2521E 05
0.1300	142.34	-154.10	-0.2418E 05	109.38	-155.10	-0.2418E 05	81.33	103.61	0.1352E 05	158.08	-273.30	-0.3150E 05
0.1350	141.30	-252.74	-0.1229E 05	108.34	-253.73	-0.1228E 05	81.97	143.47	0.6159E 03	156.33	-425.37	-0.3245E 05
0.1400	139.86	-329.43	-0.1619E 05	106.89	-330.40	-0.1619E 05	82.73	171.35	0.9373E 04	153.80	-587.23	-0.3399E 05
0.1450	138.02	-404.40	-0.1346E 05	105.04	-405.37	-0.1346E 05	83.72	225.73	0.1281E 05	150.43	-768.00	-0.3905E 05
0.1500	135.83	-465.17	-0.1057E 05	102.86	-466.15	-0.1057E 05	85.02	298.38	0.1671E 05	146.08	-977.16	-0.4548E 05
0.1550	133.39	-511.91	-0.7938E 04	100.40	-512.83	-0.7938E 04	86.74	391.45	0.2099E 05	140.59	-1221.35	-0.5314E 05
0.1600	130.73	-556.72	-0.1231E 05	97.76	-534.45	0.2543E 04	88.97	502.82	0.2297E 05	133.79	-1504.72	-0.6050E 05
0.1650	127.78	-622.29	-0.1438E 05	95.13	-512.20	0.6035E 04	91.77	620.30	0.2311E 05	125.50	-1814.92	-0.6147E 05
0.1700	124.48	-699.95	-0.1685E 05	92.66	-471.51	0.1156E 05	95.15	726.55	0.1776E 05	115.67	-2106.32	-0.5232E 05
0.1750	120.76	-787.44	-0.1730E 05	90.48	-392.99	0.2133E 05	98.97	789.57	0.4967E 04	104.55	-2323.17	-0.2995E 05
0.1800	116.61	-872.22	-0.1519E 05	88.82	-262.02	0.3188E 05	102.92	778.52	-0.1038E 05	92.67	-2409.73	-0.3147E 04
0.1850	112.08	-934.84	-0.8907E 04	87.96	-65.74	0.4822E 05	106.62	682.33	-0.2398E 05	80.66	-2369.23	0.2003E 05
0.1900	107.30	-976.49	-0.6300E 04	88.27	193.30	0.5315E 05	109.58	488.16	-0.4498E 05	69.14	-2227.74	0.3290E 05
0.1950	102.35	-998.12	-0.2254E 04	89.83	403.14	0.2651E 05	111.49	294.63	-0.2958E 05	58.41	-2064.42	0.3362E 05
0.2000	97.35	-1000.15	0.1799E 04	92.16	520.89	0.1992E 05	112.60	149.81	-0.2803E 05	48.51	-1893.29	0.3468E 05

Table XXX. Selected Printout. Example No. 5 (page 2 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972

BODY SEGMENT ANGULAR ORIENTATION (DEGREES)

TIME	UPPER ARM			LOWER ARM			UPPER LEG			LOWER LEG		
	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.	POSITION	VELOCITY	ACCEL.
0.0	-77.00	0.0	0.4277E 03	0.0	0.0	-0.2317E 04	13.50	0.0	-0.1273E 04	-39.80	0.0	-0.3290E 04
0.0050	-76.99	2.03	0.3995E 03	-0.02	-9.96	-0.1986E 04	13.48	-6.58	-0.1426E 04	-39.84	-13.03	-0.8600E 03
0.0100	-76.98	3.97	0.3690E 03	-0.10	-19.79	-0.1334E 04	13.43	-13.84	-0.1444E 04	-39.91	-14.78	-0.2950E 03
0.0150	-76.95	5.70	0.3153E 03	-0.22	-29.27	-0.1843E 04	13.35	-20.99	-0.1412E 04	-39.98	-16.27	-0.2989E 03
0.0200	-76.92	6.47	-0.1185E 04	-0.39	-38.12	-0.1311E 04	13.22	-27.88	-0.9683E 03	-40.07	-17.86	-0.7901E 03
0.0250	-76.93	-13.96	-0.7644E 04	-1.59	-37.15	0.2036E 04	13.08	-25.12	0.2441E 04	-40.18	-31.44	-0.4958E 04
0.0300	-77.11	-65.38	-0.1196E 05	-1.74	-28.27	-0.6380E 04	13.00	-10.78	-0.3155E 04	-40.41	-55.85	-0.1416E 04
0.0350	-77.62	-140.52	-0.1909E 05	-0.91	-37.40	0.7585E 04	12.96	-3.18	0.1025E 05	-40.72	-71.21	-0.6654E 04
0.0400	-78.55	-235.06	-0.2265E 05	-1.12	-49.36	0.8687E 04	12.98	11.91	0.1301E 05	-41.11	-84.07	-0.7149E 04
0.0450	-79.99	-343.51	-0.2259E 05	-1.39	-61.17	-0.3392E 04	13.10	37.72	0.5509E 04	-41.57	-100.45	-0.3811E 04
0.0500	-81.93	-458.26	-0.2326E 05	-1.75	-85.22	-0.6385E 04	13.36	64.47	0.5189E 04	-42.13	-123.78	-0.6317E 04
0.0550	-84.57	-564.73	-0.3401E 04	-2.27	-124.96	-0.1124E 05	13.74	89.19	0.4971E 04	-42.84	-165.96	-0.1115E 05
0.0600	-87.18	-421.13	0.6494E 05	-3.06	-190.61	-0.1236E 05	14.25	115.50	0.6252E 04	-43.83	-232.85	-0.1637E 05
0.0650	-88.29	8.55	0.1017E 06	-4.18	-256.33	-0.1365E 05	14.89	141.50	0.4883E 04	-45.20	-320.60	-0.1909E 05
0.0700	-87.15	358.85	0.3283E 05	-5.65	-341.51	-0.4984E 05	15.64	147.15	-0.2202E 05	-47.06	-426.04	-0.1358E 05
0.0750	-85.05	482.18	0.1167E 05	-7.59	-432.38	-0.4515E 05	16.34	137.09	-0.1920E 05	-49.48	-537.99	-0.1343E 05
0.0800	-82.50	514.98	-0.1407E 05	-9.91	-437.68	0.1397E 05	17.04	144.05	0.1240E 05	-52.43	-639.11	-0.2375E 05
0.0850	-80.22	383.98	-0.2904E 05	-12.31	-466.45	0.8977E 03	17.81	164.92	0.2571E 04	-55.87	-736.11	-0.1758E 05
0.0900	-78.65	242.14	-0.2959E 05	-14.46	-389.09	-0.1622E 05	18.78	225.68	-0.4904E 04	-59.80	-837.49	-0.1434E 05
0.0950	-77.80	99.21	-0.2930E 05	-16.16	-288.15	0.2066E 05	20.06	269.40	-0.5003E 04	-64.16	-867.37	0.2546E 05
0.1000	-77.70	-64.58	-0.3421E 05	-17.36	-197.19	0.1452E 05	21.23	176.93	-0.2910E 05	-67.96	-603.20	0.8109E 05
0.1050	-78.45	-235.18	-0.3390E 05	-18.19	-137.35	0.9392E 04	21.72	13.67	-0.3466E 05	-69.84	-127.39	0.1061E 06
0.1100	-80.08	-422.48	-0.2922E 05	-18.67	-51.82	0.1320E 05	21.71	21.50	0.1325E 05	-69.92	20.50	0.1325E 05
0.1150	-82.34	-430.53	0.3094E 05	-18.93	-96.44	-0.3215E 05	21.97	72.55	0.6814E 04	-69.66	71.55	0.6814E 04
0.1200	-83.89	-151.44	0.7392E 05	-19.86	-280.96	-0.4629E 05	22.31	56.86	-0.6655E 04	-69.33	55.86	-0.6655E 04
0.1250	-83.98	62.76	0.2152E 05	-21.72	-450.31	-0.2606E 05	22.54	48.92	0.5602E 04	-69.10	47.92	0.5602E 04
0.1300	-83.44	140.05	0.5691E 04	-24.28	-564.22	-0.1347E 05	22.85	74.20	0.6495E 04	-68.79	73.20	0.6495E 04
0.1350	-82.72	144.47	0.6158E 03	-27.24	-615.33	-0.6915E 04	23.28	95.08	0.2197E 04	-68.37	94.08	0.2197E 04
0.1400	-82.18	44.04	-0.2718E 05	-30.29	-580.65	0.1412E 05	23.79	109.13	0.3080E 04	-67.86	108.12	0.3080E 04
0.1450	-82.28	-82.39	-0.2270E 05	-33.00	-592.65	0.1712E 05	24.37	123.20	0.2454E 04	-67.29	122.20	0.2454E 04
0.1500	-82.96	-183.27	-0.1690E 05	-35.29	-412.83	0.1878E 05	25.02	133.71	0.1632E 04	-66.65	132.71	0.1632E 04
0.1550	-84.06	-253.16	-0.1033E 05	-37.12	-316.96	0.1954E 05	25.70	139.57	0.5507E 03	-65.97	138.57	0.5507E 03
0.1600	-85.43	-288.43	-0.2960E 04	-38.46	-219.12	0.1938E 05	26.40	139.77	-0.6556E 03	-65.27	139.52	0.2799E 03
0.1650	-86.89	-292.03	0.7869E 03	-39.31	-123.43	0.1871E 05	27.08	130.48	-0.3517E 04	-64.57	141.90	0.6093E 03
0.1700	-88.33	-285.40	0.1597E 04	-39.70	-32.81	0.1721E 05	27.68	105.22	-0.6933E 04	-63.85	144.87	0.5201E 03
0.1750	-89.75	-280.38	-0.2504E 03	-39.66	47.41	0.1433E 05	28.11	63.94	-0.9565E 04	-63.12	146.98	0.3230E 03
0.1800	-91.12	-249.69	0.2625E 05	-39.28	84.87	-0.3433E 04	28.30	14.74	-0.9597E 04	-62.38	148.76	0.5010E 03
0.1850	-91.88	-12.26	0.6930E 05	-39.08	-34.54	-0.3993E 05	28.26	-29.04	-0.7451E 04	-61.62	152.85	0.1267E 04
0.1900	-91.17	257.35	0.3939E 05	-39.74	-217.59	-0.3173E 05	28.02	-73.35	-0.8939E 04	-60.85	157.75	0.9652E 03
0.1950	-89.51	352.66	-0.1117E 05	-41.14	-300.43	0.7386E 04	27.55	-109.81	-0.5291E 04	-60.04	163.24	0.1220E 04
0.2000	-87.91	285.51	-0.1511E 05	-42.52	-248.31	0.1331E 05	26.94	-134.84	-0.4840E 04	-59.21	169.47	0.1259E 04

Table XXX. Selected Printout. Example No. 5 (page 3 of 9)

	VEHICULAR MOTION			BODY MOTION AT HIP JOINT					
TIME	POSITION (IN.)	VELOCITY (IN./SEC.)	ACCEL. (G-UNITS)	RELATIVE DISPL. (IN.)	HORIZONTAL VELOCITY (IN./SEC.)	ACCEL. (G-UNITS)	RELATIVE DISPL. (IN.)	VERTICAL VELOCITY (IN./SEC.)	ACCEL. (G-UNITS)
0.0	0.0	0.0	0.0	0.0	0.0	0.144	0.0	0.0	0.080
0.0050	0.005	3.22	3.333	-0.005	0.26	0.117	0.000	0.15	0.075
0.0100	0.043	12.38	6.667	-0.040	0.48	0.112	0.001	0.29	0.065
0.0150	0.145	28.98	10.000	-0.139	0.60	0.113	0.003	0.40	0.047
0.0200	0.333	45.08	6.667	-0.323	0.94	0.480	0.005	0.46	-0.088
0.0250	0.585	54.74	3.333	-0.564	4.62	3.647	0.006	-0.48	-0.961
0.0300	0.869	57.96	0.0	-0.804	13.16	2.700	-0.001	-1.63	3.192
0.0350	1.163	60.38	2.509	-1.010	22.87	9.026	-0.003	0.98	-2.505
0.0400	1.481	67.65	5.017	-1.133	35.42	11.004	0.009	4.18	-2.941
0.0450	1.848	79.77	7.526	-1.333	51.32	8.901	0.037	6.91	1.600
0.0500	2.287	96.73	10.035	-1.472	69.42	10.069	0.081	10.56	2.150
0.0550	2.823	118.54	12.543	-1.611	90.17	11.528	0.144	14.99	2.149
0.0600	3.481	145.20	15.052	-1.760	113.66	13.302	0.229	18.40	1.027
0.0650	4.278	173.73	14.482	-1.925	139.80	14.239	0.328	21.26	1.649
0.0700	5.216	201.16	13.913	-2.092	169.37	7.982	0.449	30.24	17.586
0.0750	6.288	227.49	13.344	-2.237	201.45	9.123	0.638	44.39	16.172
0.0800	7.489	252.72	12.775	-2.347	234.19	21.552	0.885	54.21	-0.713
0.0850	8.814	276.85	12.205	-2.414	268.92	16.970	1.174	60.93	3.984
0.0900	10.256	299.88	11.636	-2.414	308.67	13.606	1.474	57.40	6.542
0.0950	11.810	321.81	11.067	-2.325	346.47	14.821	1.736	46.66	-5.667
0.1000	13.472	342.64	10.498	-2.202	363.35	3.117	1.952	41.30	-1.329
0.1050	15.235	362.38	9.928	-2.142	364.43	-1.391	2.152	38.99	-1.446
0.1100	17.094	381.01	9.359	-2.142	383.57	12.811	2.319	25.01	-10.939
0.1150	19.043	398.54	8.790	-2.115	405.62	9.926	2.396	8.74	-5.599
0.1200	21.078	414.97	8.220	-2.062	429.81	11.980	2.432	6.80	1.351
0.1250	23.191	430.30	7.651	-1.969	452.22	10.089	2.464	3.93	-4.469
0.1300	25.379	444.53	7.082	-1.849	470.47	9.214	2.464	-3.87	-5.250
0.1350	27.635	457.67	6.513	-1.712	485.72	6.501	2.426	-10.39	-1.795
0.1400	29.954	469.70	5.943	-1.571	497.96	5.928	2.364	-14.87	-2.574
0.1450	32.330	480.63	5.374	-1.431	508.45	4.828	2.278	-19.49	-2.141
0.1500	34.758	490.46	4.805	-1.295	516.87	3.806	2.171	-23.14	-1.558
0.1550	37.233	499.20	4.235	-1.168	523.40	2.880	2.043	-25.51	-0.768
0.1600	39.748	506.83	3.666	-1.054	528.29	2.110	1.918	-26.33	-0.076
0.1650	42.299	513.36	3.097	-0.954	531.42	1.015	1.788	-25.26	1.457
0.1700	44.880	518.80	2.528	-0.875	532.42	-0.065	1.672	-20.77	3.394
0.1750	47.485	523.13	1.958	-0.820	531.52	-0.868	1.586	-12.76	4.880
0.1800	50.109	526.36	1.389	-0.791	529.59	-1.029	1.547	-3.14	4.738
0.1850	52.747	528.50	0.820	-0.785	527.76	-0.785	1.552	4.80	3.153
0.1900	55.393	529.53	0.250	-0.736	525.79	-0.975	1.594	12.62	4.076
0.1950	58.041	529.64	0.0	-0.819	524.85	0.114	1.673	18.51	1.804
0.2000	60.689	529.64	0.0	-0.842	525.29	0.333	1.774	21.61	1.476

Table XXX. Selected Printout. Example No. 5 (page 4 of 9)

TIME	ACCELEROMETER READINGS: HEAD RESULTANT (G-UNITS)	HEAD ANGLE (DEG.)	CHEST RESULTANT (G-UNITS)	CHEST ANGLE (DEG.)	BELT FORCES (LBS), LAP	SHOULDER RESTRAINT LOWER	SHOULDER RESTRAINT UPPER	SEAT FORCES (LBS) AT HIP	AT FRONT EDGE
0.0	0.3	-47.4	0.2	-179.2	0.0	0.0	0.0	145.00	0.0
0.0050	0.3	-48.2	0.2	-179.7	0.0	0.0	0.0	144.56	0.0
0.0100	0.3	-50.4	0.2	-177.2	0.0	0.0	0.0	143.44	0.0
0.0150	0.3	-54.7	0.2	-172.3	0.0	0.0	0.0	141.56	0.0
0.0200	0.2	7.4	0.3	-22.4	0.0	0.0	0.0	139.42	0.0
0.0250	0.6	55.9	2.9	-24.9	0.0	0.0	0.0	139.01	0.0
0.0300	5.5	72.2	5.6	39.0	0.0	0.0	0.0	140.11	0.0
0.0350	0.9	49.1	7.6	-26.3	0.0	0.0	0.0	137.51	0.0
0.0400	0.7	-17.6	9.2	-27.1	0.0	0.0	0.0	133.73	0.0
0.0450	3.3	59.4	8.6	7.6	0.0	0.0	0.0	129.76	0.0
0.0500	2.1	26.1	9.2	8.4	0.0	0.0	0.0	124.01	0.0
0.0550	3.7	-50.6	9.3	4.5	0.0	0.0	0.0	116.44	0.0
0.0600	8.8	-66.1	8.7	-8.0	0.0	0.0	0.0	108.71	0.0
0.0650	11.2	-59.9	8.7	-5.3	0.0	0.0	0.0	100.79	0.0
0.0700	8.1	57.2	22.1	60.2	0.0	0.0	0.0	85.94	0.0
0.0750	7.0	15.8	21.1	56.0	0.0	0.0	0.0	62.72	0.0
0.0800	27.2	-46.7	20.8	-26.0	0.0	0.0	0.0	40.26	0.0
0.0850	20.7	-29.4	13.3	11.7	0.0	0.0	0.0	17.48	0.0
0.0900	17.4	-10.7	15.3	67.6	0.0	0.0	0.0	3.09	0.0
0.0950	25.6	-14.7	10.4	-21.1	0.0	0.0	0.0	0.0	0.0
0.1000	24.3	-3.2	11.9	3.8	0.0	0.0	0.0	0.0	0.0
0.1050	24.7	5.4	10.8	17.6	0.0	0.0	0.0	0.0	0.0
0.1100	26.3	32.7	21.9	-10.3	0.0	0.0	0.0	0.0	0.0
0.1150	40.4	61.4	20.4	10.1	0.0	0.0	0.0	0.0	0.0
0.1200	46.6	67.0	13.2	14.8	0.0	0.0	0.0	0.0	0.0
0.1250	19.4	39.2	15.6	9.2	0.0	0.0	0.0	0.0	0.0
0.1300	19.2	38.0	17.5	3.7	0.0	0.0	0.0	0.0	0.0
0.1350	19.6	31.9	11.5	4.3	0.0	0.0	0.0	0.0	0.0
0.1400	17.6	36.4	12.0	3.3	0.0	0.0	0.0	11.46	0.0
0.1450	16.2	37.7	9.7	-0.8	0.0	0.0	0.0	25.06	0.0
0.1500	15.0	35.6	7.4	-6.8	0.0	0.0	0.0	39.06	0.0
0.1550	14.1	26.3	5.2	-14.7	0.0	0.0	0.0	52.42	0.0
0.1600	14.6	5.6	2.3	-29.2	0.0	0.0	0.0	64.17	0.0
0.1650	18.8	-23.4	0.4	2.9	0.0	0.0	0.0	73.30	0.0
0.1700	26.7	-47.7	1.8	120.1	0.0	0.0	0.0	77.31	0.0
0.1750	34.1	-66.4	3.9	132.4	0.0	0.0	0.0	75.03	0.0
0.1800	35.9	-82.7	5.1	148.5	0.0	0.0	0.0	67.80	0.0
0.1850	30.2	-98.4	8.0	170.2	0.0	0.0	0.0	59.19	0.0
0.1900	17.2	-116.6	9.1	164.2	0.0	0.0	0.0	48.24	0.0
0.1950	17.1	-133.9	3.4	-153.1	0.0	0.0	0.0	36.64	0.0
0.2000	13.4	-155.1	3.6	-130.3	0.0	0.0	0.0	26.25	0.0

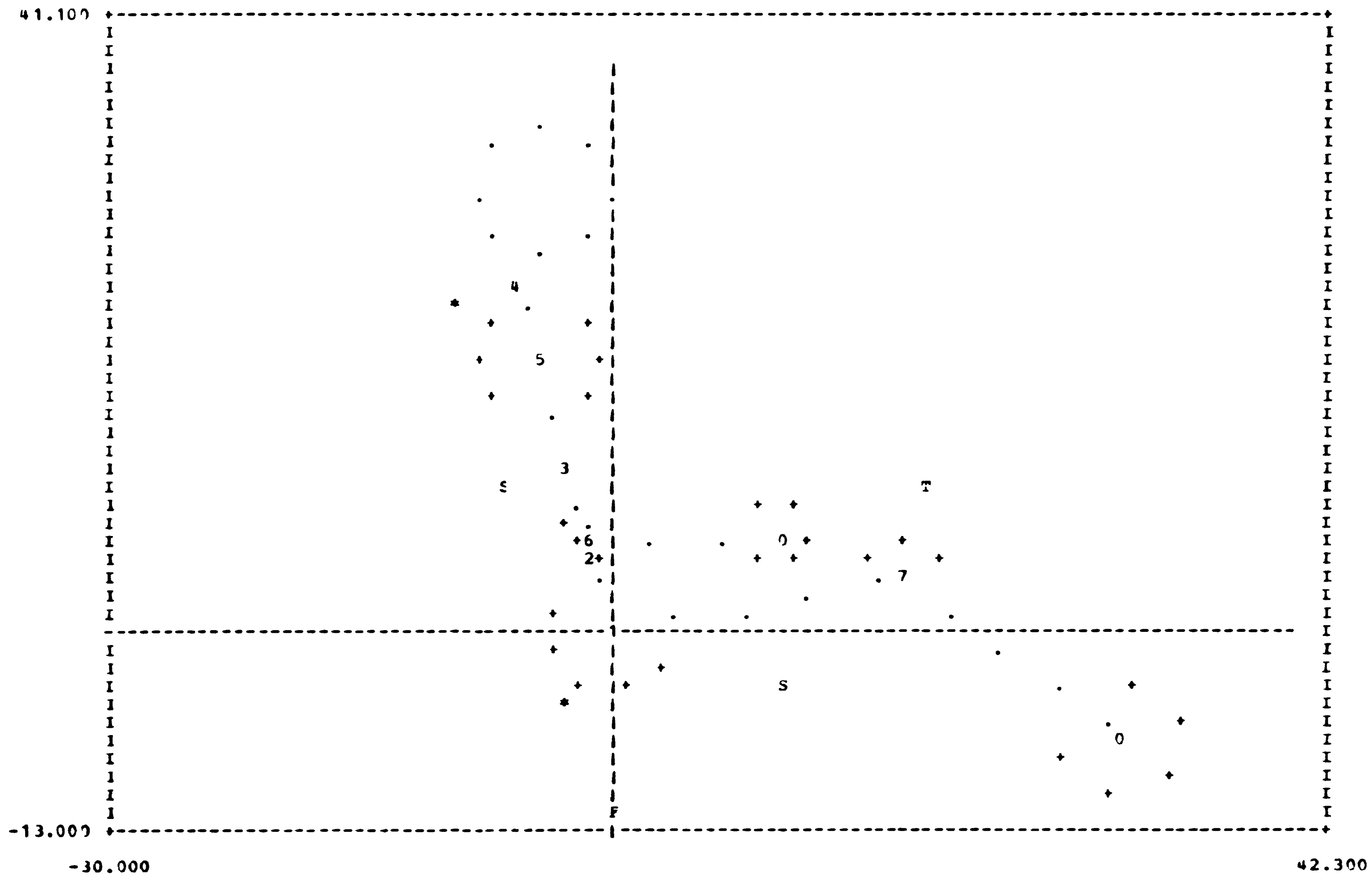
Table XXX. Selected Printout. Example No. 5 (page 5 of 9)

CONTACT FORCES (LBS.)

TIME	FOOT ON TOE BOARD	HIP ON SEAT BACK	UPPER TORSO ON UP. SEAT BACK	FOOT ON FLOOR	ELBOW ON SEAT BACK
0.0	32.9	0.0	0.0	0.0	0.0
0.0050	6.3	0.0	0.0	0.0	0.0
0.0100	0.0	0.0	0.0	0.0	0.0
0.0150	0.0	0.0	0.0	0.0	0.0
0.0200	0.0	20.7	47.5	0.0	0.0
0.0250	0.0	203.4	248.0	2.4	0.0
0.0300	0.0	397.0	449.0	57.1	0.0
0.0350	0.0	557.3	610.8	114.3	0.0
0.0400	0.0	690.0	727.5	159.1	0.0
0.0450	0.0	802.5	804.6	179.9	0.0
0.0500	0.0	902.3	852.0	163.4	0.0
0.0550	0.0	999.2	883.1	104.2	140.5
0.0600	0.0	1100.6	913.6	37.7	607.0
0.0650	0.0	1211.5	990.4	1.7	852.7
0.0700	0.0	1319.7	1096.2	8.8	741.4
0.0750	0.0	1398.6	1194.5	45.2	455.2
0.0800	0.0	1440.2	1282.3	90.9	108.6
0.0850	0.0	1439.5	1359.6	120.8	0.0
0.0900	0.0	1378.3	1430.9	99.7	0.0
0.0950	0.0	1249.3	1508.2	0.0	0.0
0.1000	0.0	1102.3	1587.8	0.0	0.0
0.1050	0.0	1013.1	1649.5	0.0	0.0
0.1100	0.0	930.3	1682.4	0.0	48.7
0.1150	0.0	943.3	1676.3	0.0	421.8
0.1200	0.0	894.2	1637.9	0.0	648.1
0.1250	0.0	812.5	1572.5	0.0	604.5
0.1300	0.0	716.7	1439.2	0.0	393.2
0.1350	0.0	616.2	1244.8	0.0	93.5
0.1400	0.0	518.7	1010.6	0.0	0.0
0.1450	0.0	427.0	753.2	0.0	0.0
0.1500	0.0	343.8	495.3	0.0	0.0
0.1550	0.0	271.2	233.6	0.0	0.0
0.1600	0.0	209.3	61.9	0.0	0.0
0.1650	0.0	160.2	0.0	0.0	0.0
0.1700	0.0	122.7	0.0	0.0	0.0
0.1750	0.0	37.4	0.0	0.0	0.0
0.1800	0.0	83.6	0.0	0.0	163.5
0.1850	0.0	78.3	0.0	0.0	337.6
0.1900	0.0	30.0	0.0	0.0	207.4
0.1950	0.0	83.2	0.0	0.0	9.7
0.2000	0.0	83.0	0.0	0.0	0.0

Table XXX. Selected Printout. Example No. 5 (page 6 of 9)

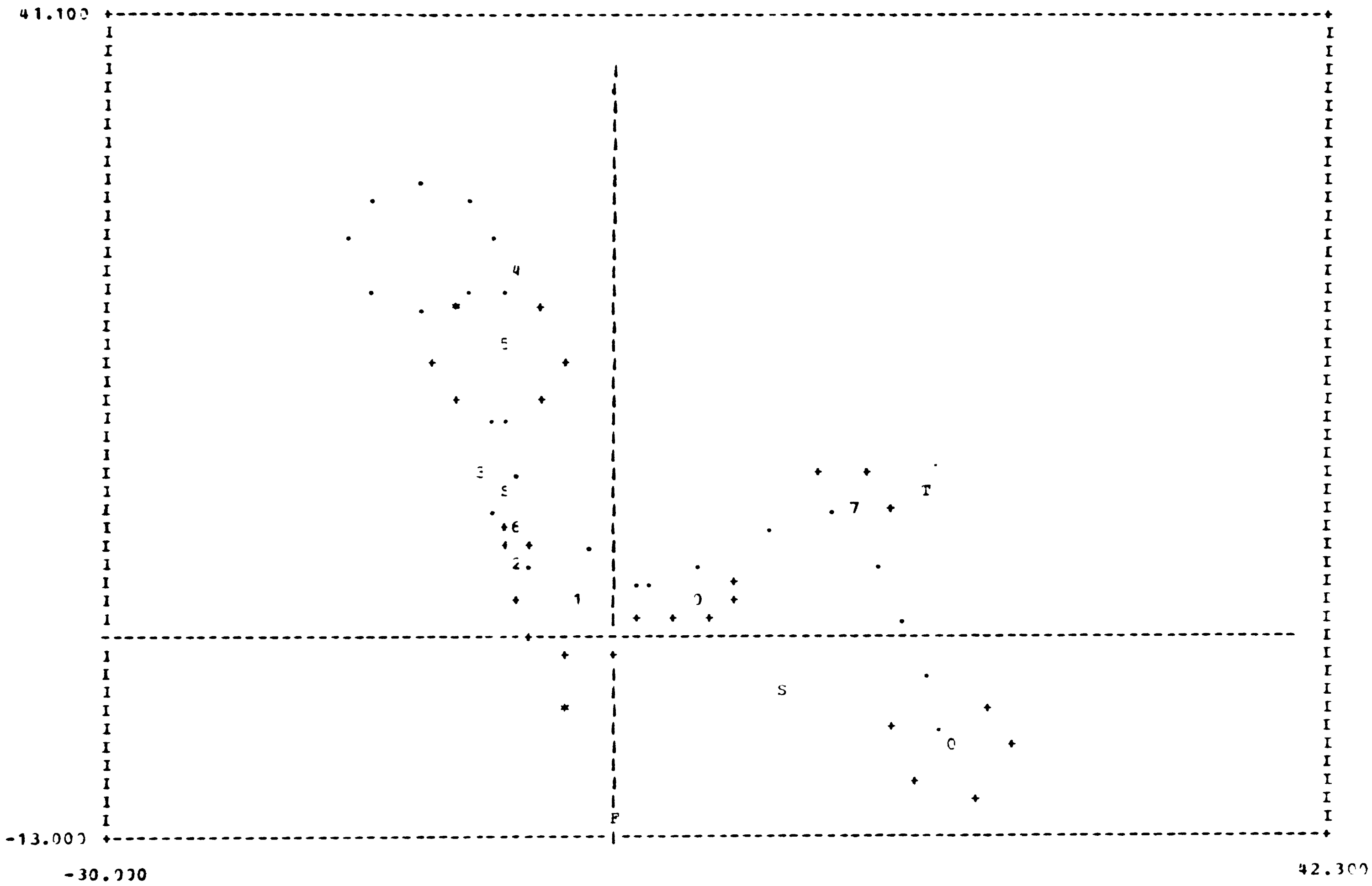
STICK FIGURE REPRESENTATION FOR TIME = 0.0   SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.06 IN THE Y DIRECTION

Table XXX. Selected Printout. Example No. 5 (page 7 of 9)

STICK FIGURE REPRESENTATION FOR TIME = 0.120 SECONDS

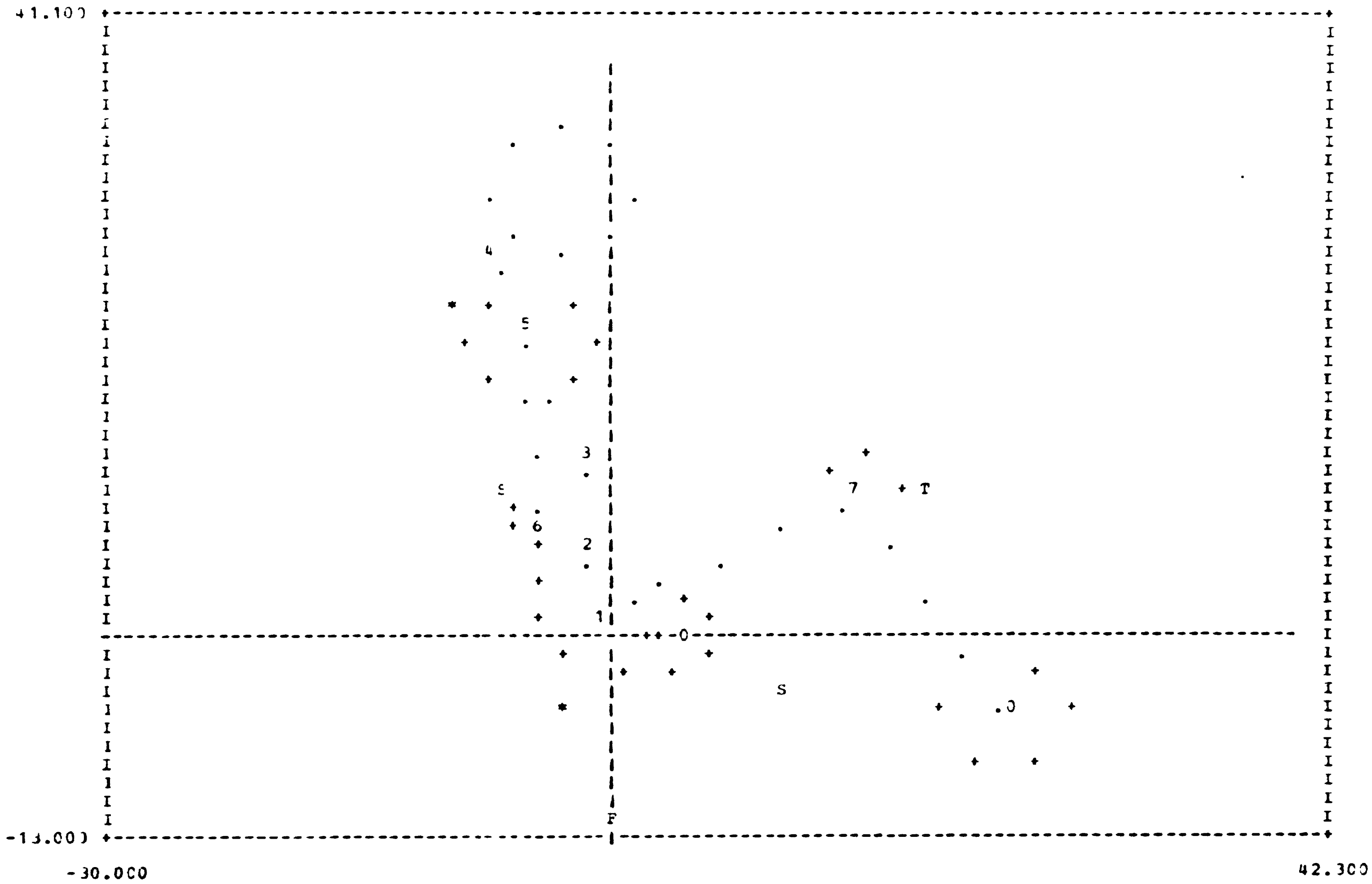


INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.05 IN THE Y DIRECTION

Table XXX. Selected Printout. Example No. 5 (page 8 of 9)

TWO DIMENSIONAL CRASH VICTIM SIMULATOR OUTPUT DATA SEP 7, 1972 PAGE 27

STICK FIGURE REPRESENTATION FOR TIME = 0.200 SECONDS



INDICATED MEASUREMENTS ARE IN INCHES
SCALING FACTORS: 1 TO 7.09 IN THE X DIRECTION
1 TO 7.96 IN THE Y DIRECTION

Table XXX. Selected Printout. Example No. 5 (page 9 of 9)

D. GENERAL PROGRAM OUTPUT

The program printout consists of the following parts: executive system printout, listing of input cards read (up to Z-card), allowable contact specifications, digest of input data, intermediate general printout with various possible debugging options, and tabular summary.

There are four levels of debugging printout provided in the program. The first level of printout, consisting only of normal summary printout, is always printed upon program execution. The other levels (IBUG = 1, 2, 3) are set up using the input data cards labeled "V." Because of the piecewise-linear nature of information inputted to the computer program using "V-cards" it is possible to isolate small time segments within the forward integration period covered by the simulation and produce detailed debugging printout as needed.

Although variable levels of debugging printout are specified only by piecewise linear sections, only integer values of IBUG have meaning, so the best practice is to use a very small time step between the integer values of IBUG. A sample of the "V card" input is given in Table XXXI and graphed in Figure 42.

If a print time occurs while IBUG is a linear ramp, some intermediate IBUG printout will occur (IBUG = 1, 2) as the values are rounded off approximately to integer values.

The first item printed out after the executive system printout is a listing of the input data file up to the Z card. After this comes a table of the permissible contacts for the NPASGR option selected. "NS" is the total number of contacts and the next two lines give the indices of the body segment and its corresponding allowed contact surface (see Table XV).

TABLE XXXI. SAMPLE V CARD DEBUG INPUT DATA SET

Data Card Column	1	11	21	31
Information on each data card	V2.	1.	0.	0.
	V2.	1.	0.099	0.
	V2.	1.	0.100	3.
	V2.	1.	0.149	3.
	V2.	1.	0.150	0.
	V2.	1.	0.200	0.

It should also be noted that contact forces are labeled by the following scheme in printouts from subroutines LODFEC and CONTAC (see Table XXXII). Indices 1, 2, and 3 are belts (lap, lower shoulder harness, upper shoulder harness). Index 4 is vestigial. The index pairs listed under I and A are labeled from 5 through a maximum of 18 (see Table XVI).

The input data follows the listing of the contacts. These variables are described in Part IV, Section A of this paper. The surface index A is printed one greater than the listing in Table VII. For example, A = 1 is the floor index whereas the value in the table is zero.

Intermediate general printout can be described by a table and a list of accompanying comments. Table XXXII consists of the debug level, the subroutine generating the output, and the variables included in each output group and Table XXXIII lists specific comments which are generated by the program indicating certain error conditions and other aspects of program function.

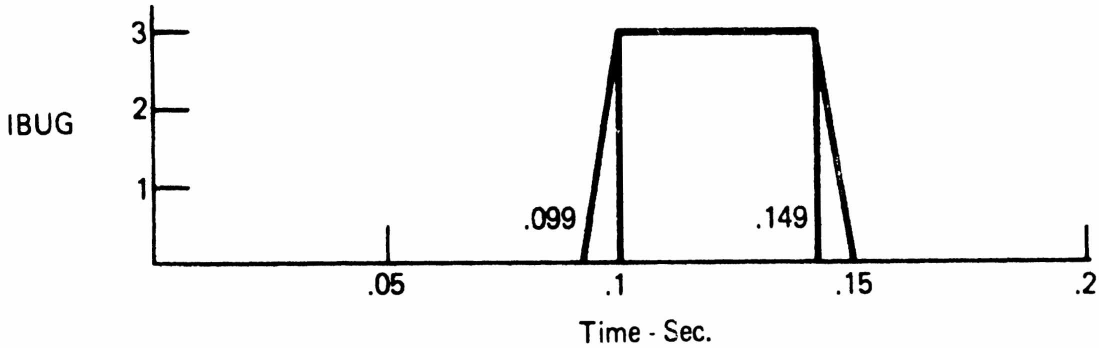


Figure 42. Description of time-varying debug table.

TABLE XXXII. INTERMEDIATE GENERAL PRINTOUT (page 1)

Debug Level* (and debug printout number)	Routine	Label	Contents
0 (1)	MAIN	--	Number of contact surfaces (NS), index of contact arcs (I), index of contact surfaces (A) (see note on Table XXXIII)
0 (2)	MAIN	--	Output of input (See Part IV. A of report) (see note on Table XXXIII)
0 (3)	KRUNCH	IGNORE	Switch indicating status of the contact surfaces (+1 = no contact, -1 = no friction, 0 = friction)
1 (4)	GETY	--	Present time (ARG), time modulo 24 (MOD ARG), table number (TABLE), ordinate (ORD)
3 (5)	ACCEL	STEP	sin θ_i, cos θ_i, θ_i^2, $L_i\theta_i^2$, $a_i\theta_i^2$ in five columns for i = 1-8 in eight lines. (L = in.) (θ = rad)*. Quantity "a" is matrix parameter.
2 (6)	SEAT	SEAT	Z (in) (distances from hip to front of seat) FS (Fs) (lb) (hip seat force) FSPRM (F's) (lb) (front edge seat force) FZ (Fz) (lb) (force on front seat) SMALLF (f) (lb) (friction force magnitude) SUMBY ($\beta_1 y_s + \beta_2 y_s^2 + \beta_3 y_s^3$) (lb) (non-linear hip force) ZMLCTS ($z - L_7 \cos \theta_7$) (in.) (distance from knee to front of seat)

*(a_i = lb in. for i = 1-8, lb for i=9, lb in.^{2} for i = 10-17.)

*NOTE: The terms "Debug Level" and "IBUG value" are equivalent throughout this report.

TABLE XXXII. INTERMEDIATE GENERAL PRINTOUT (page 2)

Debug Level	Routine	Label	Contents
1 (7)	LODFEC	LODFEC	N (index of force) (See Table XVI and text above) SDL (δ) (in.) (deflection) SDLD ($\dot{\delta}$) (in./sec) (deflection rate) PN (F) (lb) (contact force) ET (E) (in. lb) (energy since last unloaded cycle) EPSLNT (ε) (in.) (permanent deformation)
2 (8)	CONTAC	CONTAC	N (index of contact) DELOA (δ) (in.) (deflection) DELIAD ($\dot{\delta}$) (in./sec) (deflection rate) PN (F) (lb) (force) EONE (E_1) (in. lb) (total conserved energy) EPSLNY (ε) (in.) (permanent deformation)
2 (9)	CONTAC	QUE VECTOR	QUE (Subscript I = 1-10 referring to the body segments (1-8) as defined in Table IX and the x-y coordinates of the hip. Units for subscripts 1-8 are in. lb and for 9-10 are lb) (Contribution to generalized force vector of contact surfaces is defined in Table XV.)
2 (10)	BODY	BODY	I (index for each line defined as QUE subscripts) GEE (gravitational contribution to generalized force vector) DEE (contribution of seat bottom and belts) BEE (contribution of centrifugal forces) SMALLB (total generalized force vector)
2 (11)	ZMAKER	A MATRIX	AA (doubly subscripted matrix of differential equations. Rows possess units defined in QUE)
2 (12)	ZMAKER	A INVERSE	ANVERS (doubly subscripted inverse of AA)
2 (13)	ZMAKER	CHECK OF INVERSE	CK ($A^{-1}A + AA^{-1}$) (check of inversion routine)

TABLE XXXII. INTERMEDIATE GENERAL PRINTOUT (page 3)

Debug Level	Routine	Label	Contents
1 (14)	DELZMK	DELZMK	A subscription comment "FOR MODE No. (K), I = (I), A = (A)" K (Index of jittering friction mode. For K = 1-7, index refers to joint. For K = 8, index refers to seat cushion. For K = 9,..., index is k + 4, see page 26. DELZ (J,K) This doubly subscripted vector shows the change in acceleration vector (J = 1-10) due to an instability (K = 1...)
1 (15)	KRUNCH	ZK BASE	ZVECPP (acceleration vector due to continuous forces and unstable friction forces. Subscripts refer to angular coordinates (1-8), linear coordinates (9-10), and vehicle (11). Units are rad/sec^2 and in./sec^2)
1 (16)	KRUNCH	TIME IMAX	Time since beginning of collision event. MAXI (number of possible instabilities) IBIG (listing of possible unstable modes with subscript I = 1...MAXI)
1 (18)	JITTER	I AK	I (index of averaging pair) AK (weighted averaging coefficient used in eliminating instabilities)
1 (17)	JITTER		Comment: MODE (index) TURNED ON (or OFF) or JITTER FOR MODE (index)
1 (19)	JITTER	ZRV = ZPPP = DELNU = FMM =	Relative acceleration from ZKBASE for mode N Relative acceleration from previous averagings Relative acceleration from DELZMK (K = 7) Slope of vehicle deceleration (in./sec^3) These quantities are largely vestigial

TABLE XXXII. INTERMEDIATE GENERAL PRINTOUT (page 4)

Debug Level	Routine	Label	Contents
1 (20)	TAUMAK	TAUMAK	ITAU (I) (index of jittering friction contact) TAUHAT (I) (selected time interval TAUI (all predicted time intervals) (I = 1-16, in two lines)
1 (21)	TAUMAK	MODE	MODE (Switch array stating whether each friction mode (1-16) is on (+1), off (-1), or unstably jittering (0).)
3 (22)	LIMIDT	LIMIDT	I (index) AZ (rad or in.) (predicted angular position of body elements, 1-8, x and y hip position 9-10, and cart location 11) AZP (rad/sec or in./sec) (associated velocities) AX (in.) (Horizontal joint coordinates. Note index 8 refers to knee and both 1 and 7 to the hip joint here only) AY (in.) (vertical joint coordinates) AXD (in./sec) (horizontal joint velocity) AYD (in./sec) (vertical joint velocity)
1 (23)	FECLOD	FECLOD	TIME (sec) (time) INDEX (index of contact force checked) SDEL (in.) (predicted deflection) SDELD (in./sec) (predicted deflection rate) FTT (lb) (predicted contact force)
1 (24)	NORMUT	AT TIME	TIME (sec)
		THETA	ZVEC (deg) (angular position of body elements 1-8) ZVECP (deg/sec) (angular velocities) ZVECPP (deg/sec^2) (angular accelerations)
		XHIP YHIP XCAR	ZVEC, ZVECP, ZVECPP (in., in./sec, in./sec^2) (9-12) (position, velocity, and acceleration of hip in x and y directions and of the vehicle)

TABLE XXXII. INTERMEDIATE GENERAL PRINTOUT (page 5)

Debug Level	Routine	Label	Constants
1 (24)	NORMUT	TIME FS FSPRM SMALLF	TIME (sec) FS (lb) (seat bottom force on hip) FSPRM (lb) (force at front edge of seat bottom) SMALLF (lb) (friction force from seat bottom)
1 (24)	NORMUT	X Y A GAMMA	XHEAD, XCHEST (in./sec^2) (horizontal acceleration of head and chest c. g.) YHEAD, YCHEST (in./sec^2) (vertical acceleration of head and chest c. g.) AHEAD, ACHEST (in./sec^2) (resultant acceleration of head and chest) GHEAD, GCHEST (deg) (angle of resultant acceleration vector)
1 (24)	NORMUT	M DELTA DELTA DOT FM PHI EIM EPSILON DEM	Index of belt segment: seat belt (1) upper shoulder (2), lower shoulder (3). SDELTA (in.) (elongation of belt) SDELTD (in. sec) (rate of belt elongation) PN (lb) (belt force) PHI (deg) (belt angle) EONE (in./lb) (total energy conserved in belt) EPSLNY (in.) (permanent belt deformation)
1 (25)	KRUNCH	RVEL	MAXR (present number of friction modes being considered) RVEL (rad/sec, in./sec) (relative velocity for the friction modes being considered) RSEL (rad/sec^2, in./sec^2) (relative acceleration for friction modes considered)
1 (26)	KRUNCH	KRUNCH A	KPRINT (print switch) KINFL (inflection switch) KSTED (maximum time step switch) ITAU (mode selected) TAUHAT (sec) (minimum predicted mode time) TPRINT (sec) (next print time) TINFL (sec) (next inflection time) TSTEP (sec) (last inflection time) DELTAT (sec) (time step selected) TIME (sec) (new time)

TABLE XXXIII. PROGRAM COMMENTS (page 1)

Subroutine	Comment	Conditions
GETY	TABLE ____ HAS NO ENTRIES AND CALLED UPON	empty table
GETY	TABLE ____ MINX = _____. EXCEEDED BY ARG _____ Y SET TO _____	off low end of table
GETY	TABLE ____ MAXX = _____ EXCEEDED BY ARG _____. Y SET TO _____	off high end of table
LODFEC	CHANGED R FROM ___ TO ___ FOR INDEX ______	R, G, not compatible
LODFEC	RESET CONSERVED ENERGY TO LOWER LIMIT AT T = __ SEC	R reset lower
LODFEC	RESET CONSERVED ENERGY TO UPPER LIMIT AT T = __ SEC	R reset higher
LODFEC	CHANGED G FROM ___ TO ___ FOR INDEX _____	R, G not compatible
LODFEC	OUTSIDE MONOTOMIC RANGE OF LOADING CURVE FOR INDEX N =	during loading part of cycle $F(t) < F(t - \Delta t)$
ZMAKER	BAD MATRIX. DUMP	determinant of matrix = 0
JITTER	TWO LINEAR JITTER MODES AT T = __________	2 contact friction jitter modes want to jitter at same time (fatal)
LIMIDT	AT TIME = ______ DELTA T = ____ RESET TO ___	some forward contact forces predicted to change by > 1000 1.
LODFEC	NEGATIVE FORCE SET TO ZERO FOR INDEX N = ____ AT TIME = ______	during loading part of cycle $F(t) < 0$; set equal to zero.

TABLE XXXIII. PROGRAM COMMENTS (page 2)

Subroutine	Comment	Conditions
TAUMAK	RESET MODE (_______)TO ZERO	Indicates jitter mode selected
KRUNCH	AT TIME = _____, ANGLE _____ EXCEEDS 360 DEGREES	$\|\theta_1\| > 360°$ (fatal)
KRUNCH	AT TIME = _____, MORE THAN EIGHT ITEMS IN JITTER RUN STOPPED	Space alloted to storage for jitter process would be exceeded (fatal)
FECLOD	AT TIME = _____ FORCE COMING ON FROM BEHIND FOR INDEX ______	fatal
MAIN	ILLEGAL CARD SKIPPED. ____________________	Data card with illegal value or ID column is printed, processing continues.
ZMAKER	LARGE CHANGE IN ACCELERATION AT TIME=_____LOOK FOR PURIOUS FORCE.	Probably a contact circle has slid in behind a contact line.
LODFEC	NEGATIVE PERMANENT DEFORMATION PREDICTED FOR INDEX___	Saturation has occurred and bad value of unloading slope provided.

E. USE OF HSRI MODEL IN COMNET SYSTEM FROM DATA 100 TERMINAL

Preparing the Input Card Deck

When a data set has been produced according to the HSRI two-dimensional model report, it is preceded by the cards described in Table XXXIV and followed by the cards described in Table XXXV. The small letter "b" represents a blank column in these tables.

TABLE XXXIV. CONTROL CARDS APPEARING BEFORE THE DATA DECK

Card No.	Card Contents
1	..bRJSTARTbRGθθXXXX
2	..bLθGθNbXXX,XXX
3	..bJEDbCENTRAL=ALL (if delivered or held for pickup)
	or
	(no card if user waits for output on Data 100)
	or
	..bJEDbθUTPUT=DEFER (if output to be retrieved using Data 100 at a later time)
4	//GXXXXXPPbJθBb(ACCNUB,DEL/BθX,N,TWθDRUN,R), 'yourname',TIME=3,
5	//bbPRTY=m
6	//GθbEXECbPGM=MθDEL2,REGIθN=242K
7	//STEPLIBbDDbDSN=DS.G21601.HSRI2D,DISP=SHR
8	//FT05F001bDDbDDNAME=SYSIN
9	//FT06F001bDDbSYSθUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=3429)
10	//FT09F001bDDbDSNAME=DS.G21601.HθLDIT,DISP=θLD
11	//SYSINbDDb*

TABLE XXXV. CONTROL CARDS APPEARING AFTER THE DATA DECK

Card No.	Card Contents
1	/*
2	..bLΘGΘFF
3	..bRJEND

Card One in Table XXXIV identifies the DATA 100 from which you are working to the COMNET system. Card Two identifies your account for terminal charges. Card Three chooses the output option you desire. Card Four identifies you to the executive system which runs the COMNET computer. The "X's" in cards one, two and four will be provided by COMNET when you have established service with them. The P's represent values which are to be filled in by the user uniquely for this run. ACCNUB is filled in with up to 20 character of accounting break out information (optional). If you have a three character box number and want the output held in the box for pickup the box number is filled in at DEL/BOX. If not fill in DEL or DIS for delivery. Cards five through eleven tell the system where to find the model program and describe its requirements from the system. Card one of Table XXXV marks the end of the data deck.

Card two breaks the connection for your account.

Card three causes the COMNET System to hang up on the terminal.

Using the Data 100 to Put in Prepared Deck

1. Power On - your unit and check to see that the printer forms are aligned correctly, and that there is enough paper.

2. Turn the mode switch to TSM.

3. Press RESET.

4. Press START on the printer.

5. Place card deck in hopper and replace hopper top.

6. Press END OF FILE and TRSP.

7. If equipped with Bell System data set, depress the talk button and wait for dial tone. Dial COMNET number indicated on top of data set. When phone is answered, you will hear a high-pitched tone. Depress the data button on the top of the data set and place the receiver back in the cradle.

8. If equipped with a modem wired through a normal looking telephone set, first see that there is power to the modem unit. Then dial the COMNET number shown on the top of the modem. When phone is answered, you will hear a high-pitched tone. Pull up the white button and place the receiver beside the phone set.

9. When the DATA LINK ACTIVE light comes on, press START. If this light goes out, you have lost connection.

10. See the DATA 100 manual for error procedures and further information.

In order to recover over the data 100 output which has been deferred, use cards one and two of Table XXXIV followed by a card which reads:

..bØUTPUTb*

Run those three cards through, wait until printing is done, and then put in cards two and three of Table XXXV. If you are interrupted during the printout for any reason, you can use the following card to start printing again.

..bCØNTINUE

If you are hung up on, you will of course need to use also the first two cards in Table XXXIV again. If you have trouble getting your job accepted, one of the things you might try is putting in two of card one of Table XXXV instead of one. Be sure to keep changing the PP's on card four so you have an unique combination for each run yo try. Batch mode is the same as data 100 mode except you omit cards one through three in Table XXXIV, you have two of card one in Table XXXV and you omit cards two and three of Table XXXV. Also the "R" in card four of Table XXXIV should be changed to a "B". Contact COMNET Customer Support for further information on control cards.

F. TELETYPE USERS' GUIDE

This section is a technical guide for the user of the two-dimensional crash victim simulator who is familiar with MTS[27] and/or ALPHA and wishes to exercise the model from a teletype terminal remote from The University of Michigan and/or COMNET respectively. The control statements which cause the model to be exercised are described, followed by a description of the use of a conversational program which allows the user easy access to desired portions of the output generated in an exercise of the model.

Using the MTS system, the RUN statement for the two-dimensional crash victim simulator is

$RUN SCGH:2D 5=datafile 9=summary file SPRINT=*PRINT*

The terms "data file" and "summary file" refer to file names which must be supplied by the user. The input data for exercising the program, which has been described in Part IV, Section A of this report is stored in "data file." The output from the program must be stored in a file (referred to here as "summary file") which should be approximately 25 pages in length. This command will cause the model to run the problem specified in the data deck in "datafile" and route the printed output to The University of Michigan Computing Center for printing. If it is not desired to produce the output on paper at The University of Michigan Computing Center, then replace "SPRINT=*PRINT*" with "SPRINT=*DUMMY*".

The corresponding action in ALPHA is brought about by signing on with

userid, password, accountno, name, boxno

and then typing the two commands:

LØA inputdataset

EXE LFAA,LFAB,LFCA,TF3B,TFBA,LSAA,LSAC,LSAB,LFD,ASSEMØ,ABSEMP,SERSEM,

LSB,LØGSEM,GREGIØN=242K,TIME=8,M=3,DD=EXDD,SYSIN=*

The execute command is all on one line. When the job submitted is run, the output will be routed to the COMNET computer center for printing. The data set EXDD should contain one line which says

100 FT09F001 DD DSNAME=DS.G21601.HØLDIT,DISP=ØLD

Because the complete output from one exercise of the program could take up to three hours to print out at a teletype terminal, it is necessary to provide a technique for accessing sections of the output quickly and conveniently. Use of the program which accomplishes this is described in the remainder of this section.

The program can also be used to retrieve information from the output of a previous run. In either case, the summary option must have been used in carrying out the exercise. The file in which the summary information is stored ("summary file") becomes the input file to the teletype output access program.

The program has three sections: "initial," "general," and "complex." The "initial" section enables the user to list any of 54 different input values which were used in carrying out the exercise. The "general" section, allows the user to list any of 61 different output variables over any time period. The "complex" section enables the user to make comparisons. When one variable reaches a critical value, the values of other variables can be determined.

The model is designed to be conversational with the user. However, the user is given the option of putting his instructions in a file.

The following commands will trigger execution of the program using MTS,

$RUN SCD4:TALK2 1 = summary file

or, if no conversation with the program is desired:

$RUN SP78:TALK2 1 = summary file 7 = *DUMMY* 4 = instruction file

The program will begin with

ENTER 6 IF CONVERSATIONAL, 7 IF NOT

If a 7 is entered, the program will proceed to get the rest of its information from the file specified on logical unit 4. If the end of this file is reached and the program has not been terminat d, the program will return to conversational mode. If a 6 is entered, the program will proceed to prompt the user for instructions beginning with:

ENTER 1 IF INITIAL, 2 IF GENERAL, 3 IF COMPLEX, 4 IF DONE

Entering a 1, 2, or 3 will cause the program to go to the indicated section—each of which is described below, and a 4 will result in termination of the program.

In using the "initial" section of the teletype output access program, the user is prompted by the following:

1 ENTER VARIABLE NUMBER - 0 IF DONE

( )

2 ( )

3 ENTER OCCUPANT POSITION NUMBER

Statement 1 indicates that the user should enter a number. The entry of a number from 1 to 54 results in the value of the corresponding input constant (as described in Tables XXXVI and XXXVII) being printed. Then, the user is prompted for another number by a pair of parenthesis only. This process can be discontinued at any time by entering a 0.

The first time that 4, 13, or 39 is entered, the user will be prompted with statement 3. A 1, 2, or 3 must be entered, corresponding to driver, front seat passenger or rear seat passenger. (This information is used only to make the titles more descriptive and does not change any of the numerical results.)

In using the "general" section of the teletype output access program, the user is prompted by the following:

1. HOW MANY VARIABLES
2. ENTER TIME INTERVAL

   FROM (   )(   )(   )
3. ENTER TIME INTERVAL

   FROM (   ) to (   )
4. ENTER OCCUPANT POSITION NUMBER
5. ENTER VALUE OR "PHEAD"
6. ENTER VALUE OF "CHEST"

Statement 1 wants to know how many variables the user is interested in seeing. This number can be from 1 to 4. Statement 2 asks for the appropriate number of variable numbers. These numbers range from 1 to 61 and correspond to the variables as listed in Tables XXXVIII and XXXIX. If a 50 or 55 is entered, statement 4 will ask for the occupant position number. Enter 1 if driver, 2 if front seat passenger, or 3 if rear seat passenger. If a 44 or 45 is entered, statement 5 will ask for a value of "PHEAD." This is the distance from the neck joint to the location of the head accelerometer. If a 46 or 47 is entered for a variable number, statement 6 will ask for the value of "PCHEST." This is the location of the chest accelerometer. After the variable numbers have been recorded, a time interval must be specified. A carriage return will result in initial values being printed. Any other time period must be specified in the appropriate spaces. (NOTE: If a contact that does not occur is asked for, the comment CONTACT NUMBER XX NEVER OCCURRED will be printed and the corresponding heading will be meaningless.)

In using the "complex" section of the teletype output access program, the user is prompted by the following:

1. ENTER DECISION VARIABLE
2. ENTER COMPARISON VALUE
3. ENTER COMPARISON MODE - 1 if GT, 2 if LT
4. HOW MANY VARIABLES?
5. ENTER VARIABLE NUMBERS
( )( )( )
6. ENTER TIME INTERVAL
FROM ( ) to ( )
7. ENTER OCCUPANT POSITION NUMBER
8. ENTER VALUE OF "PHEAD"
9. ENTER VALUE OF "PCHEST"

This section prints the values of variables at the time when another variable reaches a critical value. Any of the variables listed in Tables XXXVIII and XXXIX can be observed in this manner. For example, the user interested in the position of the head when it hits the windshield would make the following entries.

1.	56	(head on windshield is the decision variable)
2.	0	(0 is the critical value—we become interested when the force becomes greater than 0 (hence the 1).)

3. 1

4. 2 (NOTE: maximum is 3)

5. (39) (40)

6. (0.) to (2.0) (Normally the time interval should cover the entire run, although some variables reach the critical point several times during the run and the time interval must be carefully chosen if you are not interested in the first occurence.)

The user will be prompted by statements 7, 8, and 9 only in certain instances as described in a previous section.

The output of this section consists of the time at which the critical value was exceeded, along with the value of the decision variable and the other variables at that time.

TABLE XXXVI. INPUT CONSTANTS (NUMERICAL ORDER) (page 1)

Number	Description	
1	Floor-X	
2	Seat Back-X	
3	Roof-X	
4	Upper Steering Wheel-X Upper Panel-X Front Seat Back-X	(When NPASGR=1) (When NPASGR=2) (When NPASGR=3)
5	Windshield-X	
6	Lower Steering Wheel-X	
7	Lower Panel-X	
8	Steering Column-X	
9	Toeboard-X	
10	Floor-Y	
11	Seat Back-Y	
12	Roof-Y	
13	Upper Steering Wheel-Y Upper Panel-Y Front Seat Back-Y	(When NPASGR=1) (When NPASGR=2) (When NPASGR=3)
14	Windshield-Y	
15	Lower Steering Wheel-Y	
16	Lower Panel-Y	
17	Steering Column-Y	
18	Toeboard-Y	
19	Hip Contact Arc Radius	
20	Upper Torso Contact Arc Radius	
21	Head Contact Arc Radius	
22	Elbow Contact Arc Radius	
23	Hand Contact Arc Radius	
24	Knee Contact Arc Radius	
25	Foot Contact Arc Radius	
26	To Chest Center of Curvature	

TABLE XXXVI. INPUT CONSTANTS (NUMERICAL ORDER) (page 2)

Number	Description	
27	To Head Center of Curvature	
28	Lower Torso Length	
29	Center Torso Length	
30	Upper Torso Length	
31	Center Torso to Upper Arm	
32	Upper Arm Length	
33	Lower Arm Length	
34	Upper Leg Length	
35	Lower Leg Length	
36	Floor-Length	
37	Seat Back-Length	
38	Roof-Length	
39	Upper Steering Wheel-Length Upper Panel-Length Front Seat Back-Length	(When NPASGR=1) (When NPASGR=2) (When NPASGR=3)
40	Windshield-Length	
41	Lower Steering Wheel-Length	
42	Lower Panel-Length	
43	Steering Column-Length	
44	Toeboard-Length	
45	Distance From Hip to Seat Front	
46	Number of Belt Segments	
47	Lower Torso-Center of Gravity to Lower Joint	
48	Center Torso-Center of Gravity to Lower Joint	
49	Upper Torso-Center of Gravity to Lower Joint	
50	Head-Center of Gravity to Lower Joint	
51	Upper Arm-Center of Gravity to Lower Joint	
52	Lower Arm-Center of Gravity to Lower Joint	
53	Upper Leg-Center of Gravity to Lower Joint	
54	Lower Leg-Center of Gravity to Lower Joint	

TABLE XXXVII. INPUT CONSTANTS (ALPHABET`AL ORDER) (page 1)

Number	Description	
39	Back of Front Seat-Length	(When NPASGR=3)
4	Back of Front Seat-X	(When NPASGR=3)
13	Back of Front Seat-Y	(When NPASGR=3)
26	Chest Center of Curvature (Distance to)	
48	Center Torso-Center of Gravity to Lower Joint	
29	Center Torso-Length	
31	Center Torso to Upper Arm (Distance from)	
22	Elbow Contact Arc Radius	
36	Floor-Length	
1	Floor-X	
10	Floor-Y	
25	Foot Contact Arc Radius	
23	Hand Contact Arc Radius	
27	Head Center of Curvature (Distance to)	
50	Head-Center of Gravity to Lower Joint	
21	Head Contact Arc Radius	
19	Hip Contact Arc Radius	
45	Hip to Seat Front (Distance from)	
24	Knee Contact Arc Radius	
52	Lower Arm-Center of Gravity to Lower Joint	
33	Lower Arm Length	
54	Lower Leg-Center of Gravity to Lower Joint	
35	Lower Leg-Length	
42	Lower Panel-Length	
7	Lower Panel-X	
16	Lower Panel-Y	
41	Lower Steering Wheel-Length	
6	Lower Steering Wheel-X	
15	Lower Steering Wheel-Y	

TABLE XXXVII. INPUT CONSTANTS (ALPHABETICAL ORDER) (page 2)

Number	Description	
4[illegible]	Lower Torso-Center of Gravity to Lower Joint	
28	Lower Torso-Length	
46	Number of Seat Belt Segments	
38	Roof-Length	
3	Roof-X	
12	Roof-Y	
37	Seat Back-Length	
2	Seat Back-X	
11	Seat Back-Y	
43	Steering Column-Length	
8	Steering Column-X	
17	Steering Column-Y	
44	Toeboard-X	
18	Toeboard-Y	
51	Upper Arm-Center of Gravity to Lower Joint	
32	Upper Arm-Length	
53	Upper Leg-Center of Gravity to Lower Joint	
34	Upper Leg-Length	
39	Upper Panel-Length	(When NPASGR=2)
4	Upper Panel-X	(When NPASGR=2)
13	Upper Panel-Y	(When NPASGR=2)
39	Upper Steering Wheel-Length	(When NPASGR=1)
4	Upper Steering Wheel-X	(When NPASGR=1)
13	Upper Steering Wheel-Y	(When NPASGR=1)
49	Upper Torso-Center of Gravity to Lower Joint	
20	Upper Torso Contact Arc Radius	
30	Upper Torso Length	
40	Windshield-Length	
5	Windshield-X	
14	Windshield-Y	

TABLE XXXVIII. VARIABLES (IN NUMERICAL ORDER) (page 1)

Number	Description		
1	Body Angles	Lower Torso	Position
2	Body Angles	Center Torso	Position
3	Body Angles	Upper Torso	Position
4	Body Angles	Head	Position
5	Body Angles	Upper Arm	Position
6	Body Angles	Lower Arm	Position
7	Body Angles	Upper Leg	Position
8	Body Angles	Lower Leg	Position
9	Body Angles	Lower Torso	Velocity
10	Body Angles	Center Torso	Velocity
11	Body Angles	Upper Torso	Velocity
12	Body Angles	Head	Velocity
13	Body Angles	Upper Arm	Velocity
14	Body Angles	Lower Arm	Velocity
15	Body Angles	Upper Leg	Velocity
16	Body Angles	Lower Leg	Velocity
17	Body Angles	Lower Torso	Acceleration
18	Body Angles	Center Torso	Acceleration
19	Body Angles	Upper Torso	Acceleration
20	Body Angles	Head	Acceleration
21	Body Angles	Upper Arm	Acceleration
22	Body Angles	Lower Arm	Acceleration
23	Body Angles	Upper Leg	Acceleration
24	Body Angles	Lower Leg	Acceleration
25	Body Motion	Horizontal	Position
26	Body Motion	Horizontal	Velocity
27	Body Motion	Horizontal	Acceleration
28	Body Motion	Vertical	Position
29	Body Motion	Vertical	Velocity

TABLE XXXVIII. VARIABLES (IN NUMERICAL ORDER) (page 2)

Number	Description		
30	Vehicle	Motion	Velocity
31	Vehicle	Motion	Velocity
32	Vehicle	Motion	Velocity
33	Vehicle	Motion	Acceleration
34	Belt Forces	Lap Belt	Shoulder
35	Belt Forces	Lower	Shoulder
36	Belt Forces	Upper	Shoulder
37	Seat Forces	Hip	
38	Seat Forces	Front Edge	
39	Relative Head	Position	Horizontal
40	Relative Head	Position	Vertical
41	Belt Angles	Lap Belt	
42	Belt Angles	Lower	Shoulder
43	Belt Angles	Upper	Shoulder
44	Accelerometer	Head	Resultant
45	Accelerometer	Head	Angle
46	Accelerometer	Chest	Resultant
47	Accelerometer	Chest	Angle
48	Hip on Seat Back		
49	Upper Torso on Seat Back		
50	Upper Torso on Upper Steering Wheel Upper Torso on Upper Panel Upper Torso on Front Seat Back		(When NPASGR=1) (When NPASGR=2) (When NPASGR=3)
51	Upper Torso on Lower Steering Wheel		
52	Upper Torso on Steering Column		
53	Head on Seat Back		
54	Head on Roof		
55	Head on Upper Steering Wheel Head on Upper Panel Head on Front Seat Back		(Wehn NPASGR=1) (When PNASGR=2) (When NPASGR=3)

TABLE XXXVIII. VARIABLES (IN NUMERICAL ORDER) (page 3)

Number	Description
56	Head on Windshield
57	Head on Lower Steering Wheel
58	Elbow on Seat Back
59	Knee on Lower Panel
60	Foot on Floor
61	Foot on Toeboard

TABLE XXXIX. VARIABLES (IN ALPHABETICAL ORDER) (page 1)

Number	Description		
47	Accelerometer	Chest	Angle
46	Accelerometer	Chest	Resultant
45	Accelerometer	Head	Angle
44	Accelerometer	Head	Resultant
41	Belt Angles	Lap Belt	
42	Belt Angles	Lower	Shoulder
43	Belt Angles	Upper	Shoulder
34	Belt Forces	Lap Belt	
35	Belt Forces	Lower	Shoulder
36	Belt Forces	Upper	Shoulder
18	Body Angles	Center Torso	Acceleration
2	Body Angles	Center Torso	Position
10	Body Angles	Center Torso	Velocity
20	Body Angles	Head	Acceleration
4	Body Angles	Head	Position
12	Body Angles	Head	Velocity
22	Body Angles	Lower Arm	Acceleration
6	Body Angles	Lower Arm	Position
14	Body Angles	Lower Arm	Velocity
24	Body Angles	Lower Leg	Acceleration
8	Body Angles	Lower Leg	Position
16	Body Angles	Lower Leg	Velocity
17	Body Angles	Lower Torso	Acceleration
1	Body Angles	Lower Torso	Position
9	Body Angles	Lower Torso	Velocity
21	Body Angles	Upper Arm	Acceleration
5	Body Angles	Upper Arm	Position
13	Body Angles	Upper Arm	Velocity
23	Body Angles	Upper Leg	Acceleration

TABLE XXXIX. VARIABLES (IN ALPHABETICAL ORDER) (page 2)

Number	Description		
7	Body Angles	Upper Leg	Position
15	Body Angles	Upper Leg	Velocity
19	Body Angles	Upper Torso	Acceleration
3	Body Angles	Upper Torso	Position
11	Body Angles	Upper Torso	Velocity
27	Body Motion	Horizontal	Acceleration
25	Body Motion	Horizontal	Position
26	Body Motion	Horizontal	Velocity
30	Body Motion	Vertical	Acceleration
28	Body Motion	Vertical	Position
29	Body Motion	Vertical	Velocity
58	Elbow	On	Seat Back
60	Foot	On	Floor
61	Foot	On	Toeboard
55	Head	On	Front Seat Back (3)
57	Head	On	Lower Steering Wheel
54	Head	On	Roof
53	Head	On	Seat Back
55	Head	On	Upper Panel (2)
55	Head	On	Upper Steering Wheel (1)
56	Head	On	Windshield
48	Hip	On	Seat Back
59	Knee	On	Lower Panel
39	Relative Head	Position	Horizontal
40	Relative Head	Position	Vertical
37	Seat Forces	Hip	
38	Seat Forces	Front Edge	
50	Upper Torso	On	Front Seat Back (3)
51	Upper Torso	On	Lower Steering Wheel

TABLE XXXIX. VARIABLES (IN ALPHABETICAL ORDER) (page 3)

Number	Description		
49	Upper Torso	On	Seat Back
52	Upper Torso	On	Steering Column
50	Upper Torso	On	Upper Panel (2)
50	Upper Torso	On	Upper Steering Wheel (1)
33	Vehicle	Motion	Acceleration
31	Vehicle	Motion	Position
32	Vehicle	Motion	Velocity

V. PROGRAM OPERATION AND DESCRIPTION

Figure 43 is a flowchart for the computer program. Initially data is read, constants computed, and the problem initialized to zero where necessary. The cart acceleration and the level of output printing are then ascertained from the data. Acceleration components due to inertia, continuous joint reactions and external forces are computed in subroutine ACCEL. The effective acceleration due to discontinuous forces is then computed and added to the continuous accelerations in subroutines, JITTER and TAUMAK. After the accelerations are finally predicted, standard checking, storing, incrementing and integrating of results are carried out. The program then is run in loop fashion for the required number of print time increments.

Figure 44 shows how the subprograms in the computer implementation fit together in usage. The left margin of the figure contains a numbered list of the subroutines which comprise the program. Across the top is a list of numbers, each representing the subprogram with the same number on the left margin. The figure itself consists of a set of "X"'s at various intersections of rows and columns. An "X" at the mth row and nth columns indicates that subroutine n makes use of subroutine m. The row for a particular subroutine shows all the other subroutines which use it. The column for a particular subroutine also shows all the subroutines which it uses. These subroutines have all been programmed using the Fortran IV Compiler, Level G.

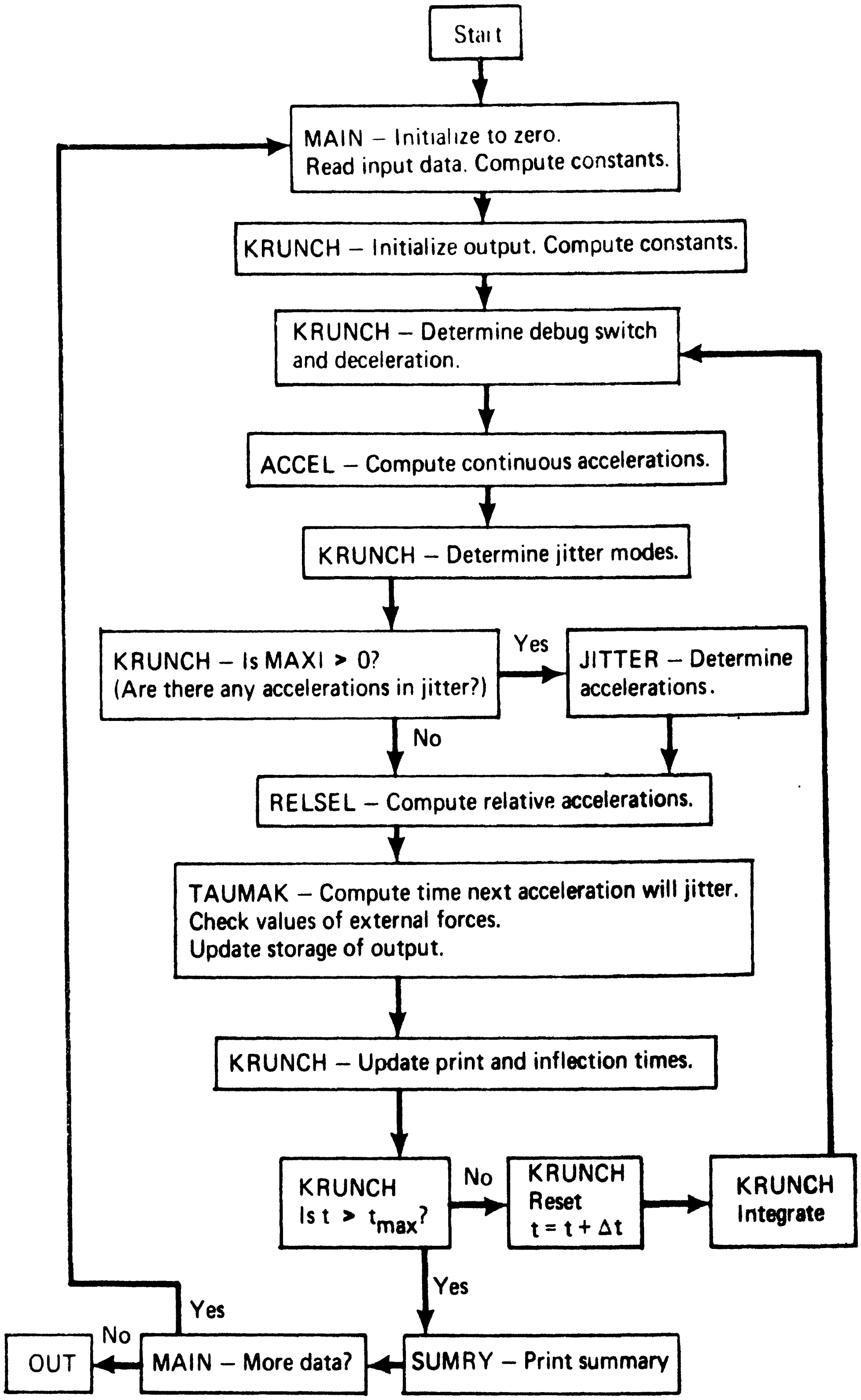


Figure 43. Simplified program flow chart.

Subroutine Number	Called Subroutine	Calling Subroutine 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	26
1	MAIN																								
2	DATE	x																							
3	PAGE 4																							x	x
4	KRUNCH	x																							x
5	GETY				x																				
6	ACCEL				x																				
7	SEAT						x																		
8	BELT						x																		
9	LODFEC								x			x													
10	MULLER									x												x			
11	CONTAC						x																		
12	BODY						x																		
13	ZMAKER						x										x								
14	RELVEL				x												x		x						
15	DELZMK				x																				
16	JITTER				x																				
17	ZKMAKR																								
18	RELSEL				x																				
19	TAUMAK				x																				
20	LIMIDT																			x					
21	FECLOD																				x				
22	NORMUT																			x					
23	SUMARY	x																							
24	ITOPOW																x								
25	ARCSIN	x																							
26	SIPP																							x	
27	STYX																							x	

Figure 44. Usage of program subroutines

Sub-routine code	Sub-routine name	Source of subroutine	Language	Sup-plied with HSRI model	Calling subroutine																																
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	b	c	d	i	j	k	l
a	XDINFO	HSRI conversion package	OS Assembler	Yes																															x	x	x	x
b	XPRINT		OS Assembler	Yes																															x	x	x	x
c	XERCOM		OS Assembler	Yes																															x	x	x	x
d	YPRINT		Fortran IV	Yes																												x	x					
e	ERROR		Fortran IV	Yes				x					x				x			x																		
f	MINV	SSP	Fortran IV	Yes													x																					
g	LAND	MTS logical package	OS Assembler	Yes																	x													x				
h	LOR		OS Assembler	Yes																														x				
i	PLOT1	MTS printer plot package	OS Assembler	Yes																							x				x							
j	PLOT2		OS Assembler	Yes																							x				x							
k	PLOT3		OS Assembler	Yes																							x				x							
l	PLOT4		OS Assembler	Yes																							x				x							
m	SIN	Fortran library	OS Assembler	No	x					x		x			x									x														
n	COS		OS Assembler	No	x					x		x			x									x														
o	ATAN		OS Assembler	No								x																										
p	ATAN2		OS Assembler	No																						x	x											
q	SQRT		OS Assembler	No	x							x		x									x			x	x		x									
r	SIGN		OS Assembler	No															x																			
s	AMAX1		OS Assembler	No	x								x																									
t	AMIN1		OS Assembler	No	x																		x															
u	MAXO		OS Assembler	No					x															x														
v	MINO		OS Assembler	No	x																																	
w	ABS		OS Assembler	No									x	x					x				x	x	x				x									
x	AMOD		OS Assembler	No					x																													

Figure 45. "Library" routines called by program.

A library of additional subroutines obtained from various sources are necessary for exercising the model. These are listed in Figure 45 which is organized in a manner similar to Figure 44. The sources of these subroutines are the Fortran library (IBM), the MTS logical and printer plot packages (University of Michigan), and SSP (IBM). Five additional subroutines (the HSRI conversion package) were developed by the current investigators to adapt the MTS packages for use external to the University of Michigan MTS system. Most of these programs were in OS Assembler language when obtained by the project. When the HSRI Two-Dimensional Crash Victim Simulator is supplied to potential users not operating under MTS, the tape includes all routines included in Figures 44 and 45 with the exception of the Fortran library.

The Fortran library in use at the University of Michigan Computing Center is an old version supplied by IBM. The calculated results presented in Section IV E of this report may vary slightly from those obtained using a more current IBM Fortran library. These variations usually occur in the fifth significant figure of computed quantities and are thus not considered to be physically significant.

The original version of the HSRI Two-Dimensional Crash Victim Simulator was written in Fortran II in 1967. Labeled common blocks were not available at that time so a large master common was used. When the program was converted to Fortran IV in 1969, the old form was retained. As later modifications were made, two labeled common blocks were added as listed in Table XL.

Table XL. Labeled Common Blocks

Name	Used
INJ	SUMARY SIPP
IO	MAIN SUMARY STYX SIPP PAGE4

A. INTEGRATION OF DISCONTINUOUS ACCELERATIONS

In the digital computer simulation, integration is done by mathematical approximation. The usual technique is to base the integration on a polynomial which has been fit through severl ordinates of the integrand. This approach will work well only when the integrand is very much like the polynomial obtained by the curve fitting. If the integrand is continuous, it is possible to find a set of intervals over each of which the integrand "looks" like a polynomial. If, however, the integrand is discontinuous, the discontinuity will remain regardless of the length of the interval within which it is imbedded, so decreasing the interval length is not effective. In this situation, either the integration must be stopped to the discontinuity or the discontinuity removed. For the two-dimensional crash victim simulator, the latter course is adopted.

Discontinuities arise in the model for seat friction force, contact surface friction force, and friction-like forces in the joints. Each of these models has a velocity-dependent component (force, torque, or slope of torque) which assumes a fixed value for all velocities greater than the velocity limit (an input parameter), the negative of the value for all velocities less than the negative of the velocity limit, and zero for the open interval defined by minus and plus values of the velocity limit.

Each instance of these discontinuous models is called a "mode" in the computer program and in the discussion which follows. If a particular mode is in either of the extreme velocity intervals, the mode is said to be "full on." If the mode is in the zero interval, the mode is said to be "full off." When velocity is at the velocity limit or its negative (the points of discontinuity), one of several things can happen, which may be catagorized into one of two general possibilities. Either the mode will pass on through the limit point without mishap to full on or full off in the other direction, or the mode will try to do one of these and be thrown back. In the latter case, the mode is said to be "in jitter." Jitter will often take the form of a rapid alternation of the full on and full off states. This occurs when momentum and other forces drive the mode to full on but the force developed by the mode coming on is large enough to throw the mode back to off. The mode going in turn causes the mode force to go to zero which leaves the momentum and other forces free to drive the mode on again and so on, and on.

The jitter type of phenomenon occurs in reality, for example, as chatter due to backlash in gears. The technique employed in the two-dimensional crash victim simulator to compensate for jitter is based on the observation that a rapid alternation of the on-off states would effectively hold the velocity at the velocity limit. Hence, for a time interval during which a single mode is jittering, the effective body accelerations are computed to be a weighted average of the accelerations computed with the mode turned full off and those computed with the mode turned full on, such that the mode acceleration is made zero, or the mode velocity is the same at the end of the time interval as it was at the beginning.

$$\ddot{\vec{Z}}_{eff} = \ddot{\vec{Z}}_{off} - \bar{a}\,(\ddot{\vec{Z}}_{on} - \ddot{\vec{Z}}_{off})$$

where

$$\bar{a} = \frac{\nu_{off}}{\dot{\nu}_{on} - \dot{\nu}_{off}} \qquad \text{(V.A.1)}$$

$\ddot{\vec{Z}}_{eff}$ is the effective generalized acceleration vector.

$\ddot{\vec{Z}}_{on}$ is the generalized acceleration vector with the mode full on.

$\ddot{\vec{Z}}_{off}$ is the generalized acceleration vector with the mode full off.

$\dot{\nu}_{off}$ is the mode acceleration magnitude with the mode full off.

$\dot{\nu}_{on}$ is the mode acceleration magnitude with the mode full on.

When the mode is infulenced by an outside acceleration (such as vehicle deceleration) applied arbitrarily, the mode acceleration forced to zero may not guarantee that there will be no change in velocity over an interval. Arbitrary accelerations are treated by the two-dimensional crash victim simulator as piecewise linear functions. Those modes which are dependent upon vehicle acceleration, e.g., any interaction of contact surface and contact arc, are termed "coupled" modes and lead to "linear" jitter. Linear jitter requires a different weighted average and also an iteration for resolution.

$$\bar{\varepsilon} = \frac{\dot{v}_{off} - 1/2\, \dot{v}_{on}}{\dot{v}_{on} - \dot{v}_{off}}$$

$$\hat{\tau}_o = \frac{\dot{v}_{on}}{\bar{a} \cos \psi_a} \qquad (V.A.2)$$

where

ψ_a is the orientation angle of the contact surface if a contact surface is involved in the mode. ψ_a is defined zero if no contact surface is involved in the mode, e.g., seat cushion.

$\hat{\tau}_o$ is a computed time interval in which the mode will reach the velocity limit. It is used in the iteration as shown the next page.

For several modes in jitter or "multiple jitter," all possible combinations of the jittering modes in the full on state and the full off state are considered and averages developed by reapplications of the single mode averaging procedure so that all the mode velocities are held constant. Only one linear jitter can be handled at one time and must be processed last in combination with other jittering modes.

If no mode changes state during a time interval, then the generalized accelerations are continuous. If the time interval is kept small enough, the generalized accelerations are nearly constant over the interval and a one point integration scheme can be validly employed.

The grand strategy for integration in the two-dimensional crash victim simulator revolves around maintaining the validity of these two requirements and taking advantage of their consequences. At each time throughout the initial value solution of the equations of motion, an integration time interval is computed that will meet the requirements that the generalized accelerations are continuous and approximately constant. The determination of the time interval is carried out by taking the smallest of the predicted time intervals, after the end of which the requirements will no longer be met due to one or another cause. In particular, the computer program predicts the next time at which any of the modes will change state. If that time is less than the time to which the program would integrate from other considerations (deceleration slope change, print time, etc.), the program integrates to that time and indicates that the mode is jittering. The program always employs the averaging procedure to resolve the questionable accelerations from jittering modes.

The time interval prediction equation (until a change of state) for an uncoupled mode is

$$\tau = \frac{\xi \operatorname{sgn} \eta - \nu}{\dot{\nu}} \qquad \text{(V.A.3)}$$

where

$$\eta = \begin{cases} \nu \text{ for } |\nu| > \xi \text{ and } \operatorname{sgn} \nu \neq \operatorname{sgn} \dot{\nu} \\ \dot{\nu} \text{ for } |\nu| < \xi \end{cases}$$

ξ is the mode velocity limit

ν is the mode velocity

$\dot{\nu}$ is the mode acceleration

Note that if $|\dot{\nu}| = \xi$, then τ is not used since the mode is already known to be jittering. If $|\nu| > \xi$ and $\operatorname{sgn} \nu = \operatorname{sgn} \dot{\nu}$, then τ is infinite since the mode is going away from the velocity limit. The corresponding equation for a coupled mode is

$$\tau = \begin{cases} \dfrac{\dot{\nu}}{a_\nu \cos\psi_a}\left[1 - \sqrt{1 - \dfrac{2(\xi \operatorname{sgn}\eta - \nu)\, a_\nu \cos\psi_a}{\dot{\nu}^2}}\,\right] \\ \hat{\tau}_o \quad \text{for } 1.\ |\nu| > \xi \text{ and } \operatorname{sgn} \nu = \operatorname{sgn} \dot{\nu} \\ \qquad\quad 2.\ |\nu| = \xi \\ \qquad\quad 3.\ \text{arg of radical is negative} \end{cases} \qquad \text{(V.A.4)}$$

where a_ν is the acceleration rate and the other conventions are as previously given. The equation is used in an interative procedure in which it is alternated with the acceleration averaging procedure and recomputation of $\hat{\tau}_o$ until two consecutive values of τ are approximately the same.

B. SUBPROGRAMS DESCRIPTIONS AND FLOW DIAGRAMS

For each of the subprograms which make up the computer implementation of the model a short description together with a flow diagram is presented here. These are in alphabetical order by the subprogram name with the main program ordered as if its name were MAIN. The subroutines included are:

Subroutine ACCEL carries out the following steps:

1. Computes sines and cosines of body angles and other needed variables.

2. Gets seat forces and contributions to the generalized force vector via SEAT.

3. Computes all joint coordinate positions and velocities.

4. Gets belt forces and contributions via BELT.

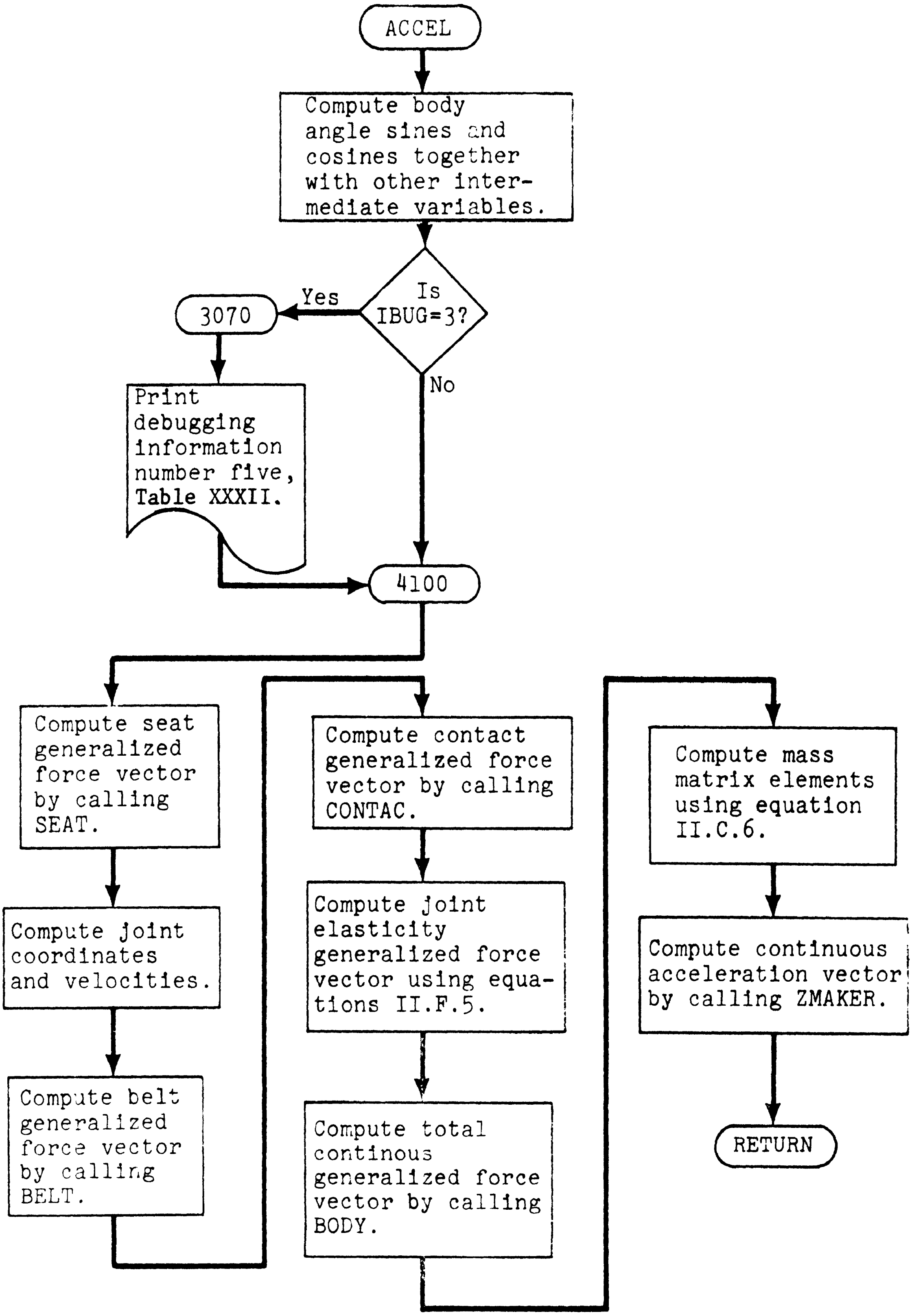
5. Gets contact forces and contributions via CONTAC.

6. Computes joint elasticity torques and contributions.

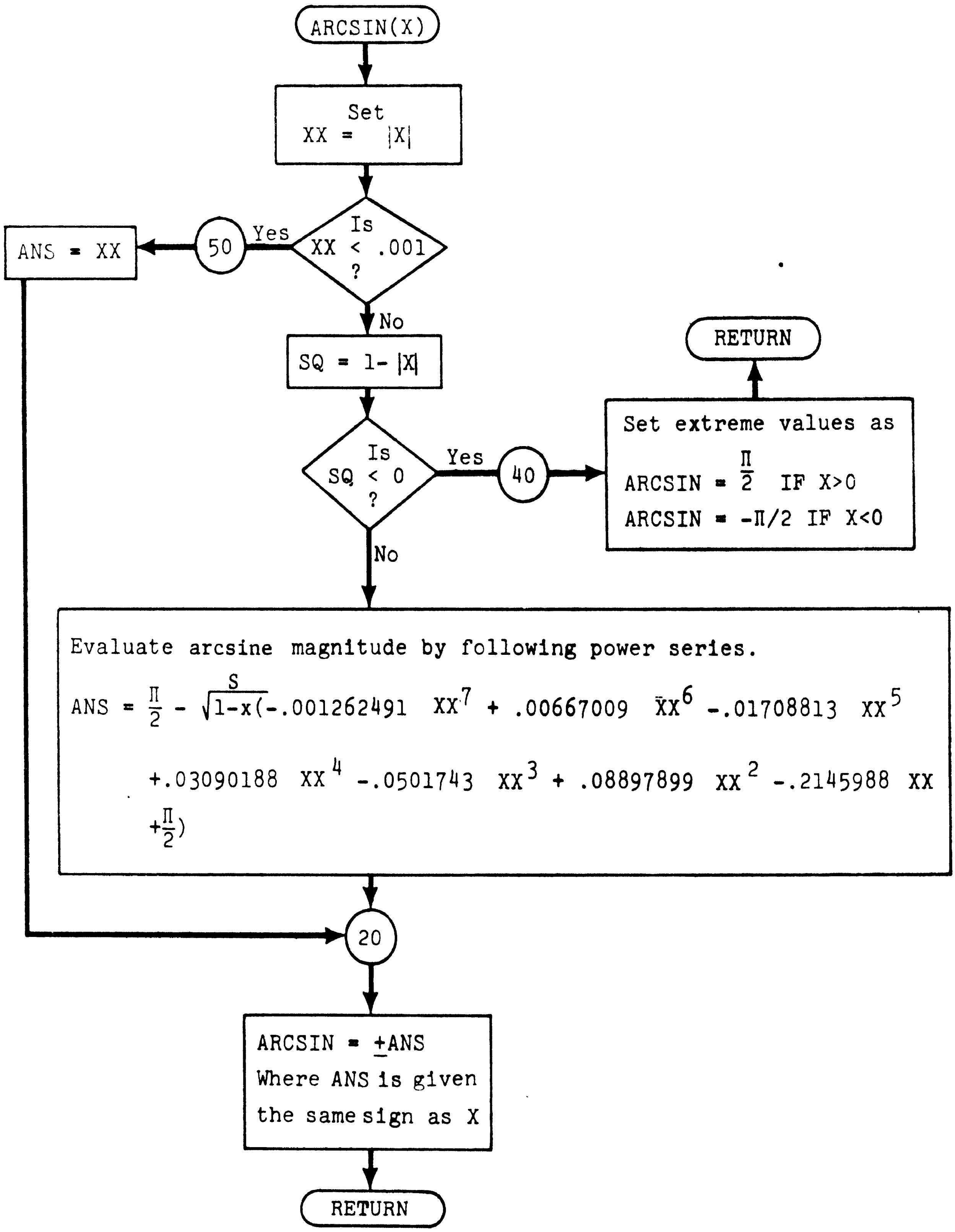
7. Procures generalized force vector from BODY.

8. Computes variable matrix elements.

9. Procures acceleration vector from ZMAKER.


ACCEL
Compute body angle sines and cosines together with other intermediate variables.
Is IBUG=3?
Yes
No
3070
Print debugging information number five, Table XXXII.
4100
Compute seat generalized force vector by calling SEAT.
Compute joint coordinates and velocities.
Compute belt generalized force vector by calling BELT.
Compute contact generalized force vector by calling CONTAC.
Compute joint elasticity generalized force vector using equations II.F.5.
Compute total continous generalized force vector by calling BODY.
Compute mass matrix elements using equation II.C.6.
Compute continuous acceleration vector by calling ZMAKER.
RETURN

Function ARCSIN finds the angle for a given sine value. The argument X is in the range $-1 \leq X \leq 1$ and is the sine of the angle to be computed by this routine.

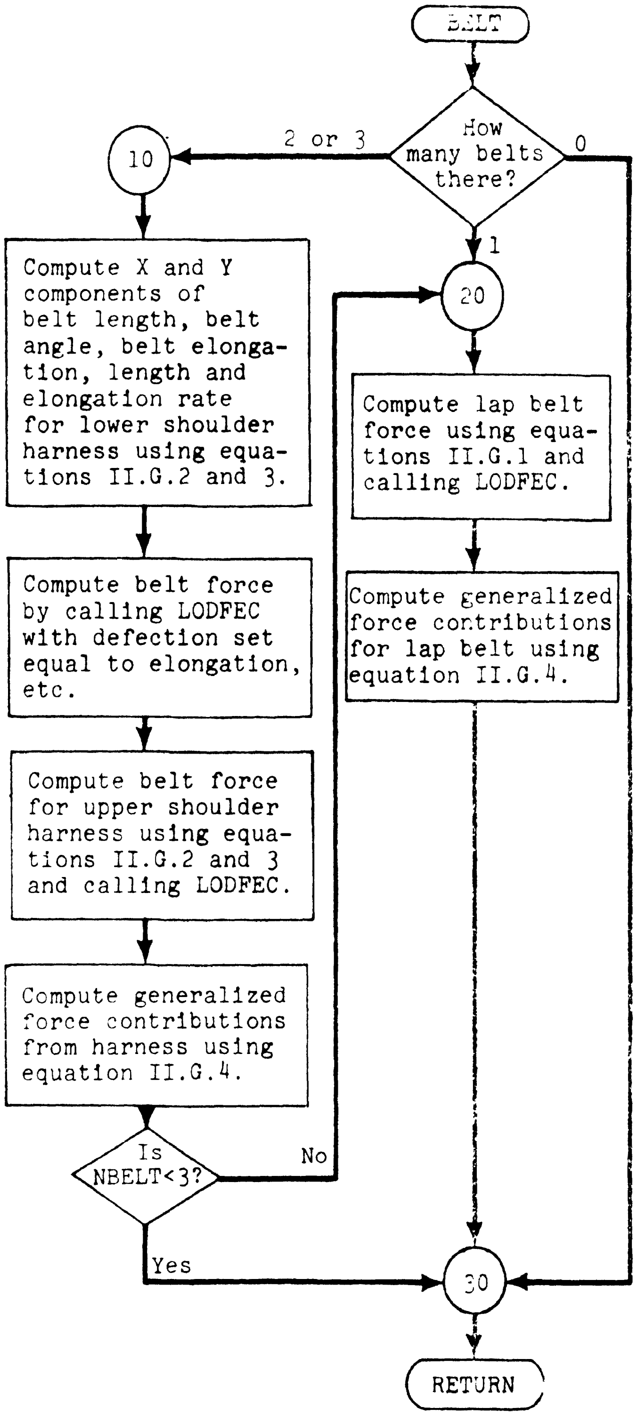


Subroutine BELT carries out the following steps:

1. Computes angle, elongation, and rate for each belt.

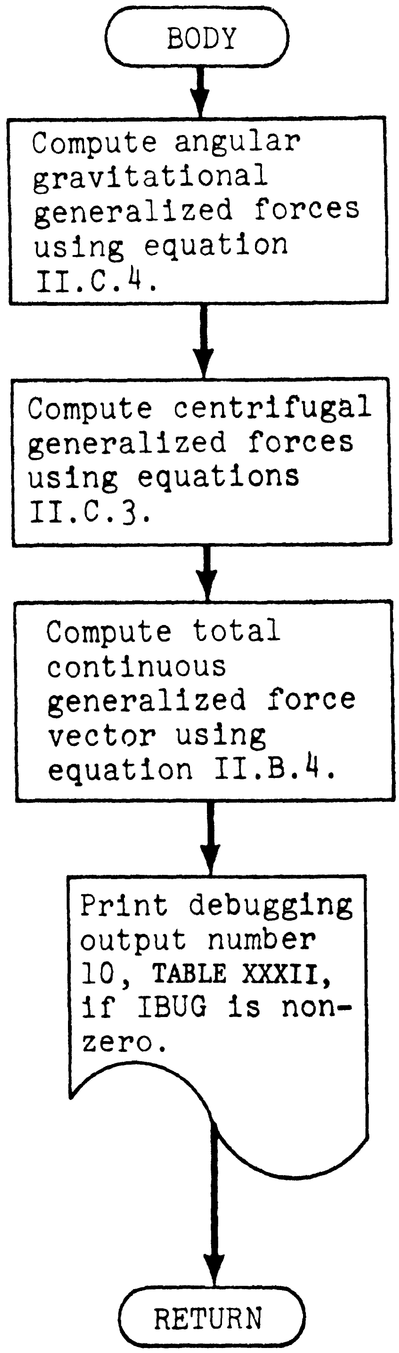
2. Obtains belt force from LODFEC.

3. Computes total belt generalized force vector and adds it to seat total generalized force vector.



Subroutine BODY

Computes generalized force vectors due to gravity and centrifugal force, and combines all five continuous generalized force vectors for total.



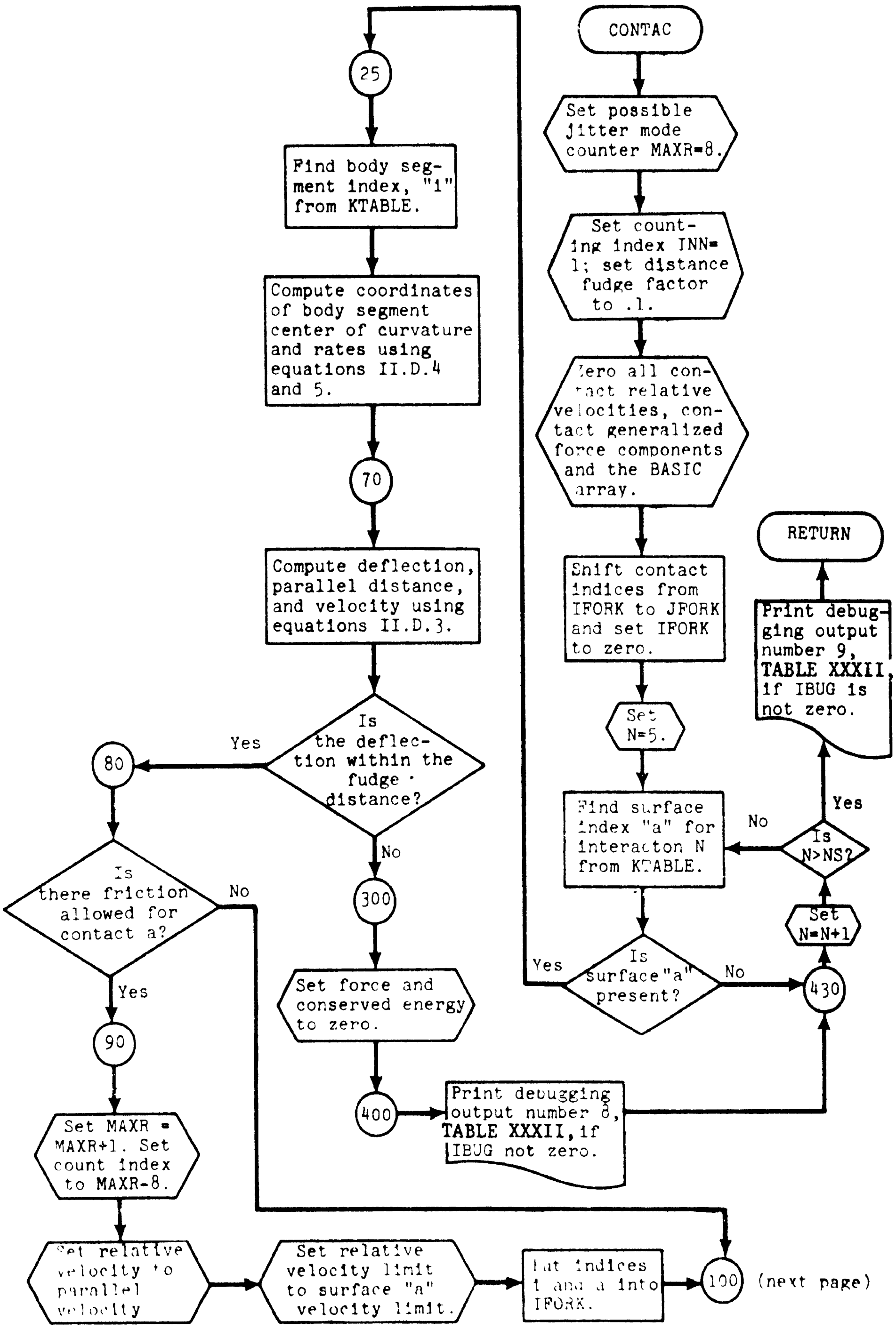
Subroutine CONTAC carries out the following steps

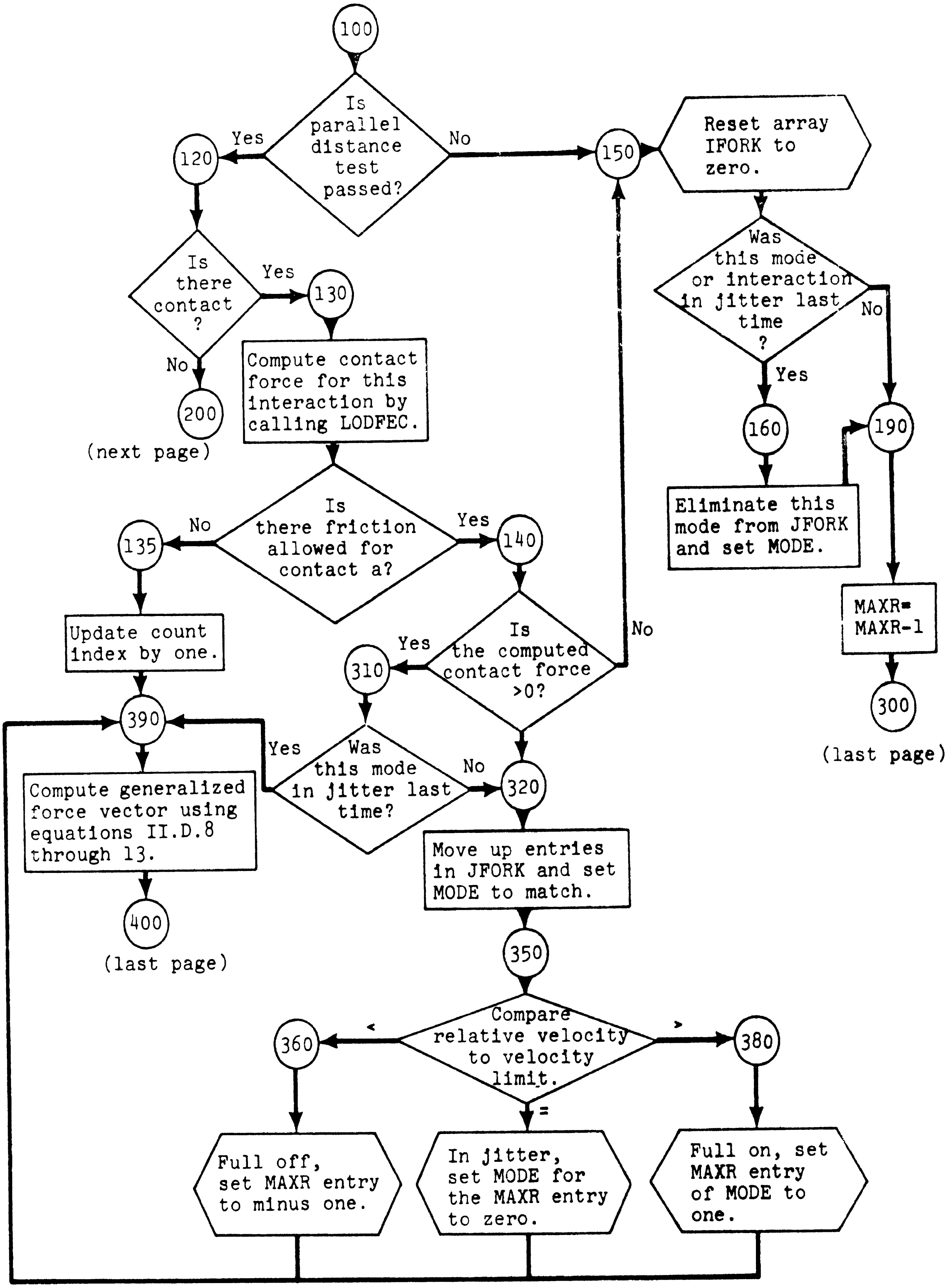
1. Searches table of possible contacts (as set up in MAIN) and determines whether contact exists using coordinates of body segment center of curvature and contact surface reference point.

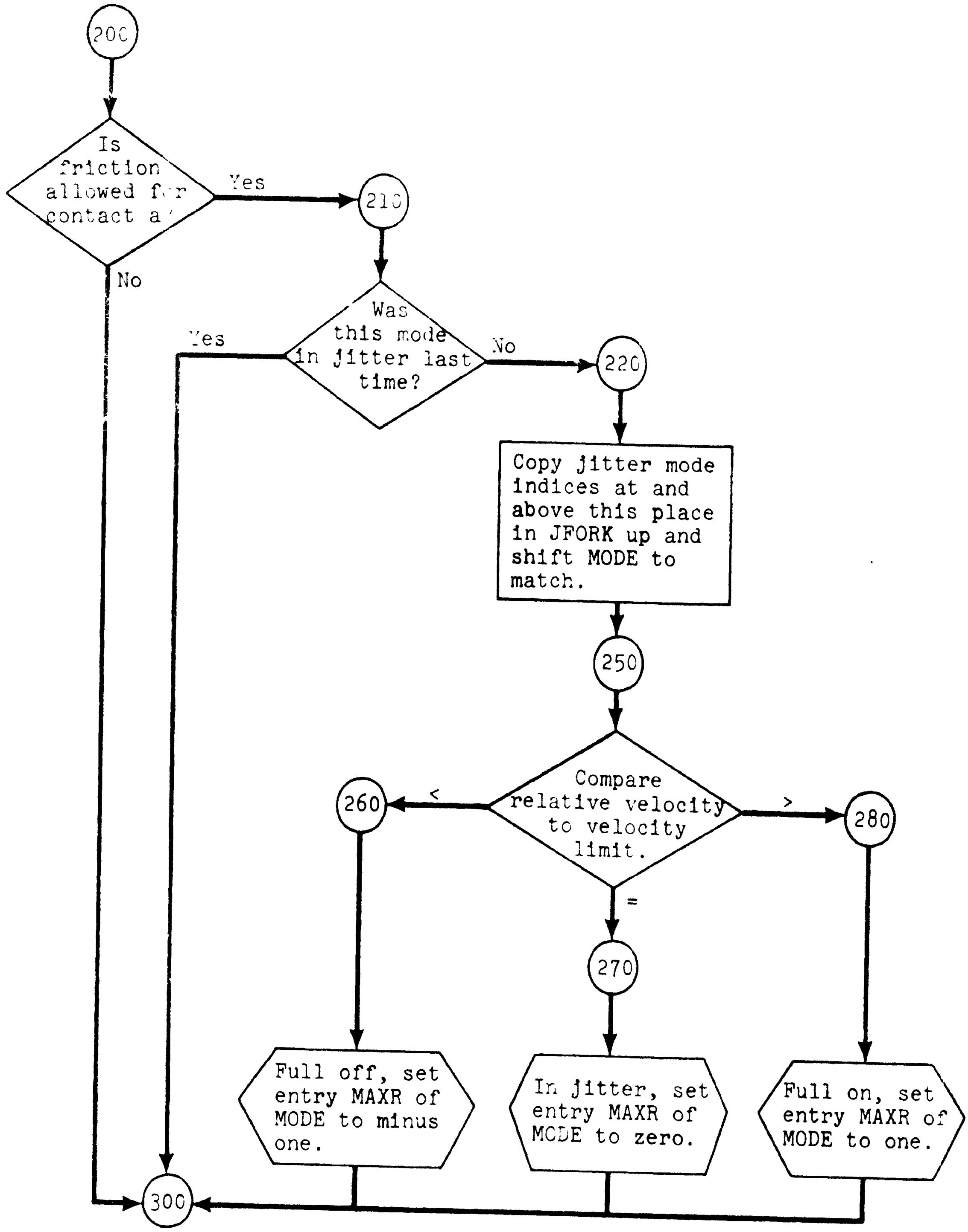
2. Does bookkeeping for linear jitter modes.

3. Obtains contact forces from LODFEC.

4. Computes contribution of contacts to total generalized force vector.

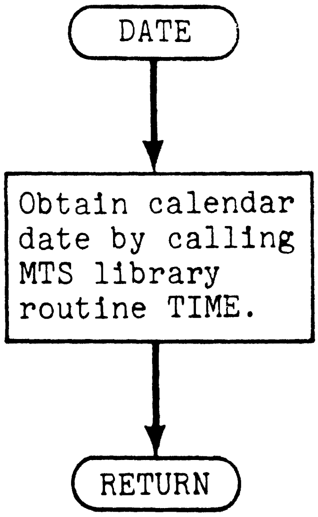



100
Is parallel distance test passed?
Yes
No
120
150
Reset array IFORK to zero.
Is there contact ?
Yes
No
130
200
(next page)
Compute contact force for this interaction by calling LODFEC.
Was this mode or interaction in jitter last time ?
No
Yes
160
190
Eliminate this mode from JFORK and set MODE.
MAXR= MAXR-1
300
(last page)
Is there friction allowed for contact a?
No
Yes
135
140
Update count index by one.
Is the computed contact force >0?
Yes
No
310
390
Was this mode in jitter last time?
Yes
No
320
Compute generalized force vector using equations II.D.8 through 13.
400
(last page)
Move up entries in JFORK and set MODE to match.
350
Compare relative velocity to velocity limit.
<
>
=
360
380
Full off, set MAXR entry to minus one.
In jitter, set MODE for the MAXR entry to zero.
Full on, set MAXR entry of MODE to one.


200
Is friction allowed for contact a?
Yes
No
210
Was this mode in jitter last time?
Yes
No
220
Copy jitter mode indices at and above this place in JFORK up and shift MODE to match.
250
Compare relative velocity to velocity limit.
<
=
>
260
270
280
Full off, set entry MAXR of MODE to minus one.
In jitter, set entry MAXR of MODE to zero.
Full on, set entry MAXR of MODE to one.
300

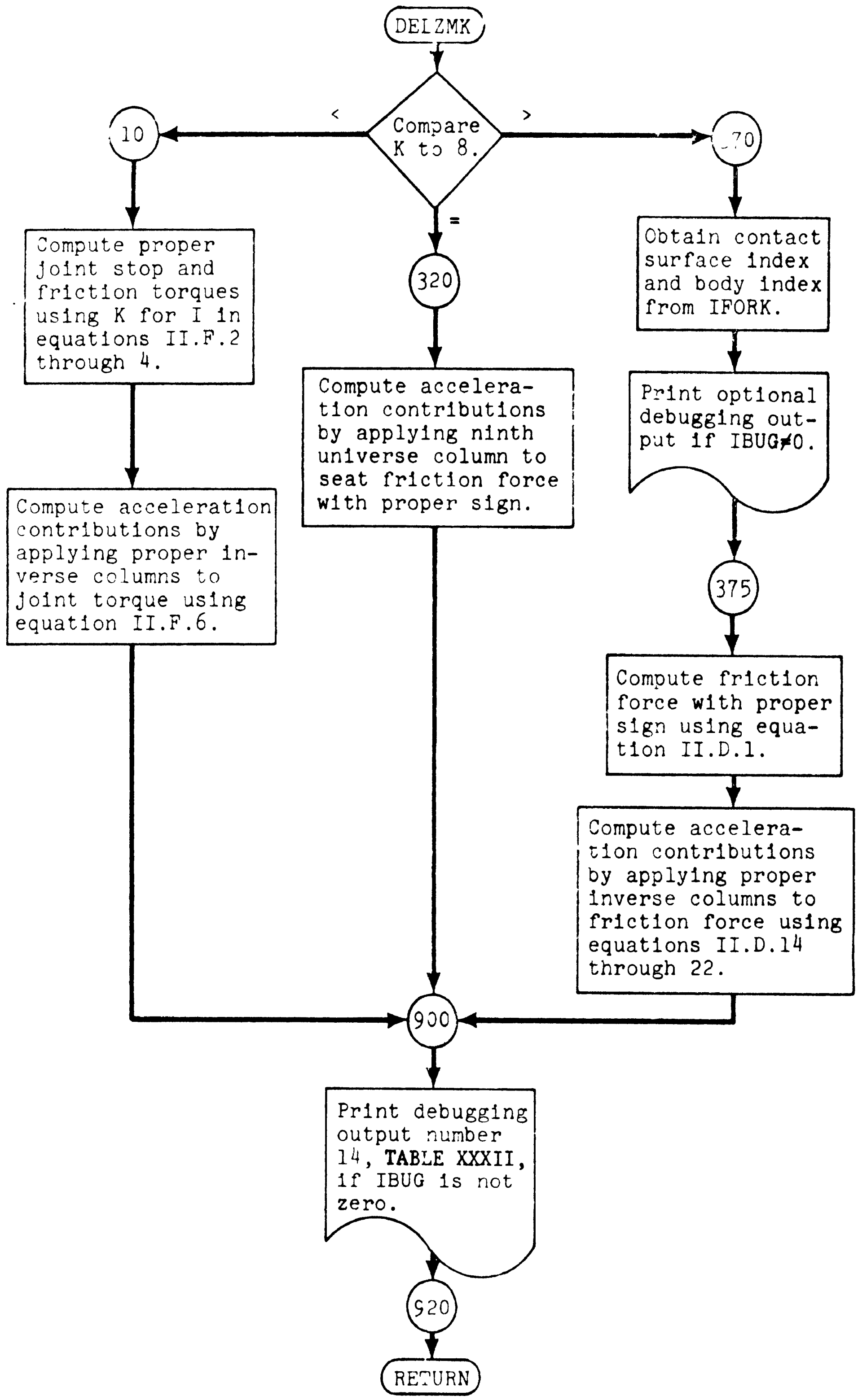
Subroutine DATE

Calls Library routine TIME in MTS system to get date program is being run for print-out identification, or similar routine at other computer facility, or return blank date if similar routine does not exist.

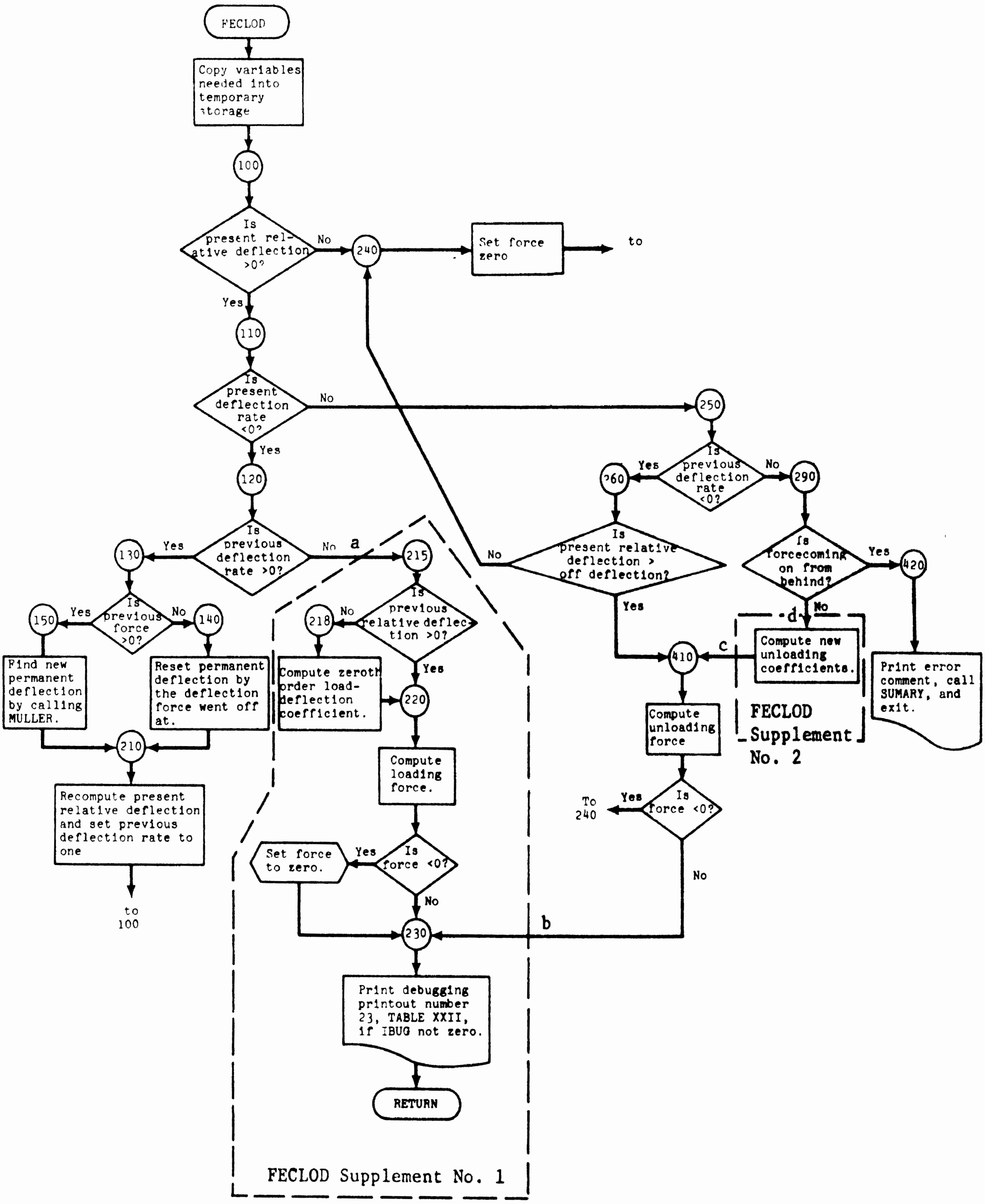


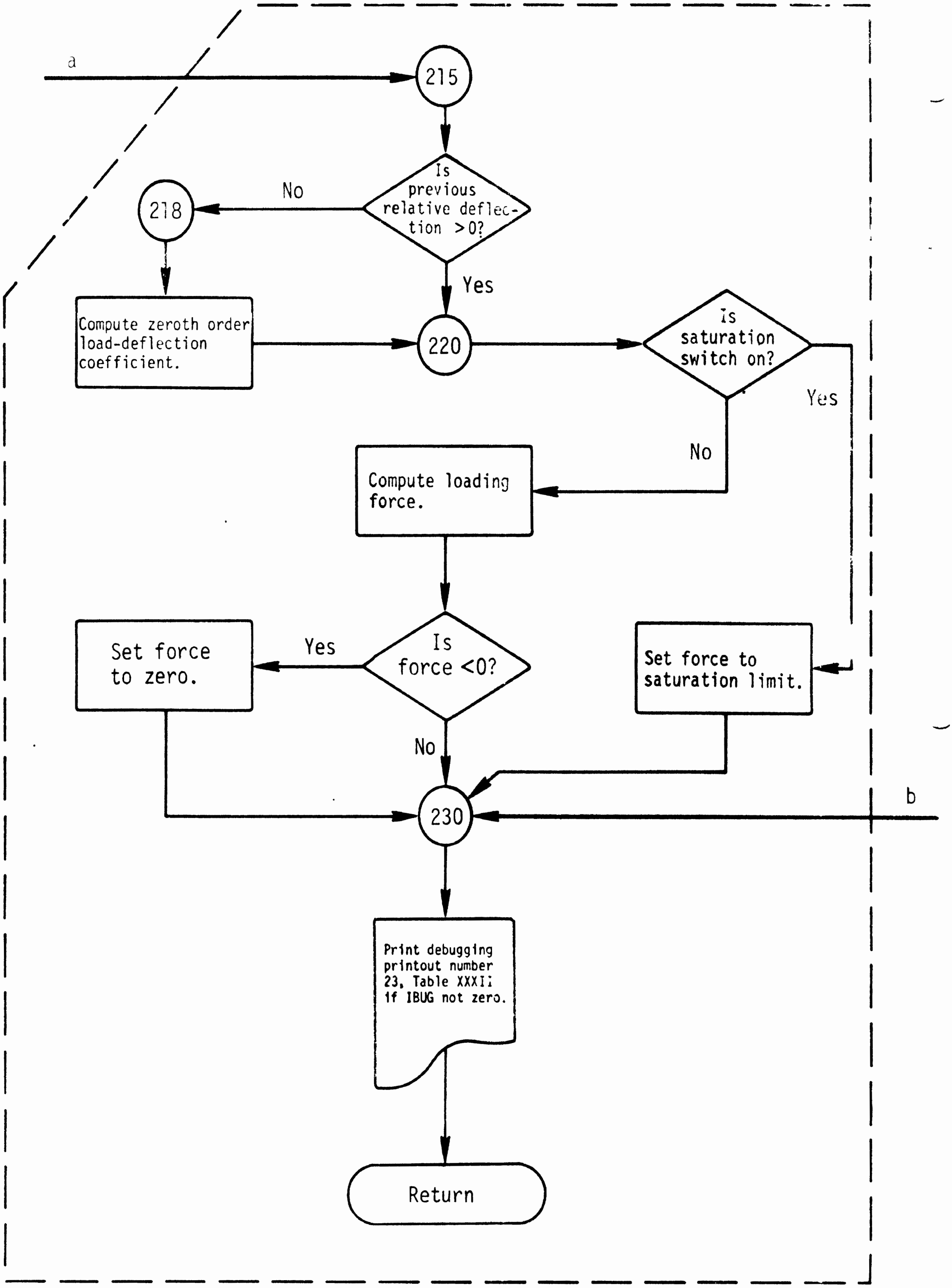
Subroutine DELZMK

Computes contributions to the acceleration vector of joint, seat, and contact friction. The argument K of DELZMK is the mode number for which acceleration contributions are to be computed.

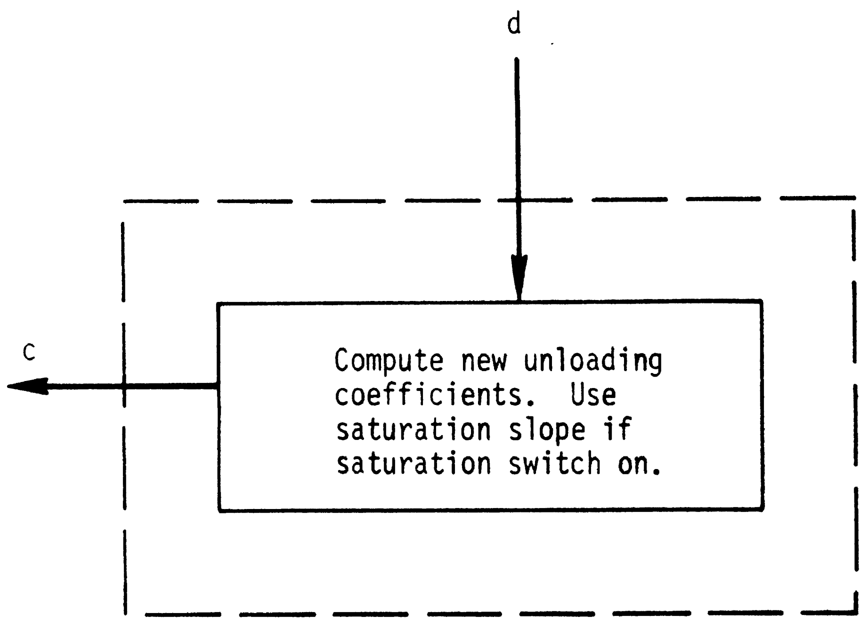


Subroutine FECLOD is used to predict contact and belt forces during the selection a new time step.





FECLOD Supplement No. 1



FECLOD Supplement No. 2

Subroutine GETY

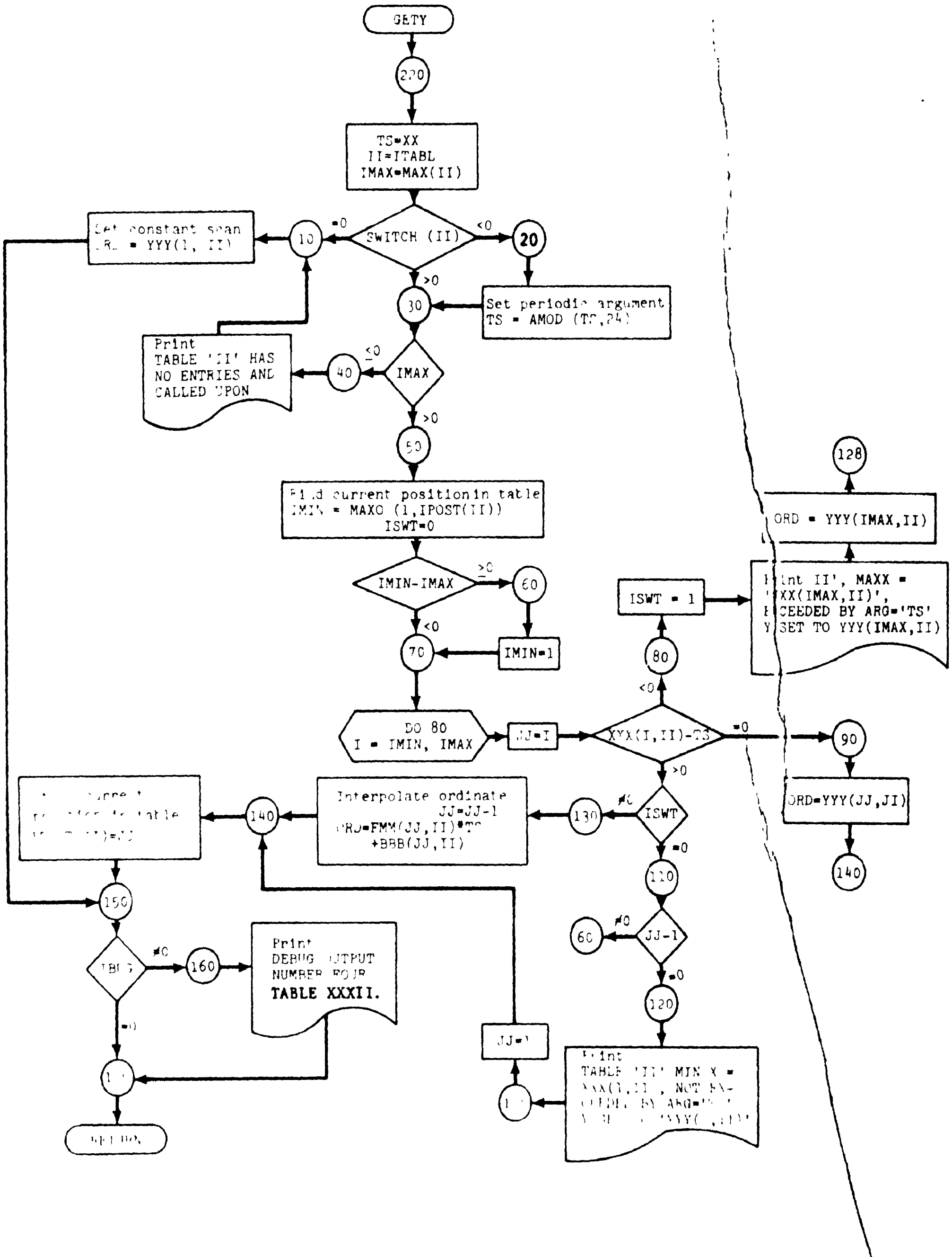
determines the ordinate of piecewise-linear tabular function for a given abcissa.

Arguments are:

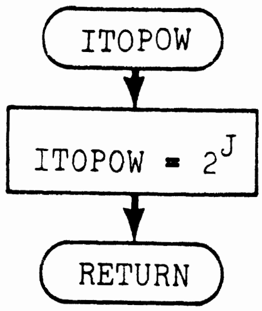
XX = abcissa desired

ITABL = table number, and

ORD = computed ordinate.

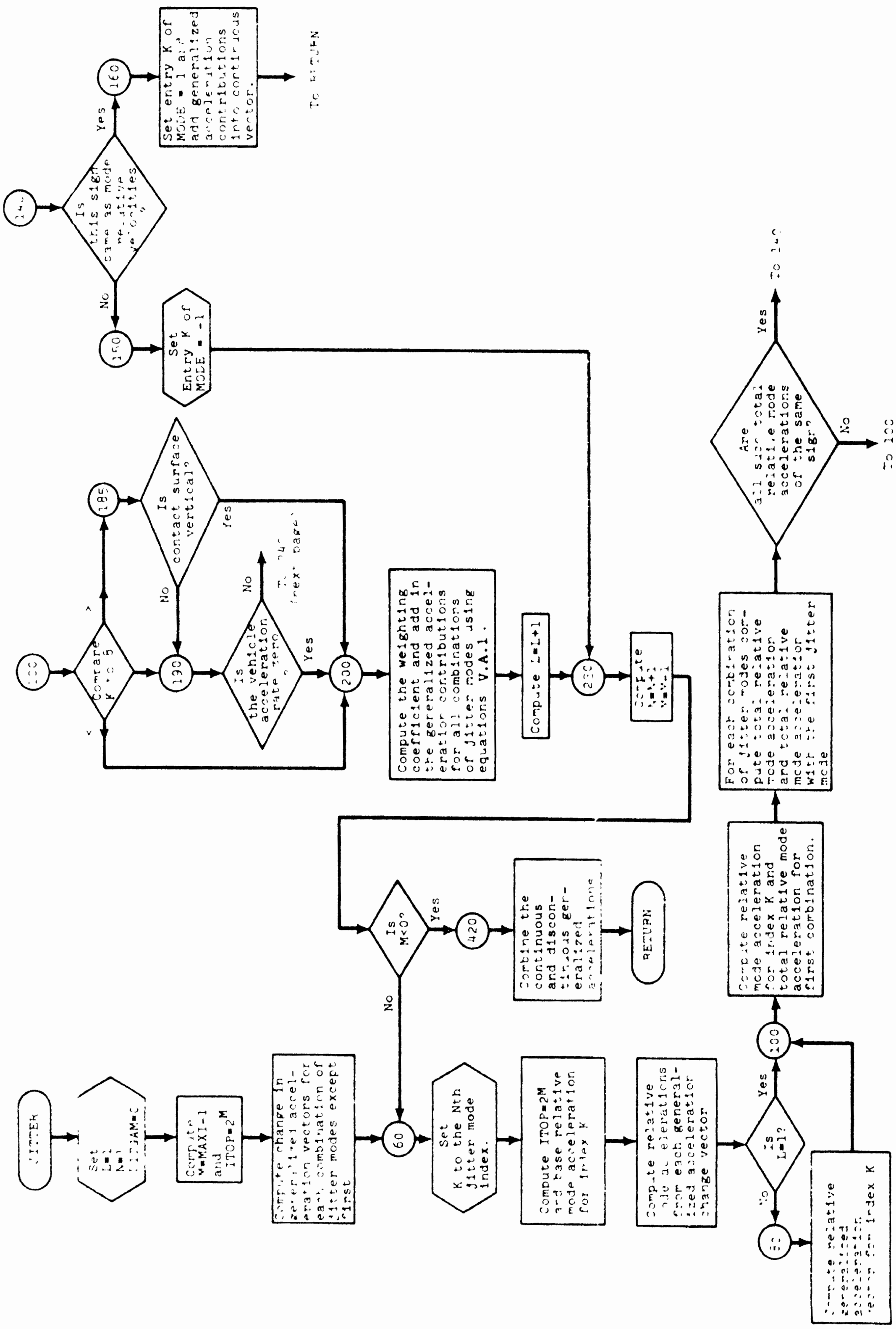


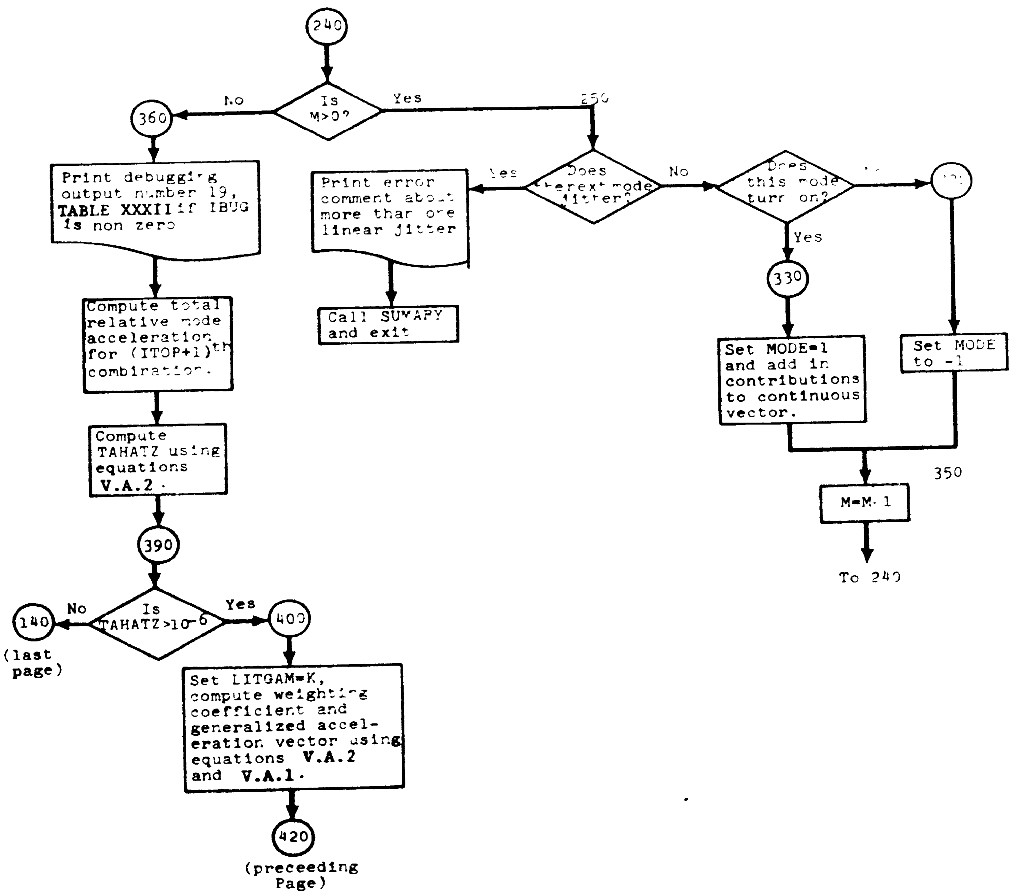
Function ITOPOW raises 2 to an integer power. The argument J is the power of 2 that is desired.



Subroutine JITTER

Computes the effective acceleration vector by combining the continuous acceleration vector with the contribution of frictional forces in the form of discontinuous accelerations using a weighted averaging technique.

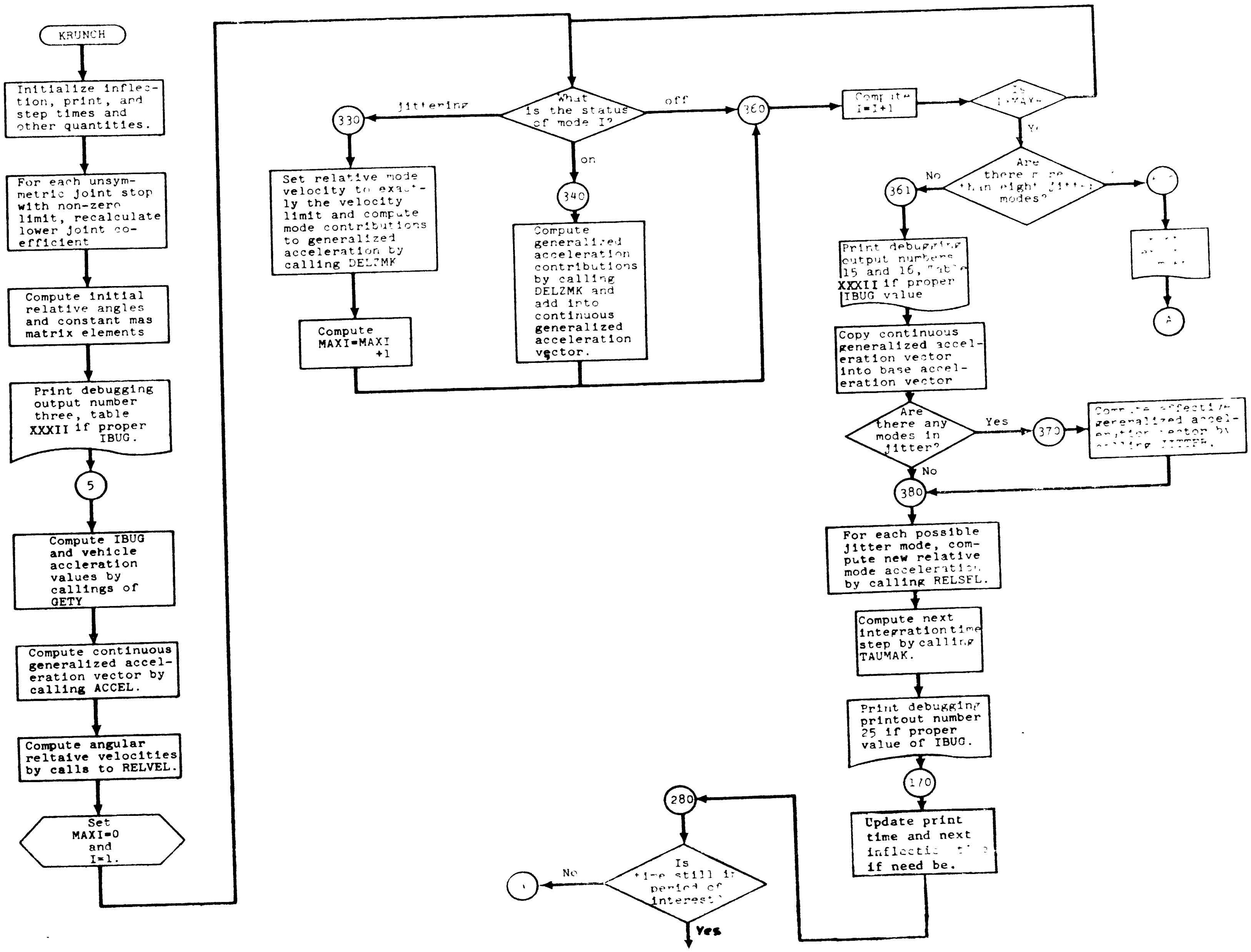




240
Is M>0?
No
Yes
360
Print debugging output number 19, TABLE XXXII if IBUG is non zero
Compute total relative mode acceleration for (ITOP+1)th combination.
Compute TAHATZ using equations V.A.2.
390
Is TAHATZ>10-6
No
140
(last page)
Yes
400
Set LITGAM=K, compute weighting coefficient and generalized acceleration vector using equations V.A.2 and V.A.1.
420
(preceeding Page)
Print error comment about more than one linear jitter
Call SUMARY and exit
No
Yes
330
Set MODE=1 and add in contributions to continuous vector.
Set MODE to -1
350
M=M-1
To 240

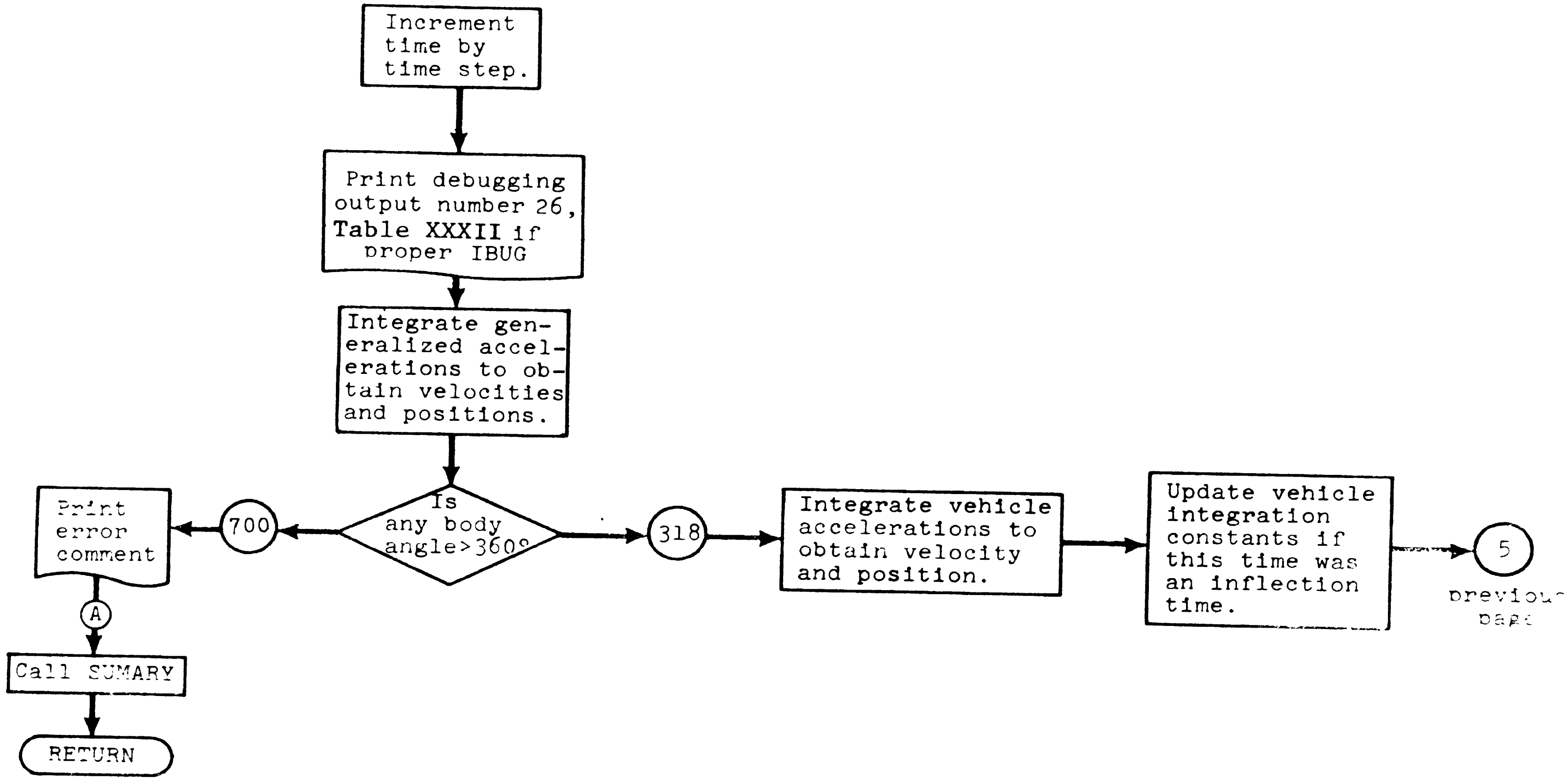
Subroutine KRUNCH carries out the following steps:

1. Initializes variables and parameters.
2. Recomputes joint stop coefficients as needed.
3. Starts time loop by finding debug variable and vehicle acceleration from tables via GETY.
4. Calls ACCEL for body accelerations due to continuous forces.
5. Computes relative velocities between body segments and between the hip and seat cushion.
6. Predicts unstable computational behavior and sets up the means (jitter vector) for compensating for it.
7. Computes the turned on friction forces contributions to the acceleration vector via DELZMK.
8. Checks number of jitter modes.
9. Computes effective acceleration due to jittering, via JITTER.
10. Computes all relative accelerations via RELSEL.
11. Computes next time interval via TAUMAK.
12. Resets print and inflection times as needed.
13. Checks time for end of program: (1) if done, returns to MAIN, and, (2) if not done, updates time and continues.
14. Integrates body variables.
15. Integrates vehicle deceleration.
16. Returns to 3.



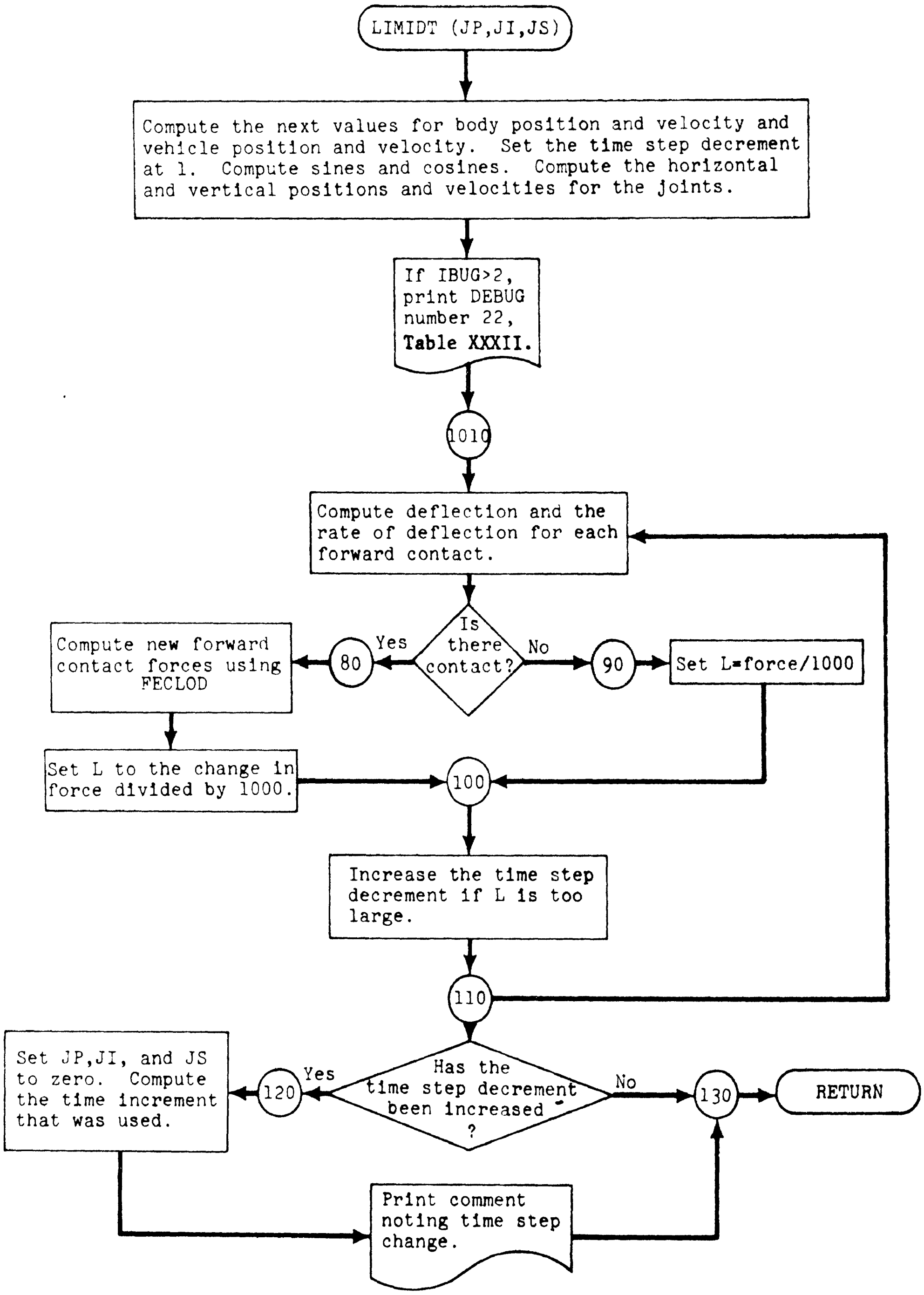
KRUNCH
Initialize inflection, print, and step times and other quantities.
For each unsymmetric joint stop with non-zero limit, recalculate lower joint coefficient
Compute initial relative angles and constant mas matrix elements
Print debugging output number three, table XXXII if proper IBUG.
5
Compute IBUG and vehicle accleration values by callings of GETY
Compute continuous generalized acceleration vector by calling ACCEL.
Compute angular reltaive velocities by calls to RELVEL.
Set MAXI=0 and I=1.
What is the status of mode I?
jittering
off
on
330
Set relative mode velocity to exactly the velocity limit and compute mode contributions to generalized acceleration by calling DELZMK
Compute MAXI=MAXI +1
340
Compute generalized acceleration contributions by calling DELZMK and add into continuous generalized acceleration vector.
360
Compute I=I+1
No
361
Print debugging output numbers 15 and 16, table XXXII if proper IBUG value
Copy continuous generalized acceleration vector into base acceleration vector
Are there any modes in jitter?
Yes
370
No
380
For each possible jitter mode, compute new relative mode acceleration by calling RELSFL.
Compute next integration time step by calling TAUMAK.
Print debugging printout number 25 if proper value of IBUG.
170
Update print time and next
if need be.
280
Is
No
Yes
A

Next Page


Increment time by time step.
Print debugging output number 26, Table XXXII if proper IBUG
Integrate generalized accelerations to obtain velocities and positions.
Is any body angle>360°
700
318
Print error comment
A
Call SUMARY
RETURN
Integrate vehicle accelerations to obtain velocity and position.
Update vehicle integration constants if this time was an inflection time.
5
previous page

Subroutine LIMIDT carries out the following steps:

1. Integrates body variables forward to a tentative new time.
2. Computes new forward contact forces via FECLOD.
3. Checks to see if changes in forces are more than 1000 lbs. If any one is, the time increment is decreased proportionately.



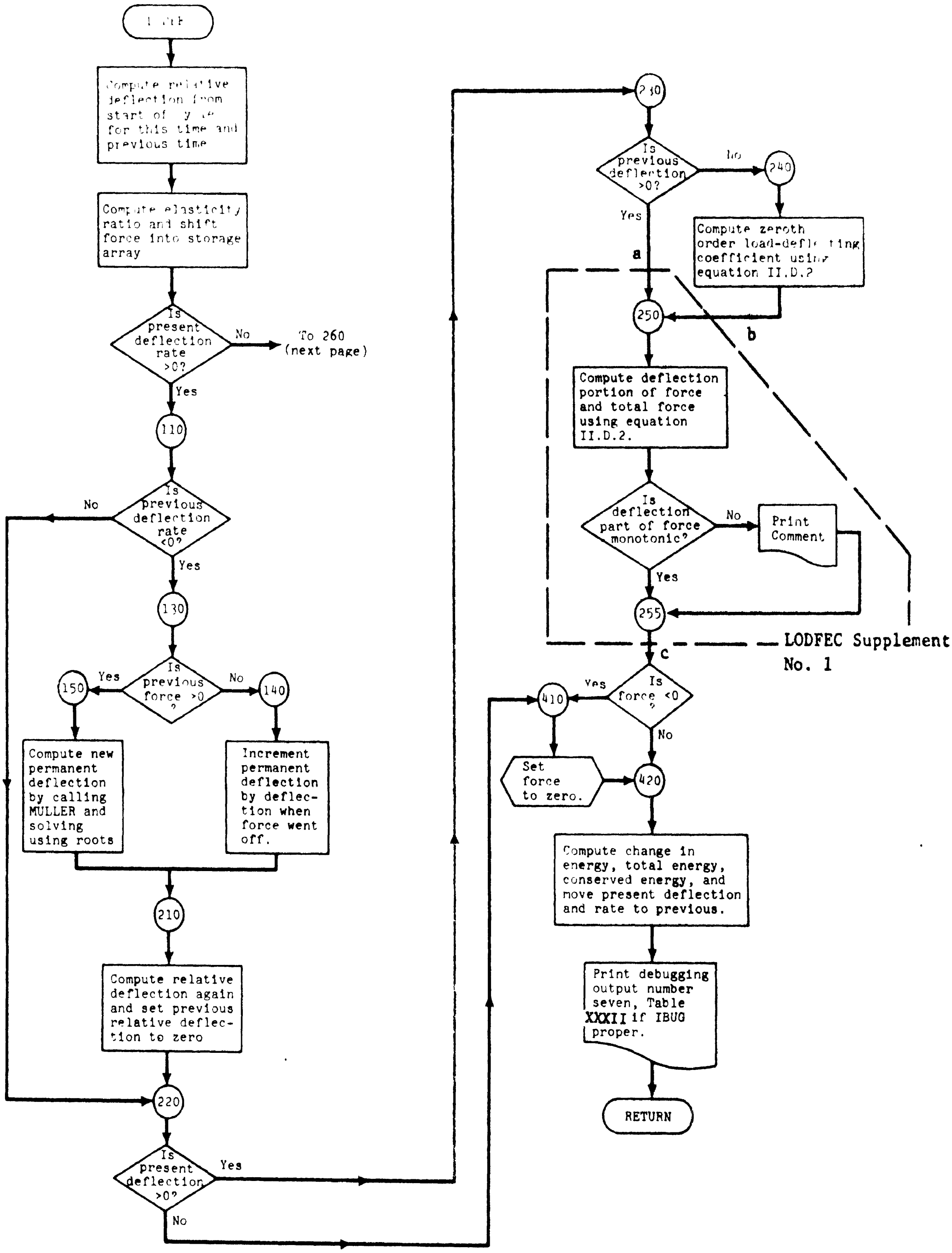
Subroutine LODFEC carries out the following steps:

1. Determines whether external forces are on loading or unloading portion of force deformation profile.

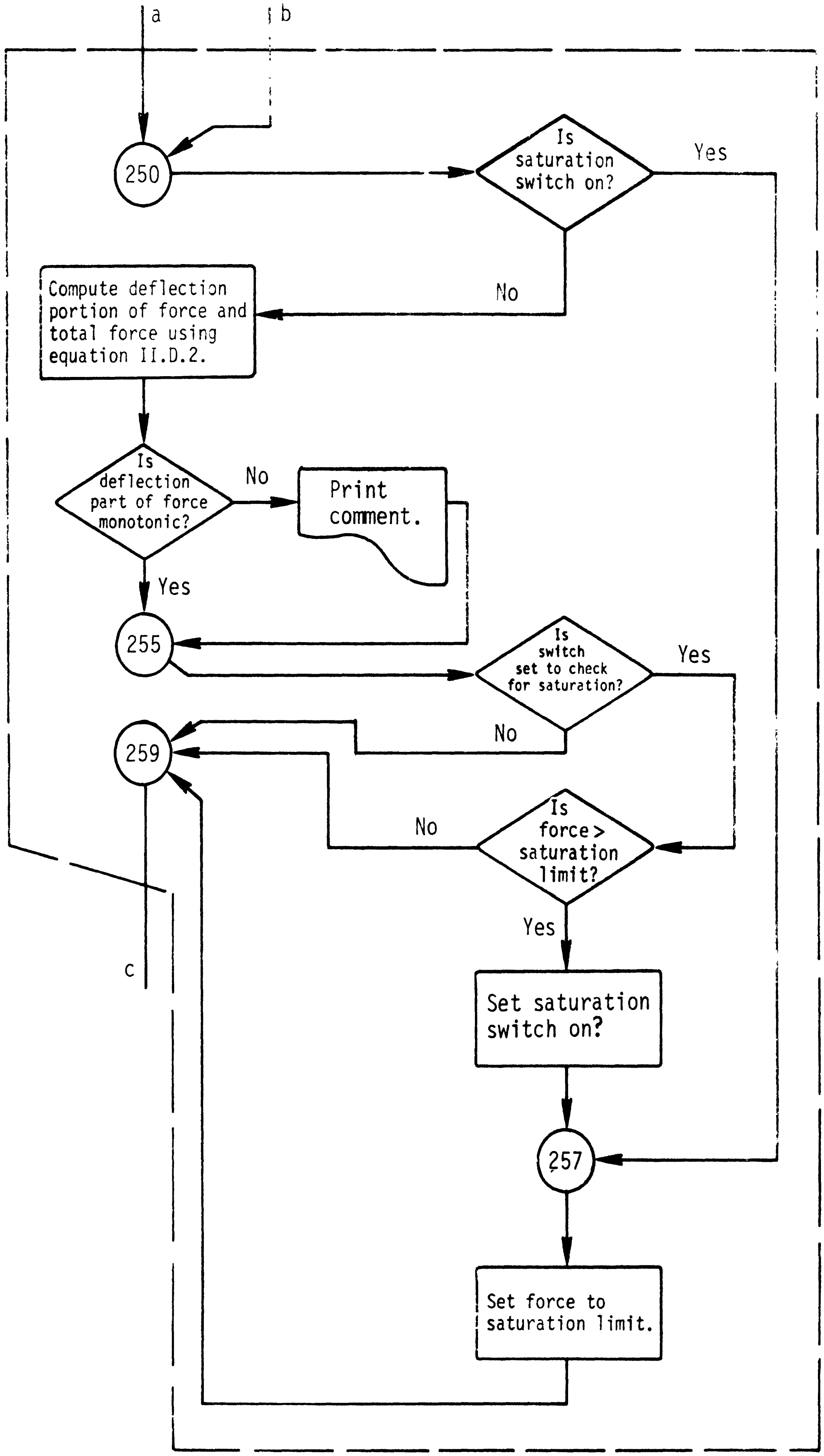
2. If loading, forces are computed from fifth order polynomial in both deflection and rate.

3. If unloading, forces are computed from second order polynomial.

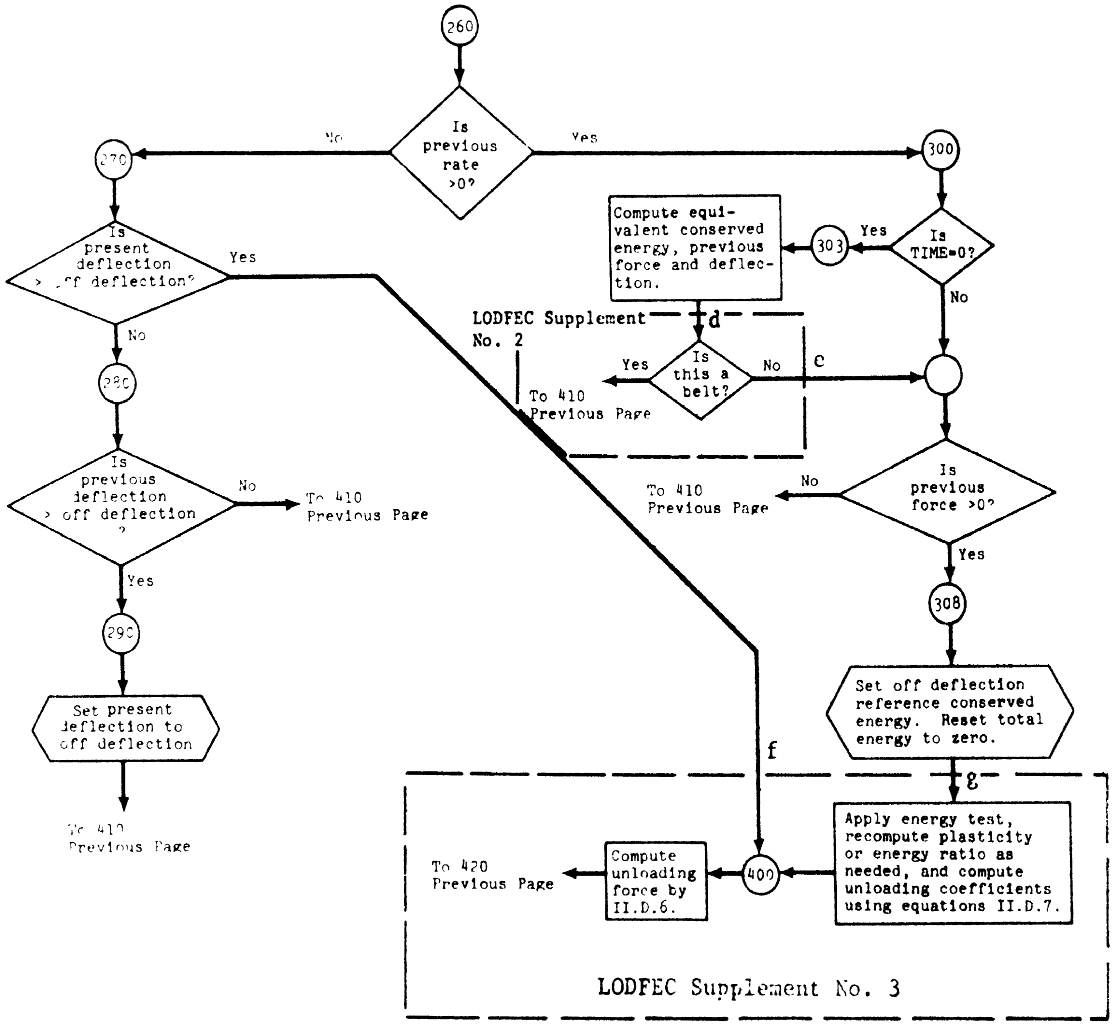
4. If in transition, the peak value is selected and coefficients for unloading computed.

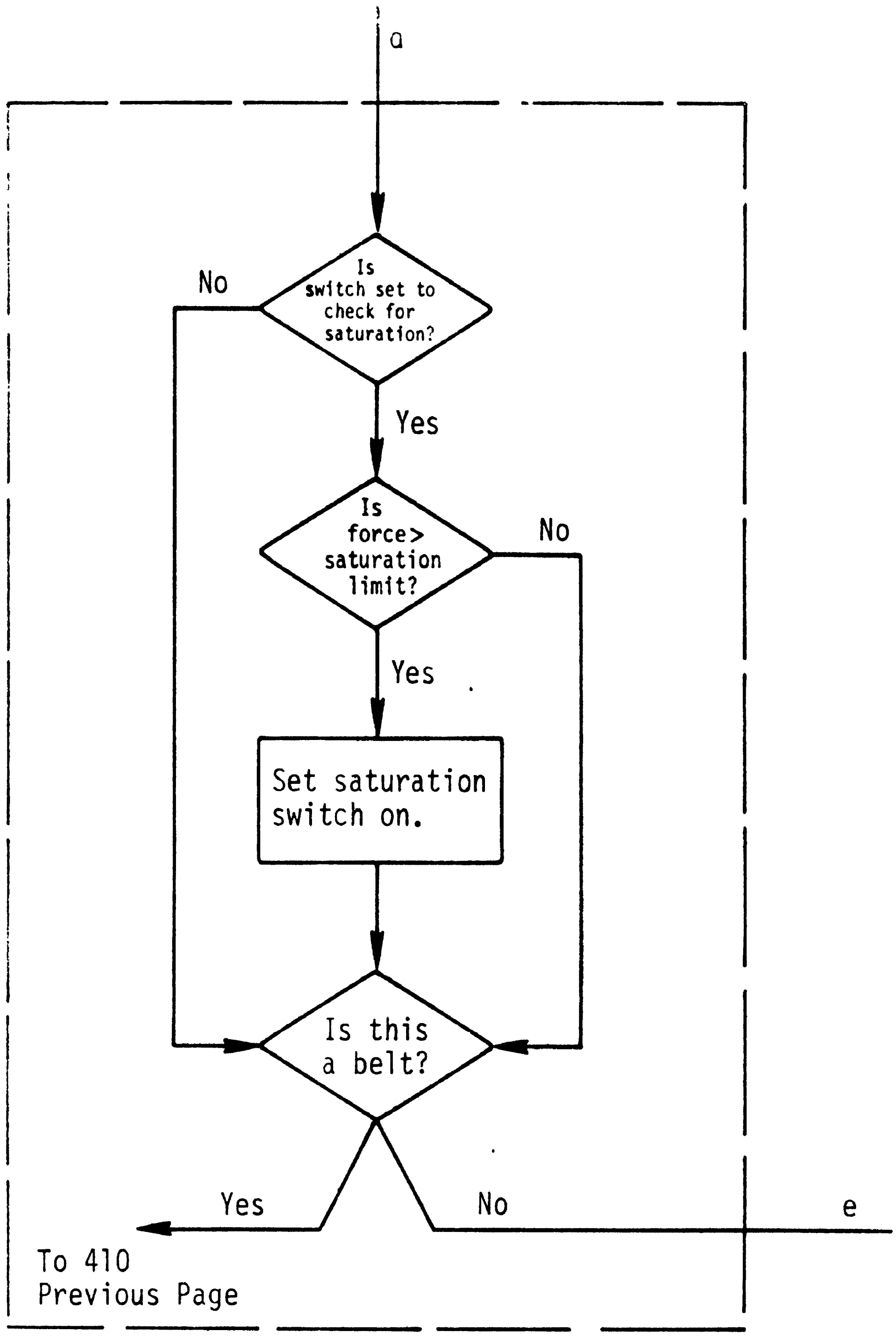


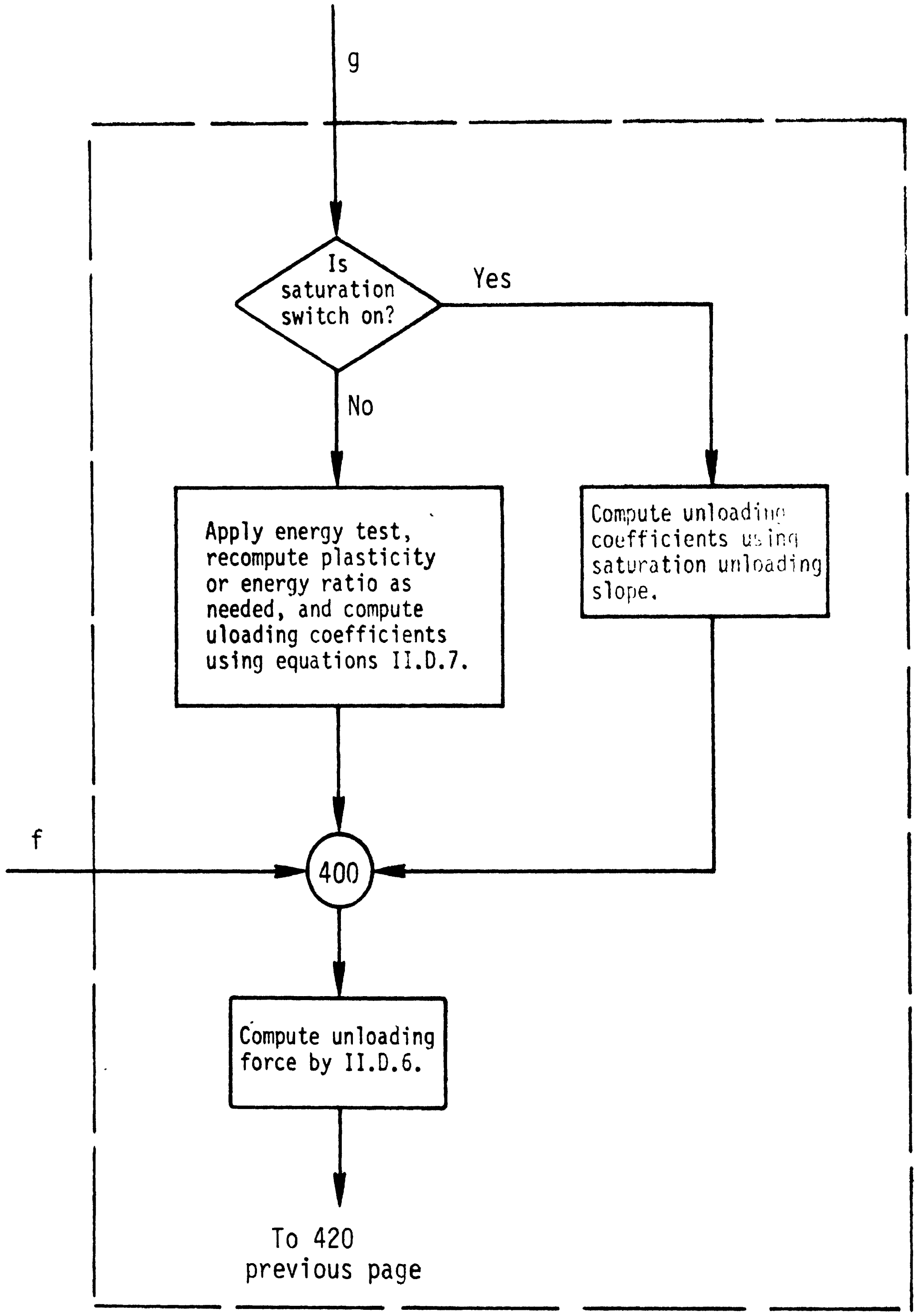
Compute relative deflection from start of cycle for this time and previous time
Compute elasticity ratio and shift force into storage array
Is present deflection rate >0?
No
To 260 (next page)
Yes
110
Is previous deflection rate <0?
No
Yes
130
Is previous force >0 ?
Yes
No
150
140
Compute new permanent deflection by calling MULLER and solving using roots
Increment permanent deflection by deflection when force went off.
210
Compute relative deflection again and set previous relative deflection to zero
220
Is present deflection >0?
Yes
No
230
Is previous deflection >0?
No
240
Yes
Compute zeroth order load-deflecting coefficient using equation II.D.2
a
250
b
Compute deflection portion of force and total force using equation II.D.2.
Is deflection part of force monotonic?
No
Print Comment
Yes
255
LODFEC Supplement No. 1
c
Is force <0 ?
Yes
No
410
Set force to zero.
420
Compute change in energy, total energy, conserved energy, and move present deflection and rate to previous.
Print debugging output number seven, Table XXXII if IBUG proper.
RETURN



LODFEC Supplement No. 1


260
Is previous rate >0?
No
Yes
270
Is present deflection > off deflection?
Yes
No
280
Is previous deflection > off deflection ?
No
To 410 Previous Page
Yes
290
Set present deflection to off deflection
To 410 Previous Page
300
Is TIME=0?
Yes
303
Compute equivalent conserved energy, previous force and deflection.
No
LODFEC Supplement No. 2
d
Is this a belt?
Yes
To 410 Previous Page
No
e
Is previous force >0?
No
To 410 Previous Page
Yes
308
Set off deflection reference conserved energy. Reset total energy to zero.
f
g
Apply energy test, recompute plasticity or energy ratio as needed, and compute unloading coefficients using equations II.D.7.
400
Compute unloading force by II.D.6.
To 420 Previous Page
LODFEC Supplement No. 3


a
Is switch set to check for saturation?
No
Yes
Is force> saturation limit?
No
Yes
Set saturation switch on.
Is this a belt?
Yes
No
e
To 410 Previous Page


g
Is saturation switch on?
Yes
No
Apply energy test, recompute plasticity or energy ratio as needed, and compute uloading coefficients using equations II.D.7.
Compute unloading coefficients using saturation unloading slope.
f
400
Compute unloading force by II.D.6.
To 420 previous page

The main program carries out the following steps:

1. Zeroes some input and variables.
2. Defines some constants and tables.
3. Reads input data for amin program up to and including Z card.
4. Sets up table of contact indices for occupant and prints it out.
5. Sets up input deceleration and debug tables.
6. Prints out input data.
7. Computes constants.
8. Sets time to zero.
9. Rewinds buffer storage unit 9.
10. Calls KRUNCH.
11. Calls SUMARY.
12. Reads additional data decks if any.

Set up the array IDATE with the EBCD equivalent of the current day's date.

↓

Eject to a new page

↓

Zero the following

AA	IPOST	SIGMAA
BBB	MAX	SIGMAC
BL	NEW	SPSIA
CPSIA	PHI	SWITCH
	PSIA	XISMLA
DA	RA	XSMALA
FMM	SDELTA	XXX
		YSMALA
FMUA	SDELTD	YYY
GA	SIGMA	ZERO

↓

Set MFORI to 7,1,2,3,3,5,8

↓

Set

$OTR=\frac{\Pi}{180} = .01745329$

$PITWO=\frac{\Pi}{2} = 1.570796$

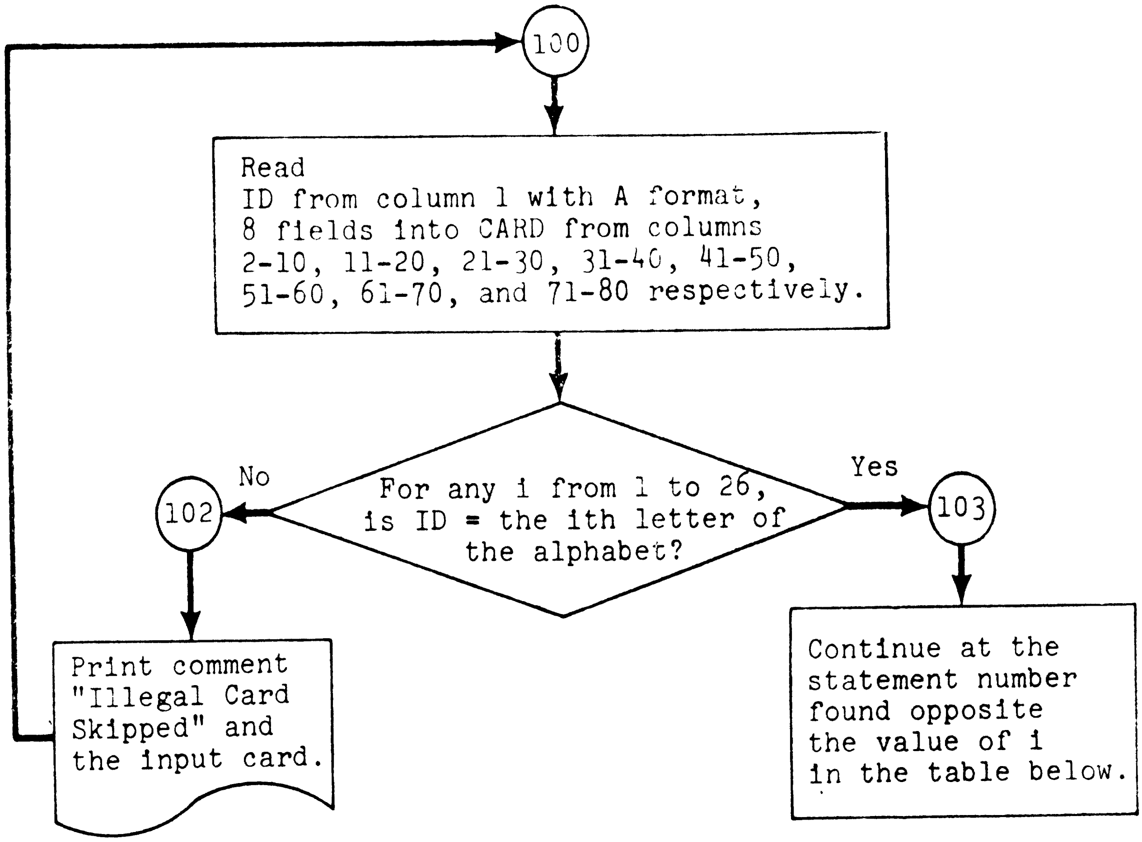
GRAVIT=386.4

↓

Set the underflow trap monitor

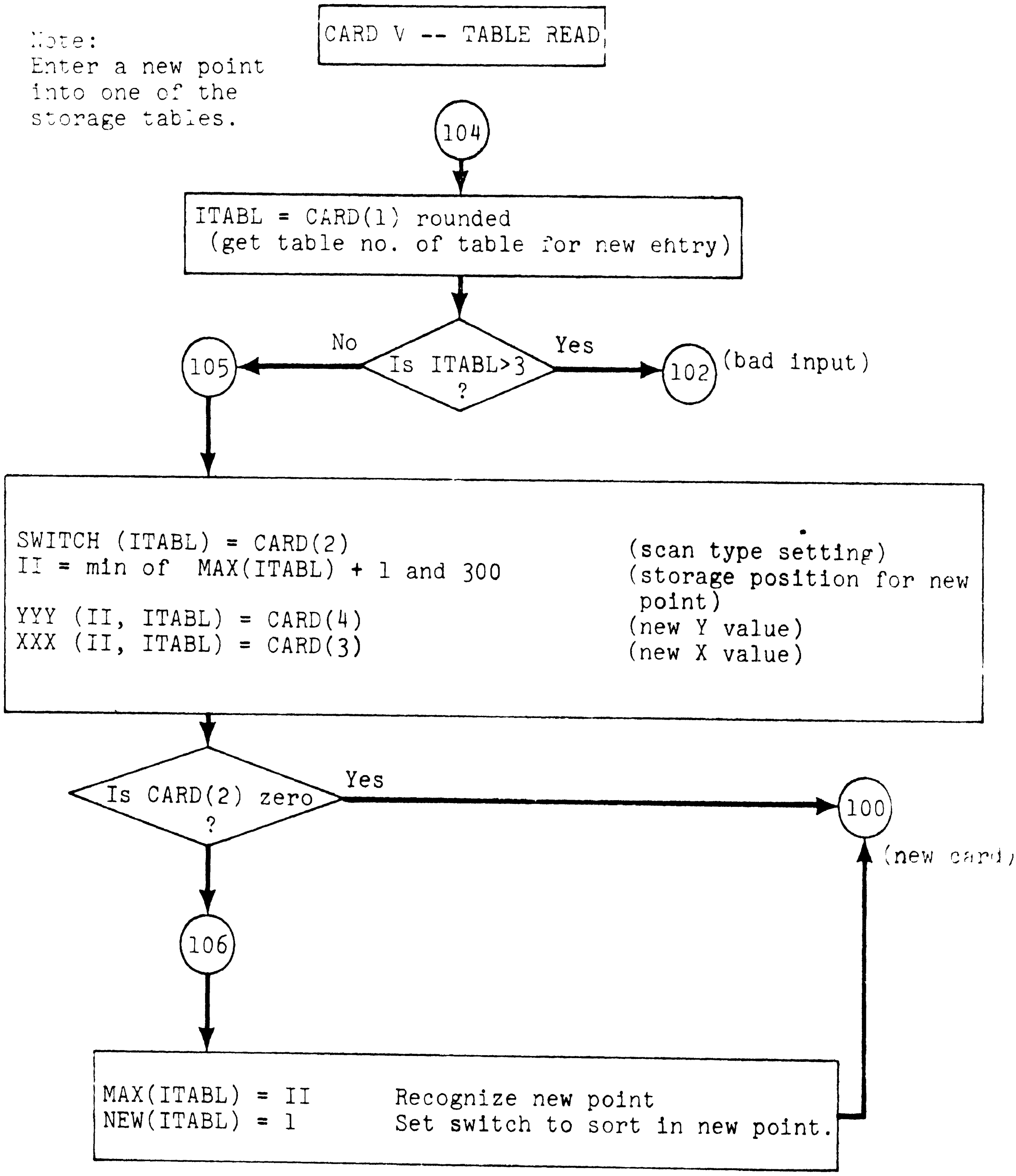
↓

(100)

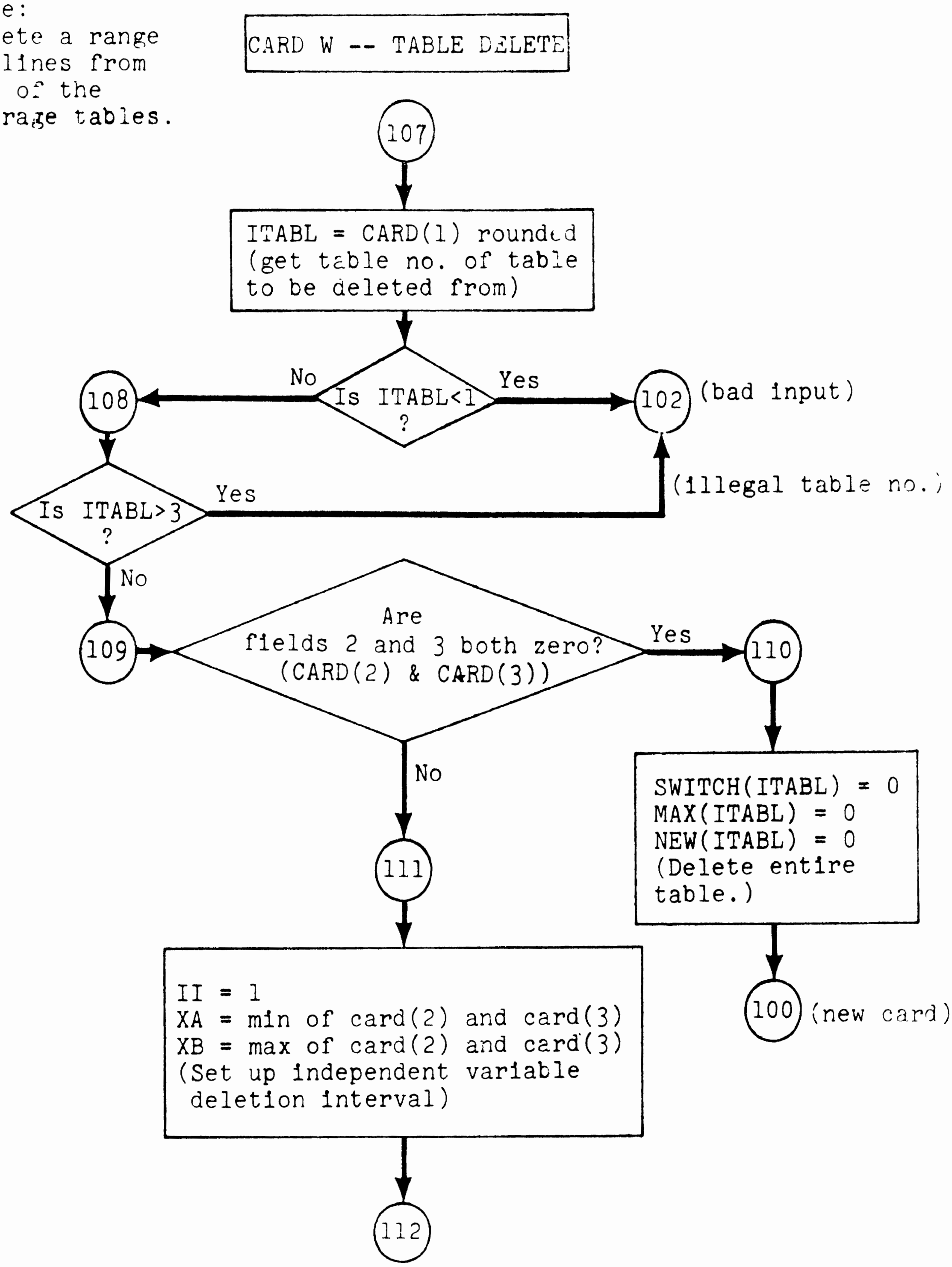


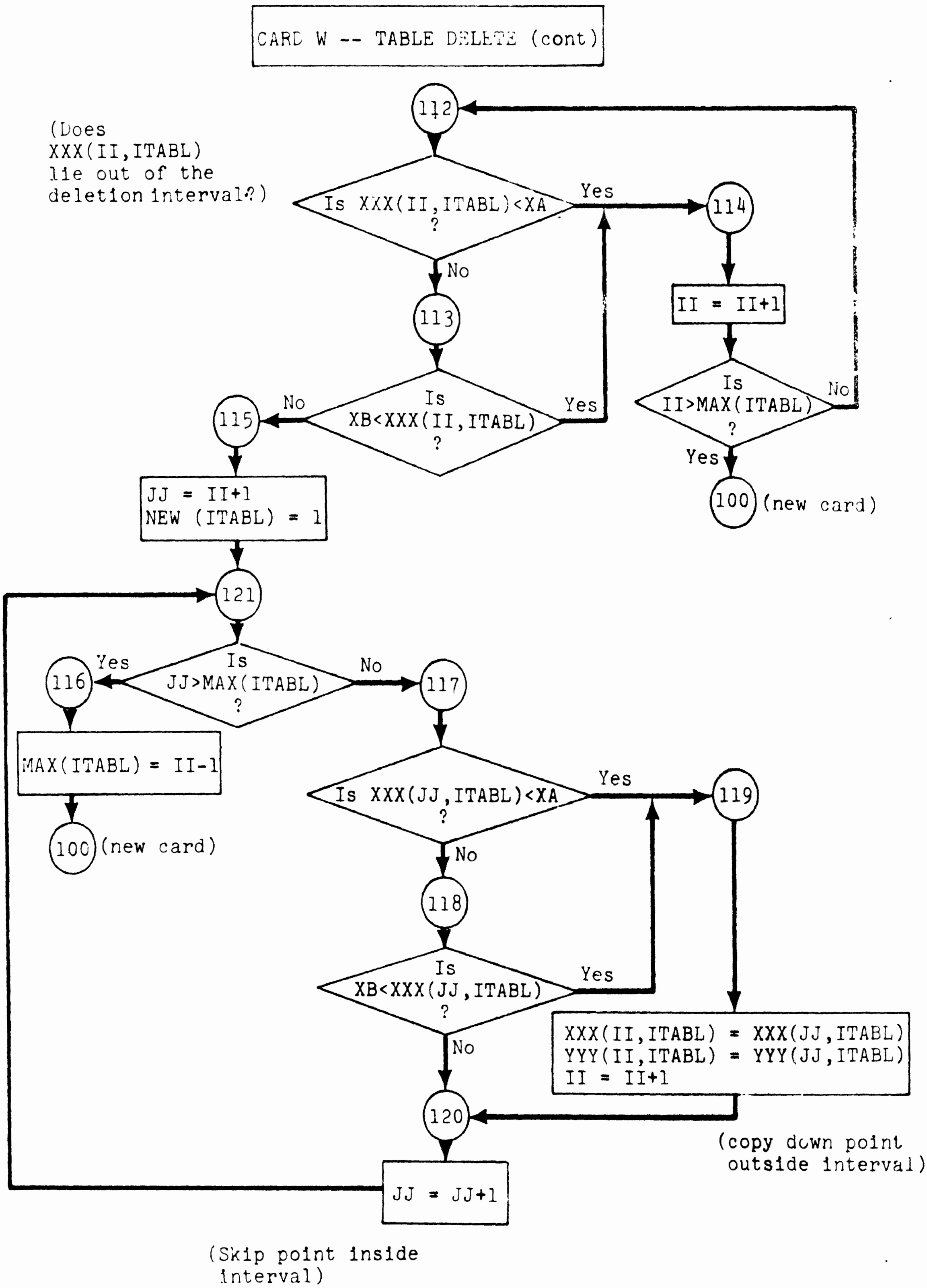
ID letter	i	Statement number	ID letter	i	Statement number
A	1	140	N	14	560
B	2	180	O	15	600
C	3	200	P	16	630
D	4	230	Q	17	660
E	5	260	R	18	700
F	6	300	S	19	730
G	7	330	T	20	760
H	8	360	U	21	800
I	9	400	V	22	104
J	10	430	W	23	107
K	11	460	X	24	850
L	12	500	Y	25	900
M	13	530	Z	26	1000

Note:
Enter a new point
into one of the
storage tables.

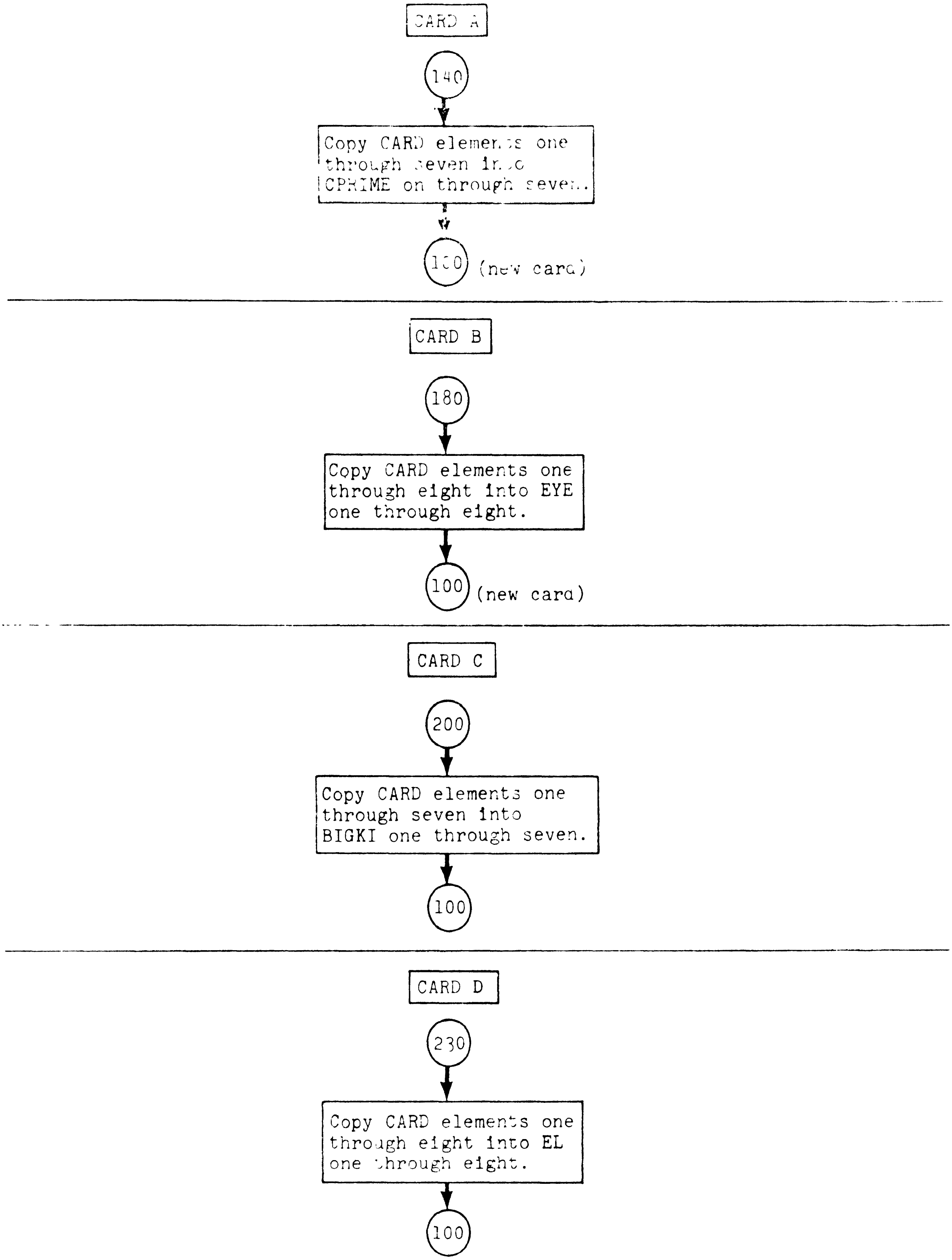


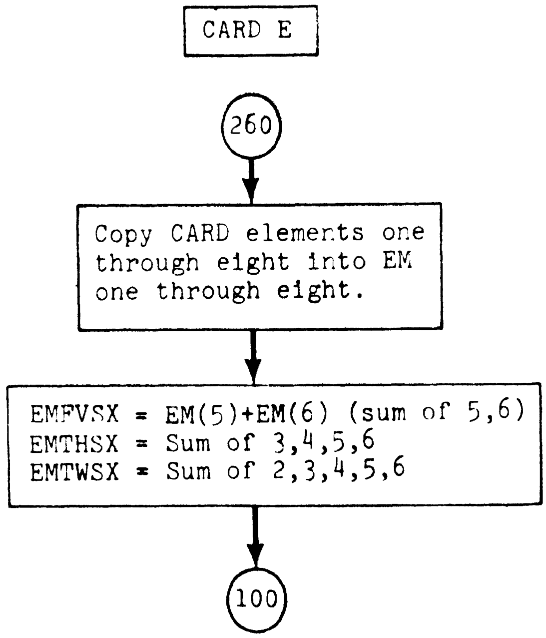
Note:
Delete a range of lines from one of the storage tables.

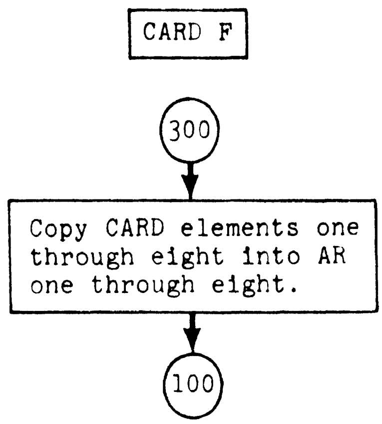


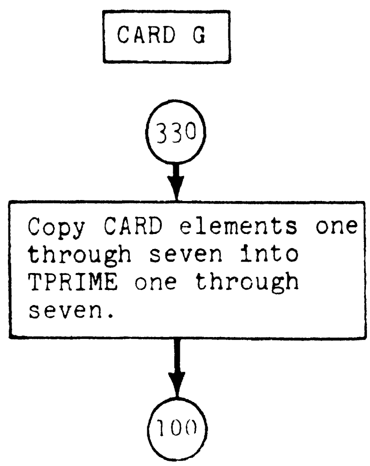


CARD W -- TABLE DELETE (cont)
112
(Does XXX(II,ITABL) lie out of the deletion interval?)
Is XXX(II,ITABL)<XA ?
Yes
No
114
II = II+1
113
Is II>MAX(ITABL) ?
No
Yes
100 (new card)
Is XB<XXX(II,ITABL) ?
No
Yes
115
JJ = II+1
NEW (ITABL) = 1
121
Is JJ>MAX(ITABL) ?
Yes
No
116
117
MAX(ITABL) = II-1
100 (new card)
Is XXX(JJ,ITABL)<XA ?
Yes
No
119
118
Is XB<XXX(JJ,ITABL) ?
Yes
No
XXX(II,ITABL) = XXX(JJ,ITABL)
YYY(II,ITABL) = YYY(JJ,ITABL)
II = II+1
120
(copy down point outside interval)
JJ = JJ+1
(Skip point inside interval)


CARD A
140
Copy CARD elements one through seven into CPRIME one through seven.
100
(new card)
CARD B
180
Copy CARD elements one through eight into EYE one through eight.
100
(new card)
CARD C
200
Copy CARD elements one through seven into BIGKI one through seven.
100
CARD D
230
Copy CARD elements one through eight into EL one through eight.
100


CARD E
260
Copy CARD elements one through eight into EM one through eight.
EMFVSX = EM(5)+EM(6) (sum of 5,6)
EMTHSX = Sum of 3,4,5,6
EMTWSX = Sum of 2,3,4,5,6
100


CARD F
300
Copy CARD elements one through eight into AR one through eight.
100


CARD G
330
Copy CARD elements one through seven into TPRIME one through seven.
100

CARD H

(360)

Copy CARD elements one through four into ALFAI elements one, five, six, and seven, converting them from degrees to radians.

Copy CARD elements five through eight into THATPW, THATPV, THATPX, and THATPS, respectively.

(100)

CARD I

(400)

Copy CARD elements one through seven into OMEGA elements one through seven, converting them from degrees to radians.

(100)

CARD J

(430)

Copy CARD elements one through seven into RPSI elements one through seven, converting them from degrees to radians.

(100)

CARD K

(460)

Copy CARD elements one through eight into RHO elements one through eight.

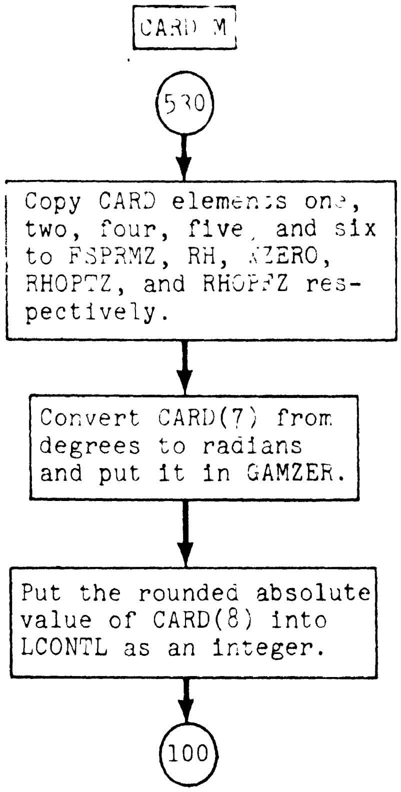
(100)

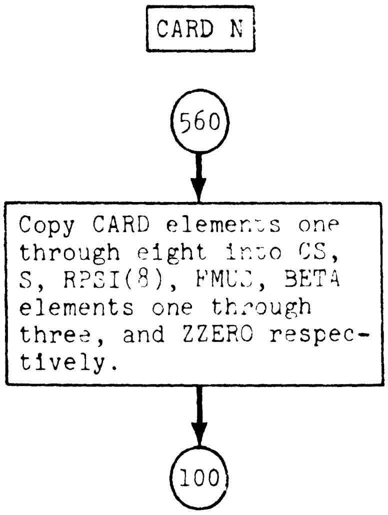
CARD L

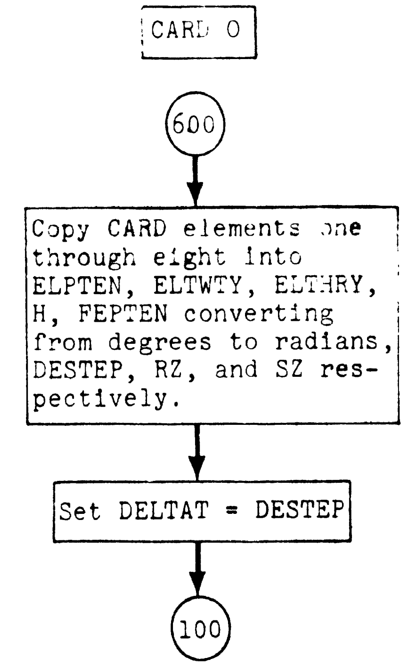
(500)

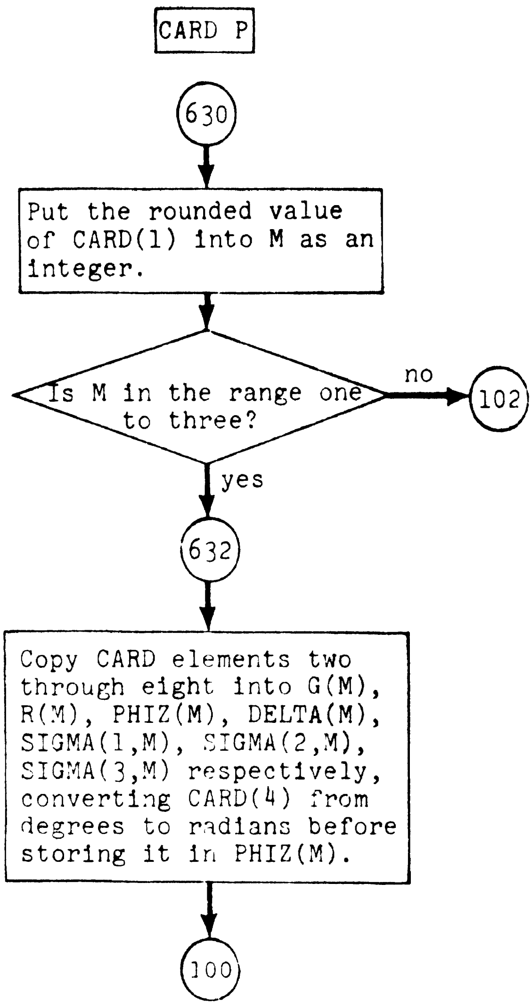
Copy CARD elements one through eight into THETAZ elements one through eight, converting them from degrees to radians. Simultaneously compute the sine and cosine for each element of THETAZ and store them in the corresponding elements of STHETZ and CTHETZ respectively.

(100)

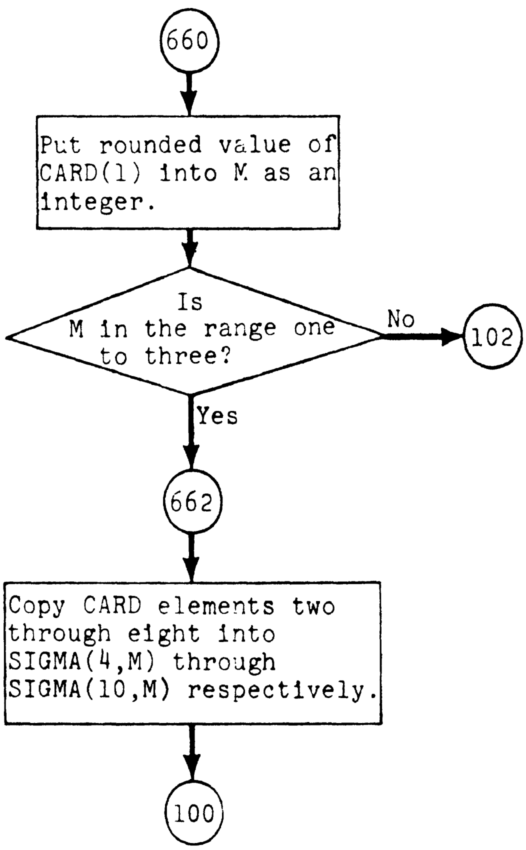

CARD M
530
Copy CARD elements one, two, four, five, and six to FSPRMZ, RH, XZERO, RHOPTZ, and RHOPFZ respectively.
Convert CARD(7) from degrees to radians and put it in GAMZER.
Put the rounded absolute value of CARD(8) into LCONTL as an integer.
100

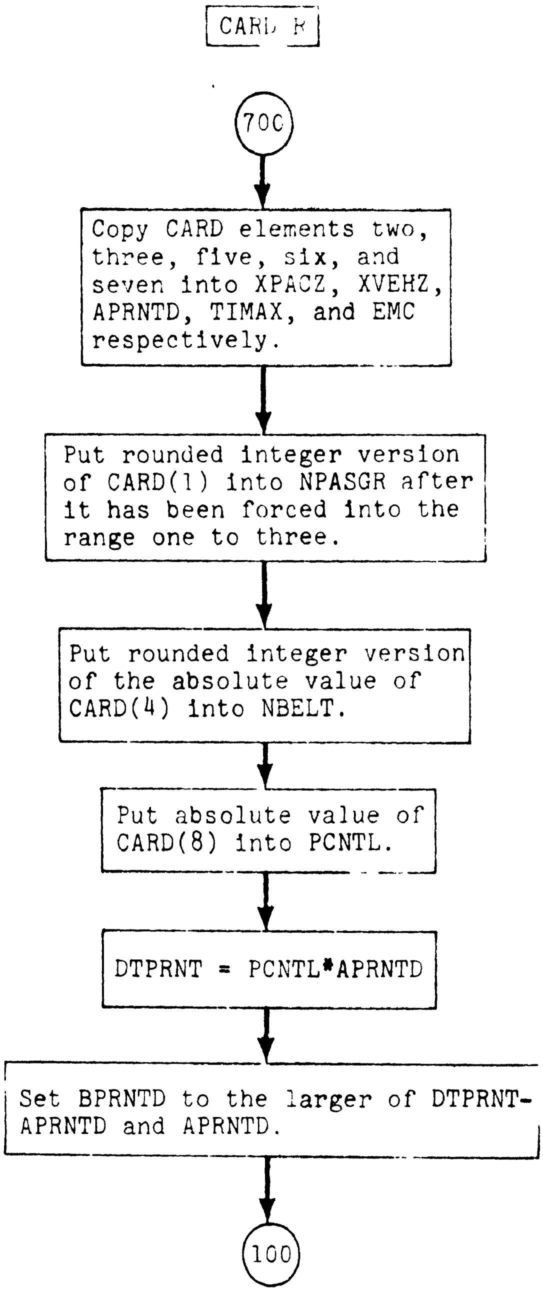

CARD N
560
Copy CARD elements one through eight into CS, S, RPSI(8), FMUO, BETA elements one through three, and ZZERO respectively.
100


CARD O
600
Copy CARD elements one through eight into ELPTEN, ELTWTY, ELTHRY, H, FEPTEN converting from degrees to radians, DESTEP, RZ, and SZ respectively.
Set DELTAT = DESTEP
100

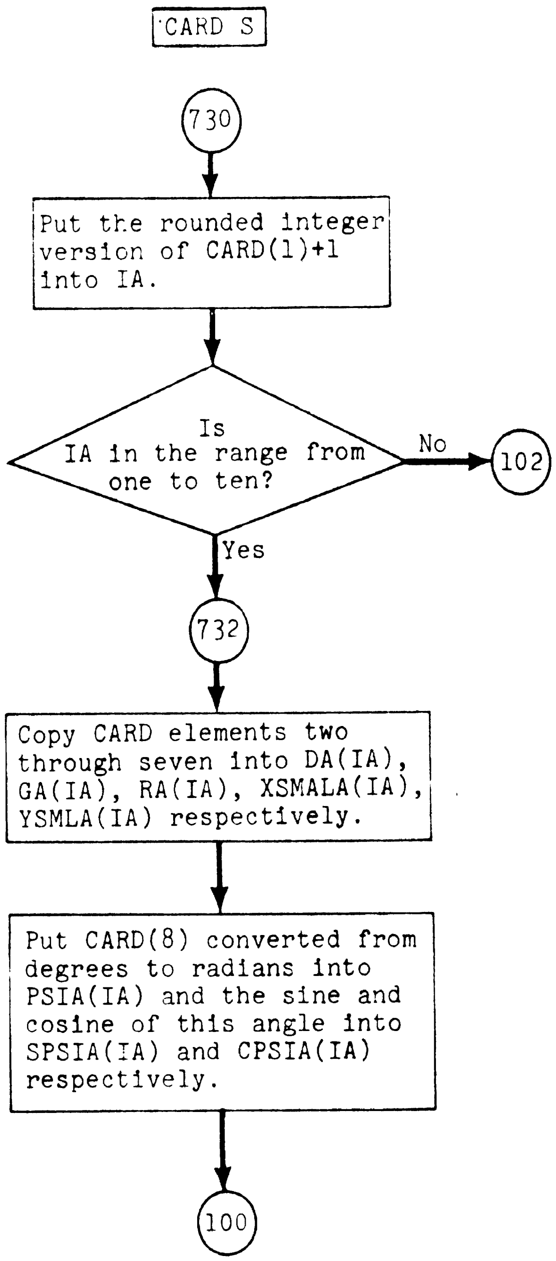

CARD P
630
Put the rounded value of CARD(1) into M as an integer.
Is M in the range one to three?
no
102
yes
632
Copy CARD elements two through eight into G(M), R(M), PHIZ(M), DELTA(M), SIGMA(1,M), SIGMA(2,M), SIGMA(3,M) respectively, converting CARD(4) from degrees to radians before storing it in PHIZ(M).
100

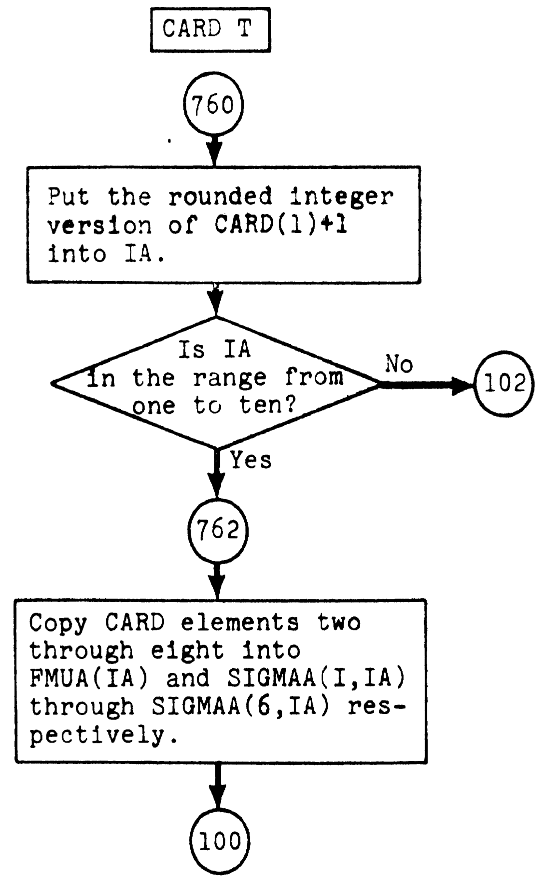
CARD Q

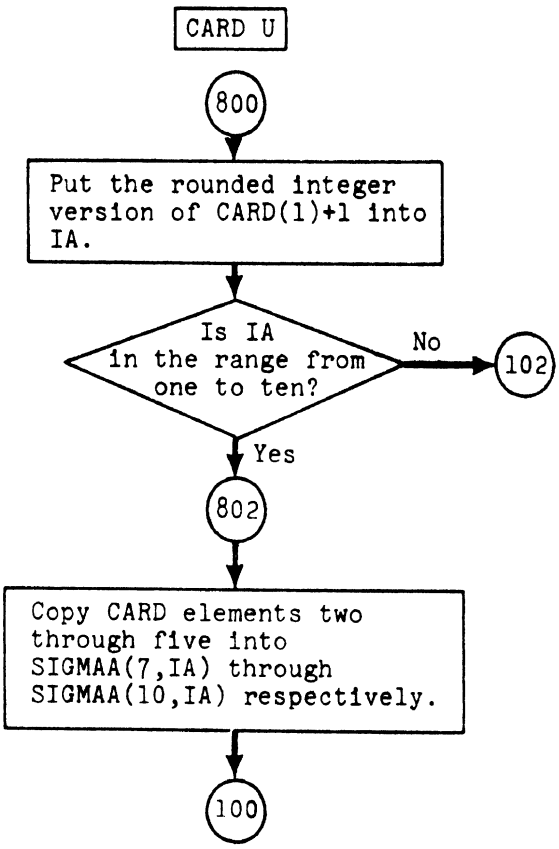

660
Put rounded value of CARD(1) into M as an integer.
Is M in the range one to three?
No
102
Yes
662
Copy CARD elements two through eight into SIGMA(4,M) through SIGMA(10,M) respectively.
100

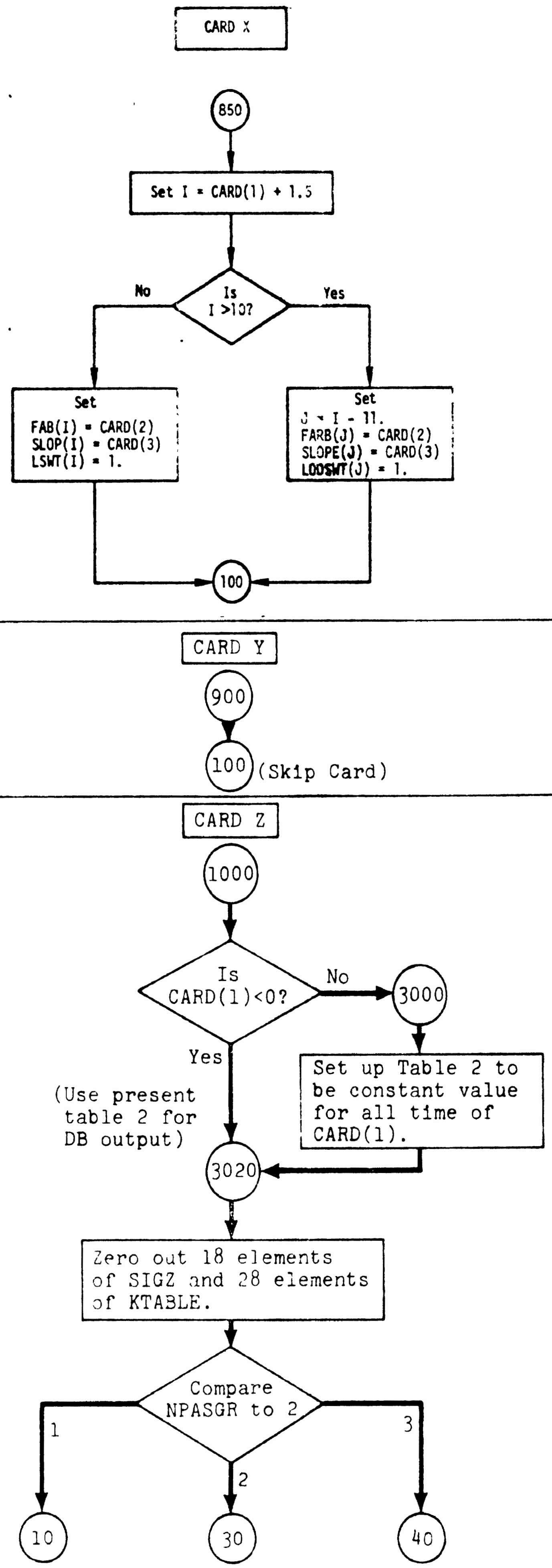


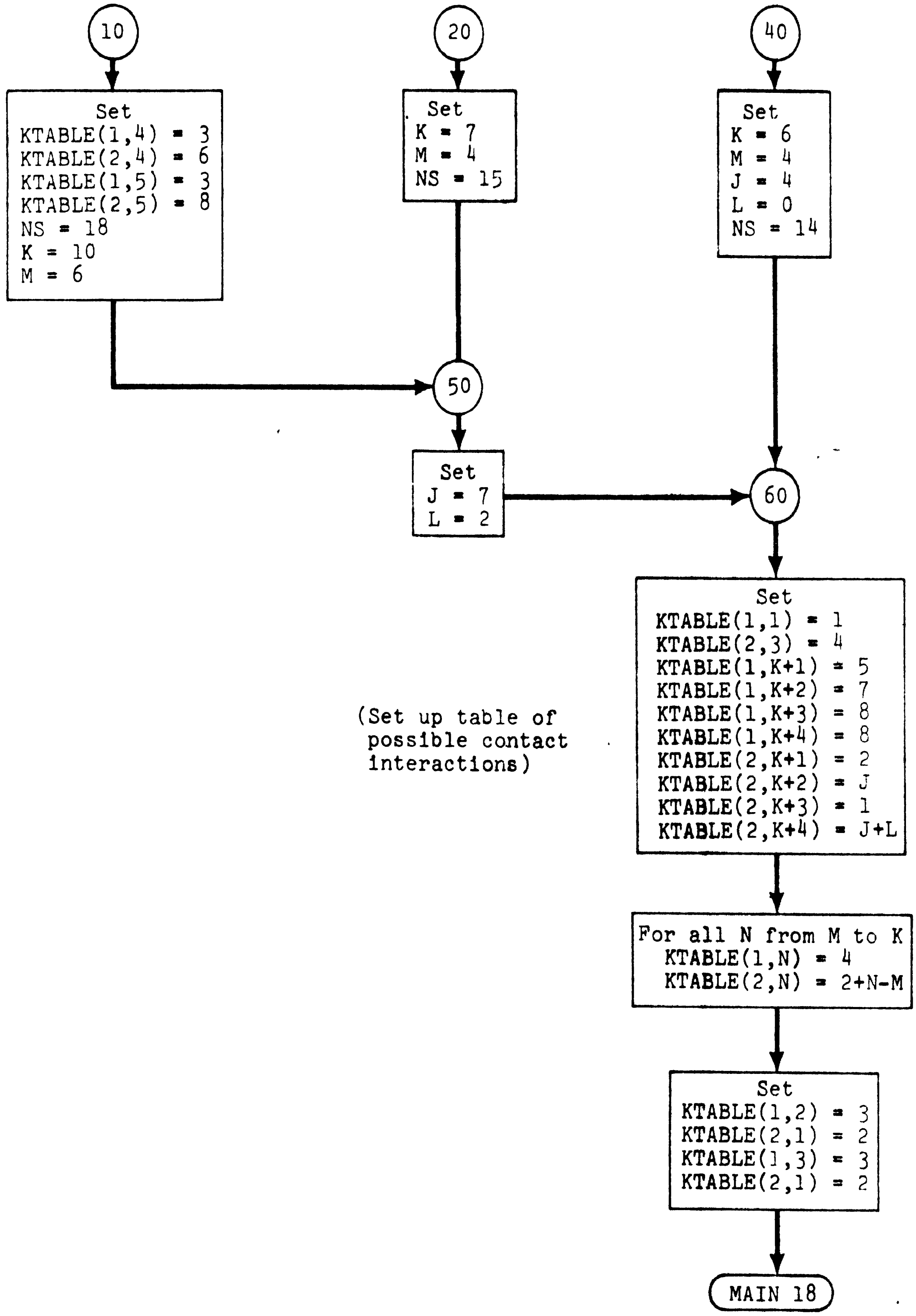
700
Copy CARD elements two, three, five, six, and seven into XPACZ, XVEHZ, APRNTD, TIMAX, and EMC respectively.
Put rounded integer version of CARD(1) into NPASGR after it has been forced into the range one to three.
Put rounded integer version of the absolute value of CARD(4) into NBELT.
Put absolute value of CARD(8) into PCNTL.
DTPRNT = PCNTL*APRNTD
Set BPRNTD to the larger of DTPRNT-APRNTD and APRNTD.
100

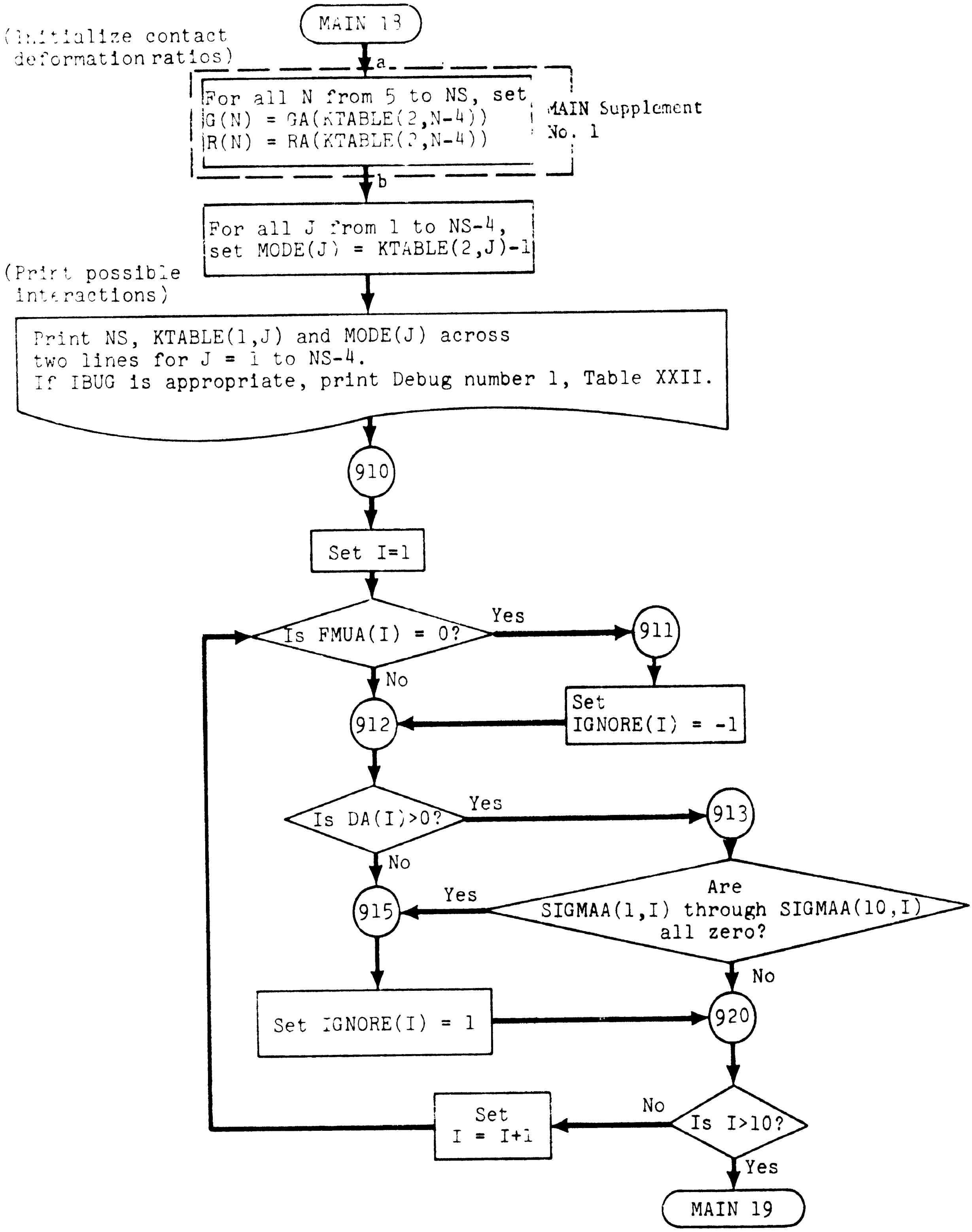

CARD S
730
Put the rounded integer version of CARD(1)+1 into IA.
Is IA in the range from one to ten?
No
102
Yes
732
Copy CARD elements two through seven into DA(IA), GA(IA), RA(IA), XSMALA(IA), YSMLA(IA) respectively.
Put CARD(8) converted from degrees to radians into PSIA(IA) and the sine and cosine of this angle into SPSIA(IA) and CPSIA(IA) respectively.
100

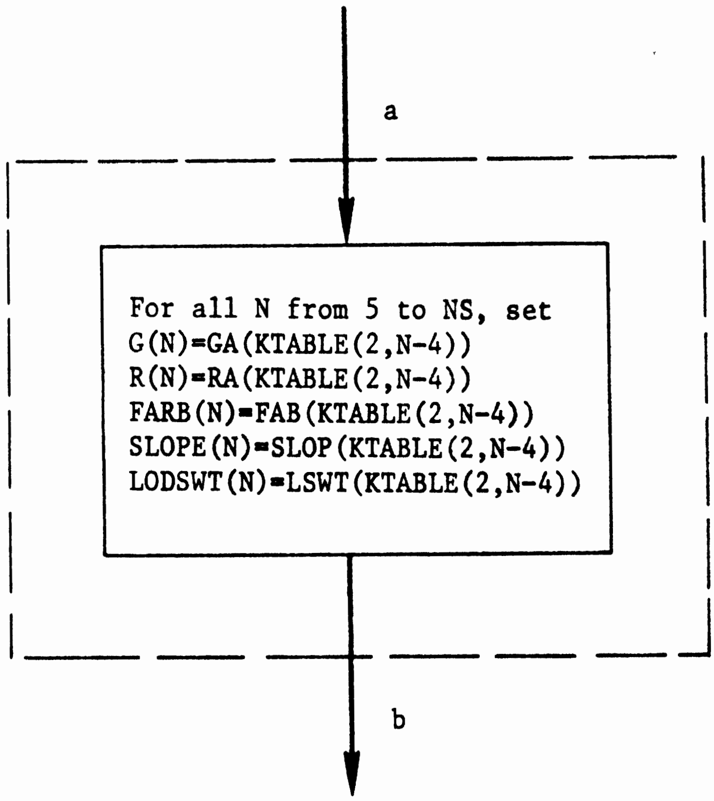

CARD T
760
Put the rounded integer version of CARD(1)+1 into IA.
Is IA in the range from one to ten?
No
102
Yes
762
Copy CARD elements two through eight into FMUA(IA) and SIGMAA(I,IA) through SIGMAA(6,IA) respectively.
100


CARD U
800
Put the rounded integer version of CARD(1)+1 into IA.
Is IA in the range from one to ten?
No
102
Yes
802
Copy CARD elements two through five into SIGMAA(7,IA) through SIGMAA(10,IA) respectively.
100

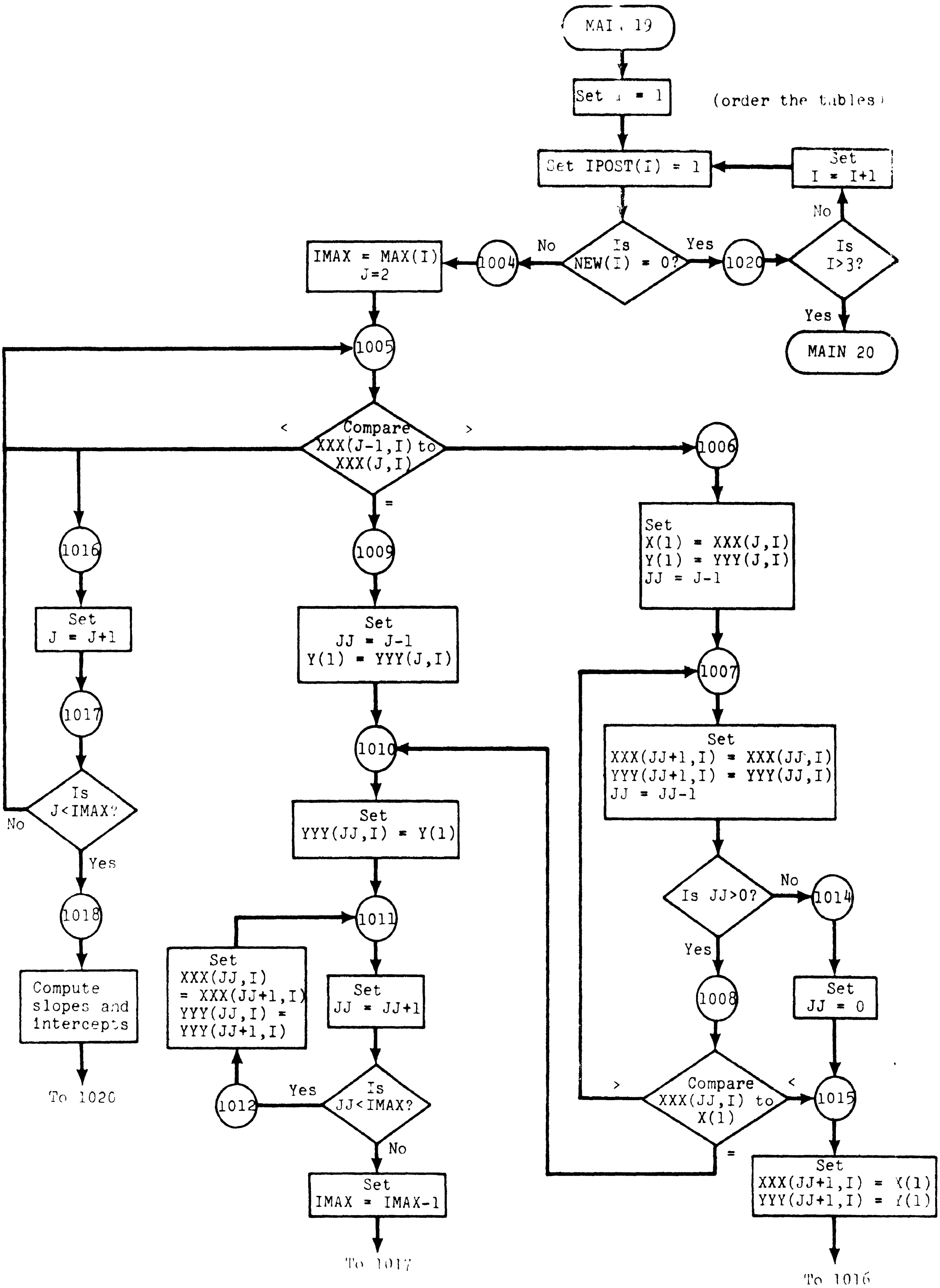

CARD X
850
Set I = CARD(1) + 1.5
Is
I >10?
No
Yes
Set
FAB(I) = CARD(2)
SLOP(I) = CARD(3)
LSWT(I) = 1.
Set
J = I - 11.
FARB(J) = CARD(2)
SLOPE(J) = CARD(3)
LOOSWT(J) = 1.
100
CARD Y
900
100
(Skip Card)
CARD Z
1000
Is
CARD(1)<0?
No
3000
Set up Table 2 to
be constant value
for all time of
CARD(1).
Yes
(Use present
table 2 for
DB output)
3020
Zero out 18 elements
of SIGZ and 28 elements
of KTABLE.
Compare
NPASGR to 2
1
2
3
10
30
40

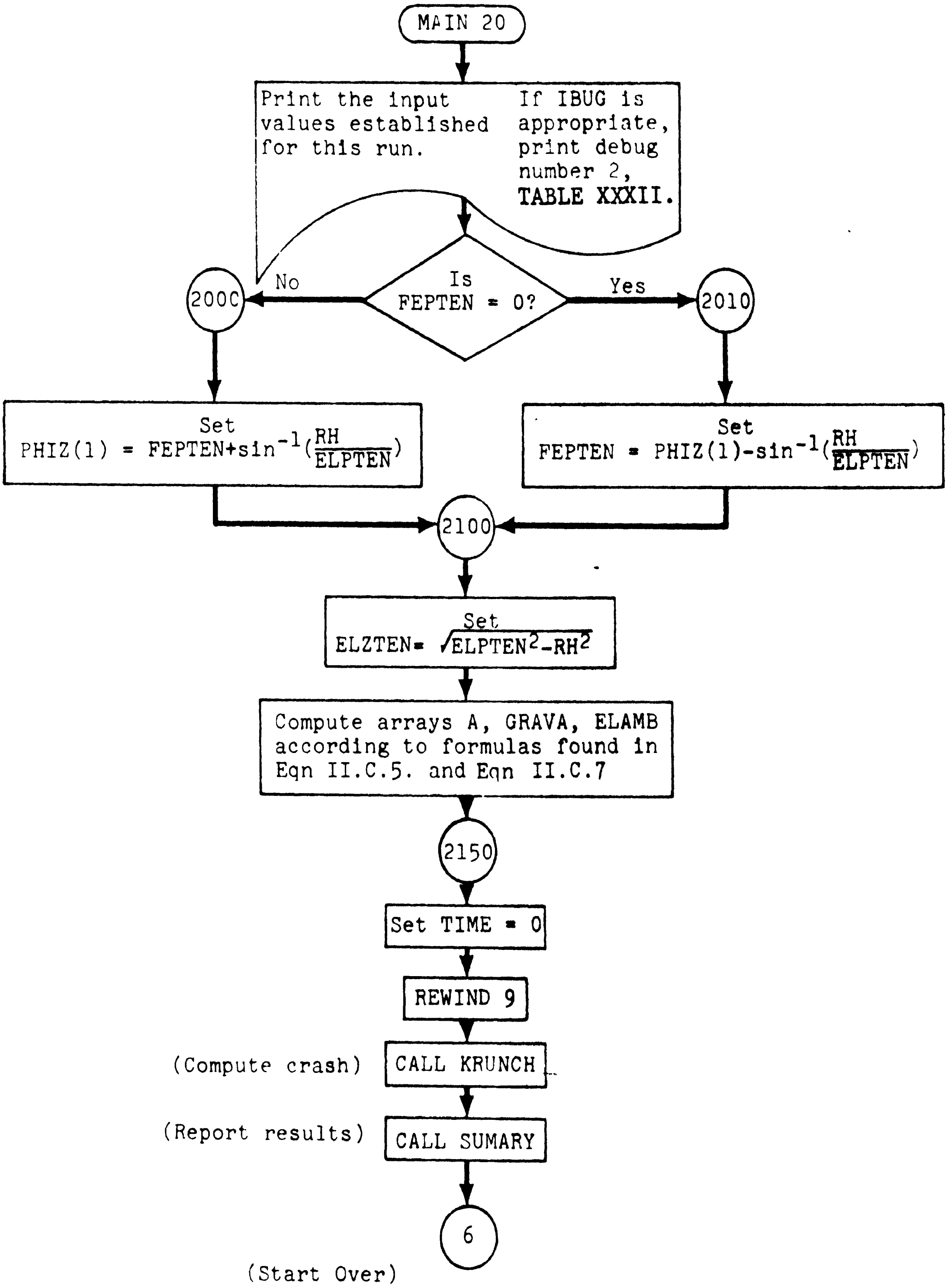

10
20
40
Set
KTABLE(1,4) = 3
KTABLE(2,4) = 6
KTABLE(1,5) = 3
KTABLE(2,5) = 8
NS = 18
K = 10
M = 6
Set
K = 7
M = 4
NS = 15
Set
K = 6
M = 4
J = 4
L = 0
NS = 14
50
Set
J = 7
L = 2
60
(Set up table of possible contact interactions)
Set
KTABLE(1,1) = 1
KTABLE(2,3) = 4
KTABLE(1,K+1) = 5
KTABLE(1,K+2) = 7
KTABLE(1,K+3) = 8
KTABLE(1,K+4) = 8
KTABLE(2,K+1) = 2
KTABLE(2,K+2) = J
KTABLE(2,K+3) = 1
KTABLE(2,K+4) = J+L
For all N from M to K
KTABLE(1,N) = 4
KTABLE(2,N) = 2+N-M
Set
KTABLE(1,2) = 3
KTABLE(2,1) = 2
KTABLE(1,3) = 3
KTABLE(2,1) = 2
MAIN 18


MAIN 18
(Initialize contact deformation ratios)
a
For all N from 5 to NS, set
G(N) = GA(KTABLE(2,N-4))
R(N) = RA(KTABLE(2,N-4))
MAIN Supplement No. 1
b
For all J from 1 to NS-4, set MODE(J) = KTABLE(2,J)-1
(Print possible interactions)
Print NS, KTABLE(1,J) and MODE(J) across two lines for J = 1 to NS-4.
If IBUG is appropriate, print Debug number 1, Table XXII.
910
Set I=1
Is FMUA(I) = 0?
Yes
911
No
Set IGNORE(I) = -1
912
Is DA(I)>0?
Yes
913
No
Are SIGMAA(1,I) through SIGMAA(10,I) all zero?
Yes
915
No
Set IGNORE(I) = 1
920
Set I = I+1
No
Is I>10?
Yes
MAIN 19



MAIN Supplement No. 1

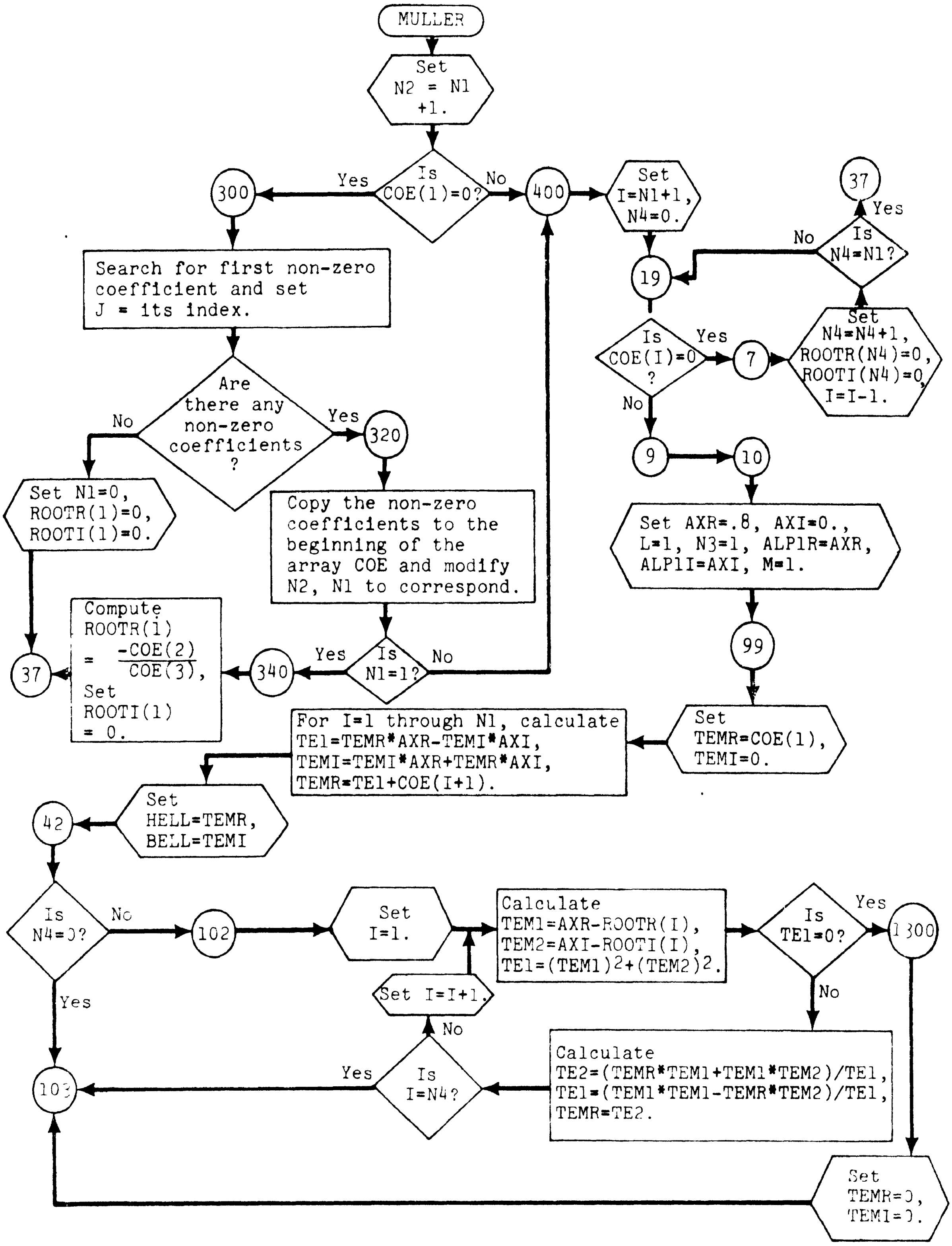

MAIN 19
Set I = 1
(order the tables)
Set IPOST(I) = 1
Set I = I+1
Is NEW(I) = 0?
No
Yes
1004
1020
Is I>3?
No
Yes
MAIN 20
IMAX = MAX(I) J=2
1005
Compare XXX(J-1,I) to XXX(J,I)
<
>
=
1006
Set X(1) = XXX(J,I) Y(1) = YYY(J,I) JJ = J-1
1007
Set XXX(JJ+1,I) = XXX(JJ,I) YYY(JJ+1,I) = YYY(JJ,I) JJ = JJ-1
Is JJ>0?
1014
Set JJ = 0
1008
Compare XXX(JJ,I) to X(1)
1015
Set XXX(JJ+1,I) = X(1) YYY(JJ+1,I) = Y(1)
To 1016
1016
Set J = J+1
1017
Is J<IMAX?
1018
Compute slopes and intercepts
To 1020
1009
Set JJ = J-1 Y(1) = YYY(J,I)
1010
Set YYY(JJ,I) = Y(1)
1011
Set JJ = JJ+1
Is JJ<IMAX?
1012
Set XXX(JJ,I) = XXX(JJ+1,I) YYY(JJ,I) = YYY(JJ+1,I)
Set IMAX = IMAX-1
To 1017

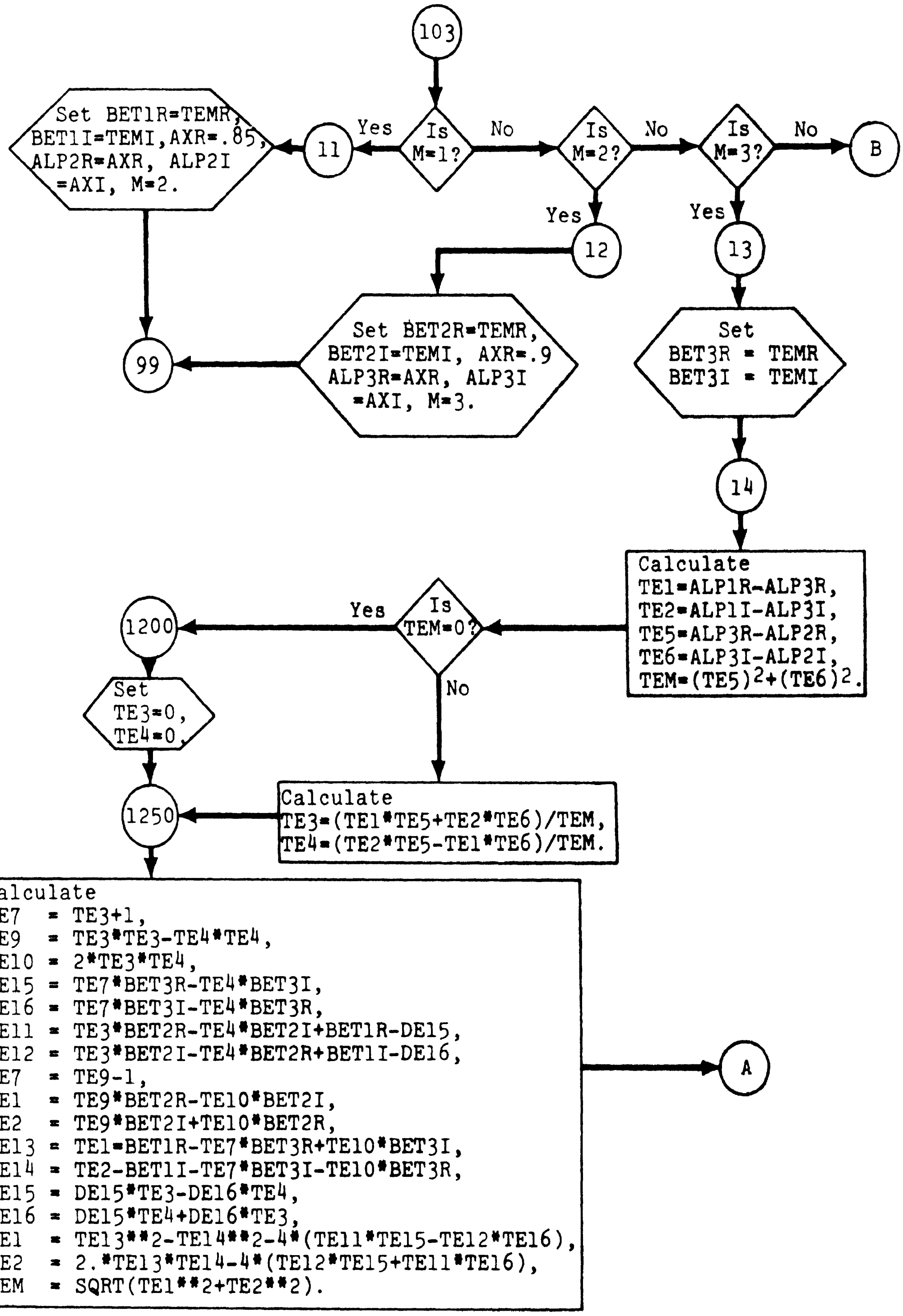


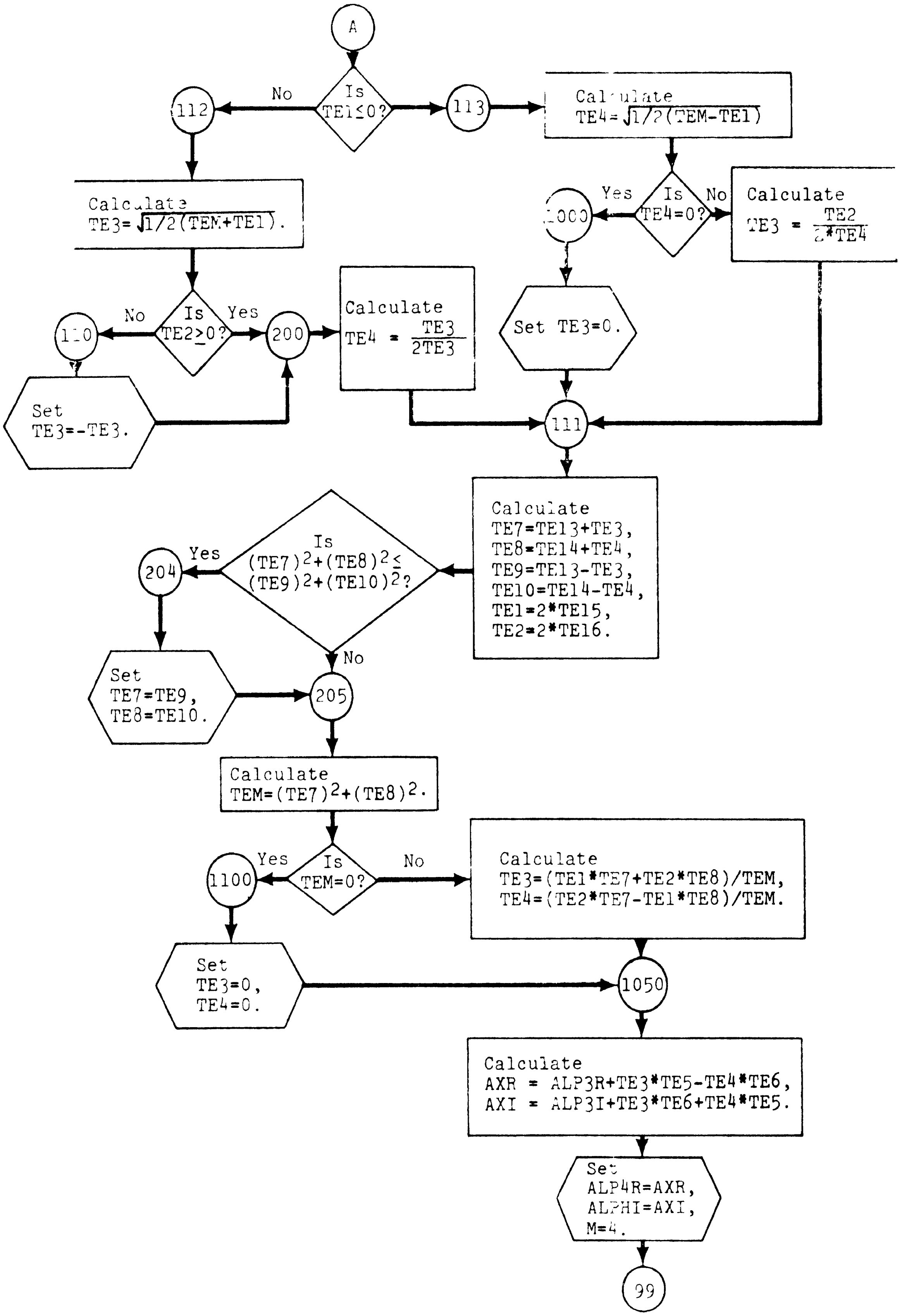
MAIN 20
Print the input values established for this run.
If IBUG is appropriate, print debug number 2, TABLE XXXII.
Is FEPTEN = 0?
No
Yes
2000
2010
Set PHIZ(1) = FEPTEN+sin-1(RH/ELPTEN)
Set FEPTEN = PHIZ(1)-sin-1(RH/ELPTEN)
2100
Set ELZTEN= √ELPTEN2-RH2
Compute arrays A, GRAVA, ELAMB according to formulas found in Eqn II.C.5. and Eqn II.C.7
2150
Set TIME = 0
REWIND 9
(Compute crash)
CALL KRUNCH
(Report results)
CALL SUMARY
6
(Start Over)

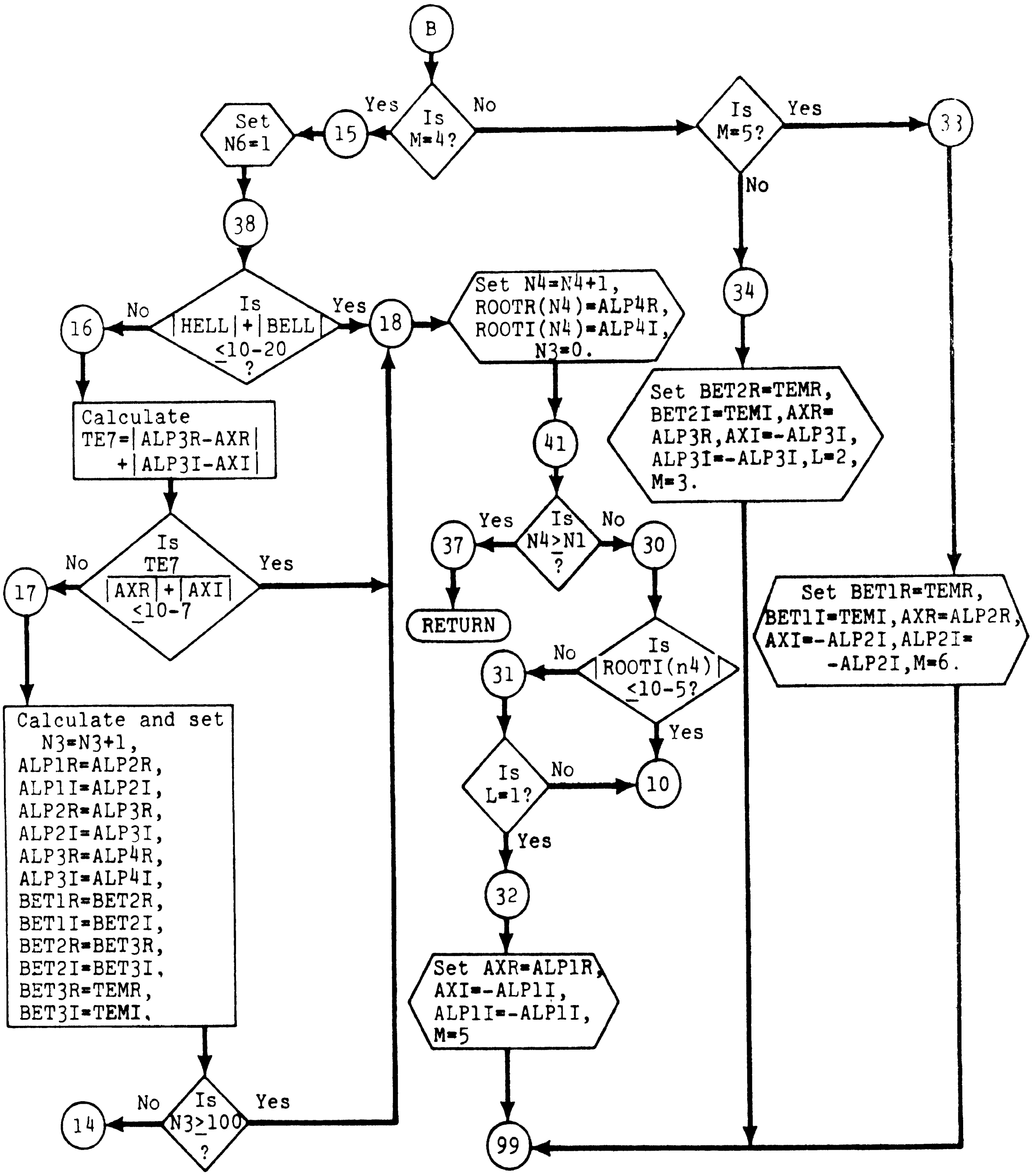
Subroutine MULLER solves a real polynomial for its complex roots.

Its arguments are: COE(10), which is the array of coefficients of the polynomial in descending order; N1, which is the order of the polynomial; ROOTR(15) and ROOTI(15), which are respectively the real and imaginary parts of the roots.




103
Is M=1?
Yes
11
Set BET1R=TEMR, BET1I=TEMI, AXR=.85, ALP2R=AXR, ALP2I =AXI, M=2.
99
No
Is M=2?
Yes
12
Set BET2R=TEMR, BET2I=TEMI, AXR=.9 ALP3R=AXR, ALP3I =AXI, M=3.
No
Is M=3?
No
B
Yes
13
Set BET3R = TEMR BET3I = TEMI
14
Calculate TE1=ALP1R-ALP3R, TE2=ALP1I-ALP3I, TE5=ALP3R-ALP2R, TE6=ALP3I-ALP2I, TEM=(TE5)2+(TE6)2.
Is TEM=0?
Yes
1200
Set TE3=0, TE4=0.
No
Calculate TE3=(TE1*TE5+TE2*TE6)/TEM, TE4=(TE2*TE5-TE1*TE6)/TEM.
1250
Calculate
TE7 = TE3+1,
TE9 = TE3*TE3-TE4*TE4,
TE10 = 2*TE3*TE4,
DE15 = TE7*BET3R-TE4*BET3I,
DE16 = TE7*BET3I-TE4*BET3R,
TE11 = TE3*BET2R-TE4*BET2I+BET1R-DE15,
TE12 = TE3*BET2I-TE4*BET2R+BET1I-DE16,
TE7 = TE9-1,
TE1 = TE9*BET2R-TE10*BET2I,
TE2 = TE9*BET2I+TE10*BET2R,
TE13 = TE1-BET1R-TE7*BET3R+TE10*BET3I,
TE14 = TE2-BET1I-TE7*BET3I-TE10*BET3R,
TE15 = DE15*TE3-DE16*TE4,
TE16 = DE15*TE4+DE16*TE3,
TE1 = TE13**2-TE14**2-4*(TE11*TE15-TE12*TE16),
TE2 = 2.*TE13*TE14-4*(TE12*TE15+TE11*TE16),
TEM = SQRT(TE1**2+TE2**2).
A

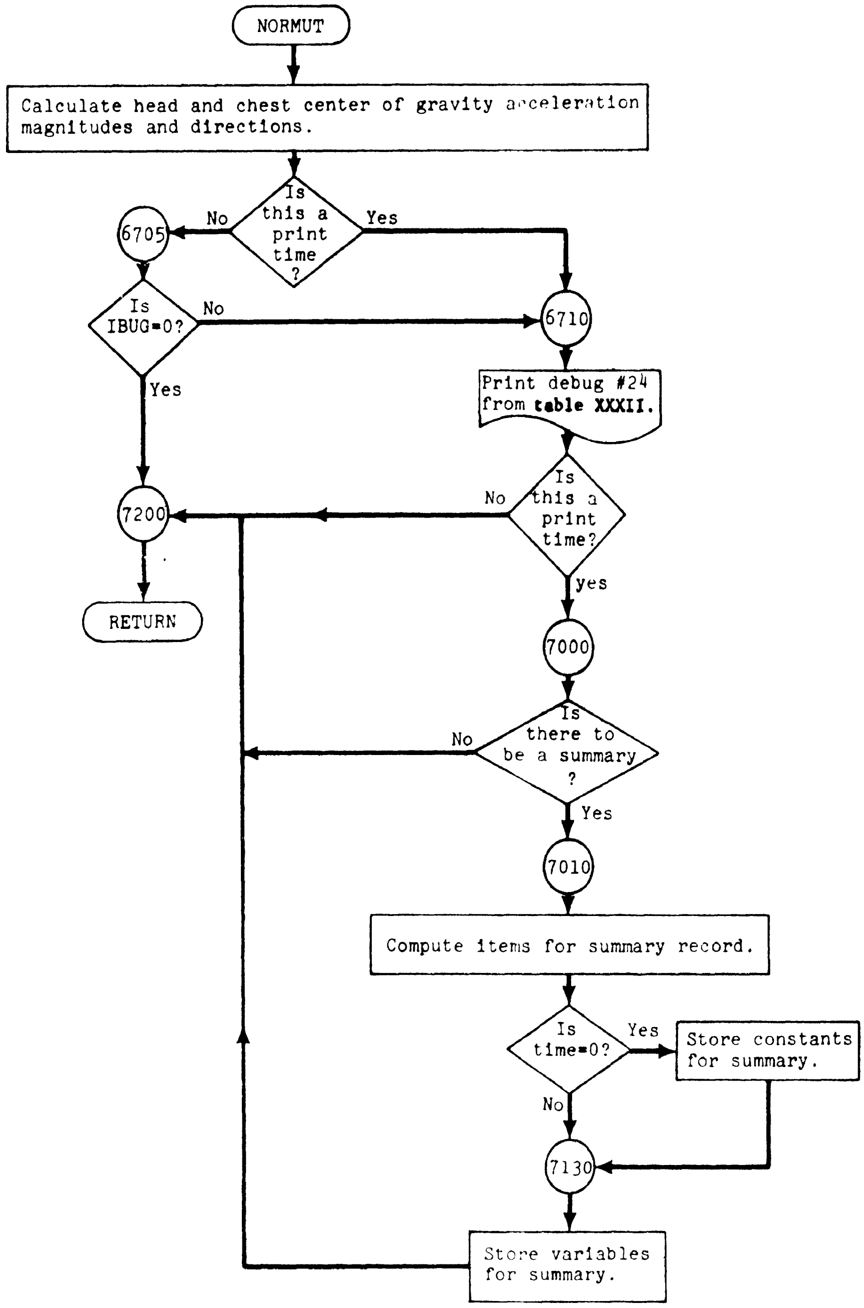

A
Is TE1≤0?
No
112
113
Calculate TE4=√1/2(TEM-TE1)
Calculate TE3=√1/2(TEM+TE1).
Is TE4=0?
Yes
No
1000
Calculate TE3 = TE2 / 2*TE4
Is TE2≥0?
No
Yes
110
200
Calculate TE4 = TE3 / 2TE3
Set TE3=0.
Set TE3=-TE3.
111
Calculate
TE7=TE13+TE3,
TE8=TE14+TE4,
TE9=TE13-TE3,
TE10=TE14-TE4,
TE1=2*TE15,
TE2=2*TE16.
Is (TE7)2+(TE8)2≤ (TE9)2+(TE10)2?
Yes
No
204
Set TE7=TE9, TE8=TE10.
205
Calculate TEM=(TE7)2+(TE8)2.
Is TEM=0?
Yes
No
1100
Calculate
TE3=(TE1*TE7+TE2*TE8)/TEM,
TE4=(TE2*TE7-TE1*TE8)/TEM.
Set TE3=0, TE4=0.
1050
Calculate
AXR = ALP3R+TE3*TE5-TE4*TE6,
AXI = ALP3I+TE3*TE6+TE4*TE5.
Set
ALP4R=AXR,
ALP4I=AXI,
M=4.
99



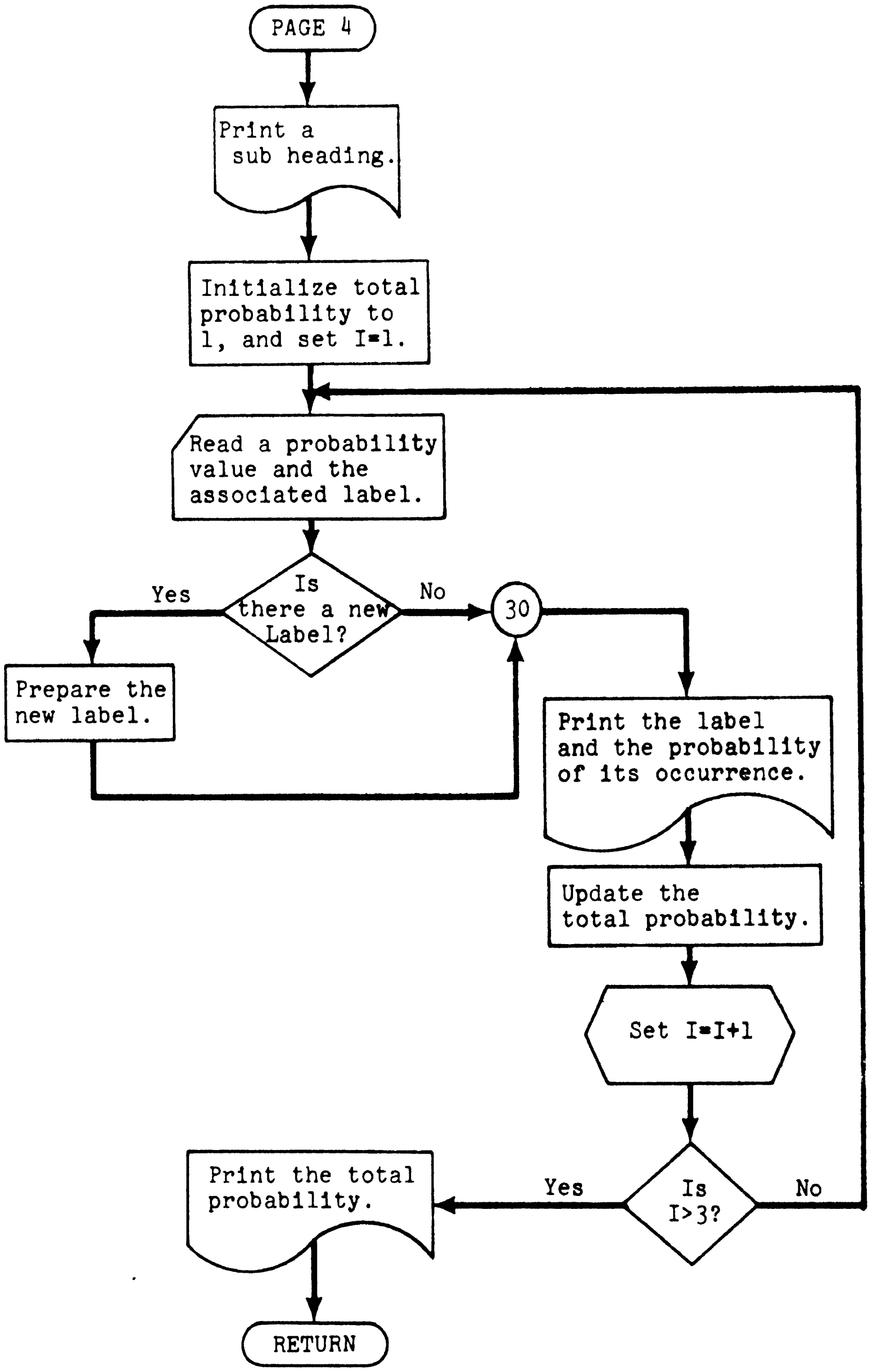
B
Is M=4?
Yes
No
15
Set N6=1
38
Is |HELL|+|BELL| ≤10-20 ?
No
Yes
16
18
Set N4=N4+1, ROOTR(N4)=ALP4R, ROOTI(N4)=ALP4I, N3=0.
Calculate TE7=|ALP3R-AXR| +|ALP3I-AXI|
41
Is N4>N1 ?
Yes
No
37
RETURN
30
Is TE7 / |AXR|+|AXI| ≤10-7
No
Yes
17
Is |ROOTI(n4)| ≤10-5?
No
Yes
31
10
Is L=1?
No
Yes
32
Calculate and set N3=N3+1, ALP1R=ALP2R, ALP1I=ALP2I, ALP2R=ALP3R, ALP2I=ALP3I, ALP3R=ALP4R, ALP3I=ALP4I, BET1R=BET2R, BET1I=BET2I, BET2R=BET3R, BET2I=BET3I, BET3R=TEMR, BET3I=TEMI.
Set AXR=ALP1R, AXI=-ALP1I, ALP1I=-ALP1I, M=5
Is N3≥100 ?
No
Yes
14
99
Is M=5?
Yes
No
33
34
Set BET2R=TEMR, BET2I=TEMI,AXR= ALP3R,AXI=-ALP3I, ALP3I=-ALP3I,L=2, M=3.
Set BET1R=TEMR, BET1I=TEMI,AXR=ALP2R, AXI=-ALP2I,ALP2I= -ALP2I,M=6.

Subroutine NORMUT carries out the following steps:

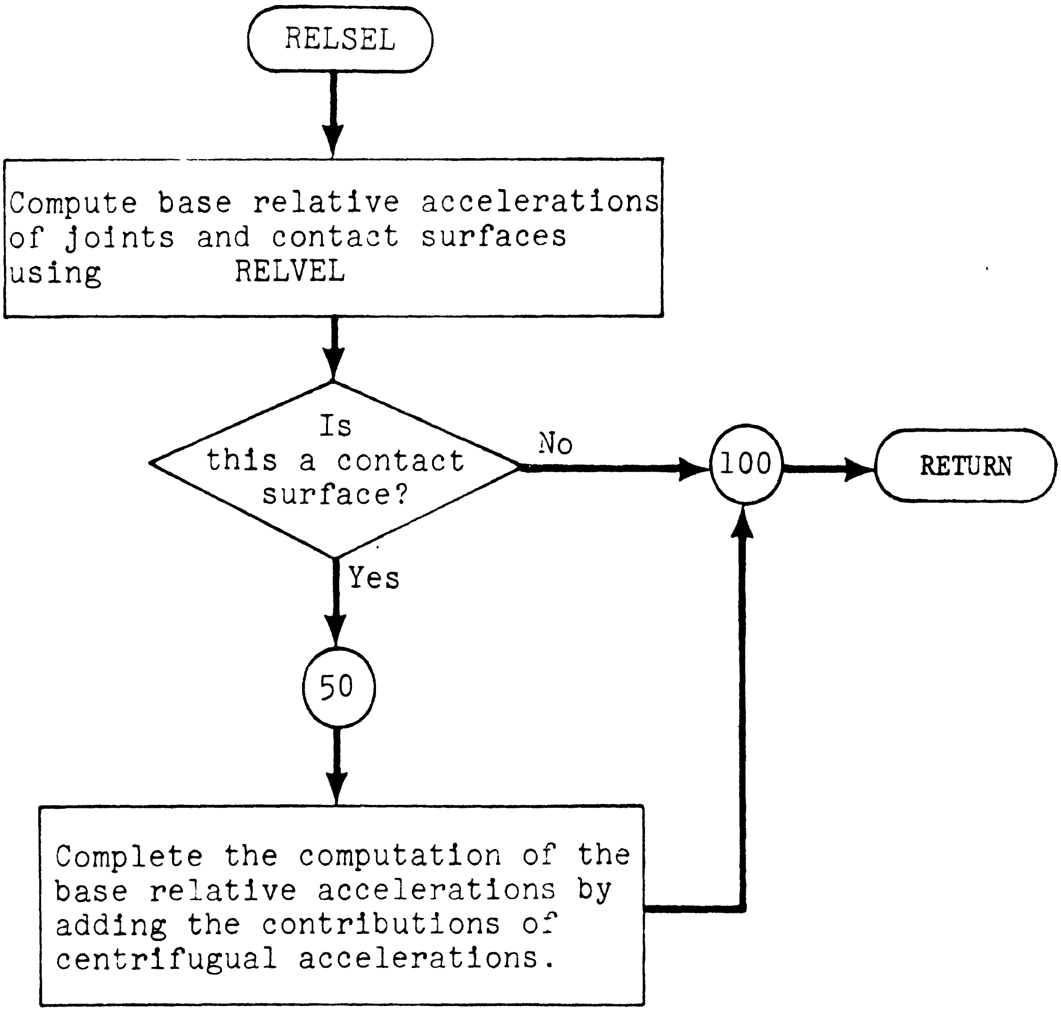
1. Computes head and chest resultant acceleration vectors (magnitudes and angles) at their centers of gravity.
2. Writes normal output on unit 6.
3. Writes data for SUMARY on unit 9.



Subroutine PAGE 4 computes probability data and prints it out after reading three input cards for the necessary information.

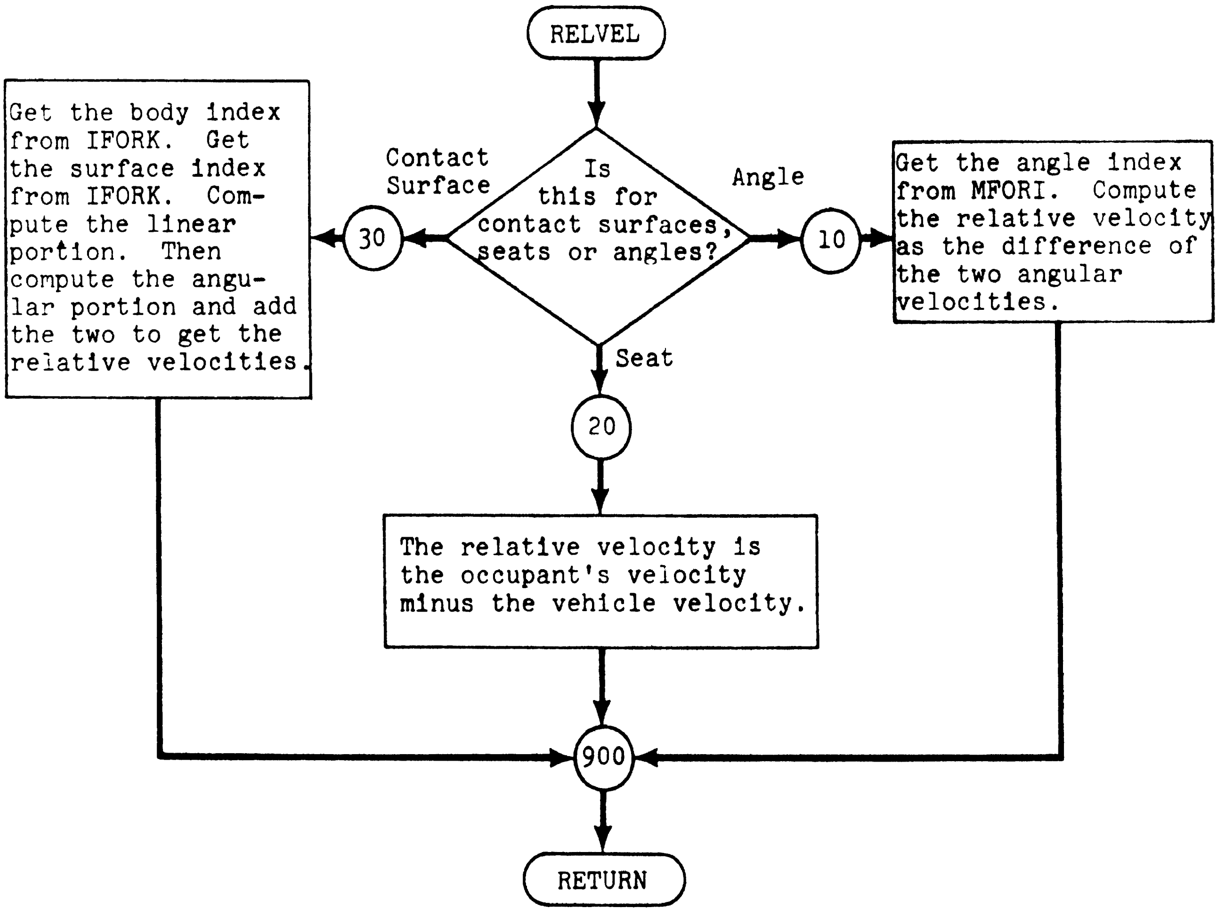


Subroutine RELSEL determines base relative acceleration of joints and contact surfaces subject to jitter via RELVEL and adds contributions of centrifugal accelerations for linear jitter modes.



Subroutine RELVEL

Computes relative velocities between joints or contact surfaces and body segments which are subject to jitter.



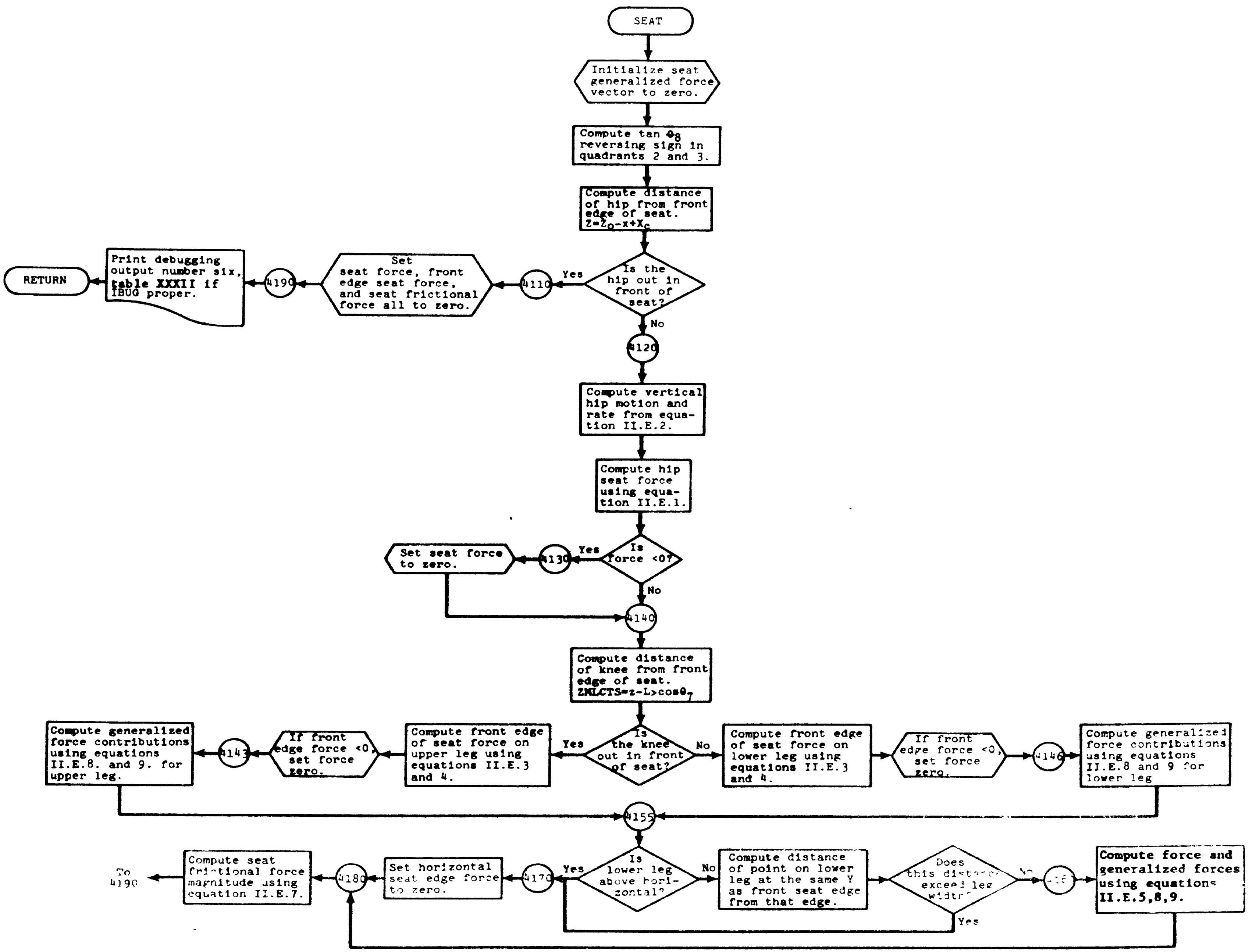
Subroutine SEAT carries out the following steps

1. Computes vertical hip seat force.

2. Computes vertical seat front force and applies it to proper leg segment. Computes horizontal force on lower leg.

3. Computes magnitude of seat friction force.

4. Computes total continuous generalized seat force vector.

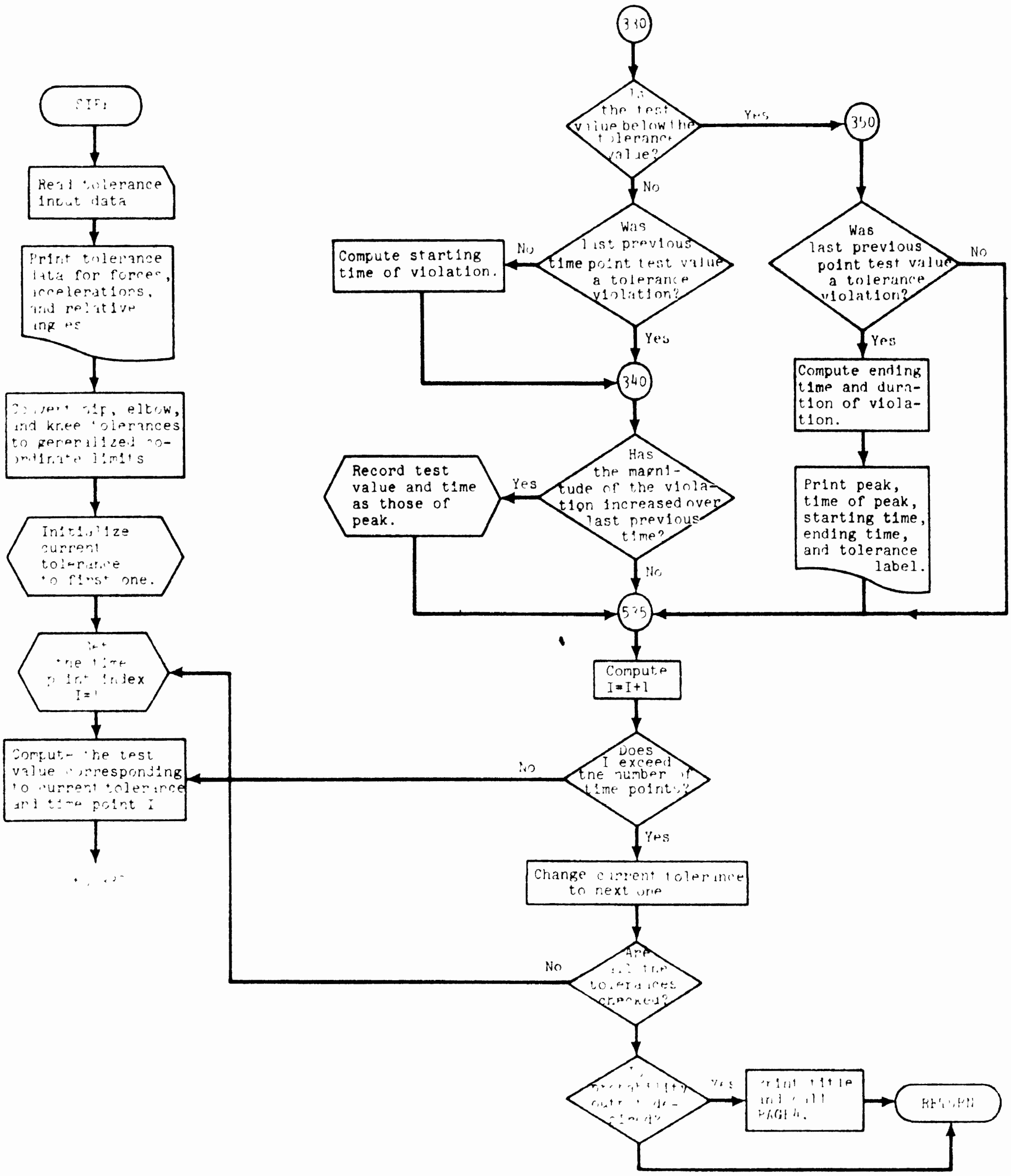

SEAT
Initialize seat generalized force vector to zero.
Compute tan θ8 reversing sign in quadrants 2 and 3.
Compute distance of hip from front edge of seat. Z=Z0-x+Xc
Is the hip out in front of seat?
Yes
No
4110
Set seat force, front edge seat force, and seat frictional force all to zero.
4190
Print debugging output number six, table XXXII if IBUG proper.
RETURN
4120
Compute vertical hip motion and rate from equation II.E.2.
Compute hip seat force using equation II.E.1.
Is force <0?
Yes
4130
Set seat force to zero.
No
4140
Compute distance of knee from front edge of seat. ZMLCTS=z-L>cosθ7
Is the knee out in front of seat?
Yes
Compute front edge of seat force on upper leg using equations II.E.3 and 4.
If front edge force <0, set force zero.
4143
Compute generalized force contributions using equations II.E.8. and 9. for upper leg.
No
Compute front edge of seat force on lower leg using equations II.E.3 and 4.
If front edge force <0, set force zero.
4146
Compute generalized force contributions using equations II.E.8 and 9 for lower leg
4155
Is lower leg above horizontal?
Yes
4170
Set horizontal seat edge force to zero.
4180
Compute seat frictional force magnitude using equation II.E.7.
To 4190
No
Compute distance of point on lower leg at the same Y as front seat edge from that edge.
Yes
Compute force and generalized forces using equations II.E.5,8,9.

Subroutine SIPP carries out the following steps:

1. Reads cards to reset injury tolerance levels (if any) and prints values, etc.

2. Scans certain variables to see if any exceed their tolerance level and prints out values, times, and durations above tolerance for those that do.

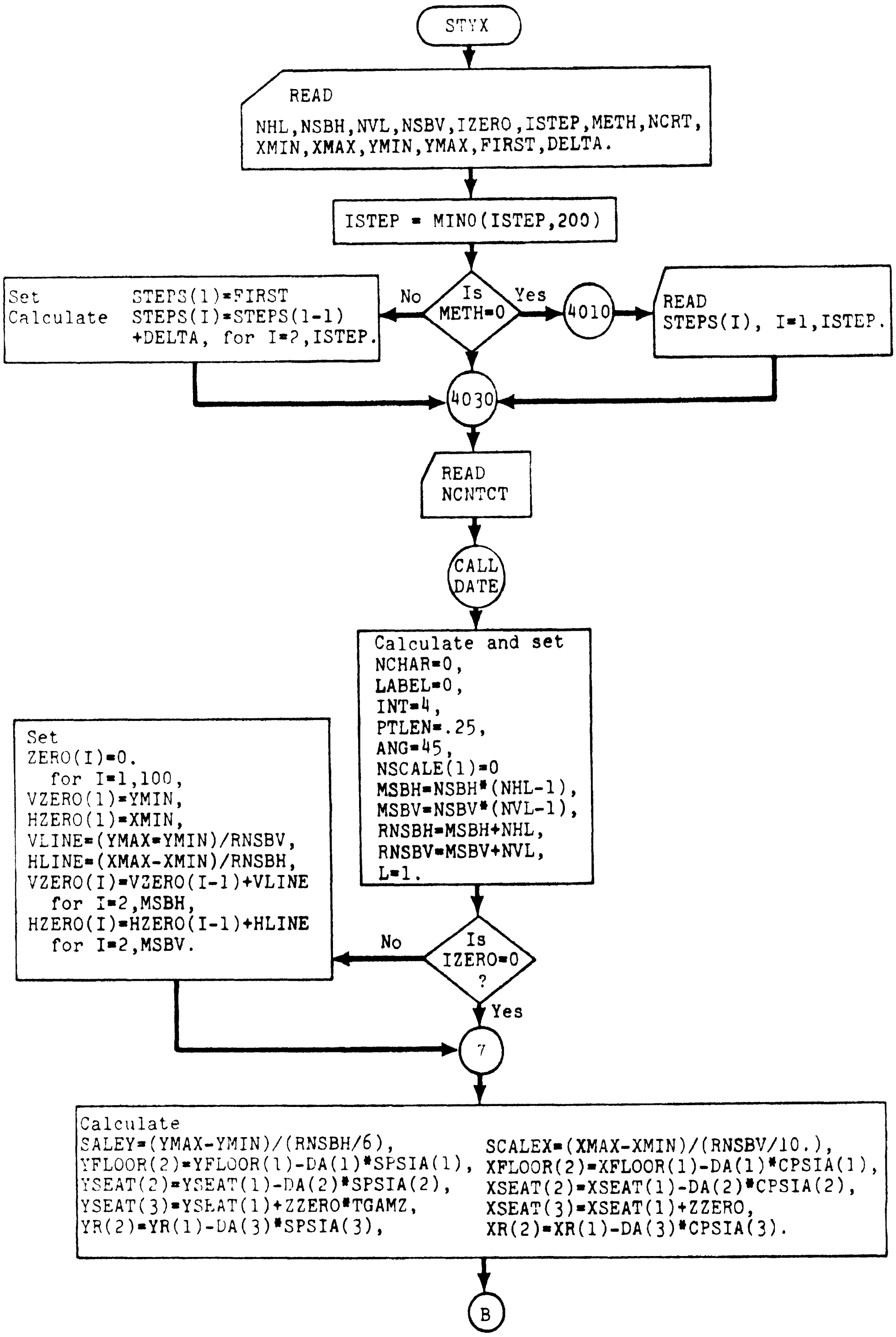
3. Calls PAGE 4 for probability output if desired.

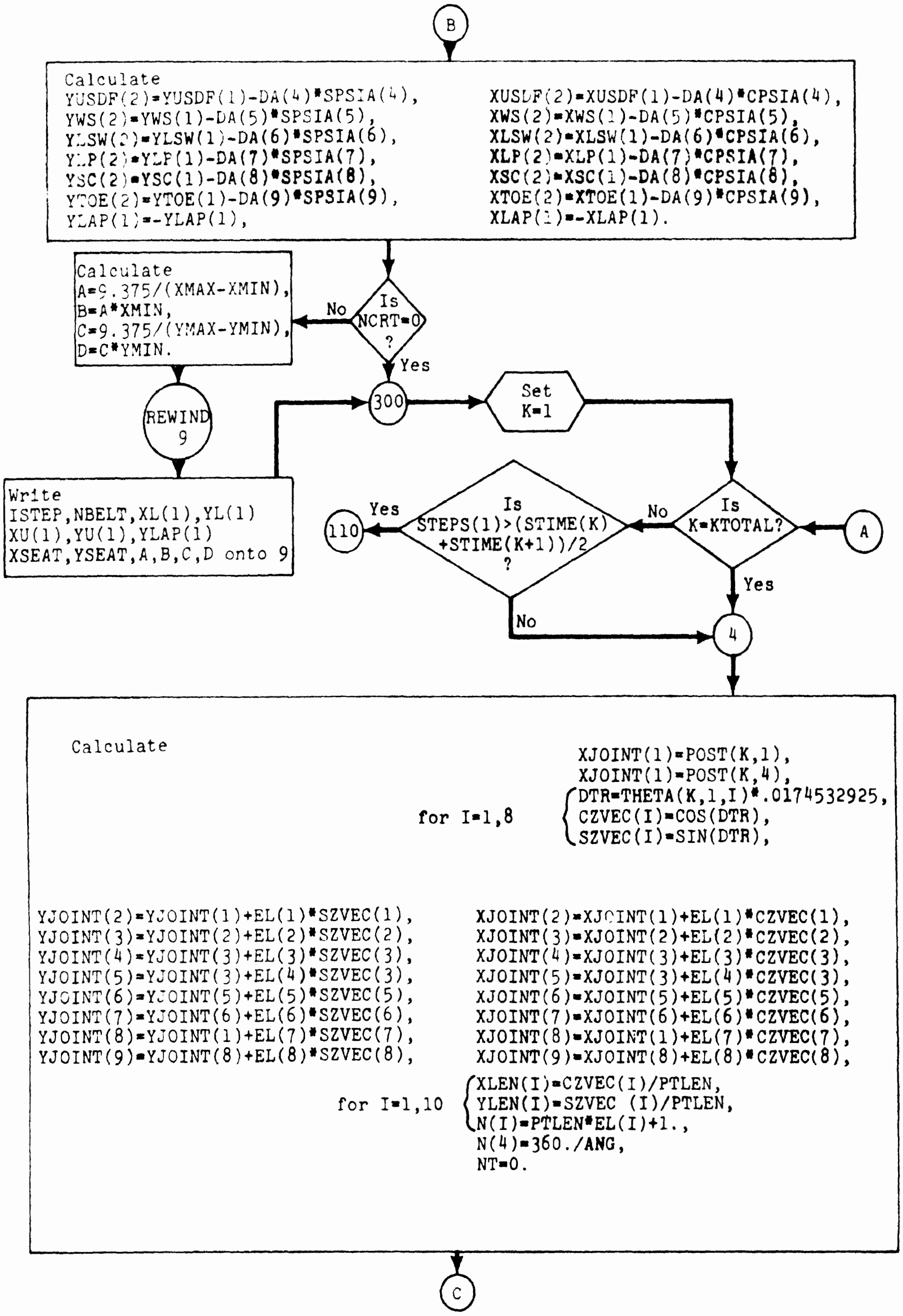


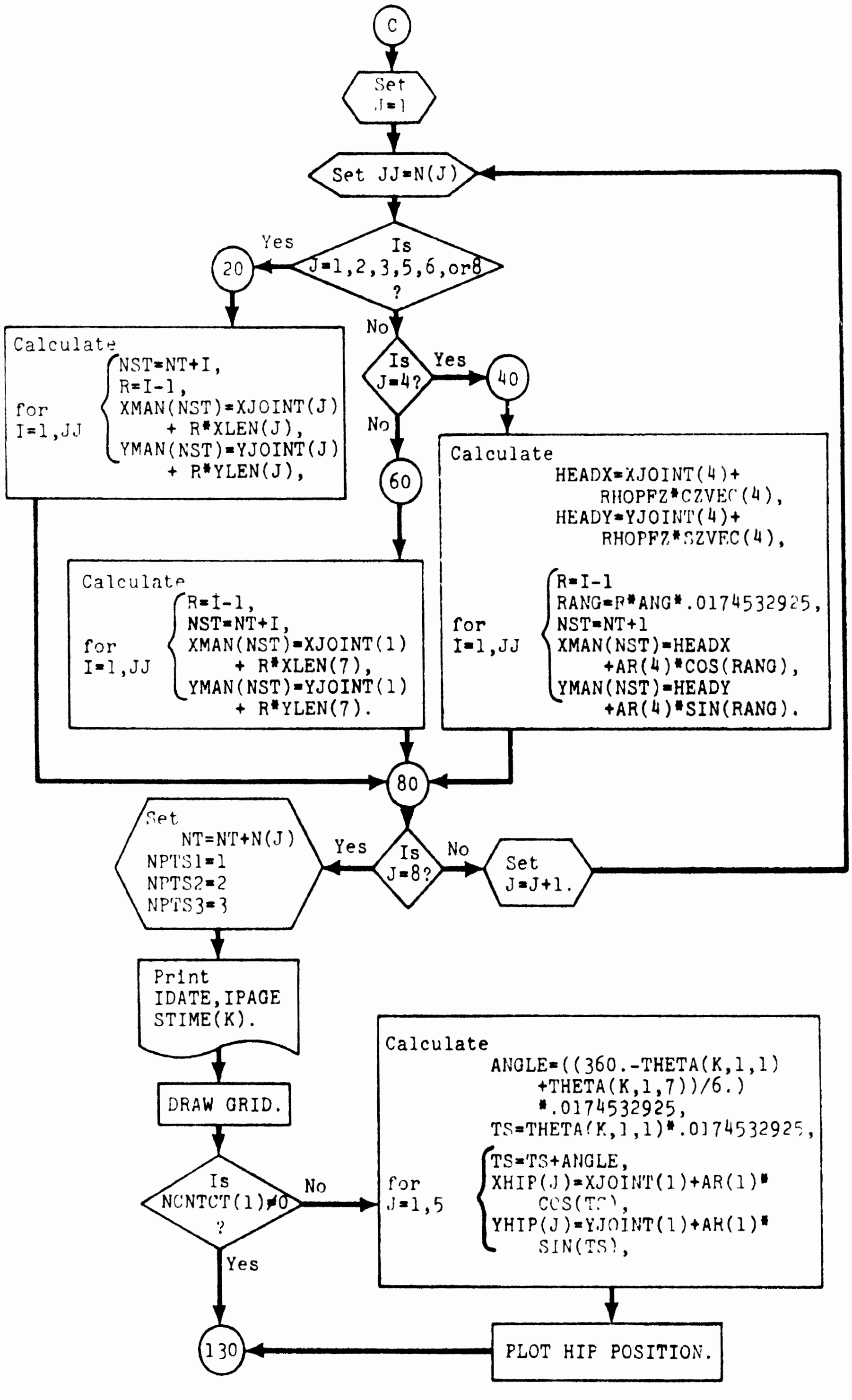
Subroutine STYX carries out the following steps:

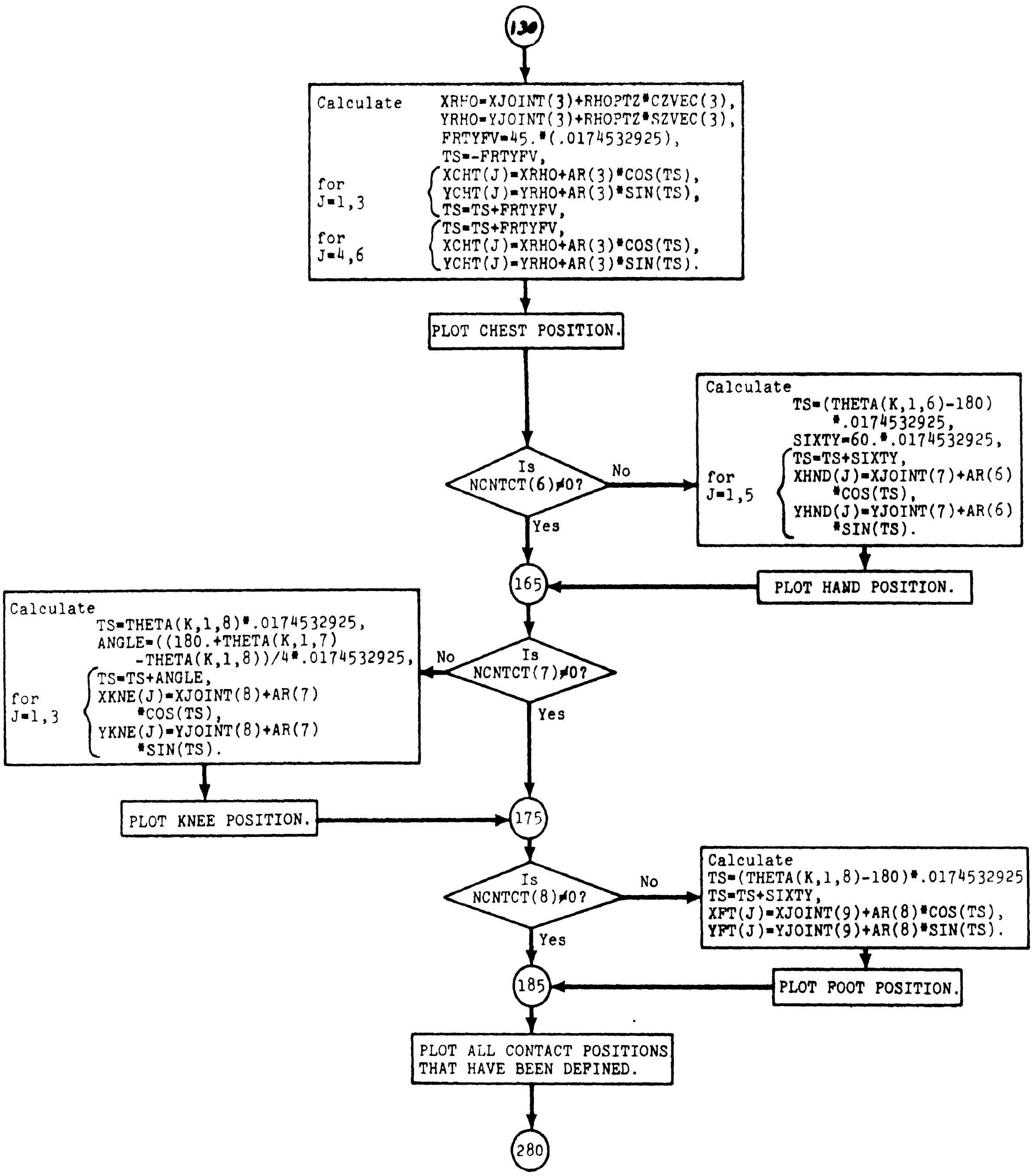
1. Reads its input cards to determine size and content of output stick figures.

2. Computes positions, etc., sets up plot images, and prints.

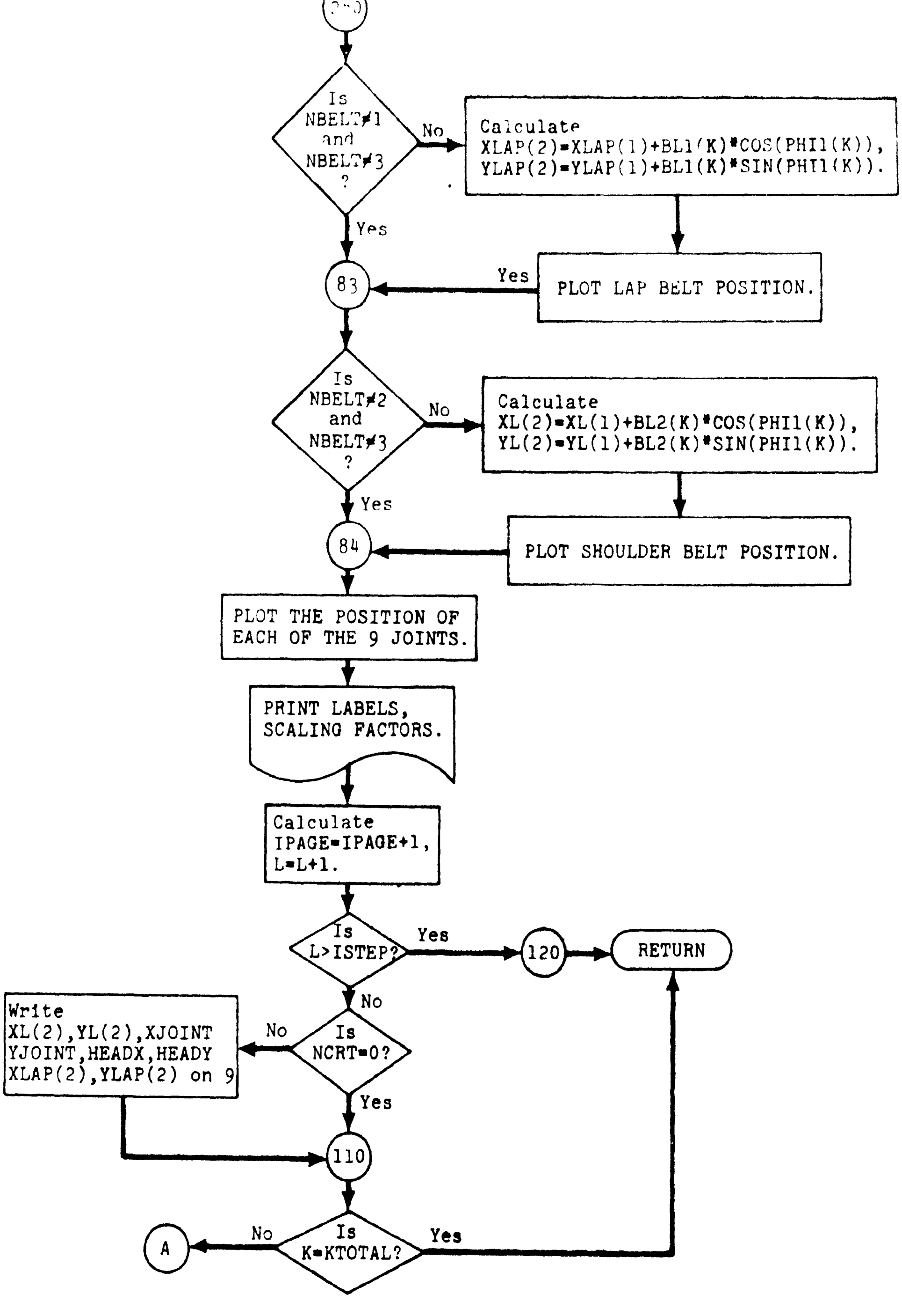



B
Calculate
YUSDF(2)=YUSDF(1)-DA(4)*SPSIA(4),
YWS(2)=YWS(1)-DA(5)*SPSIA(5),
YLSW(2)=YLSW(1)-DA(6)*SPSIA(6),
YLP(2)=YLP(1)-DA(7)*SPSIA(7),
YSC(2)=YSC(1)-DA(8)*SPSIA(8),
YTOE(2)=YTOE(1)-DA(9)*SPSIA(9),
YLAP(1)=-YLAP(1),
XUSDF(2)=XUSDF(1)-DA(4)*CPSIA(4),
XWS(2)=XWS(1)-DA(5)*CPSIA(5),
XLSW(2)=XLSW(1)-DA(6)*CPSIA(6),
XLP(2)=XLP(1)-DA(7)*CPSIA(7),
XSC(2)=XSC(1)-DA(8)*CPSIA(8),
XTOE(2)=XTOE(1)-DA(9)*CPSIA(9),
XLAP(1)=-XLAP(1).
Is NCRT=0 ?
No
Yes
Calculate
A=9.375/(XMAX-XMIN),
B=A*XMIN,
C=9.375/(YMAX-YMIN),
D=C*YMIN.
REWIND 9
Write
ISTEP,NBELT,XL(1),YL(1)
XU(1),YU(1),YLAP(1)
XSEAT,YSEAT,A,B,C,D onto 9
300
Set K=1
Is K=KTOTAL?
A
No
Yes
Is STEPS(1)>(STIME(K) +STIME(K+1))/2 ?
Yes
No
110
4
Calculate
XJOINT(1)=POST(K,1),
XJOINT(1)=POST(K,4),
for I=1,8
DTR=THETA(K,1,I)*.0174532925,
CZVEC(I)=COS(DTR),
SZVEC(I)=SIN(DTR),
YJOINT(2)=YJOINT(1)+EL(1)*SZVEC(1),
YJOINT(3)=YJOINT(2)+EL(2)*SZVEC(2),
YJOINT(4)=YJOINT(3)+EL(3)*SZVEC(3),
YJOINT(5)=YJOINT(3)+EL(4)*SZVEC(3),
YJOINT(6)=YJOINT(5)+EL(5)*SZVEC(5),
YJOINT(7)=YJOINT(6)+EL(6)*SZVEC(6),
YJOINT(8)=YJOINT(1)+EL(7)*SZVEC(7),
YJOINT(9)=YJOINT(8)+EL(8)*SZVEC(8),
XJOINT(2)=XJOINT(1)+EL(1)*CZVEC(1),
XJOINT(3)=XJOINT(2)+EL(2)*CZVEC(2),
XJOINT(4)=XJOINT(3)+EL(3)*CZVEC(3),
XJOINT(5)=XJOINT(3)+EL(4)*CZVEC(3),
XJOINT(6)=XJOINT(5)+EL(5)*CZVEC(5),
XJOINT(7)=XJOINT(6)+EL(6)*CZVEC(6),
XJOINT(8)=XJOINT(1)+EL(7)*CZVEC(7),
XJOINT(9)=XJOINT(8)+EL(8)*CZVEC(8),
for I=1,10
XLEN(I)=CZVEC(I)/PTLEN,
YLEN(I)=SZVEC (I)/PTLEN,
N(I)=PTLEN*EL(I)+1.,
N(4)=360./ANG,
NT=0.
C


C
Set J=1
Set JJ=N(J)
Is J=1,2,3,5,6,or8 ?
Yes
20
Calculate
for I=1,JJ
NST=NT+I,
R=I-1,
XMAN(NST)=XJOINT(J) + R*XLEN(J),
YMAN(NST)=YJOINT(J) + R*YLEN(J),
No
Is J=4?
Yes
40
Calculate
HEADX=XJOINT(4)+ RHOPFZ*CZVEC(4),
HEADY=YJOINT(4)+ RHOPFZ*SZVEC(4),
for I=1,JJ
R=I-1
RANG=R*ANG*.0174532925,
NST=NT+1
XMAN(NST)=HEADX +AR(4)*COS(RANG),
YMAN(NST)=HEADY +AR(4)*SIN(RANG).
No
60
Calculate
for I=1,JJ
R=I-1,
NST=NT+I,
XMAN(NST)=XJOINT(1) + R*XLEN(7),
YMAN(NST)=YJOINT(1) + R*YLEN(7).
80
Is J=8?
No
Set J=J+1.
Yes
Set NT=NT+N(J) NPTS1=1 NPTS2=2 NPTS3=3
Print IDATE,IPAGE STIME(K).
DRAW GRID.
Is NCNTCT(1)≠0 ?
No
Calculate
ANGLE=((360.-THETA(K,1,1) +THETA(K,1,7))/6.) *.0174532925,
TS=THETA(K,1,1)*.0174532925,
for J=1,5
TS=TS+ANGLE,
XHIP(J)=XJOINT(1)+AR(1)* COS(TS),
YHIP(J)=YJOINT(1)+AR(1)* SIN(TS),
Yes
130
PLOT HIP POSITION.



130
Calculate XRHO=XJOINT(3)+RHOPTZ*CZVEC(3), YRHO=YJOINT(3)+RHOPTZ*SZVEC(3), FRTYFV=45.*(.0174532925), TS=-FRTYFV,
for J=1,3 XCHT(J)=XRHO+AR(3)*COS(TS), YCHT(J)=YRHO+AR(3)*SIN(TS), TS=TS+FRTYFV,
for J=4,6 TS=TS+FRTYFV, XCHT(J)=XRHO+AR(3)*COS(TS), YCHT(J)=YRHO+AR(3)*SIN(TS).
PLOT CHEST POSITION.
Is NCNTCT(6)≠0?
No
Yes
Calculate TS=(THETA(K,1,6)-180) *.0174532925, SIXTY=60.*.0174532925,
for J=1,5 TS=TS+SIXTY, XHND(J)=XJOINT(7)+AR(6) *COS(TS), YHND(J)=YJOINT(7)+AR(6) *SIN(TS).
PLOT HAND POSITION.
165
Is NCNTCT(7)≠0?
No
Yes
Calculate TS=THETA(K,1,8)*.0174532925, ANGLE=((180.+THETA(K,1,7) -THETA(K,1,8))/4*.0174532925,
for J=1,3 TS=TS+ANGLE, XKNE(J)=XJOINT(8)+AR(7) *COS(TS), YKNE(J)=YJOINT(8)+AR(7) *SIN(TS).
PLOT KNEE POSITION.
175
Is NCNTCT(8)≠0?
No
Yes
Calculate TS=(THETA(K,1,8)-180)*.0174532925 TS=TS+SIXTY, XFT(J)=XJOINT(9)+AR(8)*COS(TS), YFT(J)=YJOINT(9)+AR(8)*SIN(TS).
PLOT FOOT POSITION.
185
PLOT ALL CONTACT POSITIONS THAT HAVE BEEN DEFINED.
280


Is
NBELT≠1
and
NBELT≠3
?
No
Calculate
XLAP(2)=XLAP(1)+BL1(K)*COS(PHI1(K)),
YLAP(2)=YLAP(1)+BL1(K)*SIN(PHI1(K)).
Yes
83
Yes
PLOT LAP BELT POSITION.
Is
NBELT≠2
and
NBELT≠3
?
No
Calculate
XL(2)=XL(1)+BL2(K)*COS(PHI1(K)),
YL(2)=YL(1)+BL2(K)*SIN(PHI1(K)).
Yes
84
PLOT SHOULDER BELT POSITION.
PLOT THE POSITION OF EACH OF THE 9 JOINTS.
PRINT LABELS, SCALING FACTORS.
Calculate
IPAGE=IPAGE+1,
L=L+1.
Is
L>ISTEP?
Yes
120
RETURN
No
Write
XL(2),YL(2),XJOINT
YJOINT,HEADX,HEADY
XLAP(2),YLAP(2) on 9
No
Is
NCRT=0?
Yes
110
A
No
Is
K=KTOTAL?
Yes

Subroutine SUMARY carries out the following steps:

1. Writes end-of-run indicator on summary record and rewinds it.

2. Reads one instruction data card.

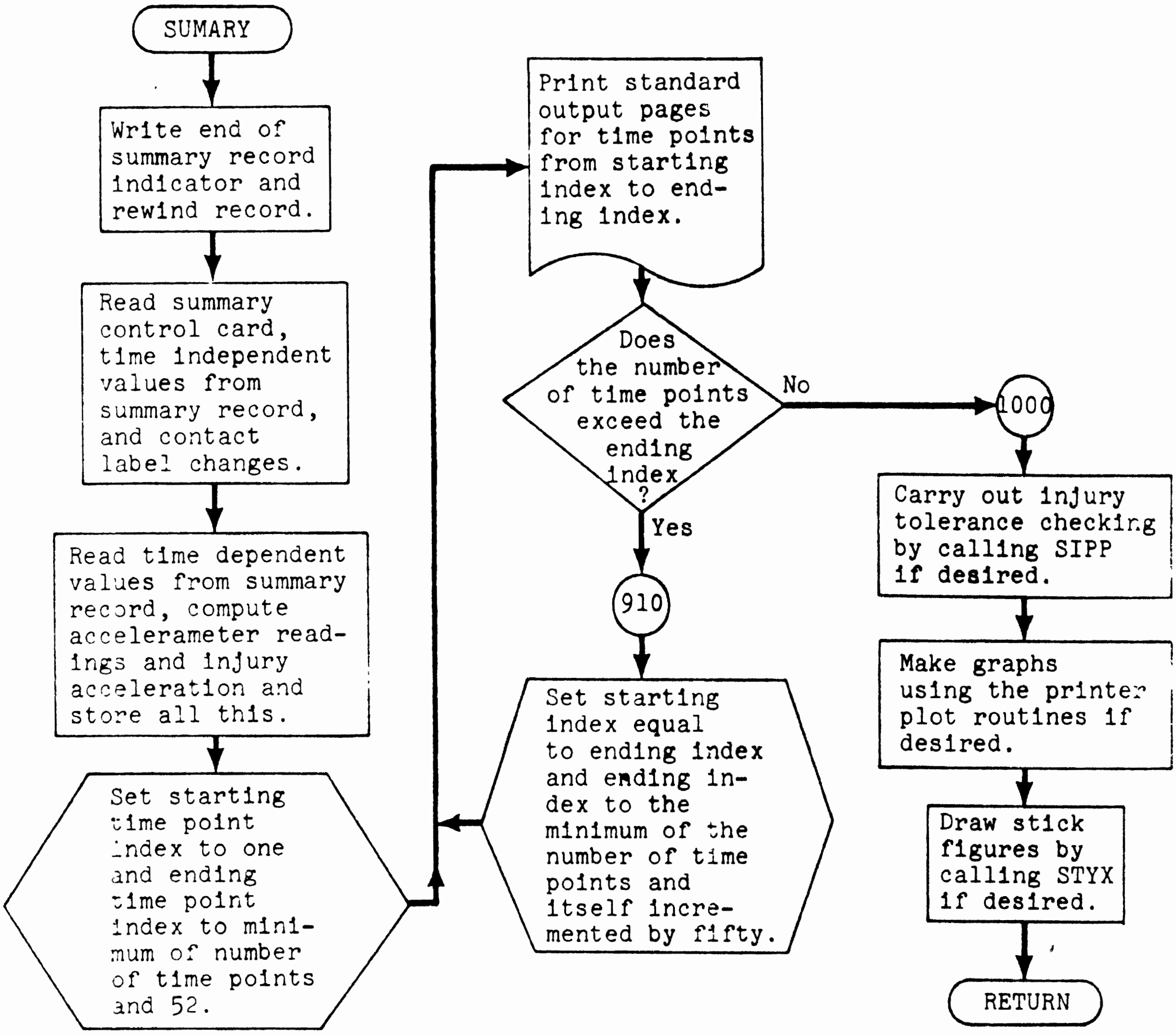
3. Alters labeling of contact surfaces.

4. Reads storage summary record, sets up page images, and prints.

5. Calls SIPP to produce injury criteria if desired.

6. Uses University of Michigan plot subroutines and produces graphical output if desired.

7. Calls STYX to produce stick figures at selected times if desired.



Subroutine TAUMAK carries out the following steps:

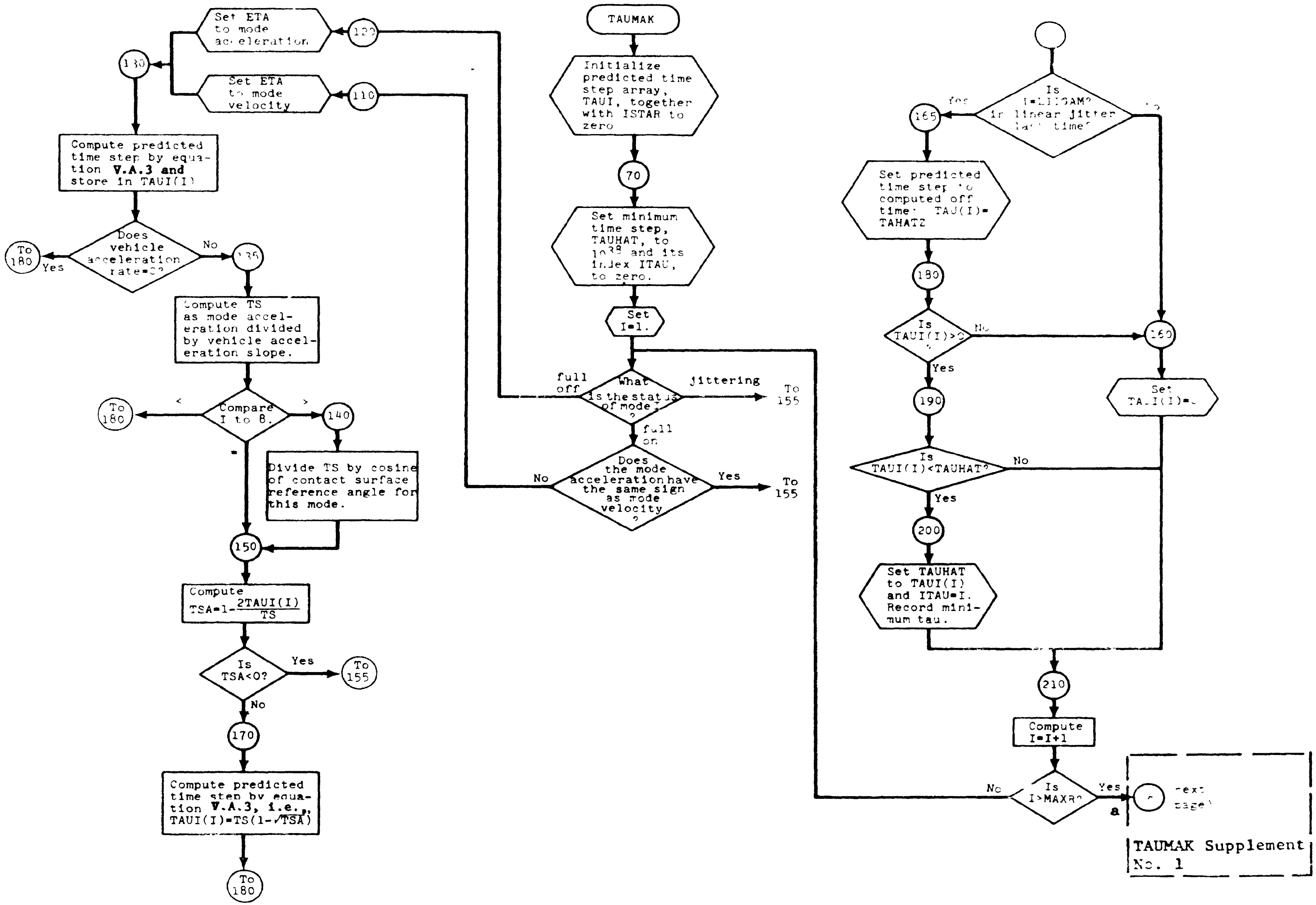
1. Computes time intervals in a manner to reduce the probability of insta-bility.

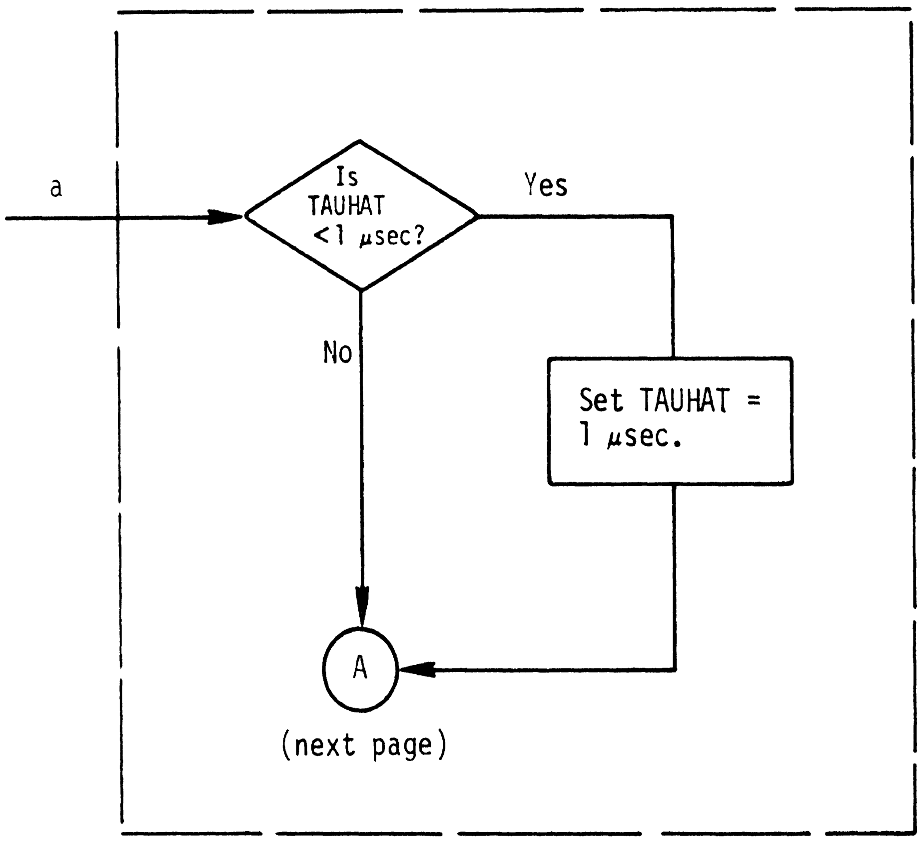
2. Utilizes LIMIDT to check time interval for force change size.

3. Modifies effective acceleration vector to suit time interval.

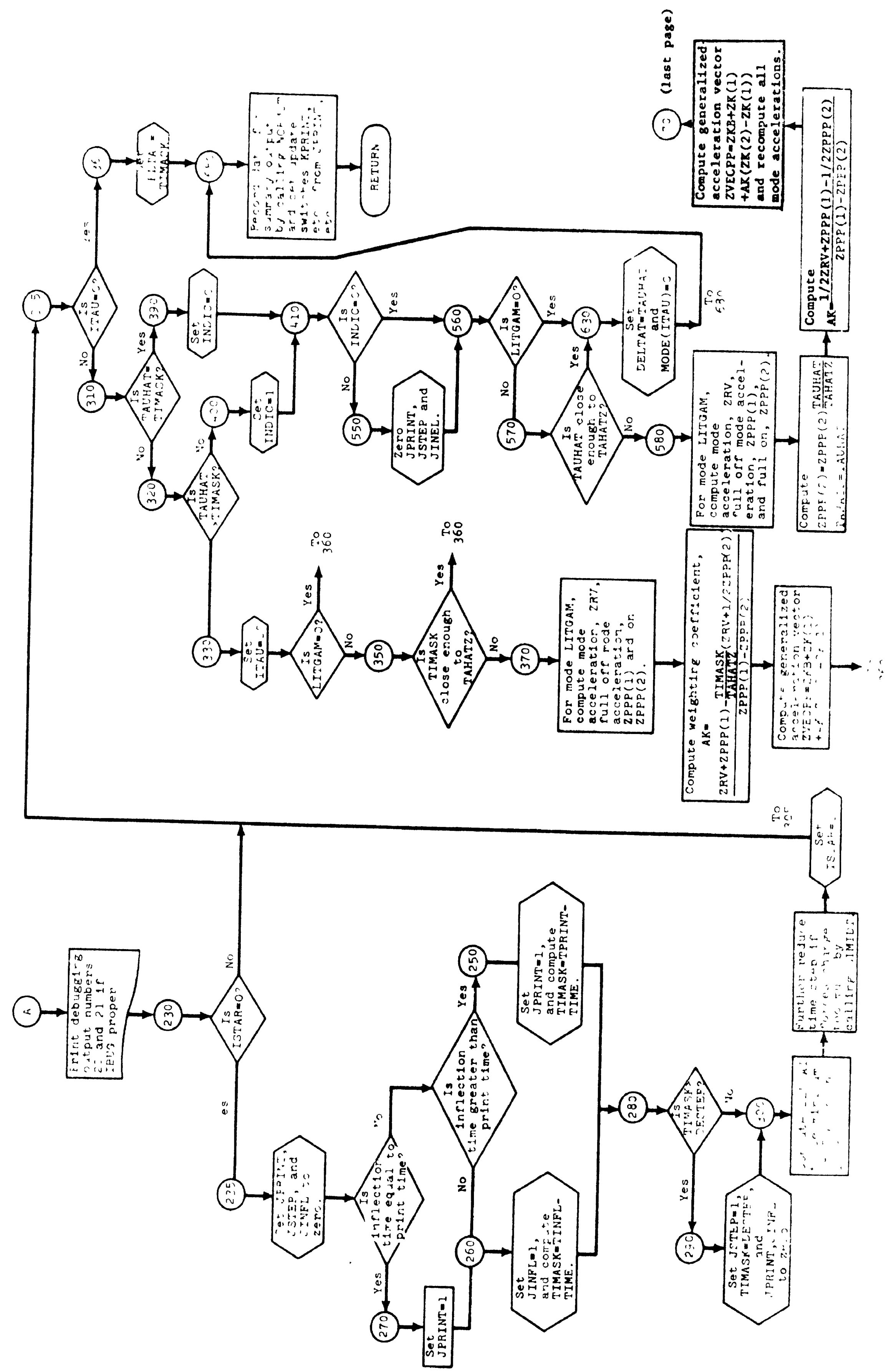
4. Calls NORMUT for normal printout storage.

5. Updates switches.


TAUMAK
Initialize predicted time step array, TAUI, together with ISTAR to zero
70
Set minimum time step, TAUHAT, to and its index ITAU, to zero.
Set I=1.
What is the status of mode I?
full off
jittering
full on
To 155
Does the mode acceleration have the same sign as mode velocity?
Yes
No
110
Set ETA to mode velocity
Set ETA to mode acceleration
130
Compute predicted time step by equation V.A.3 and store in TAUI(I)
Does vehicle acceleration rate=0?
Yes
To 180
No
Compute TS as mode acceleration divided by vehicle acceleration slope.
Compare I to 8.
<
>
140
Divide TS by cosine of contact surface reference angle for this mode.
150
Compute TSA=1-2TAUI(I)/TS
Is TSA<0?
Yes
No
170
Compute predicted time step by equation V.A.3, i.e., TAUI(I)=TS(1-√TSA)
165
Set predicted time step to computed off time: TAU(I)=TAHATZ
180
Is TAUI(I)>0?
No
Yes
160
190
Is TAUI(I)<TAUHAT?
No
Yes
200
Set TAUHAT to TAUI(I) and ITAU=I. Record minimum tau.
210
Compute I=I+1
Is I>MAXR?
No
Yes
a
next page
TAUMAK Supplement No. 1



TAUMAK Supplement No. 1

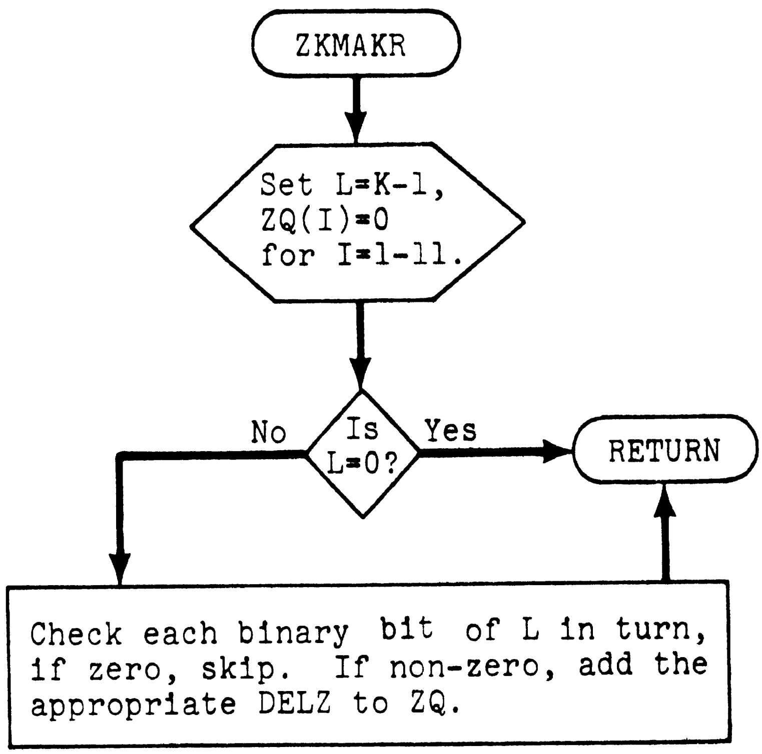


(last page)
Compute generalized acceleration vector ZVECPP=ZKB+ZK(1) +AK(ZK(2)-ZK(1)) and recompute all mode accelerations.
Compute AK=1/2ZRV+ZPPP(1)-1/2ZPPP(2) / ZPPP(1)-ZPPP(2)
RETURN
Is ITAU=0?
Is TAUHAT=TIMASK?
Is TAUHAT<TIMASK?
Set INDIC=0
Set INDIC=1
Is INDIC=0?
Zero JPRINT, JSTEP, and JINEL.
Is LITGAM=0?
Set DELTAT=TAUHAT and MODE(ITAU)=0
Is TAUHAT close enough to TAHATZ?
For mode LITGAM, compute mode acceleration, ZRV, full off mode acceleration, ZPPP(1) and full on, ZPPP(2).
Is TIMASK close enough to TAHATZ?
For mode LITGAM, compute mode acceleration, ZRV, full off mode acceleration, ZPPP(1) and on ZPPP(2).
Compute weighting coefficient, AK= ZRV+ZPPP(1)-TIMASK/TAHATZ(ZRV+1/2ZPPP(2)) / ZPPP(1)-ZPPP(2)
Compute generalized acceleration vector
Print debugging output numbers and if proper
Is ISTAR=0?
Is inflection time equal to print time?
Is inflection time greater than print time?
Set JPRINT=1
Set JINFL=1, and compute TIMASK=TINFL-TIME.
Set JPRINT=1, and compute TIMASK=TPRINT-TIME.
Set JSTEP=1, TIMASK=DELTEE, and JPRINT, JINFL to zero
Yes
No

Subroutine ZKMAKR

Sets up the components of an array of acceleration vectors needed in JITTER.

Its arguments are: K which is the index of the appropriate combination of jitter modes; ZQ (11) which is the vector containing the resultant accelerations due to this combination.

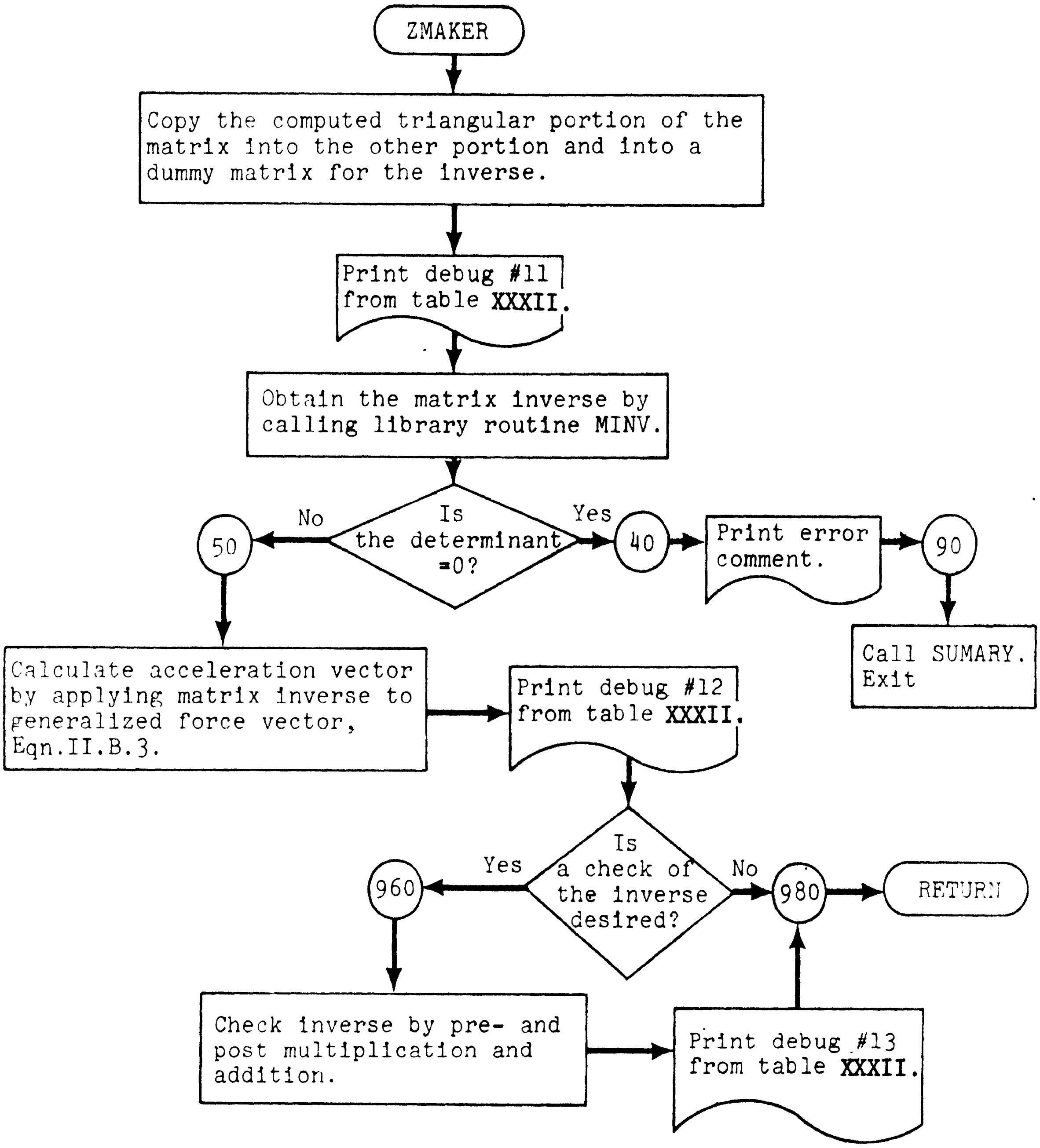


Subroutine ZMAKER carries out the following steps:

1. Inverts matrix by calling on SSP routine.

2. Computes acceleration vector by applying inverse matrix to generalized force vector.

3. Checks matrix inversion by pre- and post-multiplication if desired.



C. SYMBOL DICTIONARY

The dictionary which follows is arranged in alphabetical order by the FORTRAN name of each variable or array used in the program. If the same FORTRAN name is used in different subroutines with different meanings, the meanings are listed on separate lines for each of the uses. The second column is the FORTRAN dimension which is specified for arrays. The third column is the analytical symbol which corresponds to this FORTRAN name and is supplied if such a correspondence exists. The fourth column gives the physical units for those quantities which have them. The numbers shown are subscript ranges if units are not the same for all elements of arrays. The last column is a short definition of the quantity.

As an appendix to the symbol dictionary, there is an alphabetical list of analytical symbols together with the corresponding FORTRAN names of each quantity. This list indicates the name which can be used to find the definition.

Symbol Dictionary (page 1)

FORTRAN Name	Dimension	Symbol	Units	Definition
A	17	a_ℓ	1-8, lb sec^2 9, lb sec^2/in. 10-17, lb in. sec^2	constants used in building matrix, gravity, and centrifugal force vectors
A	36,3	-	-	probability label storage
AA	6	-	-	current probability label
AA	10,10	m	1-8,1-8, lb sec^2 in. 9-10,9-10, lb sec^2/in. rest, lb sec^2	the mass matrix
AACCA	-	-	in./sec^3	third order vehicle position integration coefficient
ACH	-	-	g-units	horizontal acceleration of upper spinal joint
ACHEST	-	-	in./sec^2	resultant acceleration of chest center of gravity
ACHEST	200	-	in./sec^2	resultant acceleration of chest accelerometer
ACOM	5,11	-	-	contact surface label storage
AEL	14	-	lb in./sec^2	constants used in building matrix
AH	-	-	g-units	horizontal acceleration of neck joint
AHEAD	-	-	in./sec^2	resultant acceleration of head center of gravity

Symbol Dictionary (page 2)

FORTRAN Name	Dimension	Symbol	Units	Definition
AHEAD	200	-	in./sec^2	resultant acceleration of head accelerometer
AK	-	$\bar{a}_k$	-	weighting coefficient for jitter mode
ALFAI	7	α_i	rad	joint stop lower relative angle limit
ALP1I	-	-	-	imaginary part of root, first approximation
ALP1R	-	-	-	real part of root, first approximation
ALP2I	-	-	-	imaginary part of root, second approximation
ALP2R	-	-	-	real part of root, second approximation
ALP3I	-	-	-	imaginary part of root, third approximation
ALP3R	-	-	-	real part of root, third approximation
ALP4I	-	-	-	imaginary part of root, fourth approximation
ALP4R	-	-	-	real part of root, fourth approximation
ANG	-	-	deg	angular spacing of dots in head representation in stickman output
ANGLE	-	-	rad	angular spacing of plus signs in contact arc representation in stickman output
ANS	-	-	rad	absolute value of arcsine

Symbol Dictionary (page 3)

FORTRAN Name	Dimension	Symbol	Units	Definition
ANVERS	10,10	m^{-1}	inverse of AA	inverse of mass matrix
APRNTD	-	-	sec	minimum print time interval
AR	8	r_i	in.	body contact arc radii
ARCSIN	-	-	rad	principal value of arcsine
ATDSQ	8	-	lb	intermediate step in centrifugal force vector computation
AVELA	-	-	in./sec^3	second order vehicle velocity integration coefficient
AX	8	x_i	in.	joint x-coordinates
AXD	8	$\dot{x}_i$	in./sec	joint x-velocities
AXI	-	-	-	imaginary part of trial root
AXR	-	-	-	real part of trial root
AY	8	y_i	in.	joint y-coordinates
AYD	8	$\dot{y}_i$	in./sec	joint y-velocities
AZ	11	z_k	1-8, rad 9-11, in.	generalized coordinate vector
AZP	11	$\dot{z}_k$	1-8, rad/sec 9-11, in./sec	generalized velocity vector

Symbol Dictionary (page 4)

FORTRAN Name	Dimension	Symbol	Units	Definition
B	-	-	in.	horizontal CRT scaling term (vestigial)
B	4,2	-	-	joint direction label storage
BACCB	-	-	in./sec^2	second order vehicle position integration coefficient
BASIC	11,8	-	1-10, in. 11, in./sec^2	elements one through five are lever arms for contact frictional forces; elements six through ten are lever arms for contact normal forces; element eleven is centrifugal force term for contact relative accelerations
BBB	300,3	-	1, in./sec^2 2,3, -	intercept for piecewise linear tables
BCH	-	-	g-units/in.	upper torso horizontal acceleration linear coefficient
BEE	10	B_i	1-8, in. lb 9-10, lb	centrifugal force vector
BELL	-	-	-	temporary storage for imaginary part of polynomial evaluation
BELTA	200	-	lb	lap belt force storage
BELTB	200	-	lb	lower shoulder belt force storage
BELTC	200	-	lb	upper shoulder belt force storag

Symbol Dictionary (page 5)

FORTRAN Name	Dimension	Symbol	Units	Definition
BETA	3	β_m	1, lb/in. 2, $lb/in.^2$ 3, $lb/in.^3$	hip seat force spring coefficients
BET1I	-	-	-	imaginary part of first polynomial evaluation
BET1R	-	-	-	real part of first polynomial evaluation
BET2I	-	-	-	imaginary part of second polynomial evaluation
BET2R	-	-	-	real part of second polynomial evaluation
BET3I	-	-	-	imaginary part of third polynomial evaluation
BET3R	-	-	-	real part of third polynomial evaluation
BH	-	-	g-units/in.	head horizontal acceleration linear coefficient
BIGKI	7	K_i	in. lb/rad	joint elasticity coefficient for each joint
BIGMI	8	J_e	in. lb	joint elasticity torque for each joint
BL	3	l_k	in.	belt segment length for each belt segment
BL1	200	-	in.	lap belt length storage
BL2	200	-	in.	lower shoulder belt length storage
BL3	200	-	in.	upper shoulder belt length storage

Symbol Dictionary (page 6)

FORTRAN Name	Dimension	Symbol	Units	Definition
BPRNTD	-	-	sec	first time for summary printing
BVELB	-	-	in./sec^2	first order vehicle velocity integration coefficient
C	-	-	-	vertical CRT scaling factor (vestigial)
C	3,7	-	-	joint label storage
CACCC	-	-	in./sec	first order vehicle position integration coefficient
CARD	5	-	-	temporary storage for reading input cards
CARD	8	-	-	temporary storage for reading input cards
CAZ	8	-	-	cosines of body angles
CCF	200,4	-	lb	chest contact forces storage
CCH	-	-	g-units	vertical acceleration of upper spinal joint
CEE	10	C_k	1-8, in. lb 9-10, lb	joint generalized force vector
CFA	200	-	in./sec^2	chest forward acceleration storage
CH	-	-	g-units	vertical acceleration of neck joint
CI	-	-	-	tolerance index as input data
CK	10,10	-	-	sum of pre- and post-matrix multiplications of matrix and inverse as check

Symbol Dictionary (page 7)

FORTRAN Name	Dimension	Symbol	Units	Definition
CKF	200	-	lb	knee contact force storage
COE	6	-	-	temporary storage for reordering load deflection coefficients
COE	16	-	-	polynomial coefficients in descending order
COMI	3,8	-	-	body contact segment label storage
CONEN	18	C_1	lb/in.	first order unloading coefficient for each interaction
CONTAC	200,21	-	lb	contact force storage
CPHI	3	-	-	cosines of belt angles
CPRIME	7	C_i'	in. lb	joint coulomb friction coefficients
CPSIA	10	-	-	cosines of contact surface reference angles
CS	-	C_s	lb sec/in.	hip seat force damping coefficient
CTHETA	8	-	-	cosines of body angles
CTHETZ	8	-	-	cosines of body angles at time zero
CTWON	18	C_2	lb/in.^{2}	second order unloading coefficient for each interaction
CUA	200	-	in./sec^2	chest upward acceleration storage
CVELA	-	-	in./sec	zeroth order vehicle velocity integration coefficient

Symbol Dictionary (page 8)

FORTRAN Name	Dimension	Symbol	Units	Definition
CZERON	18	C_O	lb	zeroth order unloading coefficient for each interaction
CZVEC	8	-	-	cosines of body angles for stick figure
C0	-	-	-	coefficient in arcsine evaluation
C1	-	-	-	coefficient in arcsine evaluation
C2	-	-	-	coefficient in arcsine evaluation
C3	-	-	-	coefficient in arcsine evaluation
C4	-	-	-	coefficient in arcsine evaluation
C5	-	-	-	coefficient in arcsine evaluation
C6	-	-	-	coefficient in arcsine evaluation
C7	-	-	-	coefficient in arcsine evaluation
D	-	-	in.	vertical CRT scaling term (vestigial)
DA	10	-	in.	contact surface lengths
DACCD	-	-	in.	zeroth order vehicle position integration coefficient
DCH	-	-	g-units/in.	upper torso vertical acceleration linear coefficient
DEE	10	D_i	1-8, in. lb 9-10, lb	seat and belt generalized force vector

Symbol Dictionary (page 9)

FORTRAN Name	Dimension	Symbol	Units	Definition
DELDOD	18	$\dot{\delta}_{m-1}$	in./sec	previous deflection rate for each interaction
DELET	-	-	in. lb	change in energy over time interval
DELIA	-	-	in.	contact deflection
DELIAD	-	-	in./sec	contact deflection rate
DELL	-	Δ	in.	slack
DELNN	-	$\Delta\nu$	accel	change in mode acceleration between two jitter states for a linear mode
DELNU	-	$\Delta\nu$	accel	change in mode acceleration between two jitter states
DELOLD	18	δ_{m-1}	in.	previous deflection for each interaction
DELTA	3	Δ	in.	belt slack for each belt segment
DELTA	-	-	sec	time interval between stick figures
DELTAT	-	Δt	sec	integration time interval
DELZ	11,16	$\Delta\ddot{Z}_i$	1-8, rad/sec^2 9-11, in./sec^2	change in generalized acceleration vector due to each possible jitter mode acting alone
DESPA	3,6	-	-	body contact arc labels
DESPB	6	-	-	vestigial

Symbol Dictionary (page 10)

FORTRAN Name	Dimension	Symbol	Units	Definition
DESPC	5,6	-	-	contact surface labels
DESTEP	-	Δt_{min}	sec	minimum integration time interval
DETERM	-	-	-	determinant of mass matrix
DE15	-	-	-	temporary storage in MULLER
DE16	-	-	-	temporary storage in MULLER
DH	-	-	g-units/in.	head vertical acceleration linear coefficient
DISP	-	x-X	in.	displacement of hip relative to vehicle
DTPRNT	-	-	sec	print time interval for normal summary output
DTR	-	$\pi/180$	rad/deg	degrees to radian conversion factor
DTR	-	-	rad	temporary storage for body angles
DUR	-	-	sec	duration of injury tolerance violation
EHAT	18	$\hat{E}$	in. lb	reference conserved energy per loading cycle for each interaction
EL	8	L_i	in.	body segment lengths except element four which is distance from upper spine to shoulder
ELAMB	6	λ_i	in.	initial condition parameters for belts

Symbol Dictionary (page 11)

FORTRAN Name	Dimension	Symbol	Units	Definition
ELP	5	L'	in.	temporary storage for proper body lengths used in computing lever arms for contacts
ELPTEN	-	l'_{10}	in.	initial distance between hip and lap belt anchor point
ELTHRY	-	l_{30}	in.	initial upper shoulder belt length
ELTWTY	-	l_{20}	in.	initial lower shoulder belt length
ELZTEN	-	l_{10}	in.	initial lap belt length
EM	8	m_i	lb sec^2/in.	body segment mass for each segment
EMC	-	m_c	lb sec^2/in.	vehicle mass (vestigial)
EMFVSX	-	-	lb sec^2/in.	total mass of arms
EMTHSX	-	-	lb sec^2/in.	total mass of upper torso, head, and arms
EMTWSX	-	-	lb sec^2/in.	total mass of upper half of body (from middle torso and including arms)
EONE	18	E_1	in. lb	total conserved energy for each interaction
EONEC	-	E_c	in. lb	vehicle conserved energy (vestigial)
EPSLNP	-	ε'	in.	residual deformation when loading begins again before unloading is complete
EPSLNY	18	ε	in.	cumulative permanent deformation for each interaction

FORTRAN Name	Dimension	Symbol	Units	Definition
EPSLNZ	-	ε_o	sec	linear mode time interval convergence limit
ET	18	E_t	in. lb	total energy for current cycle for each interaction
ETA	-	η	-	determines sign of relative velocity limit used in time prediction of entering jitter
EYE	8	I_i	lb sec^2	body segment moment of inertias at center of gravity
E0	-	$\hat{E}_o$	in. lb	reference conserved energy for prediction
FAB	10	-	lb.	saturation limit stored on contact number
FARB	18	-	lb.	saturation limit stored on interaction number
FEPTEN	-	ϕ'_{10}	rad	angle of line joining lap belt anchor and hip joint from horizontal at time zero
FFM	3	F_m	lb	belt forces for each segment
FIRST	-	-	sec	first time at which a stick figure is desired
FMAX1	-	-	lb	maximum value of all belt forces in crash
FMAX2	-	-	in./sec^2	maximum value of head and chest accelerations in crash
FMAX3	-	-	in.	maximum value of hip x and y coordinates relative to the vehicle in crash
FMAX4	-	-	in./sec^2	maximum value of vehicle acceleration in crash
FMAX5	-	-	deg	maximum value of angles of head and chest accelerations in crash

Symbol Dictionary (page 13)

FORTRAN Name	Dimension	Symbol	Units	Definition
FMAX6	-	-	lb	maximum value of seat hip and seat front forces in crash
FMIN1	-	-	lb	minimum value of all belt forces in crash
FMIN2	-	-	in./sec^2	minimum value of head and chest accelerations in crash
FMIN3	-	-	in.	minimum value of hip x and y coordinates relative to the vehicle in crash
FMIN4	-	-	in./sec^2	minimum value of vehicle acceleration in crash
FMIN5	-	-	deg	minimum value of angles of head and chest accelerations in crash
FMIN6	-	-	lb	minimum value of seat hip and seat front forces in crash
FMM	300,3	-	1, in./sec^2 2,3, -	slope of subsequent input table segment
FMUA	10	μ_a	-	contact surface coefficients of friction
FMUS	-	μ_s	-	seat cushion coefficient of friction
FOM	-	Ω	in.	latest maximum deflection
FORCE	-	F	lb	predicted contact force
FRTYFV	-	$\pi/4$	rad	forty-five degrees in radians
FS	-	F_s	lb	hip seat force

Symbol Dictionary (page 14)

FORTRAN Name	Dimension	Symbol	Units	Definition
FSPRM	-	F'_s	lb	front edge seat force
FSPRMZ	-	F'_{s0}	lb	front edge seat force at time zero
FSZCNS	-	-	lb	constant used in front edge seat force determination representing force calibration at zero time
FT	-	F	lb	predicted force
FTOLD	18	F_{m-1}	lb	previous force for each interaction
FTT	-	F	lb	predicted force
FUDGE	-	-	in.	distance from contact surface used as maximum distance error caused by time prediction error in linear jitter modes
FZ	-	F_z	lb	forward seat front edge force
G	18	G	-	material plasticity index, i.e., the ratio of permanent deformation to maximum deflection, for each interaction
GA	10	G_a	-	material plasticity index for each contact surface
GAMZER	-	γ_o	deg	angle of seat cushion surface from horizontal
GCHEST	200	-	deg	angle of chest accelerometer acceleration storage
GEE	10	G_i	1-8, in. lb 9,10, lb	negative of gravitational generalized force vector

Symbol Dictionary (page 15)

FORTRAN Name	Dimension	Symbol	Units	Definition
GHEAD	200	-	deg	angle of head accelerometer acceleration storage
GNEW	-	-	-	plasticity index
GOMG	-	-	in.	required off deflection for unloading curve
GRAVA	10	-	1-8, in. lb 9, lb	parameters used in computation of gravitational generalized force vector; element ten is vestigial
GRAVIT	-	g	in./sec^2	acceleration of earth standard gravity (32.2)
H	-	h	in.	distance from the point of action of the lower shoulder belt from lower spinal joint along centerline of middle torso
HELL	-	-	-	temporary storage of real part of polynomial evaluation
HEADX	-	x_h	in.	x-coordinate of head center of gravity
HEADX	-	-	in.	x-coordinate of center of curvature of head
HEADY	-	y_h	in.	y-coordinate of head center of gravity
HEADY	-	-	in.	y-coordinate of center of curvature of head
HFA	200	-	in./sec^2	head forward acceleration at center of gravity storage
HLA	200	-	in./sec^2	vestigial
HLINE	-	-	in.	horizontal distance represented per grid line

Symbol Dictionary (page 16)

FORTRAN Name	Dimension	Symbol	Units	Definition
HZERO	130	-	in.	horizontal distance represented at plot origin
I	-	i	-	general index but often body segment index
IA	-	a	-	contact surface index
IALPH	26	-	-	contains alphabetic characters for identifying input cards
IBIG	8	I_k	-	contains indices of modes in jitter state in order that they came in jitter except for linear jitters which are always last
IBUG	-	-	-	debug printout control level
IC	-	-	-	input card counter
ID	-	-	-	input card identification field storage
IDATE	3	-	-	contains calendar date of the current run
IFORK	3,8	-	-	element one is body segment index, element two is contact surface index, and element three is the interaction index for each of eight possible linear jitter modes
IGNORE	10	-	-	contains a switch for each of the contacts which tells whether the surface is not used or has no friction
II	-	i	-	body segment index
IMAGE	1392	-	-	temporary storage for prediction of summary plots

FORTRAN Name	Dimension	Symbol	Units	Definition
IMAGE	1500	-	-	temporary storage for prediction of stick figures
IMAX	-	-	-	index of last time point of input table
IMIN	-	-	-	index of latest inflection point of input table
IND	-	-	-	code index for combination of on and off states being tried to resolve jittering modes
INDEX	-	-	-	index of contact interaction
INDIC	-	-	-	switch indicating whether to reset inflection, print and step switches to zero if jitter mode time is selected
INN	-	-	-	In common /IO/, logical device number for input
INN	-	-	-	index used in contact friction bookkeeping
INT	-	-	-	number of spacer points between plotted points
IPAGE	-	-	-	page number counter
IPOST	3	-	-	pointer for latest input table entry used
ISON	-	-	-	switch indicating whether a tolerance violation is in progress during a scan of values for all time
ISTAR	-	i*	-	switch indicating need for force limiting
ISTART	-	-	-	index of starting time point on printed page
ISTEP	-	-	-	maximum number of stick figure times

Symbol Dictionary (page 18)

FORTRAN Name	Dimension	Symbol	Units	Definition
ISTOP	-	-	-	index of stopping time point on printed page
ISW	-	-	-	extracted mode contribution inclusion switch
ISWT	18	-	-	saturation switch stored on interaction number
ISWT	-	-	-	switch to control new page title printing
ITABLE	-	-	-	input table number
ITAU	-	-	-	index of mode with minimum time to reach jitter
ITOL	-	-	-	temporary storage for tolerance limit data
ITOP	-	-	-	number of possible jitter mode combinations
ITOPOW	-	-	-	two raised to an integer power
ITPH	-	-	-	(vestigial)
IZERO	-	-	-	switch controlling zero line printing
J	-	j	-	general index
JFORK	8	-	-	temporary storage for previous linear jitter mode contact interaction indices
JI	-	-	-	inflection switch for prediction
JINFL	-	-	-	temporary inflection switch
JJ	-	-	-	general index often maximum number of nonzero contact forces at any time

Symbol Dictionary (page 19)

FORTRAN Name	Dimension	Symbol	Units	Definition
JK	-	-	-	general index
JL	-	-	-	general index
JNN	-	-	-	(vestigial)
JOINT	9	-	-	stick figure joint index labels
JP	-	-	-	print switch for prediction
JPRINT	-	-	-	temporary print switch
JS	-	-	-	time step switch for prediction
JSTEP	-	-	-	temporary time step switch
K	-	k	-	general index often maximum number of time points for summary printout or index of present jitter mode
KA	8	a	-	contact surface index for each nonzero force
KI	8	i	-	body contact arc index for each nonzero force
KINFL	-	-	-	inflection switch
KK	-	-	-	general index
KKK	-	-	-	general index
KN	-	-	-	index of second linear jitter mode

Symbol Dictionary (page 20)

FORTRAN Name	Dimension	Symbol	Units	Definition
KPOST	-	-	-	index of current input table entry
KPRINT	-	-	-	print switch
KSTEP	-	-	-	time step switch
KTABLE	2,14	-	-	contains the body arc and contact surface indices for each of the allowable interactions for the current passenger position; the interaction index is the second subscript plus four
KTOTAL	-	-	-	total number of time points for printout
KTS	-	-	-	temporary value of KPOST
L	-	l	-	general index
LA	21	a	-	contact surface indices for contact force printout
LABEL	-	-	-	switch indicating no plot label for stick figure
LCONTL	-	-	-	switch controlling some standard printout options
LI	21	i	-	body arc indices for contact force printout
LINE	-	-	-	line counter for page length control of printout
LITGAM	-	γ	-	index of linear jitter mode
LL	-	-	-	general index
LODSWT	18	-	-	saturation control switch on interaction number
LSWT	10	-	-	saturation control switch on contact number

Symbol Dictionary (page 21)

FORTRAN Name	Dimension	Symbol	Units	Definition
M	-	m	-	general index, often the index of the body segment forming the other side of a joint angle corresponding to the side with the same index as the joint, also used for the number of jitter modes less one left to resolve, or the number of contact forces left to be printed
MASK	8	-	-	masks used to extract individual bit positions
MAX	3	-	-	maximum numbers of time points in input tables
MAXI	-	-	-	number of modes in jitter
MAXR	-	-	-	number of modes for which jitter is possible for an occupant position
METH	-	-	-	switch indicating whether stick figure times are computed or to be inputted
MFORI	7	-	-	table containing the body segment index of the other side of the joint given the joint index
MM	-	-	-	number of nonzero forward chest contact forces
MMAX	-	-	-	maximum number of nonzero contact forces to be printed
MN	-	-	-	number of nonzero knee contact forces
MODE	16	-	-	table containing a status indicator for each possible jitter mode

Symbol Dictionary (page 22)

FORTRAN Name	Dimension	Symbol	Units	Definition
MPRINT	-	-	-	special initial print switch
MSBH	-	-	-	horizontal spaces on stick figure plot without grid
MSBV	-	-	-	vertical spaces on stick figure plot without grid
MSTART	-	-	-	starting index to print contact forces
MSTEP	-	-	-	number of contact forces already printed
MSTOP	-	-	-	stopping index to print contact forces
N	-	n	-	general index
N	8	-	-	number of points to represent each body segment in stick figure plot
NBELT	-	-	-	belt option indicator
NC	-	-	-	switch indicating no captions on graphs
NCHAR	-	-	-	switch indicating no captions on stick figures
NCNTCT	8	-	-	switches indicating whether contact arcs are to appear in stick figure
NCRT	-	-	-	CRT output switch (vestigial)
NEW	3	-	-	input table switches indicating whether changes made

Symbol Dictionary (page 23)

FORTRAN Name	Dimension	Symbol	Units	Definition
NGRAPH	-	-	-	switch indicating whether graphs are desired
NHL	-	-	-	number of horizontal lines in grid
NINJ	-	-	-	switch indicating whether injury tolerance printout is desired
NMAX	-	-	-	maximum ratio of predicted force change to allowed force change
NNK	-	-	-	maximum number of input table entries
NONO	1402	-	-	dummy array to ensure master common big enough
NPASGR	-	-	-	occupant position indicator
NPROB	-	-	-	switch indicating whether injury probability printout is desired
NPTS1	-	-	-	number of points plotted on first graph
NPTS2	-	-	-	number of points plotted on second graph
NPTS3	-	-	-	number of points plotted on third graph
NS	-	-	-	maximum value of interaction index for occupant position
NS	5	-	-	plot scaling specification array for graphs
NSBH	-	-	-	number of spaces between horizontal grid lines
NSBV	-	-	-	number of spaces between vertical grid lines

Symbol Dictionary (page 24)

FORTRAN Name	Dimension	Symbol	Units	Definition
NSCALE	5	-	-	plot scaling specification array for stick figures
NST	-	-	-	general index
NSTICK	-	-	-	switch indicating whether stick figures are desired
NSTOP	-	-	-	number of contact forces for a page of printout
NT	-	-	-	general index
NVL	-	-	-	number of vertical grid lines
N1	-	-	-	degree of polynomial
N2	-	-	-	number of polynomial coefficients
N3	-	-	-	iteration counter
N4	-	-	-	general index
N6	-	-	-	general index
OLDELD	-	$\dot{\delta}_{m-1}$	in./sec	previous deflection rate
OMEGA	18	-	in.	required off deflection for unloading curve for each interaction
OMEGAI	7	Ω_i	rad	upper joint relative angle limits
OMGT	-	Ω	in.	maximum relative deflection

Symbol Dictionary (page 25)

FORTRAN Name	Dimension	Symbol	Units	Definition
OMSGE	-	-	-	elasticity for load-deflection model (1-G)
ON	-	-	-	label used in printing contact forces
ORD	-	-	1, in./sec^2 2,3, -	ordinate of table point
P	200,9	-	-	storage for hip and vehicle positions, velocities, and accelerations
PCHEST	-	-	in.	distance of chest accelerometer above upper spinal joint along upper torso centerline
PCNTL	-	-	-	number of minimum print times in one print time interval
PEAK	-	-	-	maximum absolute value of injury tolerance violation
PHEAD	-	-	in.	distance of head accelerometer above neck
PHI	3	ϕ_m	rad	belt angles
PHIZ	3	ϕ_{mo}	rad	initial belt angles
PHI1	200	-	rad	lap belt angle storage
PHI2	200	-	rad	lower shoulder belt angle storage
PHI3	200	-	rad	upper shoulder belt angle storage
PI	-	π	rad	180 degrees in radians

Symbol Dictionary (page 26)

FORTRAN Name	Dimension	Symbol	Units	Definition
PI	-	p	-	probability value
PITWO	-	$\pi/2$	rad	ninety degrees in radians
PLC	-	$\ddot{X}$	g-units	vehicle acceleration
PLX	-	$\ddot{x}$	g-units	hip forward acceleration
PLY	-	$\ddot{y}$	g-units	hip vertical acceleration
PN	18	-	lb	elements one through three are belt forces; elements five through eighteen are contact forces stored on the interaction index; element four is vestigial; (this is summarized, "for each interaction")
PNDEL	18	-	lb	spring portion of loading force for each interaction
POMG	-	Ω_{m-1}	in.	previous relative deflection
POST	200,9	-	-	storage for hip and vehicle positions, velocities, and accelerations
POUNDS	-	-	lb	change limit for a forward contact force in one time interval
PP	8	-	lb	current nonzero contact forces storage
PR	-	-	-	total probability
PRMX	-	-	in.	x-coordinate of center of curvature

Symbol Dictionary (page 27)

FORTRAN Name	Dimension	Symbol	Units	Definition
PRMY	-	-	in.	y-coordinate of center of curvature
PSIA	10	ψ_a	deg	contact surface reference angle
PTIM	-	-	sec	time of peak tolerance violation
PTLEN	-	-	$in.^{-1}$	points per inch for plotting stick figure
PVAR	-	-	-	previous value of tolerance violation
QI	-	-	-	combination switch indicating whether a new probability label or which old label by index
QUE	10	Q_k	1-8, in. lb 9-10, lb	contact generalized force vector
R	-	-	-	number of points up to current point in stick figure representation of a line used in computation of coordinates
R	18	R	-	material energy absorption index, i.e., ratio of conserved energy to total energy, for each interaction
RA	10	R_a	-	material energy absorption index for each contact surface
RANG	-	-	-	temporary storage in stick figure computations
RH	-	r_h	in.	radius of arc of action of lap belt force

Symbol Dictionary (page 28)

FORTRAN Name	Dimension	Symbol	Units	Definition
RHO	8	ρ_i	in.	distance of body segment centers of gravity above previous joints
RHOPFZ	-	ρ_4'	in.	distance of head center of curvature above neck
RHOPRM	8	ρ_i'	in.	distance of body segment center of curvature above previous joint
RHOPTZ	-	ρ_3'	in.	distance of chest center of curvature above upper spinal joint
RNEW	-	R	-	energy absorption index
RNSBH	-	-	-	number of horizontal spaces in stick figure plot
RNSBV	-	-	-	number of vertical spaces in stick figure plot
ROOTI	5	-	-	imaginary parts of roots of fifth order equation
ROOTI	15	-	-	imaginary parts of roots
ROOTR	5	-	-	real parts of roots of fifth order equation
ROOTR	15	-	-	real parts of roots
RPSI	16	ξ	1-7, rad/sec 8-16, in./sec	velocity limits for possible jitter modes
RSEL	16	$\dot{\nu}$	1-7, rad/sec^2 8-16, in./sec^2	relative or mode accelerations for possible jitter modes

Symbol Dictionary (page 29)

FORTRAN Name	Dimension	Symbol	Units	Definition
RTM	-	-	-	temporary storage for root selection
RV	-	-	-	relative or mode velocity
RVEL	16	ν	1-7, rad/sec 8-16, in./sec	relative or mode velocity for possible jitter modes
RZ	-	r_z	in.	distance from lower leg centerline to skin
S	-	s	lb/in.	spring constant for front edge of seat
SAGXXX	-	σ_o	lb	zeroth order loading coefficient
SAZ	8	-	-	sine of body angle
SCALEX	-	-	-	horizontal scale factor for plotting stick figures
SCALEY	-	-	-	vertical scale factor for plotting stick figures
SDEL	-	δ_m	in.	present deflection
SDELA	-	δ	in.	present contact deflection
SDELD	-	$\dot{\delta}$	in./sec	deflection rate
SDELTA	3	δ	in.	belt deflections for each belt segment
SDELTD	3	$\dot{\delta}$	in./sec	belt deflection rates for each belt segment
SDL	-	δ_m	in.	present deflection

Symbol Dictionary (page 30)

FORTRAN Name	Dimension	Symbol	Units	Definition
SDLD	-	$\dot{\delta}_m$	in./sec	present deflection rate
SETBCK	200	-	lb	hip seat force storage
SETFRT	200	-	lb	seat front vertical force storage
SI	-	-	-	head severity index
SIA	-	-	in.	perpendicular distance of body center of curvature from surface
SIG	10	σ_m	n=1-5, $lb/in.^n$ n=6-10, $lb/(in./sec)^{n-5}$	material load-deflection coefficients
SIGMA	10,3	σ_m	same as SIG	belt load-deflection coefficients
SIGMAA	10,10	σ_{am}	same as SIG	contact surface load-deflection coefficients for all surfaces
SIGMAC	10	σ_{cm}	same as SIG	(vestigial)
SIGZ	18	σ_o	lb	material zeroth order load-deflection coefficients for all interactions
SINTEN	-	-	-	sine of the relative angle between upper torso and upper arm
SIXTY	-	-	rad	angular spacing in foot contact arc representation in stick figure
SLOP	10	-	lb./in.	saturation unloading slope on contact number
SLOPE	18	-	lb./in.	saturation unloading slope on interaction number

Symbol Dictionary (page 31)

FORTRAN Name	Dimension	Symbol	Units	Definition
SMALLB	10	b_i	1-8, in. lb 9-10, lb	total continuous generalized force vector
SMALLF	-	f	lb	seat cushion friction force
SPHI	3	-	-	sines of belt angles
SPSIA	10	-	-	sines of contact surface angles
SQ	-	-	-	temporary storage
STEPS	200	-	sec	time storage for producing stick figures
STHETA	8	-	-	sines of body angles
STHETZ	8	-	-	initial values of sines of body angles
STIME	200	-	sec	time point storage for summary printout
STIMFJ	6	-	-	sines of belt angles relative to body segments
STIMTJ	13	-	-	sines of angles between body segments
SUMBY	-	-	lb	hip seat spring force
SWITCH	3	-	-	scan type switches for input tables
SZ	-	s_z	lb/in.	spring constant for horizontal front edge seat force
SZVEC	8	-	-	sines of body angles

Symbol Dictionary (page 32)

FORTRAN Name	Dimension	Symbol	Units	Definition
T	200	-	sec	time point storage
TA	8	$\ddot{\theta}_i$	deg/sec^2	body angle accelerations
TAHATZ	-	$\hat{\tau}_o$	sec	predicted time interval for the linear jitter mode to turn off
TANTEG	-	-	-	tangent of lower leg angle
TANTSV	-	-	-	tangent of upper leg angle
TAUHAT	-	$\hat{\tau}$	sec	minimum time interval until mode velocity reaches velocity limit
TAUI	16	τ_k	sec	storage of time intervals until mode velocity reaches velocity limit for all modes
TDSQLI	8	$L_i\ \dot{\theta}_i^2$	in./sec^2	intermediate step in centrifugal forces
TEM	-	-	-	temporary storage in calculation of zeroes
TEMI	-	-	-	temporary storage in calculation of zeroes
TEMR	-	-	-	temporary storage in calculation of zeroes
TE1	-	-	-	temporary storage in calculation of zeroes
TE2	-	-	-	temporary storage in calculation of zeroes
TE3	-	-	-	temporary storage in calculation of zeroes

Symbol Dictionary (page 33)

FORTRAN Name	Dimension	Symbol	Units	Definition
TE4	-	-	-	temporary storage in calculation of zeroes
TE5	-	-	-	temporary storage in calculation of zeroes
TE6	-	-	-	temporary storage in calculation of zeroes
TE7	-	-	-	temporary storage in calculation of zeroes
TE8	-	-	-	temporary storage in calculation of zeroes
TE9	-	-	-	temporary storage in calculation of zeroes
TE10	-	-	-	temporary storage in calculation of zeroes
TE11	-	-	-	temporary storage in calculation of zeroes
TE12	-	-	-	temporary storage in calculation of zeroes
TE13	-	-	-	temporary storage in calculation of zeroes
TE14	-	-	-	temporary storage in calculation of zeroes
TE15	-	-	-	temporary storage in calculation of zeroes
TE16	-	-	-	temporary storage in calculation of zeroes
TGAMZ	-	-	-	tangent of seat cushion angle
THATPS	-	$\hat{T}'_7$	in. lb/rad	upper knee joint stop torque coefficient

Symbol Dictionary (page 34)

FORTRAN Name	Dimension	Symbol	Units	Definition
THATPV	-	$\hat{T}'_5$	in. lb/rad	upper shoulder joint stop torque coefficient
THATPW	-	$\hat{T}'_1$	in. lb/rad	upper hip joint stop torque coefficient
THATPX	-	$\hat{T}'_6$	in. lb/rad	upper elbow joint stop torque coefficient
THEDSQ	8	$\dot{\theta}_i^2$	$(rad/sec)^2$	square of body angular velocity
THEFEE	-	-	rad	initial value of relative angle between lower torso centerline and lap belt
THETA	200,3,8	-	deg,etc.	body angular position, velocity, and acceleration storage
THETAZ	8	θ_{io}	rad	initial values of body angles
TIA	-	T_{ia}	in.	length of the line joining the body center of curvature to the contact surface reference point projected on the contact surface
TIMASK	-	τ^*	sec	minimum of print interval, inflection interval, and maximum time step
TIMAX	-	t_{max}	sec	duration of simulation
TIME	-	t	sec	value of time during simulation
TIMTJ	16	-	rad	body relative angles
TIMTJZ	16	-	rad	initial values of body relative angles

Symbol Dictionary (page 35)

FORTRAN Name	Dimension	Symbol	Units	Definition
TINFL	-	-	sec	time of next vehicle acceleration table entry (inflection time)
TMATII	8	T_{ij}	in. lb	joint stop torque
TOF	-	t_{off}	sec	time that the tolerance violation ceases
TOL	22	-	-	tolerance level values
TON	-	t_{on}	sec	time that the tolerance violation begins
TPRIME	7	T_i'	in. lb/rad	symmetric or lower joint stop torque coefficient
TPRINT	-	-	sec	next print time
TS	-	-	-	temporary storage
TSA	-	-	-	temporary storage
TSB	-	-	-	temporary storage
TSC	-	-	-	temporary storage
TSTEP	-	-	sec	last vehicle acceleration inflection time
TT	8	θ_i	deg	body angles
TV	8	$\dot{\theta}_i$	deg	body angle velocities
VAR	-	-	-	injury tolerance quantity

Symbol Dictionary (page 36)

FORTRAN Name	Dimension	Symbol	Units	Definition
VLINE	-	-	in.	vertical distance represented per grid line
VTIA	-	v_T	in./sec	velocity of body segment contact arc along contact surface
VXIA	-	V_x	in./sec	forward velocity of body center of curvature
VYIA	-	V_y	in./sec	upward velocity of body center of curvature
VZERO	50	-	in.	vertical distances represented at grid line
WORKA	10	-	-	temporary storage for matrix inversion
WORKB	10	-	-	temporary storage for matrix inversion
WZERO	-	W_0	lb	initial hip seat force
X	-	-	-	sine of desired angle
X	-	-	in./sec^2	forward acceleration of chest center of gravity, chest center of curvature, or head center of curvature
X	7	-	-	temporary storage for sorting input tables
X	7	x_i	in.	x-coordinates of joints
XA	-	-	sec	one end of deletion interval from input table
XAP	-	$\dot{x}$	in./sec	hip forward velocity

Symbol Dictionary (page 37)

FORTRAN Name	Dimension	Symbol	Units	Definition
XB	-	-	sec	one end of deletion interval from input table
XC	-	X	in.	vehicle x-coordinate
XCHEST	-	-	in./sec^2	chest center of gravity forward acceleration
XCHT	5	-	in.	x-coordinates of chest contact arc points
XCP	-	$\dot{X}$	in./sec	vehicle forward velocity
XELB	3	-	in.	x-coordinates of elbow contact arc points
XFLOOR	2	-	in.	x-coordinates of floor end points
XFT	5	-	in.	x-coordinates of foot contact arc points
XHEAD	-	-	in./sec^2	head center of gravity forward acceleration
XHEAD	200	-	in.	x-coordinate of head center of gravity storage
XHIP	5	-	in.	x-coordinates of hip contact arc points
XHND	5	-	in.	x-coordinates of hand contact arc points
XIDOT	7	-	in./sec	joint forward velocity
XISMLA	10	ξ_a	in./sec	contact surface friction velocity limit
XJOINT	9	-	in.	x-coordinates of joints including wrist and ankle

Symbol Dictionary (page 38)

FORTRAN Name	Dimension	Symbol	Units	Definition
XKNE	3	-	in.	x-coordinates of knee contact arc points
XL	2	-	in.	x-coordinates of lower shoulder belt end points
XLAP	2	-	in.	x-coordinates of lap belt end points
XLEN	8	-	in.	x-coordinates of plot arcs
XLP	2	-	in.	x-coordinates of lower panel end points
XLSW	2	-	in.	x-coordinates of lower steering wheel end points
XMAN	64	-	in.	x-coordinates of stick figure points
XMAX	-	-	in.	maximum x-coordinate of plot area
XMIN	-	-	in.	minimum x-coordinate of plot area
XPACZ	-	-	in./sec	initial value of hip forward velocity
XPRM	8	-	in.	x-coordinates of body centers of curvature
XR	2	-	in.	x-coordinates of roof end points
XRHO	-	-	in.	x-coordinate of chest center of curvature
XSC	2	-	in.	x-coordinates of steering column end points
XSEAT	3	-	in.	x-coordinates of seat end points and intersection

Symbol Dictionary (page 39)

FORTRAN Name	Dimension	Symbol	Units	Definition
XSMALA	10	-	in.	x-coordinates of contact surface reference points
XTOE	2	-	in.	x-coordinate of toeboard end points
XU	-	-	in.	x-coordinate of upper shoulder belt anchor point
XUSDF	2	-	in.	x-coordinates of upper steering wheel end points
XVEHZ	-	-	in./sec	initial value of vehicle forward velocity
XWS	2	-	in.	x-coordinates of windshield end points
XX	-	-	sec	argument of input table
XX	-	-	-	sine of desired angle
XXX	300,3	-	sec	input table time storage
XZ	-	x_z	in.	horizontal distance of front edge of seat from lower leg centerline
Y	-	-	in./sec^2	upward acceleration of chest center of gravity, chest center of curvature, or head center of curvature
Y	7	y_i	in.	y-coordinates of joints
YA	-	y	in.	hip y-coordinate
YAP	-	$\dot{y}$	in./sec	hip forward velocity

Symbol Dictionary (page 40)

FORTRAN Name	Dimension	Symbol	Units	Definition
YCHEST	-	-	in./sec^2	chest center of gravity upward acceleration
YCHT	6	-	in.	y-coordinates of chest contact arc points
YELB	3	-	in.	y-coordinates of elbow contact arc points
YEPSLN	-	-	in.	cumulative permanent deflection
YFLOOR	2	-	in.	y-coordinates of floor end points
YFT	5	-	in.	y-coordinates of foot contact arc points
YHEAD	-	-	in./sec^2	head center of gravity upward acceleration
YHEAD	200	-	in.	head center of gravity y-coordinate storage
YHIP	5	-	in.	y-coordinates of hip contact arc points
YHND	5	-	in.	y-coordinates of hand contact arc points
YIDOT	7	-	in./sec	joint upward velocity
YJOINT	9	-	in.	y-coordinates of joints including wrist and ankle
YKNE	3	-	in.	y-coordinates of knee contact arc points
YL	2	-	in.	y-coordinates of lower shoulder belt end points
YLAP	2	-	in.	y-coordinates of lap shoulder belt end points

Symbol Dictionary (page 41)

FORTRAN Name	Dimension	Symbol	Units	Definition
YLEN	8	-	in.	y-coordinates of plot arcs
YLP	2	-	in.	y-coordinates of lower panel end points
YLSW	2	-	in.	y-coordinates of lower steering wheel end points
YMAN	64	-	in.	y-coordinates of stick figure points
YMAX	-	-	in.	maximum y-coordinate of plot area
YMIN	-	-	in.	minimum y-coordinate of plot area
YPRM	8	-	in.	y-coordinates of body centers of curvature
YR	2	-	in.	y-coordinates of roof end points
YRHO	-	-	in.	y-coordinate of chest center of curvature
YS	-	y_s	in.	deflection of hip seat spring
YSC	2	-	in.	y-coordinates of steering column end points
YSEAT	3	-	in.	y-coordinates of seat end points and intersection
YSMALA	10	-	in.	y-coordinates of contact surface reference points
YSP	-	$\dot{y}_s$	in./sec	deflection rate of hip seat spring
YTOE	2	-	in.	y-coordinates of toeboard end points

Symbol Dictionary (page 42)

FORTRAN Name	Dimension	Symbol	Units	Definition
YU	-	-	in.	y-coordinate of upper shoulder belt anchor point
YUSDF	2	-	in.	y-coordinates of steering wheel end points
YWS	2	-	in.	y-coordinates of windshield end points
YYY	300,3	-	1, in./sec^2 2,3, -	ordinates of input tables
YZZERO	-	y_{z0}	in.	vertical distance from the front edge of the seat to the point of seat cushion directly beneath the hip joint
Z	-	z	in.	horizontal distance of the front edge of the seat from the hip joint
ZERO	-	-	-	(vestigial)
ZERO	130	-	-	zero line plot array
ZK	11,128	$\ddot{z}_k$	1-8, rad/sec^2 9-11, in./sec^2	generalized acceleration contributions for all combinations of jitter modes on and off
ZKB	11	-	1-8, rad/sec^2 9-11, in./sec^2	base acceleration vector including both all continuous and turned on discontinuous
ZKBASE	11	-	1-8, rad/sec^2 9-11, in./sec^2	base acceleration vector including both all continuous and turned on discontinuous
XMLCTS	-	-	in.	horizontal distance of knee joint from front edge of seat

Symbol Dictionary (page 43)

FORTRAN Name	Dimension	Symbol	Units	Definition
ZP	11	-	-	temporary storage for mode velocities or accelerations
ZPAR	-	-	-	(vestigial)
ZPP	-	-	-	mode acceleration
ZPPP	128	-	-	mode acceleration for all combinations of jitter modes on and off for a particular mode
ZQ	11	-	1-8, rad/sec^2 9-11, in./sec^2	temporary storage of continuous generalized acceleration vector
ZR	10	-	1-8, rad/sec^2 9-11, in./sec^2	temporary storage of continuous generalized acceleration vector
ZRV	-	-	-	mode acceleration from base acceleration vector for jitter mode being considered
ZRVN	-	-	-	mode acceleration from base acceleration vector for second linear jitter mode
ZVEC	11	-	1-8, rad 9-11, in.	generalized coordinate vector including vehicle coordinate
ZVECP	11	-	1-8, rad/sec 9-11, in./sec	generalized velocity vector
ZVECPP	11	-	1-8, rad/sec^2 9-11, in./sec^2	generalized acceleration vector

Symbol Dictionary (page 44)

FORTRAN Name	Dimension	Symbol	Units	Definition
ZZERO	-	z_0	in.	x-coordinate of front edge of seat

Appendix to Symbol Dictionary (page 1)

Symbol	FORTRAN Name(s)
a	KA, LA, IA
a_1	A
$\bar{a}_k$	AK
$\vec{B}$	BEE
$\vec{b}$	SMALLB
$\vec{C}$	CEE
C_o	CZERON
C_1	CONEN
C_2	CTWON
C_s	CS
C_i'	CPRIME
$\vec{D}$	DEE
E_1	EONE
E_t	ET
$\hat{E}$	EHAT
$\hat{E}_o$	EO
F	FORCE, FT, FTT
F_m	FFM
F_{n-1}	FTOLD
F_s	FS
F_z	FZ

Appendix to Symbol Dictionary (page 2)

Symbol	FORTRAN Name(s)
F'_s	FSPRM
F'_{s_o}	FSPRMZ
f	SMALLF
G	G
$\vec{G}$	GEE
G_a	GA
g	GRAVIT
h	H
I_i	EYE
i	KI, LI, I, II
i*	ISTAR
K_i	BIGKI
J_e	BIGMI
L_i	EL
L'	ELP
l_k	BL
l_{10}	ELZTEN
l_{20}	ELTWTY
l_{30}	ELTHRY
l'_{10}	ELPTEN
m_i	EM

Appendix to Symbol Dictionary (page 3)

Symbol	FORTRAN Name(s)
m	AA
m^{-1}	ANVERS
p	PI
$\vec{Q}$	QUE
R	R, RNEW
R_a	RA
r_h	RH
r_i	AR
r_z	RZ
s	S
s_z	SZ
Tia	TIA
Tij	TMATII
T'_i	TPRIME
$\hat{T}'_1$	THATPW
$\hat{T}'_5$	THATPV
$\hat{T}'_6$	THATPX
$\hat{T}'_7$	THATPS
t	TIME
t_{max}	TIMAX
t_{off}	TOF

Appendix to Symbol Dictionary (page 4)

Symbol	FORTRAN NAME(s)
T_{on}	TON
v_T	VTIA
V_x	VXIA
V_y	VYIA
W_o	WZERO
X	XC
$\dot{X}$	XCP
$\ddot{X}$	PLC
$\dot{x}$	XAP
$\ddot{x}$	PLX
x_h	HEADX
x_i	X, AX
$\dot{x}_i$	AXD
x_z	XZ
y_s	YS
$\dot{y}_s$	YSP
y_{zo}	YZZERO
y	YA
$\dot{y}$	YAP
$\ddot{y}$	PLY
y_h	HEADY

Appendix to Symbol Dictionary (page 5)

Symbol	FORTRAN Name(s)
$\dot{y}_i$	Y, AY
Z_o	ZZERO
$\ddot{Z}_k$	ZK
z	Z
z_k	AZ
$\dot{z}_k$	AZP
α_i	ALFAI
β_m	BETA
γ	LITGAM
γ_o	GAMZER
Δ	DELL, DELTA
Δ	DELTAT
Δt_{min}	DESTEP
$\Delta\ddot{\vec{z}}$	DELZ
$\Delta\nu$	DELNN, DELNU
δ	SDELTA, SDELA
δ_n	SDL
δ_{n-1}	DELOLD
$\dot{\delta}$	SDELTD, SDELD
$\dot{\delta}$	SDLD
$\dot{\delta}_{n-1}$	OLDELD, DELDOD

Appendix to Symbol Dictionary (page 6)

Symbol	FORTRAN Name(s)
ε	EPSLNY
ε_o	EPSLNZ
ε'	EPSLNP
η	ETA
θ_i	TT
θ_{i_o}	THETAZ
$\dot{\theta}_i$	TV
$\dot{\theta}_i^2$	THEDSQ
$\ddot{\theta}_i$	TA
λ_i	ELAMB
μ_a	FMUA
μ_s	FMUS
ν	RVEL
$\dot{\nu}$	RSEL
ξ	RPSI
ξ_a	XISMLA
π	PI
ρ_i	RHO
ρ_i'	RHOPRM
ρ_3'	RHOPTZ
ρ_4'	RHOPFZ

Symbol	FORTRAN Name(s)
σ_o	SIGZ, SIGXX
σ_{am}	SIGMAA
σ_n	SIG, SIGMA
τ_k	TAUI
τ^*	TIMASK
$\hat{\tau}$	TAUHAT
$\hat{\tau}_o$	TAHATZ
ϕ'_{10}	FEPTEN
ϕ_m	PHI
ϕ_{m_o}	PHIZ
ψ_a	PSIA
Ω	OMGT, FOM
Ω_i	OMEGAI
Ω_{n-1}	POMG

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APPENDIX

LISTINGS OF

HSRI 2-D MODEL ROUTINES

AND

SUPPLEMENTARY ROUTINES

Subroutine Index

Subroutine Index (Con·inued)

Routine	Routine Number (Figs. 44 and 45)	Listing Page	Flow Diagram Page
PLOT4	1	A-114	-
RELSEL	18	A-65	302
RELVEL	14	A-66	303
SEAT	7	A-68	304
SIPP	26	A-70	306
STYX	27	A-75	307
SUMARY	23	A-80	312
TAUMAK	19	A-89	313
XDINFO	a	A-97	-
XERCOM	c	A-98	-
XPRINT	b	A-98	-
YPRINT	d	A-92	-
ZKMAKR	17	A-93	317
ZMAKER	13	A-95	318
TALK2*	-	A-152	-
BAIL2*	-	A-158	-

*These two are for recovery of output from an aborted run. Supplied here in unconverted form; Common/$\overline{IO}$/INN needs to be added in BAIL2 along with INN=5 and the l.d.n.'s may need switching around in TALK2. BAIL2 is run with SUMARY and the routines called by SUMARY with the cards after the Z card supplied on l.d.n. five and the summary file supplied on l.d.n. nine.

```
                                                                        *2D21600
      SUBROUTINE ACCEL                                                  *2D21610
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D21620
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D21630
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D21640
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D21650
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D21660
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D21670
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLVZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D21680
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D21690
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D21700
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D21710
      COMMON CZERON,CCNEN,CTWCN,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D21720
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D21730
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D21740
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D21750
                                                                        *2D21760
                                                                        *2D21770
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D21780
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D21790
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D21800
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D21810
     4),STHETA(8),         BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D21820
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D21830
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BF*2D21840
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D21850
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D21860
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D21870
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D21880
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D21890
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D21900
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D21910
     4LE(2,14),ZPPP(128),BL(3)                                          *2D21920
                                                                        *2D21930
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D21940
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D21950
      COMMON NOVO(1402)                                                 *2D21960
      DO 3060 I=1,8                                                     *2D21970
      STHETA(I) = SIN(ZVEC(I))                                          *2D21980
      CTHETA(I) = COS(ZVEC(I))                                          *2D21990
      THEDSQ(I) = ZVECP(I)*ZVECP(I)                                     *2D22000
      TDSQLI(I) = EL(I)*THEDSQ(I)                                       *2D22010
      ATDSQ(I) = A(I)*THEDSQ(I)                                         *2D22020
 3060 CONTINUE                                                          *2D22030
      TIMTJ(1) = ZVEC(1)-ZVEC(2)                                        *2D22040
      STIMTJ(1) = SIN(TIMTJ(1))                                         *2D22050
      TIMTJ(2) = ZVEC(1)-ZVEC(3)                                        *2D22060
      STIMTJ(2) = SIN(TIMTJ(2))                                         *2D22070
      TIMTJ(3) = ZVEC(1)-ZVEC(4)                                        *2D22080
      STIMTJ(3) = SIN(TIMTJ(3))                                         *2D22090
```

Subroutine ACCEL (page 1 of 3)

```
      TIMTJ(4) = ZVEC(1)-ZVEC(5)                                       *2D22100
      STIMTJ(4) = SIN(TIMTJ(4))                                        *2D22110
      TIMTJ(5) = ZVEC(1)-ZVEC(6)                                       *2D22120
      STIMTJ(5) = SIN(TIMTJ(5))                                        *2D22130
      TIMTJ(6) = ZVEC(1)-ZVEC(7)                                       *2D22140
      TIMTJ(7) = ZVEC(2)-ZVEC(3)                                       *2D22150
      STIMTJ(6) = SIN(TIMTJ(7))                                        *2D22160
      TIMTJ(8) = ZVEC(2)-ZVEC(4)                                       *2D22170
      STIMTJ(7) = SIN(TIMTJ(8))                                        *2D22180
      TIMTJ(9) = ZVEC(2)-ZVEC(5)                                       *2D22190
      STIMTJ(8) = SIN(TIMTJ(9))                                        *2D22200
      TIMTJ(10)= ZVEC(2)-ZVEC(6)                                       *2D22210
      TIMTJ(11)= ZVEC(3)-ZVEC(4)                                       *2D22220
      STIMTJ(9) = SIN(TIMTJ(11))                                       *2D22230
      TIMTJ(12)= ZVEC(3)-ZVEC(5)                                       *2D22240
      STIMTJ(10) = SIN(TIMTJ(12))                                      *2D22250
      TIMTJ(13)= ZVEC(3)-ZVEC(6)                                       *2D22260
      STIMTJ(11) = SIN(TIMTJ(13))                                      *2D22270
      TIMTJ(14)= ZVEC(4)-ZVEC(5)                                       *2D22280
      TIMTJ(15)= ZVEC(5)-ZVEC(6)                                       *2D22290
      STIMTJ(12) = SIN(TIMTJ(15))                                      *2D22300
      TIMTJ(16)= ZVEC(7)-ZVEC(8)                                       *2D22310
      STIMTJ(13) = SIN(TIMTJ(16))                                      *2D22320
      IF (IBUG-3) 4100,3070,3070                                       *2D22330
 3070 WRITE(6,5950)(STHETA(I),CTHETA(I),THEDSQ(I),TDSQLT(I),ATDSQ(I),  *2D22340
     1I=1,8)                                                           *2D22350
 5950 FORMAT (5HOSTEP/(1X5E20.8))                                      *2D22360
 4100 CALL SEAT                                                        *2D22370
      X(1) = ZVEC(9)-ZVEC(11)                                          *2D22380
      Y(1) = ZVEC(10)                                                  *2D22390
      X(2)=X(1)+EL(1)*CTHETA(1)                                        *2D22400
      Y(2)=Y(1)+EL(1)*STHETA(1)                                        *2D22410
      X(3)=X(2)+EL(2)*CTHETA(2)                                        *2D22420
      Y(3)=Y(2)+EL(2)*STHETA(2)                                        *2D22430
      X(4)=X(3)+EL(3)*CTHETA(3)                                        *2D22440
      Y(4)=Y(3)+EL(3)*STHETA(3)                                        *2D22450
      X(5) = X(3)+EL(4)*CTHETA(3)                                      *2D22460
      Y(5)=Y(3)+EL(4)*STHETA(3)                                        *2D22470
      X(6)=X(5)+EL(5)*CTHETA(5)                                        *2D22480
      Y(6)=Y(5)+EL(5)*STHETA(5)                                        *2D22490
      X(7) = X(1)+EL(7)*CTHETA(7)                                      *2D22500
      Y(7) = Y(1)+EL(7)*STHETA(7)                                      *2D22510
      XIDOT(1) = ZVECP(9)-ZVECP(11)                                    *2D22520
      YIDOT(1) = ZVECP(10)                                             *2D22530
      XIDOT(2) = XIDOT(1)-EL(1)*STHETA(1)*ZVECP(1)                     *2D22540
      YIDOT(2) = YIDOT(1)+EL(1)*CTHETA(1)*ZVECP(1)                     *2D22550
      XIDOT(3) = XIDOT(2)-EL(2)*STHETA(2)*ZVECP(2)                     *2D22560
      YIDOT(3) = YIDOT(2)+EL(2)*CTHETA(2)*ZVECP(2)                     *2D22570
      XIDOT(4) = XIDOT(3)-EL(3)*STHETA(3)*ZVECP(3)                     *2D22580
      YIDOT(4) = YIDOT(3)+EL(3)*CTHETA(3)*ZVECP(3)                     *2D22590
```

Subroutine ACCEL (page 2 of 3)

```
      XIDOT(5) = XIDOT(3)-EL(4)*STHETA(3)*ZVECP(3)                      *2D22600
      YIDOT(5) = YIDOT(3)+EL(4)*CTHETA(3)*ZVECP(3)                      *2D22610
      XIDOT(6) = XIDOT(5)-EL(5)*STHETA(5)*ZVECP(5)                      *2D22620
      YIDOT(6) = YIDOT(5)+EL(5)*CTHETA(5)*ZVECP(5)                      *2D22630
      XIDOT(7) = XIDOT(1)-EL(7)*STHETA(7)*ZVECP(7)                      *2D22640
      YIDOT(7) = YIDOT(1)+EL(7)*CTHETA(7)*ZVECP(7)                      *2D22650
      CALL BELT                                                         *2D22660
 423C CALL CONTAC                                                       *2D22670
      BIGMI(1) = BIGKI(1)*(TIMTJZ(6)-TIMTJ(6))                          *2D22680
      BIGMI(2) = BIGKI(2)*(TIMTJ(1)-TIMTJZ(1))                          *2D22690
      BIGMI(3) = BIGKI(3)*(TIMTJ(7)-TIMTJZ(7))                          *2D22700
      BIGMI(4) = BIGKI(4)*(TIMTJ(11)-TIMTJZ(11))                        *2D22710
      BIGMI(5) = BIGKI(5)*(TIMTJ(12)-TIMTJZ(12))                        *2D22720
      BIGMI(6) = BIGKI(6)*(TIMTJ(15)-TIMTJZ(15))                        *2D22730
      BIGMI(7) = BIGKI(7)*(TIMTJ(16)-TIMTJZ(16))                        *2D22740
      CEE(3) = BIGMI(3)-BIGMI(4)-BIGMI(5)                               *2D22750
      CEE(2) = BIGMI(2)-BIGMI(3)                                        *2D22760
      CEE(1) = BIGMI(1)-BIGMI(2)                                        *2D22770
      CEE(5) = BIGMI(5)-BIGMI(6)                                        *2D22780
      CEE(7) =-BIGMI(1)-BIGMI(7)                                        *2D22790
      CEE(6) = BIGMI(6)                                                 *2D22800
      CEE(4) = BIGMI(4)                                                 *2D22810
      CEE(9) = 0.                                                       *2D22820
      CEE(10) = 0.                                                      *2D22830
      CEE(8) = BIGMI(7)                                                 *2D22840
 5000 CALL BODY                                                         *2D22850
C     SECTION  5.2.2      MATRIX SECTION                                *2D22860
 5200 AA(2,1) = AEL(1)*COS(TIMTJ (1))                                   *2D22870
      AA(3,1)=AEL(2)*COS(TIMTJ (2))                                     *2D22880
      AA(3,2) = AEL(3)*COS(TIMTJ (7))                                   *2D22890
      AA(4,1)=AEL(4)*COS(TIMTJ (3))                                     *2D22900
      AA(4,2)=AEL(5)*COS(TIMTJ (8))                                     *2D22910
      AA(4,3)=AEL(6)*COS(TIMTJ (11))                                    *2D22920
      AA(5,1)=AEL(7)*COS(TIMTJ (4))                                     *2D22930
      AA(5,2)=AEL(8)*COS(TIMTJ (9))                                     *2D22940
      AA(5,3)=AEL(9)*COS(TIMTJ (12))                                    *2D22950
      AA(6,1)=AEL(10)*COS(TIMTJ (5))                                    *2D22960
      AA(6,2)=AEL(11)*COS(TIPTJ (10))                                   *2D22970
      AA(6,3)=AEL(12)*COS(TIMTJ (13))                                   *2D22980
      AA(6,5)=AEL(13)*COS(TIMTJ (15))                                   *2D22990
      AA(8,7)=AEL(14)*COS(TIMTJ (16))                                   *2D23000
      DO 5210 I=1,8                                                     *2D23010
      AA(9,I) = -A(I)*STHETA(I)                                         *2D23020
 5210 AA(10,I) = A(I)*CTHETA(I)                                         *2D23030
      CALL ZMAKER                                                       *2D23040
 5330 RETURN                                                            *2D23050
      END                                                               *2D23060
```

Subroutine ACCEL (page 3 of 3)

```
      FUNCTION ARCSIN(X)                                             *2D28420
      DATA PITWO,PI,C0,C1,C2,C3,C4,C5,C6,C7/1.570796,                *2D28430
     13.14159,1.570796,-.2145989,.0889789 9,-.05017430,              *2D28440
     2.03089188,-.01708813,.00667009,-.001262491/                    *2D28450
      XX=ABS(X)                                                      *2D28460
      IF (XX.LE..001) GO TO 50                                       *2D28470
      SQ=1.-XX                                                       *2D28480
      IF (SQ.LT.0.) GO TO 40                                         *2D28490
      ANS=PITWO-SQRT(SQ)*((((((C7*XX+C6)*XX+C5)*XX+                  *2D28500
     1C4)*XX+C3)*XX+C2)*XX+C1)*XX+C0)                                *2D28510
   20 ARCSIN=SIGN(ANS,X)                                             *2D28520
      RETURN                                                         *2D28530
   40 ARCSIN=SIGN(PITWO,X)                                           *2D28540
      RETURN                                                         *2D28550
   50 ANS=XX                                                         *2D28560
      GO TO 20                                                       *2D28570
      END                                                            *2D28580
                                                                     *2D28590
```

Subroutine ARCSIN

```
                                                                        *2D20070
      SUBROUTINE BELT                                                   *2D20080
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D20090
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D20100
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D20110
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D20120
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D20130
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D20140
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D20150
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D20160
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D20170
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D20180
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D20190
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D20200
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D20210
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D20220
                                                                        *2D20230
                                                                        *2D20240
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D20250
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D20260
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D20270
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D20280
     4),STHETA(8),        BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D20290
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D20300
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D20310
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D20320
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D20330
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D20340
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D20350
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D20360
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),         SIGMAA(10,1*2D20370
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D20380
     4LE(2,14),ZPPP(128),BL(3)                                          *2D20390
                                                                        *2D20400
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D20410
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D20420
      COMMON NONO(1402)                                                 *2D20430
      DIMENSION CPHI(3),SPHI(3),STIMFJ(6)                               *2D20440
      IF (NBELT-1) 30,20,10                                             *2D20450
   10 TS = X(2)+H*CTHETA(2)-ELAMB(4)                                    *2D20460
      TSA = Y(2)+H*STHETA(2)-ELAMB(3)                                   *2D20470
      PHI(2)=ATAN2(TSA,TS)                                              *2D20480
      CPHI(2) = COS(PHI(2))                                             *2D20490
      SPHI(2) = SIN(PHI(2))                                             *2D20500
      STIMFJ(2) = SIN(ZVEC(1)-PHI(2))                                   *2D20510
      STIMFJ(4) = SIN(ZVEC(2)-PHI(2))                                   *2D20520
      SDELTA(2) = SQRT(TS*TS+TSA*TSA)-ELTWTY                            *2D20530
      BL(2)=SDELTA(2)+ELTWTY                                            *2D20540
      SDELTD(2)=XIDOT(1)*CPHI(2)+YIDOT(1)*SPHI(2)-EL(1)*ZVECP(1)*STIMFJ(*2D20550
     12)-H*ZVECP(2)*STIMFJ(4)                                           *2D20560
```

Subroutine BELT (page 1 of 2)

```
      CALL LODFEC(2,DELTA(2),SIGMA(1,2),SDELTA(2),SDELTD(2))             *2D20570
      TS = X(5)-ELAMB(6)                                                 *2D20580
      TSA = Y(5)-ELAMB(5)                                                *2D20590
      PHI(3)=ATAN2(TSA,TS)                                               *2D20600
      CPHI(3) = COS(PHI(3))                                              *2D20610
      SPHI(3) = SIN(PHI(3))                                              *2D20620
      STIMFJ(3) = SIN(ZVEC(1)-PHI(3))                                    *2D20630
      STIMFJ(5) = SIN(ZVEC(2)-PHI(3))                                    *2D20640
      STIMFJ(6) = SIN(ZVEC(3)-PHI(3))                                    *2D20650
      SDELTA(3) = SQRT(TS*TS+TSA*TSA)-ELTHRY                             *2D20660
      BL(3)=SDELTA(3)+ELTHRY                                             *2D20670
      SDELTD(3)=XIDOT(1)*CPHI(3)+YIDOT(1)*SPHI(3)-EL(1)*ZVECP(1)*STIMFJ(*2D20680
     13)-EL(2)*ZVECP(2)*STIMFJ(5)-EL(4)*ZVECP(3)*STIMFJ(6)               *2D20690
      CALL LODFEC(3,DELTA(3),SIGMA(1,3),SDELTA(3),SDELTD(3))             *2D20700
      DEE(1) = EL(1)*(PN(2)*STIMFJ(2)+PN(3)*STIMFJ(3))                   *2D20710
      DEE(2) = H*PN(2)*STIMFJ(4)+EL(2)*PN(3)*STIMFJ(5)                   *2D20720
      DEE(3) = EL(4)*PN(3)*STIMFJ(6)                                     *2D20730
      DEE(9) = DEE(9)-PN(2)*CPHI(2)-PN(3)*CPHI(3)                        *2D20740
      DEE(10) = DEE(10)-PN(2)*SPHI(2)-PN(3)*SPHI(3)                      *2D20750
      IF (NBELT-3) 30,20,20                                              *2D20760
   20 TS = X(1)+ELAMB(1)                                                 *2D20770
      TSA = Y(1)+ELAMB(2)                                                *2D20780
      TSB = SQRT(TS*TS+TSA*TSA-RH*RH)                                    *2D20790
      BL(1)=TSB                                                          *2D20800
      PHI(1)=ATAN2(TSA,TS)+ATAN(RH/TSB)                                  *2D20810
      CPHI(1) = COS(PHI(1))                                              *2D20820
      SPHI(1) = SIN(PHI(1))                                              *2D20830
      STIMFJ(1) = SIN(ZVEC(1)-PHI(1))                                    *2D20840
      SDELTA(1) = TSB-ELZTEN+RH*(PHI(1)-ZVEC(1)+THEFEE)                  *2D20850
      SDELTD(1)=XIDOT(1)*CPHI(1)+YIDOT(1)*SPHI(1)-RH*ZVECP(1)            *2D20860
      CALL LODFEC(1,DELTA(1),SIGMA(1,1),SDELTA(1),SDELTD(1))             *2D20870
      DEE(1) = DEE(1)+RH*PN(1)                                           *2D20880
      DEE(9) = DEE(9)-PN(1)*CPHI(1)                                      *2D20890
      DEE(10) = DEE(10)-PN(1)*SPHI(1)                                    *2D20900
   30 RETURN                                                             *2D20910
      END                                                                *2D20920
```

Subroutine BELT (page 2 of 2)

```
                                                                      *2D20930
      SUBROUTINE BODY                                                 *2D20940
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D20950
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D20960
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D20970
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D20980
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D20990
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D21000
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D21010
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D21020
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFFE,RH*2D21030
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D21040
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D21050
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D21060
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D21070
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D21080
                                                                      *2D21090
                                                                      *2D21100
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D21110
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D21120
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D21130
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D21140
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D21150
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D21160
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D21170
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D21180
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D21190
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D21200
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D21210
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D21220
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D21230
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D21240
     4LE(2,14),ZPPP(128),BL(3)                                        *2D21250
                                                                      *2D21260
      COMMON THATPW,THATPX,THATPS,XVEHZ                               *2D21270
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                   *2D21280
      COMMON NONO(1402)                                               *2D21290
C     SECTIONS  5.2.1 +  5.1   BODY FORCES AND CART ACCELERATION      *2D21300
 5000 DO 5010 I=1,8                                                   *2D21310
 5010 GEE(I) = GRAVA(I)*CTHETA(I)                                     *2D21320
      BEE(1) = -EL(1)*(ATDSQ(2)*STIMTJ(1)+ATDSQ(3)*STIMTJ(2)+ATDSQ(4)*ST*2D21330
     1IMTJ(3)+ATDSQ(5)*STIMTJ(4)+ATDSQ(5)*STIMTJ(5))                  *2D21340
      SINTEN = SIN(TIMTJ(10))                                         *2D21350
      BEE(2)=EL(1)*A(2)*THEDSQ(1)*STIMTJ(1)-EL(2)*(ATDSQ(3)*STIMTJ(6)+  *2D21360
     1ATDSQ(4)*STIMTJ(7)+ATDSQ(5)*STIMTJ(8)+ATDSQ(6)*SINTEN)           *2D21370
      BEE(3)=A(3)*(TDSQLI(1)*STIMTJ(2)+TDSQLI(2)*STIMTJ(6))-EL(3)*ATDSQ(*2D21380
     14)*STIMTJ(9)-EL(4)*(ATDSQ(5)*STIMTJ(10)+ATDSQ(6)*STIMTJ(11))     *2D21390
      BEE(4)=A(4)*(TDSQLI(1)*STIMTJ(3)+TDSQLI(2)*STIMTJ(7)+TDSQLI(3)*STI*2D21400
     1MTJ(9))                                                         *2D21410
      BEE(5)=A(5)*(TDSQLI(1)*STIMTJ(4)+TDSQLI(2)*STIMTJ(8)+EL(4)*THEDSQ(*2D21420
```

Subroutine BODY (page 1 of 2)

```
      13)*STIMTJ(10))-EL(5)*ATDSQ(6)*STIMTJ(12)                               *2D21430
       BEE(6)=A(6)*(TDSQLI(1)*STIMTJ(5)+TDSQLI(3)*STIMTJ(11)+TDSQLI(5)*ST*2D21440
      1IMTJ(12)+TDSQLI(2)*SINTEN)                                              *2D21450
       BEE(7) = -ATDSQ(8)*EL(7)*STIMTJ(13)                                     *2D21460
       BEE(8)=TDSQLI(7)*A(8)*STIMTJ(13)                                        *2D21470
       BEE(9) = 0.                                                             *2D21480
       BEE(10) = 0.                                                            *2D21490
       DO 5100 I=1,8                                                           *2D21500
       BEE(9) = BEE(9) + ATDSQ(I)*CTHETA(I)                                    *2D21510
 5100  BEE(10)=BEE(10)+ATDSQ(I)*STHETA(I)                                      *2D21520
       DO 5110 I=1,10                                                          *2D21530
 5110  SMALLB(I)=BEE(I)+CEE(I)+DFE(I)-GEE(I)+QUE(I)                            *2D21540
 5200  IF(IBUG-2) 5206,5202,5202                                               *2D21550
 5202  WRITE(6,9955)(I,GEE(I),DEE(I),BEE(I),SMALLB(I),I=1,10)                  *2D21560
 9955  FORMAT (6HOBODY /(1XI5,4E20.8))                                         *2D21570
 5206  RETURN                                                                  *2D21580
       END                                                                     *2D21590
```

Subroutine BODY (page 2 of 2)

```
                                                                       *2D15550
       SUBROUTINE CONTAC                                               *2D15560
       COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D15570
      1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D15580
      2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D15590
      3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D15600
      4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D15610
      5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D15620
      6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D15630
      7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D15640
      8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D15650
      9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D15660
       COMMON CZERON,CCNEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D15670
      1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D15680
      2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D15690
      3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D15700
                                                                       *2D15710
                                                                       *2D15720
       DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D15730
      1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D15740
      2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D15750
      38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D15760
      4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D15770
      5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D15780
      6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D15790
      7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D15800
      8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(15),RVEL(16),MODE(16),TIMTJZ(*2D15810
      916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D15820
       DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D15830
      1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D15840
      2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),         SIGMAA(10,1*2D15850
      30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D15860
      4LE(2,14),ZPPP(128),BL(3)                                        *2D15870
                                                                       *2D15880
       COMMON THATPW,THATPX,THATPS,XVEHZ                               *2D15890
       COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                   *2D15900
       COMMON NONO(1402)                                               *2D15910
       DIMENSION JFORK(8),ELP(5)                                       *2D15920
       JNN=MAXR-8                                                      *2D15930
       MAXR=8                                                          *2D15940
       INN = 1                                                         *2D15950
       FUDGE=.1                                                        *2D15960
       DO 20 I=1,8                                                     *2D15970
       RVEL(I+8) = 0.                                                  *2D15980
       IFORK(1,I) = 0                                                  *2D15990
       IFORK(2,I) = 0                                                  *2D16000
       JFORK(I) = IFORK(3,I)                                           *2D16010
       IFORK(3,I) = 0                                                  *2D16020
       QUE(I) = 0.                                                     *2D16030
       DO 10 II=1,11                                                   *2D16040
```

Subroutine CONTAC (page 1 of 4)

```
 10   BASIC(II,I) = 0.                                             *2D16050
 20   CONTINUE                                                     *2D16060
      QUE(9) = 0.                                                  *2D16070
      QUE(10) = 0.                                                 *2D16080
      DO 430  N=5,NS                                               *2D16090
      IA = KTABLE(2,N-4)                                           *2D16100
      IF (IGNORE(IA)) 25,25,430                                    *2D16110
 25   I = KTABLE(1,N-4)                                            *2D16120
      TSA = RHOPRM(I)*STHETA(I)                                    *2D16130
      TSB = RHOPRM(I)*CTHETA(I)                                    *2D16140
      GO TO (30,430,30,30,30,430,40,50),I                          *2D16150
 30   XPRM(I) = X(I) + TSB                                         *2D16160
      YPRM(I) = Y(I) + TSA                                         *2D16170
      TSA = XIDOT(I) - TSA*ZVECP(I)                                *2D16180
      TSB = YIDOT(I) + TSB*ZVECP(I)                                *2D16190
      GO TO 70                                                     *2D16200
 40   XPRM(I) = X(1) + TSB                                         *2D16210
      YPRM(I) = Y(1) + TSA                                         *2D16220
      TSA = XIDOT(1) - TSA*ZVECP(I)                                *2D16230
      TSB = YIDOT(1) + TSB*ZVECP(I)                                *2D16240
      GO TO 70                                                     *2D16250
 50   XPRM(I) = X(I-1) + TSB                                       *2D16260
      YPRM(I) = Y(I-1) + TSA                                       *2D16270
      TSA = XIDOT(I-1)-TSA*ZVECP(I)                                *2D16280
      TSB = YIDOT(I-1)+TSB*ZVECP(I)                                *2D16290
 70   DELIAD = TSA*SPSIA(IA) - TSB*CPSIA(IA)                       *2D16300
      VTIA = TSA*CPSIA(IA) + TSB*SPSIA(IA) + AR(I)*ZVECP(I)        *2D16310
      TSA = XSMALA(IA) - XPRM(I)                                   *2D16320
      TSB = YSMALA(IA) - YPRM(I)                                   *2D16330
      DELIA = AR(I) - TSA*SPSIA(IA) + TSB*CPSIA(IA)                *2D16340
      TIA = TSA*CPSIA(IA) + TSB*SPSIA(IA)                          *2D16350
      IF (DELIA+FUDGE) 300,300,80                                  *2D16360
 80   IF (IGNORE(IA)) 100,90,90                                    *2D16370
 90   MAXR = MAXR+1                                                *2D16380
      INN = MAXR-8                                                 *2D16390
      RVEL(MAXR) = VTIA                                            *2D16400
      RPSI(MAXR) = XISMLA(IA)                                      *2D16410
      IFORK(1,INN) = I                                             *2D16420
      IFORK(2,INN) = IA                                            *2D16430
      IFORK(3,INN) = N                                             *2D16440
100   IF (TIA) 150,150,110                                         *2D16450
110    IF (TIA-DA(IA)) 120,120,150                                 *2D16460
120   IF (DELIA) 200,200,130                                       *2D16470
130   CALL LODFEC(N,0.,SIGMAA(1,IA),DELIA,DELIAD)                  *2D16480
      IF (IGNORE(IA)) 135,140,140                                  *2D16490
135   INN = INN + 1                                                *2D16500
      GO TO 390                                                    *2D16510
140   IF (PV(N)) 150,150,310                                       *2D16520
150   IFORK(1,INN) = 0                                             *2D16530
      IFORK(2,INN) = 0                                             *2D16540
```

Subroutine CONTAC (page 2 of 4)

```
      IFORK(3,INN) = 0                                          *2D16550
      IF (JFORK(INN)) 160,190,160                               *2D16560
  160 DO 170 JJ=INN,7                                           *2D16570
  170 JFORK(JJ) = JFORK(JJ+1)                                   *2D16580
      DO 180 JK=MAXR,15                                         *2D16590
  180 MODE(JK)=MODE(JK+1)                                       *2D16600
  190 MAXR = MAXR-1                                             *2D16610
      GO TO 300                                                 *2D16620
  200 IF (IGNORE(IA)) 300,210,210                               *2D16630
  210 IF (IFORK(3,INN)-JFORK(INN)) 220,300,220                  *2D16640
  220 DO 230 JJ=INN,7                                           *2D16650
      JK=MAXR-JJ-1                                              *2D16660
  230 JFORK(JK+1) = JFORK(JK)                                   *2D16670
      JL=16-MAXR                                                *2D16680
      DO 240 JJ=1,JL                                            *2D16690
      JK=16-JJ                                                  *2D16700
  240 MODE(JK+1) = MODE(JK)                                     *2D16710
  250 IF (ABS(RVEL(MAXR))-RPSI(MAXR)) 260,270,280               *2D16720
  260 MODE(MAXR) = -1                                           *2D16730
      GO TO 300                                                 *2D16740
  270 MODE(MAXR) = 0                                            *2D16750
      GO TO 300                                                 *2D16760
  280 MODE(MAXR) = 1                                            *2D16770
  300 PN(N)=0.                                                  *2D16780
      EONE(N) = 0.                                              *2D16790
      GO TO 400                                                 *2D16800
  310 IF (IFORK(3,INN)-JFORK(INN)) 320,390,320                  *2D16810
  320 DO 330 JJ=INN,7                                           *2D16820
      JK=MAXR-JJ-1                                              *2D16830
  330 JFORK(JK+1) = JFORK(JK)                                   *2D16840
      JL=16-MAXR                                                *2D16850
      DO 340 JJ=1,JL                                            *2D16860
      JK=16-JJ                                                  *2D16870
  340 MODE(JK+1) = MODE(JK)                                     *2D16880
  350 IF (ABS(RVEL(MAXR))-RPSI(MAXR)) 360,370,380               *2D16890
  360 MODE(MAXR) = -1                                           *2D16900
      GO TO 390                                                 *2D16910
  370 MODE(MAXR) = 0                                            *2D16920
      GO TO 390                                                 *2D16930
  380 MODE(MAXR) = 1                                            *2D16940
  390 BASIC(11,INN) = 0.                                        *2D16950
      GO TO (399,399,391,392,393,399,396,395),I                 *2D16960
  391 ELP(3) = RHOPTZ                                           *2D16970
      GO TO 394                                                 *2D16980
  392 ELP(4) = RHOPFZ                                           *2D16990
      ELP(3) = EL(3)                                            *2D17000
      GO TO 394                                                 *2D17010
  393 ELP(5) = EL(5)                                            *2D17020
      ELP(4) = 0.                                               *2D17030
      ELP(3) = EL(4)                                            *2D17040
```

Subroutine CONTAC (page 3 of 4)

```
394  ELP(2) = EL(2)                                                      *2D17050
     ELP(1) = EL(1)                                                      *2D17060
     KK = 0                                                              *2D17070
     GO TO 397                                                           *2D17080
395  ELP(2) = EL(9)                                                      *2D17090
396  ELP(1) = EL(7)                                                      *2D17100
     KK = 5                                                              *2D17110
397  JJ = I-KK                                                           *2D17120
     DO 398 J=1,JJ                                                       *2D17130
     JK = J+KK                                                           *2D17140
     TS = PSIA(IA)-ZVEC(JK)                                              *2D17150
     BASIC(J,INN) = ELP(J)*SIN(TS)                                       *2D17160
     BASIC(J+5,INN)=ELP(J)*COS(TS)                                       *2D17170
     BASIC(11,INN) = BASIC(11,INN)-BASIC(J+5,INN)*THECSQ(JK)             *2D17180
398  QUE(JK) = QUE(JK) + PN(N)*BASIC(J+5,INN)                            *2D17190
     BASIC(JJ,INN) = BASIC(JJ,INN)+AR(I)                                 *2D17200
399  QUE(9) = QUE(9)-PN(N)*SPSIA(IA)                                     *2D17210
     QUE(10) = QUE(10)+PN(N)*CPSIA(IA)                                   *2D17220
400  IF (IBUG-2) 430,410,410                                             *2D17230
410  WRITE(6,9998)N,DELIA,DELIAD,PN(N),EONE(N),EPSLNY(N)                 *2D17240
9998 FORMAT (8H  CONTACI5,5E22.8)                                        *2D17250
430  CONTINUE                                                            *2D17260
     IF (IBUG-2) 450,440,440                                             *2D17270
440  WRITE(6,9999)QUE                                                    *2D17280
9999 FORMAT (11HOQUE VECTOR/(5F20.8))                                    *2D17290
450  RETURN                                                              *2D17300
     END                                                                 *2D17310
```


Subroutine CONTAC (page 4 of 4)

```
      SUBROUTINE DATE(IA)                                                *2D39460
C                DUMMY DATE ROUTINE                                      *2D39470
      DIMENSION IA(3)                                                    *2D39480
      DATA IB/1H /                                                       *2D39490
      IA(1)=IB                                                           *2D39500
      IA(2)=IB                                                           *2D39510
      IA(3)=IB                                                           *2D39520
      RETURN                                                             *2D39530
      END                                                                *2D39540
                                                                         *2D39550
```

Subroutine DATE

```
                                                                  *2017320
      SUBROUTINE DELZMK(KK)                                       *2017330
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2017340
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2017350
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2017360
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2017370
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2017380
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2017390
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2017400
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2017410
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2017420
     9OPRM,XPRM,YPRM,BEF,CEE,DEE,QUF,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2017430
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2017440
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVFLC,AACCA,*2017450
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2017460
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2017470
                                                                  *2017480
                                                                  *2017490
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2017500
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPPIME(7),BIGKI(7),*2017510
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AP(*2017520
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2017530
     4),STHETA(8),           BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2017540
     5,TDSQLI(8),ATDSQ(9),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2017550
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2017560
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2017570
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2017580
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2017590
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2017600
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2017610
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),         SIGMAA(10,1*2017620
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2017630
     4LE(2,14),ZPPP(128),BL(3)                                    *2017640
                                                                  *2017650
      COMMON THATPW,THATPX,THATPS,XVEHZ                           *2017660
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)               *2017670
      COMMON NONO(1402)                                           *2017680
      K=KK                                                        *2017690
      IF (K-8) 10,320,370                                         *2017700
   10 GO TO (20,50,80,110,140,190,240),K                          *2017710
   20 IF (RVEL(1)) 40,290,30                                      *2017720
   30 IF (TIMTJ(6).GE.ALFAI(1)) GO TO 290                         *2017730
      TMATII(1)=TPRIME(1)*(ALFAI(1)-TIMTJ(6))                     *2017740
      GO TO 300                                                   *2017750
   40 IF (TIMTJ(6).LE.OMEGAI(1)) GO TO 290                        *2017760
      TMATII(1)=THATPW*(OMEGAI(1)-TIMTJ(6))                       *2017770
      GO TO 300                                                   *2017780
   50 IF (ABS(TIMTJ(1))-OMEGAI(2)) 290,290,60                     *2017790
   60 IF (RVEL(2)*TIMTJ(1)) 290,70,70                             *2017800
   70 TMATII(2)=TPRIME(2)*(TIMTJ(1)-SIGN(OMEGAI(2),TIMTJ(1)))     *2017810
```

Subroutine DELZMK (page 1 of 3)

```
      GO TO 300                                                    *2D17820
80    IF (ABS(TIMTJ(7))-CMEGAI(3)) 290,290,90                      *2D17830
90    IF (RVEL(3)*TIMTJ(7)) 290,100,100                            *2D17840
100   TMATII(3)=TPRIME(3)*(TIMTJ(7)-SIGN(OMEGAI(3),TIMTJ(7)))      *2D17850
      GO TO 300                                                    *2D17860
110   IF (ABS(TIMTJ(11))-CMEGAI(4)) 290,290,120                    *2D17870
120   IF (RVEL(4)*TIMTJ(11)) 290,130,130                           *2D17880
130   TMATII(4)=TPRIME(4)*(TIMTJ(11)-SIGN(OMEGAI(4),TIMTJ(11)))    *2D17890
      GO TO 300                                                    *2D17900
140   IF (RVEL(5)) 170,290,150                                     *2D17910
150   IF (TIMTJ(12)-OMEGAI(5)) 290,290,160                         *2D17920
160   TMATII(5)=THATPV*(TIMTJ(12)-OMEGAI(5))                       *2D17930
      GO TO 300                                                    *2D17940
170   IF (TIMTJ(12)-ALFAI(5)) 180,290,290                          *2D17950
180   TMATII(5) = TPRIME(5)*(TIMTJ(12)-ALFAI(5))                   *2D17960
      GO TO 300                                                    *2D17970
190   IF (RVEL(6)) 210,290,200                                     *2D17980
200   IF (TIMTJ(15)+ALFAI(6).LE.0.) GO TO 290                      *2D17990
      TMATII(6)=TPRIME(6)*(TIMTJ(15)+ALFAI(6))                     *2D18000
      GO TO 300                                                    *2D18010
210   IF (TIMTJ(15)+OMEGAI(6).GE.0.) GO TO 290                     *2D18020
      TMATII(6)=THATPX*(TIMTJ(15)+OMEGAI(6))                       *2D18030
      GO TO 300                                                    *2D18040
240   IF (RVEL(7)) 260,290,250                                     *2D18050
250   IF (TIMTJ(16).GE.ALFAI(7)) GO TO 290                         *2D18060
      TMATII(7)=TPRIME(7)*(ALFAI(7)-TIMTJ(16))                     *2D18070
      GO TO 300                                                    *2D18080
260   IF (TIMTJ(16).LE.OMEGAI(7)) GO TO 290                        *2D18090
      TMATII(7)=THATPS*(OMEGAI(7)-TIMTJ(16))                       *2D18100
      GO TO 300                                                    *2D18110
290   TMATII(K)=0.                                                 *2D18120
300   M = MFORI(K)                                                 *2D18130
      TS=TMATII(K)+SIGN(CPRIME(K),RVEL(K))                         *2D18140
      DO 310 J=1,10                                                *2D18150
310   DELZ(J,K)=(ANVERS(J,K)-ANVERS(J,M))*TS                       *2D18160
      GO TO 900                                                    *2D18170
320   TS = -SIGN(SMALLF,RVEL(8))                                   *2D18180
      DO 330 J=1,10                                                *2D18190
330   DELZ(J,8) = ANVERS(J,9)*TS                                   *2D18200
      GO TO 900                                                    *2D18210
370   N = IFORK(3,K-8)                                             *2D18220
      IA = IFORK(2,K-8)                                            *2D18230
      II = IFORK(1,K-8)                                            *2D18240
      IF (IBUG) 375,375,373                                        *2D18250
373   J=IA-1                                                       *2D18260
      WRITE(6,9998)K,II,J                                          *2D18270
9998  FORMAT(13HOFOR MODE NO.I5,4H, I=I5,4H, A=I5)                 *2D18280
375   TSA=FMUA(IA)*PN(N)                                           *2D18290
      TS = -SIGN(TSA,RVEL(K))                                      *2D18300
      GO TO (380,900,400,420,420,900,460,480),II                   *2D18310
```

Subroutine DELZMK (page 2 of 3)

```
      380 DO 390 J=1,10                                                    *2D18320
          DELZ(J,K)=(AR(1)*ANVERS(J,1)+CPSIA(2)*ANVERS(J,9)+SPSIA(2)*ANVERS(*2D18330
         1J,10))*TS                                                        *2D18340
      390 CONTINUE                                                         *2D18350
          GO TO 900                                                        *2D18360
      400 DO 410 J=1,10                                                    *2D18370
          DELZ(J,K)=(ANVERS(J,1)*BASIC(1,K-8)+ANVERS(J,2)*BASIC(2,K-8)     *2D18380
         1+ANVERS(J,3)*BASIC(3,K-8)+ANVERS(J,9)*CPSIA(IA)+ANVERS(J,10)     *2D18390
         2*SPSIA(IA))*TS                                                   *2D18400
      410 CONTINUE                                                         *2D18410
          GO TO 900                                                        *2D18420
      420 DO 430 J=1,10                                                    *2D18430
          DELZ(J,K)=(ANVERS(J,1)*BASIC(1,K-8)+ANVERS(J,2)*BASIC(2,K-8)     *2D18440
         1+ANVERS(J,3)*BASIC(3,K-8)+ANVERS(J,9)*CPSIA(IA)+ANVERS(J,10)     *2D18450
         2*SPSIA(IA)+ANVERS(J,II)*BASIC(II,K-8))*TS                        *2D18460
      430 CONTINUE                                                         *2D18470
          GO TO 900                                                        *2D18480
      460 DO 470 J=1,10                                                    *2D18490
          DELZ(J,K)=(ANVERS(J,7)*BASIC(1,K-8)+ANVERS(J,9)*CPSIA(IA)        *2D18500
         1+ANVERS(J,10)*SPSIA(IA))*TS                                      *2D18510
      470  CONTINUE                                                        *2D18520
          GO TO 900                                                        *2D18530
      480 DO 490 J=1,10                                                    *2D18540
          DELZ(J,K)=(ANVERS(J,7)*BASIC(1,K-8)+ANVERS(J,8)*BASIC(2,K-8)     *2D18550
         1+ANVERS(J,10)*SPSIA(IA)+ANVERS(J,9)*CPSIA(IA))*TS                *2D18560
      490  CONTINUE                                                        *2D18570
      900 IF (IBUG-1) 920,910,910                                          *2D18580
      910 WRITE(6,9999)K,(DELZ(J,K),J=1,10)                                *2D18590
     9999 FORMAT (8H0DELZMK I10,3X5F20.6/21X5E20.6)                        *2D18600
      920 RETURN                                                           *2D18610
          END                                                              *2D18620
```

Subroutine DELZMK (page 3 of 3)

```
      SUBROUTINE ERROR                                                  *2D39360
C             OS DUMMY ERROR ROUTINE                                    *2D39370
      PRINT 9999                                                        *2D39380
 9999 FORMAT(13H0ERROR RETURN/1H1)                                      *2D39390
      I=0                                                               *2D39400
      IF(I) 20,10,20                                                    *2D39410
   10 STOP                                                              *2D39420
   20 RETURN                                                            *2D39430
      END                                                               *2D39440
                                                                        *2D39450
```

Subroutine ERROR

```
                                                                        *2D25170
      SUBROUTINE FECLOD(II,SIG,SDL,SDLD,FTT)                            *2D25180
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D25190
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D25200
     2TWO,GRAVIT,CPRIME,BIGKI,FL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D25210
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D25220
     4,S,FMJS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGP*2D25230
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,RPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D25240
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D25250
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D25260
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN,  MODE,OMEGA,X,Y,THEFEE,RH*2D25270
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D25280
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D25290
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D25300
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D25310
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D25320
                                                                        *2D25330
                                                                        *2D25340
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D25350
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D25360
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),FL(8),AR(*2D25370
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D25380
     4),STHETA(8),             BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D25390
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D25400
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D25410
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D25420
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D25430
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),FONE(18),PN(18) *2D25440
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D25450
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D25460
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),          SIGMAA(10,1*2D25470
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D25480
     4LE(2,14),ZPPP(128),BL(3)                                          *2D25490
                                                                        *2D25500
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D25510
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D25520
      COMMON NONO(1402)                                                 *2D25530
      DIMENSION COE(6),ROOTR(5),ROOTI(5),SIG(10)                        *2D25540
      INDEX = II                                                        *2D25550
      SDELD = SDLD                                                      *2D25560
      SDEL = SDL                                                        *2D25570
      GNEW = G(INDEX)                                                   *2D25580
      RNEW = R(INDEX)                                                   *2D25590
      OMGT = SDEL-EPSLNY(INDEX)                                         *2D25600
      OLDELD=DELDOD(INDEX)                                              *2D25610
      YEPSLN = EPSLNY(INDEX)                                            *2D25620
      FOM = OMEGA(INDEX)/G(INDEX)                                       *2D25630
      N=INDEX                                                           *2D25640
      EO = EHAT(INDEX)                                                  *2D25650
      FT = FTOLD(INDEX)                                                 *2D25660
```

Subroutine FECLOD (page 1 of 3)

```
      CO = CZERON(INDEX)                                                *2D25670
      C1 = CONEN(INDEX)                                                 *2D25680
      C2 = CTWON(INDEX)                                                 *2D25690
      SAGXXX = SIGZ(INDEX)                                              *2D25700
      OMSGE = 1. - GNEW                                                 *2D25710
      GOMG = OMEGA(INDEX)                                               *2D25720
  100 IF (OMGT) 240,240,110                                             *2D25730
  110 IF (SDELD) 250,120,120                                            *2D25740
  120 IF (OLDELD) 130,215,215                                           *2D25750
  130 IF (FT) 140,140,150                                               *2D25760
  140 YEPSLN = YEPSLN + GOMG                                            *2D25770
      GO TO 210                                                         *2D25780
  150 DO 160 I=1,5                                                      *2D25790
      J=6-I                                                             *2D25800
  160 COE(I) = SIG(J)                                                   *2D25810
      COE(6) = SAGXXX - FT                                              *2D25820
      KKK = 5                                                           *2D25830
      CALL MULLER(COE,KKK,ROOTR,ROOTI)                                  *2D25840
      RTM = 1.E20                                                       *2D25850
      DO 200 I=1,KKK                                                    *2D25860
      TS = DELOLD(INDEX)-YEPSLN-ROOTR(I)                                *2D25870
      IF (TS) 200,170,170                                               *2D25880
  170 IF (TS-OMGT) 180,180,200                                          *2D25890
  180 IF(RTM-ABS(ROOTI(I))) 200,200,190                                 *2D25900
  190 EPSLNP = TS                                                       *2D25910
      RTM = ABS(ROOTI(I))                                               *2D25920
  200 CONTINUE                                                          *2D25930
      YEPSLN = YEPSLN + EPSLNP                                          *2D25940
  210 OMGT = SDEL-YEPSLN                                                *2D25950
      OLDELD = 1.                                                       *2D25960
      GO TO 100                                                         *2D25970
  215 IF (DELOLD(INDEX)-YEPSLN) 218,218,220                             *2D25980
  218 SAGXXX=-((((SIG(10)*SDELD+SIG(9))*SDELD+SIG(8))*SDELD+SIG(7))*    *2D25990
     1SDELD+SIG(6))*SDELD                                               *2D26000
  220 IF(ISWT(INDEX).EQ.0) GO TO 225                                    *2D26010
      FTT=FARB(N)                                                       *2D26020
      GO TO 230                                                         *2D26030
  225 FTT=((((SIG(5)*OMGT+SIG(4))*OMGT+SIG(3))*OMGT+SIG(2))*OMGT+SIG(1))*2D26040
     1*OMGT+SAGXXX+((((SIG(10)*SDELD+SIG(9))*SDELD+SIG(8))*SDELD+SIG(7))*2D26050
     2*SDELD+SIG(6))*SDELD                                              *2D26060
      IF(FTT.LT.0.) FTT=0.                                              *2D26070
  230 IF (IBUG) 233,236,233                                             *2D26080
  233 WRITE(6,9999)TIME,INDEX,SDEL,SDELD,FTT                            *2D26090
 9999 FORMAT (8H FECLOD F20.6,I10,3E20.8)                               *2D26100
  236 RETURN                                                            *2D26110
  240 FTT = 0.                                                          *2D26120
      GO TO 230                                                         *2D26130
  250 IF(OLDELD) 260,290,290                                            *2D26140
  260 IF (OMGT-GOMG) 240,240,410                                        *2D26150
  290 FOM=AMAX1(SDEL,DELOLD(INDEX))-YEPSLN                              *2D26160
```

Subroutine FECLOD (page 2 of 3)

```
      IF(ISWT(INDEX).EQ.0) GO TO 295                                    *2D26170
      CO=FARB(N)-SLOPE(N)*FOM                                           *2D26180
      C1=SLOPE(N)                                                       *2D26190
      C2=0.                                                             *2D26200
      GO TO 410                                                         *2D26210
  295 GOMG=GNEW*FOM                                                     *2D26220
      EO = EONE(INDEX)                                                  *2D26230
      IF (EO.EQ.0.) GO TO 420                                           *2D26240
      TS = FT*(FOM-GOMG)                                                *2D26250
  300 IF (2.*EO-TS) 340,320,310                                         *2D26260
  310 EO = .5*TS                                                        *2D26270
  320 CO = -GNEW/OMSGE*FT                                               *2D26280
      C1=FT/FOM/OMSGE                                                   *2D26290
      C2=0.                                                             *2D26300
      GO TO 410                                                         *2D26310
  340 IF (3.*EO-TS) 350,380,400                                         *2D26320
  350 RNEW = RNEW/EO*TS/3.                                              *2D26330
      IF(RNEW-1.) 360,370,370                                           *2D26340
  360 EO = TS/3.                                                        *2D26350
      GO TO 380                                                         *2D26360
  370 GNEW = 1.-3./FOM*EO/FT                                            *2D26370
      OMSGE=1.-GNEW                                                     *2D26380
  380 CO = GNEW/OMSGE*GNEW/OMSGE*FT                                     *2D26390
      C1 = -2./FOM*GNEW/OMSGE*FT/OMSGE                                  *2D26400
      C2=FT/FOM/FOM/OMSGE/OMSGE                                         *2D26410
      GO TO 410                                                         *2D26420
  400 TSB = FOM*OMSGE*OMSGE*OMSGE                                       *2D26430
      CO = GNEW*(TS*(2.+GNEW)-6.*EO)/TSB                                *2D26440
      TSB = TSB*FOM                                                     *2D26450
      C1 = 2.*(3.*EO*(1.+GNEW)-TS*(1.+GNEW*GNEW))/TSB                   *2D26460
      C2 = 3./FOM*(TS-2.*EO)/TSB                                        *2D26470
  410 FTT = (C2*OMGT+C1)*OMGT +CO                                       *2D26480
      IF (FTT) 240,230,230                                              *2D26490
  420 PRINT 9998,TIME,INDEX                                             *2D26500
 9998 FORMAT (8HOAT TIME,F8.6,38H FORCE COMING ON FROM BEHIND FOR INDEX *2D26510
     1,I3)                                                              *2D26520
      PRINT 9997                                                        *2D26530
 9997 FORMAT (1H1)                                                      *2D26540
      CALL SUMARY                                                       *2D26550
      CALL ERROR                                                        *2D26560
      END                                                               *2D26570
```

Subroutine FECLOD (page 3 of 3)

```
                                                                          *2D10500
      SUBROUTINE GETY(XX,ITABL,ORD)                                       *2D10510
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORF,DA,XSMALA,YSMAL *2D10520
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D10530
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D10540
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D10550
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D10560
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D10570
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D10580
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D10590
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D10600
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ   *2D10610
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D10620
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D10630
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D10640
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ   *2D10650
                                                                          *2D10660
                                                                          *2D10670
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D10680
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D10690
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D10700
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D10710
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D10720
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D10730
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D10740
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D10750
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D10760
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D10770
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D10780
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D10790
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),         SIGMAA(10,1*2D10800
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D10810
     4LE(2,14),ZPPP(128),BL(3)                                           *2D10820
                                                                          *2D10830
      COMMON THATPW,THATPX,THATPS,XVEHZ                                   *2D10840
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                       *2D10850
      COMMON NONO(1402)                                                   *2D10860
  220 TS = XX                                                             *2D10870
      II = ITABL                                                          *2D10880
      IMAX = MAX(II)                                                      *2D10890
      IF (SWITCH(II))  20,10,30                                           *2D10900
   10 ORD = YYY(1,II)                                                     *2D10910
      GO TO 150                                                           *2D10920
   20 TS = AMOD(TS,24.)                                                   *2D10930
   30 IF (IMAX)  40,40,50                                                 *2D10940
   40 PRINT 9900,II                                                       *2D10950
 9900 FORMAT (7HOTABLE I4,32H HAS NO ENTRIES AND CALLED UPON.)            *2D10960
      GO TO 10                                                            *2D10970
   50 IMIN = MAX0(1,IPOST(II))                                            *2D10980
      IXSWT=0                                                             *2D10990
```

Subroutine GETY (page 1 of 2)

```
      IF (IMIN-IMAX)  70,60,60                                          *2D11000
   60 IMIN = 1                                                          *2D11010
   70 DO 80 I= IMIN,IMAX                                                *2D11020
      JJ = I                                                            *2D11030
      IF (XXX(I,II)-TS) 80,90,100                                       *2D11040
   80 IXSWT=1                                                           *2D11050
      PRINT 9901,II,XXX(IMAX,II),TS,YYY(IMAX,II)                        *2D11060
 9901 FORMAT (7H0TABLE I4,7H MAX X=E17.8,17H EXCEEDED BY ARG=E17.8,10H,Y*2D11070
     1 SET TO E17.8)                                                    *2D11080
      ORD = YYY(IMAX,II)                                                *2D11090
      GO TO 128                                                         *2D11100
   90 ORD = YYY(JJ,II)                                                  *2D11110
      GO TO 140                                                         *2D11120
  100 IF (IXSWT) 130,110,130                                            *2D11130
  110 IF (JJ-1) 60,120,60                                               *2D11140
  120 PRINT 9902,II,XXX(1,II),TS,YYY(1,II)                              *2D11150
 9902 FORMAT (7H0TABLE I4,7H MIN X=E17.8,21H NOT EXCEEDED BY ARG=E17.8,1*2D11160
     10H,Y SET TO E17.8)                                                *2D11170
      ORD = YYY(1,II)                                                   *2D11180
  128 JJ=1                                                              *2D11190
      GO TO 140                                                         *2D11200
  130 JJ=JJ-1                                                           *2D11210
      ORD = FMM(JJ,II)*TS + BBB(JJ,II)                                  *2D11220
  140 IPOST(II)=JJ                                                      *2D11230
  150 IF (IBUG) 160,170,160                                             *2D11240
  160 WRITE(6,9903)XX,TS,II,ORD                                         *2D11250
 9903 FORMAT (5H ARG=F8.2,9H,MOD ARG=F8.2,7H,TABLE=I4,5H,ORD=E17.8)     *2D11260
  170 RETURN                                                            *2D11270
      END                                                               *2D11280
```

Subroutine GETY (page 2 of 2)

```
      INTEGER FUNCTION ITOPOW(J)                                 *2D28600
      ITOPOW=2**J                                                *2D28610
      RETURN                                                     *2D28620
      END                                                        *2D28630
                                                                 *2D28640
```

Subroutine ITOPOW

```
                                                                                *2D18630
      SUBROUTINE  JITTER(ZKB)                                                   *2D18640
      COMMON  SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D18650
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D18660
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D18670
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D18680
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D18690
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D18700
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D18710
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D18720
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDFLTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D18730
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELODD,EPSLNY,FTOLD,FSPRMZ  *2D18740
      COMMON  CZERON,CONEN,CTWON,FT,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D18750
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D18760
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D18770
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D18780
                                                                        *2D18790
                                                                        *2D18800
      DIMENSION  SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D18810
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D18820
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D18830
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D18840
     4),STHETA(8),        BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D18850
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D18860
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D18870
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D18880
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D18890
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D18900
      DIMENSION  DELOLD(18),DELODD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D18910
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D18920
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),          SIGMAA(10,1*2D18930
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D18940
     4LE(2,14),ZPPP(128),BL(3)                                          *2D18950
                                                                        *2D18960
      COMMON  THATPW,THATPX,THATPS,XVEHZ                                *2D18970
      COMMON  FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                    *2D18980
      COMMON  NONG(1402)                                                *2D18990
      DIMENSION  ZKB(11)                                                *2D19000
      LITGAM=0                                                          *2D19010
      L=1                                                               *2D19020
      N=1                                                               *2D19030
      M=MAXI-1                                                          *2D19040
      ITOP=ITOPOW(M)                                                    *2D19050
      DO 40  I=1, ITOP                                                  *2D19060
   40 CALL  ZKMAKR(I,ZK(1,I))                                           *2D19070
   60 K=IBIG(N)                                                         *2D19080
      ITOP  =  ITOPOW(M)                                                *2D19090
      ITPH=ITOPOW(M-1)+1                                                *2D19100
      CALL  RELSEL(ZKB,K,ZRV)                                           *2D19110
      DO 70  I=1, ITOP                                                  *2D19120
```

Subroutine JITTER (page 1 of 3)

```
 70   CALL RELSEL(ZK(1,I),K,ZPPP(I))                      *2D19130
      IF (L-1) 100,100,80                                  *2D19140
 80   DO 90  J=1,10                                        *2D19150
 90   DELZ(J,K) = ZK(J,ITOP+1)-ZK(J,1)                     *2D19160
 100  CALL RELSEL(DELZ(1,K),K,DELNU)                       *2D19170
      TSB = ZRV+ZPPP(1)                                    *2D19180
 110  DO 130 I=1,ITOP                                      *2D19190
      TS = ZRV+ZPPP(I)                                     *2D19200
      TSA = TS+DELNU                                       *2D19210
      IF (TS*TSA) 180,12C,120                              *2D19220
 120  IF (TS*TSB) 180,130,130                              *2D19230
 130  CONTINUE                                             *2D19240
 140  IF (RVEL(K)*TSB) 150,150,160                         *2D19250
 150  MODE(K) = -1                                         *2D19260
      IF (IBUG-1) 230,155,155                              *2D19270
 155  WRITE(6,9998)K                                       *2D19280
 9998 FORMAT (6H MODE(I2,12H) TURNED OFF)                  *2D19290
      GO TO 230                                            *2D19300
 160  MODE(K) = 1                                          *2D19310
      IF (IBUG-1) 167,163,163                              *2D19320
 163  WRITE(6,9997)K                                       *2D19330
 9997 FORMAT (6H MODE(I2,11H) TURNED ON)                   *2D19340
 167  DO 170 J=1,10                                        *2D19350
 170  ZKB(J)=ZKB(J)+DELZ(J,K)                              *2D19360
      GO TO 230                                            *2D19370
 180  IF (K-8) 200,190,185                                 *2D19380
 185  IA = IFORK(2,K-8)                                    *2D19390
      IF (ABS(PSIA(IA)-PITWO).LE.1.E-4) GO TO 200          *2D19400
      IF (ABS(PSIA(IA)-3.*PITWO).LE.1.E-4) GO TO 200       *2D19410
 190  IF (FMM(KPOST,1)) 240,200,240                        *2D19420
 200  IF (IBUG-1) 205,203,203                              *2D19430
 203  WRITE(6,9996)K                                       *2D19440
 9996 FORMAT (17HOJITTER FOR MODE(I2,1H))                  *2D19450
 205  DO 220 I=1,ITOP                                      *2D19460
      AK = (ZPPP(I)+ZRV)/DELNU                             *2D19470
      IF (IBUG-2) 208,206,206                              *2D19480
 206  WRITE(6,9995)I,AK                                    *2D19490
 9995 FORMAT (3H I=I2,4H,AK=E14.6)                         *2D19500
 208  DO 210 J=1,10                                        *2D19510
 210  ZK(J,I) = ZK(J,I)-AK*DELZ(J,K)                       *2D19520
 220  CONTINUE                                             *2D19530
      L=L+1                                                *2D19540
 230  N=N+1                                                *2D19550
      M=M-1                                                *2D19560
      IF (M) 420,60,60                                     *2D19570
 240  IF (M) 360,360,250                                   *2D19580
 250  KN=IBIG(N+1)                                         *2D19590
      CALL RELSEL(ZKB,KN,ZRVN)                             *2D19600
      IF (L-1) 280,280,260                                 *2D19610
 260  DO 270 I=1,10                                        *2D19620
```

Subroutine JITTER (page 2 of 3)

```
270  DELZ(I,K) = ZK(I,ITOP+1)-ZK(I,1)                                      *2D19630
280  CALL RELSEL(DELZ(1,K),KN,DELNN)                                         *2D19640
290  DO 310 I=1,ITOP                                                         *2D19650
     CALL RELSEL(ZK(1,I),KN,TS)                                              *2D19660
     TSA = ZRVN+TS+DELNN                                                     *2D19670
     TSB = TS+ZRVN                                                           *2D19680
     IF (I-1) 293,293,297                                                    *2D19690
293  TSC = ZRVN+TS                                                           *2D19700
297  IF (TSA*TSB) 500,300,300                                                *2D19710
300  IF (TSC*TSB) 500,310,310                                                *2D19720
310  CONTINUE                                                                *2D19730
     IF (RVEL(KN)*TSC) 320,320,330                                           *2D19740
320  MODE(KN) = -1                                                           *2D19750
     GO TO 350                                                               *2D19760
330  MODE(KN) = 1                                                            *2D19770
     DO 340 J=1,10                                                           *2D19780
340  ZKB(J)=ZKB(J)+DELZ(J,KN)                                                *2D19790
     CALL RELSEL(ZKB,K,ZRV)                                                  *2D19800
350  M=M-1                                                                   *2D19810
     GO TO 240                                                               *2D19820
360  TS=ZRV+ZPPP(1)+DELNU                                                    *2D19830
     IF (IBUG) 368,368,363                                                   *2D19840
363  WRITE(6,9990)ZRV,ZPPP(1),DELNU,FMM(KPOST,1)                             *2D19850
9990 FORMAT (5H0ZRV=E12.4,6H,ZPPP=E12.4,7H,DELNU=E12.4,5H,FMM=E12.4)        *2D19860
368  IF (K-8) 370,370,380                                                    *2D19870
370  TAHATZ = TS/FMM(KPOST,1)                                                *2D19880
     GO TO 390                                                               *2D19890
380  IA=IFORK(2,K-8)                                                         *2D19900
     TAHATZ = TS/FMM(KPOST,1)/CPSIA(IA)                                      *2D19910
390  IF (TAHATZ-1.E-6) 140,140,400                                           *2D19920
400  LITGAM = K                                                              *2D19930
     AK = .5/DELNU*(ZRV+ZPPP(1)-DELNU)                                       *2D19940
     DO 410 J=1,10                                                           *2D19950
      ZK(J,2)=ZK(J,1)+DELZ(J,K)                                              *2D19960
     ZVECPP(J)=ZKB(J)+ZK(J,1)-AK*DELZ(J,K)                                   *2D19963
410  CONTINUE                                                                *2D19965
     RETURN                                                                  *2D19967
420  DO 430 J=1,10                                                           *2D19970
430  ZVECPP(J)=ZKB(J)+ZK(J,1)                                                *2D19980
     RETURN                                                                  *2D19990
500  PRINT 9999,TIME                                                         *2D20000
9999 FORMAT (30H0TWO LINEAR JITTER MODES AT T=F8.6)                         *2D20010
     PRINT 9991                                                              *2D20020
9991 FORMAT(1H1)                                                             *2D20030
     CALL SUMARY                                                             *2D20040
     CALL ERROR                                                              *2D20050
     END                                                                     *2D20060
```

Subroutine JITTER (page 3 of 3)

```
                                                                        *2D05540
      SUBROUTINE KRUNCH                                                 *2D05550
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D05560
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D05570
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D05580
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D05590
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTFP,DELTAT,PHIZ,DELTA,NPASGR*2D05600
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D05610
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D05620
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,         BIGMI,TMATII,*2D05630
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D05640
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D05650
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D05660
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D05670
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D05680
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D05690
                                                                        *2D05700
                                                                        *2D05710
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D05720
     1),PHI(3),SDELTA(3),SCELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D05730
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D05740
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D05750
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D05760
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D05770
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D05780
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D05790
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D05800
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D05810
      DIMENSION CELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D05820
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D05830
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),         SIGMAA(10,1*2D05840
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D05850
     4LE(2,14),ZPPP(128),BL(3)                                          *2D05860
                                                                        *2D05870
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D05880
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D05890
      COMMON NONO(1402)                                                 *2D05900
      DIMENSION ZKBASE(11)                                              *2D05910
      TINFL = XXX(2,1)                                                  *2D05920
      KPOST = 1                                                         *2D05930
      KTS = 1                                                           *2D05940
      TPRINT = APRNTD                                                   *2D05950
      TSTEP = XXX(1,1)                                                  *2D05960
      AVELA = FMM(1,1)/2.                                               *2D05970
      AACCA = AVELA/3.                                                  *2D05980
      BVELB = YYY(1,1)                                                  *2D05990
      BACCB = BVELB/2.                                                  *2D06000
      CVELC = XVEHZ                                                     *2D06010
      CACCC = CVELC                                                     *2D06020
      DACCD = 0.                                                        *2D06030
```

Subroutine KRUNCH (page 1 of 5)

```
      MPRINT = 1                                              *2D06040
      MAXR = 8                                                *2D06050
      LITGAM = 0                                              *2D06060
      EPSLNZ = 1.E-7                                          *2D06070
      DO 2270 I=1,16                                          *2D06080
      MODE(I) = -1                                            *2D06090
      DELZ(11,I) = 0.                                         *2D06100
      RSEL(I) = 0.                                            *2D06110
 2270 RVEL(I) = 0.                                            *2D06120
      GEE(9) = 0.                                             *2D06130
      GEE(10) = GRAVA(9)                                      *2D06140
      KPRINT = 1                                              *2D06150
      DO 2310 I=1,11                                          *2D06160
      ZVEC(I) = 0.                                            *2D06170
      ZVECP(I) = 0.                                           *2D06180
      ZVECPP(I) = 0.                                          *2D06190
 2310 CONTINUE                                                *2D06200
      DO 2333 I=1,8                                           *2D06210
      ZVEC(I) = THETAZ(I)                                     *2D06220
 2333 IBIG(I) = 0                                             *2D06230
      ZVECP(9) = XPACZ                                        *2D06240
      ZVECP(11) = XVEHZ                                       *2D06250
      EONEC = 0.                                              *2D06260
      THEFEE = THETAZ(1) - PHIZ(1)                            *2D06270
      RHOPRM(1) = 0.                                          *2D06280
      RHOPRM(2) = 0.                                          *2D06290
      RHOPRM(3)=RHOPTZ                                        *2D06300
      RHOPRM(4) = RHOPFZ                                      *2D06310
      RHOPRM(5) = EL(5)                                       *2D06320
      RHOPRM(6) = EL(6)                                       *2D06330
      RHOPRM(7) = EL(7)                                       *2D06340
      RHOPRM(8) = EL(8)                                       *2D06350
      DO 2490 I=1,18                                          *2D06360
      DELDOD(I) = 1.                                          *2D06370
      DELOLD(I) = 0.                                          *2D06380
      FTOLD(I) = 0.                                           *2D06390
      OMEGA(I) = 0.                                           *2D06400
      EPSLNY(I) = 0.                                          *2D06410
      CZERON(I) = 0.                                          *2D06420
      CONEN(I) = 0.                                           *2D06430
      CTWON(I) = 0.                                           *2D06440
      ET(I) = 0.                                              *2D06450
      PN(I)=0.                                                *2D06460
      EONE(I)=0.                                              *2D06470
      EHAT(I)=0.                                              *2D06480
 2490 CONTINUE                                                *2D06490
      DO 2950 I=1,7                                           *2D06500
      GO TO (2900,2950,2950,2950,2900,2900,2900),I            *2D06510
 2900 IF (ALFAI(I)) 2910,2950,2910                            *2D06520
 2910 TPRIME(I) = TPRIME(I)/ABS(ALFAI(I))                     *2D06530
```

Subroutine KRUNCH (page 2 of 5)

```
 2950 CONTINUE                                                   *2D06540
      DO 2960 I=1,128                                            *2D06550
 2960 ZK(11,I) = 0.                                              *2D06560
 2378 TIMTJZ(1) = THETAZ(1)-THETAZ(2)                            *2D06570
      TIMTJZ(2) = THETAZ(1)-THETAZ(3)                            *2D06580
      TIMTJZ(3)=THETAZ(1)-THETAZ(4)                              *2D06590
      TIMTJZ(4) = THETAZ(1)-THETAZ(5)                            *2D06600
      TIMTJZ(5)=THETAZ(1)-THETAZ(6)                              *2D06610
      TIMTJZ(6)=THETAZ(1)-THETAZ(7)                              *2D06620
      TIMTJZ(7)=THETAZ(2)-THETAZ(3)                              *2D06630
      TIMTJZ(8)=THETAZ(2)-THETAZ(4)                              *2D06640
      TIMTJZ(9)=THETAZ(2)-THETAZ(5)                              *2D06650
      TIMTJZ(10)=THETAZ(2)-THETAZ(6)                             *2D06660
      TIMTJZ(11)=THETAZ(3)-THETAZ(4)                             *2D06670
      TIMTJZ(12)=THETAZ(3)-THETAZ(5)                             *2D06680
      TIMTJZ(13) = THETAZ(3)-THETAZ(6)                           *2D06690
      TIMTJZ(14) = THETAZ(4)-THETAZ(5)                           *2D06700
      TIMTJZ(15) = THETAZ(5)-THETAZ(6)                           *2D06710
      TIMTJZ(16) = THETAZ(7) - THETAZ(8)                         *2D06720
      AEL(1) = A(2)*EL(1)                                        *2D06730
      AEL(2) = A(3)*EL(1)                                        *2D06740
      AEL(3)=A(3)*EL(2)                                          *2D06750
      AEL(4) = A(4)*EL(1)                                        *2D06760
      AEL(5) = A(4)*EL(2)                                        *2D06770
      AEL(6) = A(4)*EL(3)                                        *2D06780
      AEL(7)=A(5)*EL(1)                                          *2D06790
      AEL(8) = A(5)*EL(2)                                        *2D06800
      AEL(9) = A(5)*EL(4)                                        *2D06810
      AEL(10)=A(6)*EL(1)                                         *2D06820
      AEL(11) = A(6)*EL(2)                                       *2D06830
      AEL(12) = A(6)*EL(4)                                       *2D06840
      AEL(13)=A(6)*EL(5)                                         *2D06850
      AEL(14) = A(8)*EL(7)                                       *2D06860
      AA(1,1) = A(10)                                            *2D06870
      AA(2,2) = A(11)                                            *2D06880
      AA(3,3) = A(12)                                            *2D06890
      AA(4,4) = A(13)                                            *2D06900
      AA(5,5) = A(14)                                            *2D06910
      AA(6,6) = A(15)                                            *2D06920
      AA(7,7) = A(16)                                            *2D06930
      AA(8,8) = A(17)                                            *2D06940
      AA(9,9) = A(9)                                             *2D06950
      AA(10,10) = A(9)                                           *2D06960
      TGAMZ = SIN(GAMZER)/COS(GAMZER)                            *2D06970
      YZZERO=ZZERO*TGAMZ                                         *2D06980
      FSZCNS = FSPRMZ + S*YZZERO                                 *2D06990
      CALL GETY(TIME,2,TS)                                       *2D06992
       IBUG=TS+.5                                                *2D06993
      IF (IBUG.EQ.0) GO TO 5                                     *2D06995
      WRITE(6,9919)IGNORE                                        *2D07000
```

Subroutine KRUNCH (page 3 of 5)

```
      5919 FORMAT (7HOIGNORE10I5)                                          *2D07010
      5    CALL GETY(TIME,2,TS)                                            *2D07020
           IBUG = TS + .5                                                  *2D07030
           CALL GETY(TIME,1,ZVECPP(11))                                    *2D07040
           CALL ACCEL                                                      *2D07050
           DO 110 I=1,8                                                    *2D07060
      110  CALL RELVEL(I,ZVECP,RVEL(I))                                    *2D07070
      320  MAXI = 0                                                        *2D07080
           K = 1                                                           *2D07090
           DO 360 I=1,MAXR                                                 *2D07100
           IF (MODE(I)) 360,330,340                                        *2D07110
      330  RVEL(I) = SIGN(RPSI(I),RVEL(I))                                 *2D07120
           CALL DELZMK(I)                                                  *2D07130
           IBIG(K) = I                                                     *2D07140
           K = K+1                                                         *2D07150
           MAXI = MAXI+1                                                   *2D07160
           GO TO 360                                                       *2D07170
      340  CALL DELZMK(I)                                                  *2D07180
           DO 350 J=1,10                                                   *2D07190
      350  ZVECPP(J) = ZVECPP(J) + DELZ(J,I)                               *2D07200
      360  CONTINUE                                                        *2D07210
           IF(MAXI-8) 361,361,690                                          *2D07220
      361  IF(IBUG-1) 367,363,363                                          *2D07230
      363  WRITE(6,9990)(ZVECPP(I),I=1,11)                                 *2D07240
      9990 FORMAT (9HOZK BASE ,6E18.8)                                     *2D07250
           WRITE(6,9994)TIME,MAXI,(IBIG(I),I=1,MAXI)                       *2D07260
      9994 FORMAT (6HOTIME=F10.8,10X8HI VECTOR10X5HIMAX=I10,1X8I7)         *2D07270
      367  DO 20 I=1,11                                                    *2D07280
      20   ZKBASE(I)=ZVECPP(I)                                             *2D07290
           IF (MAXI) 380,380,370                                           *2D07300
      370  CALL JITTER(ZKBASE)                                             *2D07310
      380  DO 8 I=1,MAXR                                                   *2D07320
      8    CALL RELSEL(ZVECPP,I,RSEL(I))                                   *2D07330
           CALL TAUMAK(ZKBASE)                                             *2D07340
           IF (IBUG) 392,170,392                                           *2D07350
      392  WRITE(6,9997)MAXR,(RVEL(I),I=1,MAXR)                            *2D07360
      5997 FORMAT (5HORVEL10XI10/(1X8E16.6))                               *2D07370
           WRITE(6,9989)(RSEL(I),I=1,MAXR)                                 *2D07380
      5989 FORMAT (1X8E16.6)                                               *2D07390
      170  IF (KPRINT) 180,220,180                                         *2D07400
      180  IF (MPRINT) 190,210,200                                         *2D07410
      190  TPRINT = TPRINT + APRNTD                                        *2D07420
           MPRINT = 1                                                      *2D07430
           GO TO 220                                                       *2D07440
      200  TPRINT = TPRINT + BPRNTD                                        *2D07450
           MPRINT = 0                                                      *2D07460
           GO TO 220                                                       *2D07470
      210  TPRINT = TPRINT + DTPRNT                                        *2D07480
      220  IF (KINFL) 250,280,250                                          *2D07490
      250  KTS = KPOST + 1                                                 *2D07500
```

Subroutine KRUNCH (page 4 of 5)

```
      IF (KTS-MAX(1)) 270,270,260                                          *2007510
 260  TINFL = 1.E20                                                        *2007520
      GO TO 280                                                            *2007530
 270  TINFL = XXX(KTS+1,1)                                                 *2007540
 280  IF (TIME-TIMAX) 300,300,290                                          *2007550
 290  PRINT 9991                                                           *2007560
9991  FORMAT (1H1)                                                         *2007570
      RETURN                                                               *2007580
 300  TIME = TIME + DELTAT                                                 *2007590
 302  IF (IBUG) 303,306,303                                                *2007610
 303  WRITE(6,9998)KPRINT,KINFL,KSTEP,ITAU,TAUHAT,TPRINT,TINFL,TSTEP,      *2007620
     1DELTAT,TIME                                                          *2007630
9998  FORMAT (9HOKRUNCH A4I5,6E16.6)                                       *2007640
 306  TS = DELTAT*DELTAT/2.                                                *2007650
      DO 310 I=1,10                                                        *2007660
      ZVEC(I)=ZVEC(I)+DELTAT*ZVECP(I)+TS*ZVECPP(I)                         *2007670
      ZVECP(I)=ZVECP(I)+DELTAT*ZVECPP(I)                                   *2007680
 310  CONTINUE                                                             *2007690
      DO 318 I=1,8                                                         *2007700
      IF(ABS(ZVEC(I)).GE.6.3) GO TO 700                                    *2007710
 318  CONTINUE                                                             *2007720
      TSA = TIME - TSTEP                                                   *2007730
      TSB = TSA*TSA                                                        *2007740
      ZVEC(11) = (AACCA*TSA+BACCB)*TSB +CACCC*TSA +DACCD                   *2007750
      ZVECP(11) = AVELA*TSB+BVELB*TSA +CVELC                               *2007760
      IF (KINFL) 4000,5,4000                                               *2007770
4000  KPOST = KTS                                                          *2007780
      TSTEP = TIME                                                         *2007790
      AVELA = FMM(KPOST,1)/2.                                              *2007800
      AACCA = AVELA/3.                                                     *2007810
      BVELB = YYY(KPOST,1)                                                 *2007820
      BACCB = BVELB/2.                                                     *2007830
      CVELC = ZVECP(11)                                                    *2007840
      CACCC = CVELC                                                        *2007850
      DACCD = ZVEC(11)                                                     *2007860
      GO TO 5                                                              *2007870
 650  PRINT 9995,TIME                                                      *2007880
9995  FORMAT (9HOAT TIME=F10.6,45H, MORE THAN EIGHT ITEMS IN JITTER, RUN*2007890
     1STOPPED)                                                             *2007900
      GO TO 290                                                            *2007910
 700  PRINT 9989,TIME,I                                                    *2007920
9988  FORMAT(9HOAT TIME=F8.6,10H ANGLE NO.I5,21H EXCEEDS 360 DEGREES.)    *2007930
      GO TO 290                                                            *2007940
      END                                                                  *2007950
```

Subroutine KRUNCH (page 5 of 5)

```
                                                                       *2D23930
      SUBROUTINE LIMIDT( JP,JI,JS)                                     *2D23940
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D23950
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D23960
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D23970
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D23980
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D23990
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D24000
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D24010
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D24020
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D24030
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D24040
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEF,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D24050
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D24060
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D24070
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D24080
                                                                       *2D24090
                                                                       *2D24100
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D24110
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D24120
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),FL(8),AR(*2D24130
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D24140
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D24150
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D24160
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D24170
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D24180
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(15),RVEL(16),MODE(16),TIMTJZ(*2D24190
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D24200
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D24210
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D24220
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D24230
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D24240
     4LE(2,14),ZPPP(128),BL(3)                                         *2D24250
                                                                       *2D24260
      COMMON THATPW,THATPX,THATPS,XVEHZ                                *2D24270
      COMMON FARB(13),SLOPE(18),ISWT(18),LODSWT(18)                    *2D24280
      COMMON NONO(1402)                                                *2D24290
      DIMENSION AX(8),AY(8),AXD(8),AYD(8),CAZ(8),SAZ(8),AZ(11),AZP(11) *2D24300
      POUNDS=1000.                                                     *2D24310
      TS = DELTAT*DELTAT/2.                                            *2D24320
      DO 10 I=1,10                                                     *2D24330
      AZ(I)=ZVEC(I)+DELTAT*ZVECP(I)+TS*ZVECPP(I)                       *2D24340
      AZP(I)=ZVECP(I)+DELTAT*ZVECPP(I)                                 *2D24350
   10 CONTINUE                                                         *2D24360
      TSA = TIME-TSTEP + DELTAT                                        *2D24370
      TSB = TSA*TSA                                                    *2D24380
      AZ(11)=(AACCA*TSA+BACCB)*TSB+CACCC*TSA+DACCD                     *2D24390
      AZP(11)=AVELA*TSB+BVELB*TSA+CVELC                                *2D24400
      NMAX = 1                                                         *2D24410
      DO 12 I=1,8                                                      *2D24420
```

Subroutine LIMIDT (page 1 of 3)

```
      CAZ(I) = COS(AZ(I))                                          *2D24430
      SAZ(I) = SIN(AZ(I))                                          *2D24440
   12 CONTINUE                                                     *2D24450
      AX(1) = AZ(9) - AZ(11)                                       *2D24460
      AY(1) = AZ(10)                                               *2D24470
      AX(2) = AX(1) + EL(1)*CAZ(1)                                 *2D24480
      AY(2) = AY(1) + EL(1)*SAZ(1)                                 *2D24490
      AX(3) = AX(2) + EL(2)*CAZ(2)                                 *2D24500
      AY(3) = AY(2) + EL(2)*SAZ(2)                                 *2D24510
      AX(4) = AX(3) + EL(3)*CAZ(3)                                 *2D24520
      AY(4) = AY(3) + EL(3)*SAZ(3)                                 *2D24530
      AX(5) = AX(3) +EL(4)*CAZ(3)                                  *2D24540
      AY(5) = AY(3) + EL(4)*SAZ(3)                                 *2D24550
      AX(6) = AX(5) + EL(5)*CAZ(5)                                 *2D24560
      AY(6) = AY(5) + EL(5)*SAZ(5)                                 *2D24570
      AX(7) = AX(1)                                                *2D24580
      AY(7) = AY(1)                                                *2D24590
      AX(8) = AX(7) + EL(7)*CAZ(7)                                 *2D24600
      AY(8) = AY(7) + EL(7)*SAZ(7)                                 *2D24610
      AXD(1) = AZP(9) - AZP(11)                                    *2D24620
      AYD(1) = AZP(10)                                             *2D24630
      AXD(2) = AXD(1) -EL(1)*SAZ(1)*AZP(1)                         *2D24640
      AYD(2)=AYD(1) +EL(1)*CAZ(1)*AZP(1)                           *2D24650
      AXD(3) = AXD(2) -EL(2)*SAZ(2)*AZP(2)                         *2D24660
      AYD(3) = AYD(2) +EL(2)*CAZ(2)*AZP(2)                         *2D24670
      AXD(4) = AXD(3) -EL(3)*SAZ(3)*AZP(3)                         *2D24680
      AYD(4) = AYD(3) +EL(3)*CAZ(3)*AZP(3)                         *2D24690
      AXD(5) = AXD(3) -EL(4)*SAZ(3)*AZP(3)                         *2D24700
      AYD(5) = AYD(3) +EL(4)*CAZ(3)*AZP(3)                         *2D24710
      AXD(6) = AXD(5) -EL(5)*SAZ(5)*AZP(5)                         *2D24720
      AYD(6) = AYD(5) +EL(5)*CAZ(5)*AZP(5)                         *2D24730
      AXD(7) = AXD(1)                                              *2D24740
      AYD(7) = AYD(1)                                              *2D24750
      AXD(8) = AXD(7) -EL(7)*SAZ(7)*AZP(7)                         *2D24760
      AYD(8) = AYD(7) +EL(7)*CAZ(7)*AZP(7)                         *2D24770
      IF (IBUG-2) 1010,1010,1000                                   *2D24780
 1000 WRITE(6,9998)(I,AZ(I),AZP(I),AX(I),AY(I),AXD(I),AYD(I),I=1,8) *2D24790
 9998 FORMAT (7H0LIMIDT/(2XI3, 6E17.8))                            *2D24800
      WRITE(6,9997)(I,AZ(I),AZP(I),I=9,11)                         *2D24810
 9997 FORMAT (2XI3, 2E17.8)                                        *2D24820
 1010 DO 110  N=6,NS                                               *2D24830
      IA = KTABLE(2,N-4)                                           *2D24840
      IF (IA-3) 110,110,40                                         *2D24850
   40 IF (IGNORF(IA)) 50,50,110                                    *2D24860
   50 I = KTABLE(1,N-4)                                            *2D24870
      PRMX = AX(I) +RHOPRM(I)*CAZ(I)                               *2D24880
      PRMY = AY(I) + RHOPRM(I)*SAZ(I)                              *2D24890
      TS = XSMALA(IA) - PRMX                                       *2D24900
      TSA = YSMALA(IA) - PRMY                                      *2D24910
      SIA = TS*SPSIA(IA) - TSA*CPSIA(IA)                           *2D24920
```

Subroutine LIMIDT (page 2 of 3)

```
      SDELA = AR(I)-SIA                                                  *2D24930
      IF (SDELA) 90,90,60                                                *2D24940
60    TIA = TS*CPSIA(IA) + TSA*SPSIA(IA)                                 *2D24950
      IF (TIA) 90,90,70                                                  *2D24960
70    IF (TIA-DA(IA)) 80,80,90                                           *2D24970
80    VXIA = AXD(I) - RHOPRM(I)*AZP(I)*SAZ(I)                            *2D24980
      VYIA = AYD(I) + RHOPRM(I) * AZP(I)*CAZ(I)                          *2D24990
      SDELD = VXIA*SPSIA(IA) - VYIA*CPSIA(IA)                            *2D25000
      CALL FECLOD(N,SIGMAA(1,IA),SDELA,SDELD,FORCE)                      *2D25010
      L = ABS(PN(N)-FORCE)/POUNDS                                        *2D25020
      GO TO 100                                                          *2D25030
90    L = ABS(PN(N))/POUNDS                                              *2D25040
100   NMAX = MAX0(L+1,NMAX)                                              *2D25050
110   CONTINUE                                                           *2D25060
      IF (NMAX-1) 130,130,120                                            *2D25070
120   TS = NMAX                                                          *2D25080
      JP = 0                                                             *2D25090
      JI = 0                                                             *2D25100
      JS = 0                                                             *2D25110
      TIMASK = DELTAT/TS                                                 *2D25120
      WRITE(6,9999)TIME,DELTAT,TIMASK                                    *2D25130
9999  FORMAT (9HOAT TIME=F10.6,5X8HDELTA T=F12.8,5X8HRESET TO F12.8)     *2D25140
130   RETURN                                                             *2D25150
      END                                                                *2D25160
```

Subroutine LIMIDT (page 3 of 3)

```
                                                                           *2D11290
      SUBROUTINE LODFEC( INDEX,DELL,SIG,SDL,SDLD)                          *2D11300
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D11310
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D11320
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D11330
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZEP,LCONTL,CS*2D11340
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D11350
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D11360
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D11370
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,          BIGMI,TMATII,*2D11380
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D11390
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D11400
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D11410
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D11420
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D11430
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D11440
                                                                           *2D11450
                                                                           *2D11460
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D11470
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D11480
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D11490
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D11500
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D11510
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D11520
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D11530
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D11540
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D11550
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D11560
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D11570
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D11580
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),          SIGMAA(10,1*2D11590
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D11600
     4LE(2,14),ZPPP(128),BL(3)                                             *2D11610
                                                                           *2D11620
      COMMON THATPW,THATPX,THATPS,XVEHZ                                    *2D11630
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                        *2D11640
      COMMON NONO(1402)                                                    *2D11650
      DIMENSION COE(6),RCOTR(5),ROOTI(5),SIG(10),PNDEL(18)                 *2D11660
      N=INDEX                                                              *2D11670
      OMGT = SDL-DELL-EPSLNY(N)                                            *2D11680
      POMG = DELOLD(N)-DELL-EPSLNY(N)                                      *2D11690
      OMSGE = 1.-G(N)                                                      *2D11700
      FTOLD(N)=PN(N)                                                       *2D11710
      IF(SDLD) 260,26C,110                                                 *2D11720
  110 IF (DELDOD(N)) 130,220,220                                           *2D11730
  130 IF (FTOLD(N)) 140,140,150                                            *2D11740
  140 EPSLNY(N) = EPSLNY(N) + OMEGA(N)                                     *2D11750
      GO TO 210                                                            *2D11760
  150 DO 160 I=1,5                                                         *2D11770
      J=6-I                                                                *2D11780
```

Subroutine LODFEC (page 1 of 4)

```
 160  COE(I) = SIG(J)                                                          *2D11790
      COE(6) = SIGZ(N)-FTOLD(N)                                                 *2D11800
      KKK=5                                                                    *2D11810
      CALL MULLER(COE,KKK,RJCTR,ROOTI)                                         *2D11820
      RTM = 1.E20                                                              *2D11830
      DO 200 I=1,KKK                                                           *2D11840
      TS = POMG-ROOTR(I)                                                       *2D11850
      IF (TS) 200,170,170                                                      *2D11860
 170  IF (TS-OMGT) 180,180,200                                                 *2D11870
 180  IF (RTM-ABS(ROOTI(I))) 200,200,190                                       *2D11880
 190  EPSLNP = TS                                                              *2D11890
      RTM = ABS(ROOTI(I))                                                      *2D11900
 200  CONTINUE                                                                 *2D11910
      EPSLNY(N) = EPSLNY(N)+EPSLNP                                             *2D11920
 210  OMGT = SDL-DELL-EPSLNY(N)                                                *2D11930
      POMG=0.                                                                  *2D11940
 220  IF (OMGT) 410,410,230                                                    *2D11950
 230  IF (POMG) 240,240,250                                                    *2D11960
 240  SIGZ(N)=-((((SIG(10)*SDLD+SIG(9))*SDLD+SIG(8))*SDLD+SIG(7))*SDLD         *2D11970
     1+SIG(6))*SDLD                                                            *2D11980
      ISWT(N)=0                                                                *2D11990
      PNDEL(N)=0.                                                              *2D12000
 250  IF(ISWT(N).NE.0) GO TO 257                                               *2D12010
      TSA=((((SIG(5)*OMGT+SIG(4))*OMGT+SIG(3))*OMGT+SIG(2))*OMGT               *2D12020
     1+SIG(1))*OMGT                                                            *2D12030
      PN(N)=TSA+SIGZ(N)+((((SIG(10)*SDLD+SIG(9))*SDLD+SIG(8))*SDLD             *2D12040
     1+SIG(7))*SDLD+SIG(6))*SDLD                                               *2D12050
      IF(DELTAT.LE.1.E-5) GO TO 255                                            *2D12060
      IF(PNDEL(N).LT.0.) GO TO 255                                             *2D12070
      IF (TSA.GE.PNDEL(N)) GO TO 255                                           *2D12080
      PRINT 9998,N,TIME                                                        *2D12090
 9998 FORMAT (54H OUTSIDE MONOTONIC RANGE OF LOADING CURVE FOR INDEX N=        *2D12100
     1I5,10H AT TIME =F8.6)                                                    *2D12110
      IF(TSA.LT.0.) PRINT 9997,N,TIME                                          *2D12120
 255  PNDEL(N)=TSA                                                             *2D12130
      IF(LODSWT(N).EQ.0) GO TO 259                                             *2D12140
      IF(PN(N).LT.FARR(N)) GO TO 259                                           *2D12150
      ISWT(N)=1                                                                *2D12160
 257  PN(N)=FARR(N)                                                            *2D12170
 259  IF(PN(N)) 410,420,420                                                    *2D12180
 260  IF (DELDOD(N)) 270,270,300                                               *2D12190
 270  IF (OMGT-OMEGA(N)) 280,280,400                                           *2D12200
 280  IF (POMG-OMEGA(N)) 410,410,290                                           *2D12210
 290  OMGT=OMEGA(N)                                                            *2D12220
      GO TO 410                                                                *2D12230
 300  IF (TIME) 303,303,307                                                    *2D12240
 303  EONE(N) = ((((SIG(5)/6.*OMGT+SIG(4)/5.)*OMGT+SIG(3)/4.)*OMGT+            *2D12250
     1SIG(2)/3.)*OMGT+SIG(1)/2.)*OMGT*OMGT*R(N)                                *2D12260
      FTOLD(N) = ((((SIG(5)*OMGT+SIG(4))*OMGT+SIG(3))*OMGT+SIG(2))*OMGT+       *2D12270
     1SIG(1))*OMGT                                                             *2D12280
```

Subroutine LODFEC (page 2 of 4)

```
      IF(LODSWT(N).EQ.0) GO TO 306                                    *2D12290
      IF(FTOLD(N).GE.FARB(N)) ISWT(N)=1                               *2D12300
306   POMG=OMGT                                                       *2D12310
      IF(N-4) 410,410,307                                             *2D12320
 307  IF (FTOLD(N)) 410,410,308                                       *2D12330
 308  TSB=AMAX1(OMGT,POMG)                                            *2D12340
      OMEGA(N)=G(N)*TSB                                               *2D12350
      EHAT(N)=EONE(N)                                                 *2D12360
      ET(N)=0.                                                        *2D12370
      IF(ISWT(N).EQ.0) GC TO 309                                      *2D12380
      OMEGA(N)=TSB-FARB(N)/SLOPE(N)                                   *2D12390
      IF(OMEGA(N).LT.0.) GO TO 500                                    *2D12400
      CZERON(N)=FARB(N)-SLOPE(N)*TSB                                  *2D12410
      CONEN(N)=SLOPE(N)                                               *2D12420
      CTWON(N)=0.                                                     *2D12430
      ISWT(N)=0                                                       *2D12440
      GO TO 400                                                       *2D12450
3C9   TS=FTOLD(N)*TSB*OMSGE                                           *2D12460
      IF (2.*EHAT(N)-TS) 330,320,310                                  *2D12470
 310  TSA = TS/EHAT(N)*R(N)/2.                                        *2D12480
      PRINT 9900,R(N),TSA,N                                           *2D12490
 9900 FORMAT (15HOCHANGED R FROME17.8,3H TO E17.8,11H FOR INDEX I5)   *2D12500
      R(N) = TSA                                                      *2D12510
      PRINT 9901,TIME                                                 *2D12520
 9901 FORMAT (44HORESET CONSERVED ENERGY TO LOWER LIMIT AT T=F8.6,    *2D12530
     15H SEC.)                                                        *2D12540
      EHAT(N) = TS/2.                                                 *2D12550
 320  TS = G(N)/OMSGE*FTCLD(N)                                        *2D12560
      CZERON(N) = -TS                                                 *2D12570
      CONEN(N)=FTOLD(N)/CMSGE/TSB                                     *2D12580
      CTWON(N)=0.                                                     *2D12590
      GO TO 400                                                       *2D12600
 330  IF (3.*EHAT(N)-TS) 340,370,390                                  *2D12610
 340  TSA = TS/EHAT(N)*R(N)/3.                                        *2D12620
      IF (TSA-1.) 350,360,360                                         *2D12630
 350  PRINT 9900,R(N),TSA,N                                           *2D12640
      R(N) = TSA                                                      *2D12650
      PRINT 9902,TIME                                                 *2D12660
 9902 FORMAT (44HORESET CONSERVED ENERGY TO UPPER LIMIT AT T=F8.6,    *2D12670
     15H SEC.)                                                        *2D12680
      EHAT(N)=TS/3.                                                   *2D12690
      GO TO 370                                                       *2D12700
 360  OMSGE=3./FTOLD(N)*EHAT(N)/TSB                                   *2D12710
      TSA = 1.-OMSGE                                                  *2D12720
      OMEGA(N)=TSB*TSA                                                *2D12730
      PRINT 9903,G(N),TSA,N                                           *2D12740
 9903 FORMAT (15HOCHANGED G FROME17.8,3H TO E17.8,11H FOR INDEX I5)   *2D12750
      G(N) = TSA                                                      *2D12760
 370  TS=FTOLD(N)/OMSGE/CMSGE                                         *2D12770
      CZERON(N)=G(N)*G(N)*TS                                          *2D12780
```

Subroutine LODFEC (page 3 of 4)

```
      CONEN(N)=-2./TSB*G(N)*TS                                          *2D12790
      CTWON(N)=TS/TSB/TSB                                               *2D12800
      GO TO 400                                                         *2D12810
  390 TSA=TSB*OMSGE*OMSGE*OMSGE                                         *2D12820
      CZERON(N)=G(N)/TSA*(TS*(2.+G(N))-6.*EHAT(N))                      *2D12830
      TSA=TSA*TSB                                                       *2D12840
      CONEN(N)=2./TSA*(3.*EHAT(N)*(1.+G(N))                             *2D12850
     1-TS*(1.+G(N)+G(N)))                                               *2D12860
      CTWON(N)=3./TSA*(TS-2.*EHAT(N))/TSB                               *2D12870
  400 PN(N)=(CTWON(N)*OMGT+CONEN(N))*OMGT+CZERON(N)                     *2D12880
      GO TO 420                                                         *2D12890
  410 PN(N)=0.                                                          *2D12900
  420 DELET=(FTOLD(N)+PN(N))/2.*(OMGT-POMG)                             *2D12910
      ET(N) = ET(N)+DELET                                               *2D12920
      EONE(N) = EHAT(N)+R(N)*ET(N)                                      *2D12930
      DELOLD(N) = SDL                                                   *2D12940
      DELDOD(N) = SDLD                                                  *2D12950
      IF (IBUG.EQ.0) RETURN                                             *2D12955
      WRITE(6,9999)N,SDL,SDLD,PN(N),FT(N),EPSLNY(N)                     *2D12960
 9999 FORMAT (8H LODFEC I5,5E22.8)                                      *2D12970
      RETURN                                                            *2D12980
 9997 FORMAT (40H NEGATIVE FORCE SET TO ZERO FOR INDEX N=I5,10H AT TIME *2D12990
     1=F8.6)                                                            *2D13000
  500 PRINT 9996,N                                                      *2D13010
 9996 FORMAT(51H0NEGATIVE PERMANENT DEFORMATION PREDICTED FOR INDEX I3) *2D13020
      PRINT 9995                                                        *2D13030
 9995 FORMAT(1H1)                                                       *2D13040
      CALL SUMARY                                                       *2D13050
      CALL ERROR                                                        *2D13060
      END                                                               *2D13070
```

Subroutine LODFEC (page 4 of 4)

```
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D000010
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D000020
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D000030
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D000040
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D000050
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D000060
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D000070
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,         BIGMI,TMATII,*2D000080
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D000090
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D000100
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D000110
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D000120
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D000130
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D000140
                                                                        *2D000150
                                                                        *2D000160
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D000170
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D000180
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D000190
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D000200
     4),STHETA(8),           BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D000210
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D000220
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D000230
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D000240
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D000250
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D000260
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D000270
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D000280
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),          SIGMAA(10,1*2D000290
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D000300
     4LE(2,14),ZPPP(128),BL(3)                                          *2D000310
                                                                        *2D000320
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D000330
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D000340
      COMMON NONO(1402)                                                 *2D000350
      COMMON/IO/INN                                                     *2D000355
      DIMENSION CARD(8),EYE(8),EM(8),GA(10),RA(10),IALPH(26),IDATE(3)   *2D000360
      DIMENSION FAB(10),SLOP(10),LSWT(10)                               *2D000370
      DATA IALPH/1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,1HM,1HN*2D000380
     1,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ/                 *2D000390
      INN=5                                                             *2D000395
    6 CALL DATE(IDATE)                                                  *2D000400
      PRINT 9904                                                        *2D000410
 9904 FORMAT (1H1)                                                      *2D000420
      ZERO = 0.                                                         *2D000430
      DO 92 I=1,3                                                       *2D000440
      SWITCH(I) = 0.                                                    *2D000450
      NEW(I) = 0                                                        *2D000460
      MAX(I) = 0                                                        *2D000470
   92 IPOST(I) = 0                                                      *2D000480
```


MAIN Program (page 1 of 12)

```
      DO 94 I=1,3                                      *2D00490
      DO 94 J=1,300                                    *2D00500
      XXX(J,I)=0.                                      *2D00510
      YYY(J,I)=0.                                      *2D00520
      FMM(J,I)=0.                                      *2D00530
   94 BBB(J,I)=0.                                      *2D00540
      DO 96 I=1,10                                     *2D00550
      DA(I) = 0.                                       *2D00560
      GA(I) = 0.                                       *2D00570
      RA(I) = 0.                                       *2D00580
      IGNORE(I) = 0                                    *2D00590
      XSMALA(I) = 0.                                   *2D00600
      YSMALA(I) = 0.                                   *2D00610
      XISMLA(I) = 0.                                   *2D00620
      PSIA(I) = 0.                                     *2D00630
      SPSIA(I) = 0.                                    *2D00640
      CPSIA(I) = 0.                                    *2D00650
      FMUA(I) = 0.                                     *2D00660
      SIGMAC(I) = 0.                                   *2D00670
      FAB(I)=0.                                        *2D00680
      SLOP(I)=0.                                       *2D00690
      LSWT(I)=0                                        *2D00700
   96 CONTINUE                                         *2D00710
      DO 2 I=1,10                                      *2D00720
      DO 1 J=1,10                                      *2D00730
    1 SIGMAA(I,J) = 0.                                 *2D00740
      SIGMA(I,1)  = 0.                                 *2D00750
      SIGMA(I,2)  = 0.                                 *2D00760
    2 SIGMA(I,3)  = 0.                                 *2D00770
      DO 3 I=1,10                                      *2D00780
      DO 3 J=1,10                                      *2D00790
    3 AA(I,J)=0.                                       *2D00800
      DO 4 I=1,3                                       *2D00810
      SDELTA(I) = 0.                                   *2D00820
      SDELTD(I) = 0.                                   *2D00830
      BL(I)=0.                                         *2D00840
    4 PHI(I) = 0.                                      *2D00850
      DO 73 I=1,18                                     *2D00860
      FARB(I)=0.                                       *2D00870
      SLOPE(I)=0.                                      *2D00880
      ISWT(I)=0                                        *2D00890
   73 LODSWT(I)=0                                      *2D00900
      MFORI(1) = 7                                     *2D00910
      MFORI(2) = 1                                     *2D00920
      MFORI(3) = 2                                     *2D00930
      MFORI(4) = 3                                     *2D00940
      MFORI(5) = 3                                     *2D00950
      MFORI(6) = 5                                     *2D00960
      MFORI(7) = 8                                     *2D00970
      DTR = .01745329                                  *2D00980
```

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```
      PITWO = 1.570796                                                  *2D00990
      GRAVIT = 386.4                                                    *2D01000
      IC=0                                                              *2D01005
  100 READ (INN,9900,END=8150) ID,CARD                                  *2D01010
 9900 FORMAT (A1,E9.0,7E10.0)                                           *2D01020
      IC=IC+1                                                           *2D01023
      PRINT 9920,IC,ID,CARD                                             *2D01025
 9920 FORMAT (1X,I5,5X,A1,8F13.4)                                       *2D01028
      DO 101 I=1,26                                                     *2D01030
      IF (ID-IALPH(I))  101,103,101                                     *2D01040
  101 CONTINUE                                                          *2D01050
  102 PRINT 9901,ID,CARD                                                *2D01060
 9901 FORMAT (22HOILLEGAL CARD SKIPPED.3XA1,2X8E13.4)                   *2D01070
      GO TO 100                                                         *2D01080
C                                                                       *2D01090
C           A   B   C   D   E   F   G   H   I   J   K   L   M   N   O   *2D01100
  103 GO TO (140,180,200,230,260,300,330,360,400,430,460,500,530,560,600*2D01110
     1,630,660,700,730,760,800,104,107,850,900,1000),I                  *2D01120
C       P   Q   R   S   T   U   V   W   X   Y   Z                       *2D01130
C                                                                       *2D01140
C        CARD     V        TABLE READ                                   *2D01150
  104 ITABL = CARD(1) + .5                                              *2D01160
      IF (ITABL-3)  105,105,102                                         *2D01170
  105 SWITCH(ITABL) = CARD(2)                                           *2D01180
      II = MINO(MAX(ITABL)+1,300)                                       *2D01190
      YYY(II,ITABL) = CARD(4)                                           *2D01200
      XXX(II,ITABL) = CARD(3)                                           *2D01210
      IF (CARD(2)) 106,100,106                                          *2D01220
  106 MAX(ITABL) = II                                                   *2D01230
      NEW(ITABL) = 1                                                    *2D01240
      GO TO 100                                                         *2D01250
C     CARD  W          TABLE DELETE                                     *2D01260
  107 ITABL = CARD(1) + .5                                              *2D01270
      IF (ITABL)  102,102,108                                           *2D01280
  108 IF (ITABL-3)  109,109,102                                         *2D01290
  109 IF (ABS(CARD(2))+ABS(CARD(3))) 111,110,111                        *2D01300
  110 SWITCH(ITABL) = 0.                                                *2D01310
      MAX(ITABL) = 0                                                    *2D01320
      NEW(ITABL) = 0                                                    *2D01330
      GO TO 100                                                         *2D01340
  111 II = 1                                                            *2D01350
      XA = AMIN1(CARD(2),CARD(3))                                       *2D01360
      XB = AMAX1(CARD(2),CARD(3))                                       *2D01370
  112 IF (XXX(II,ITABL)-XA)  114,113,113                                *2D01380
  113 IF (XB-XXX(II,ITABL))  114,115,115                                *2D01390
  114 II = II + 1                                                       *2D01400
      IF (II-MAX(ITABL))  112,112,100                                   *2D01410
  115 JJ = II + 1                                                       *2D01420
      NEW(ITABL) = 1                                                    *2D01430
  121 IF (JJ-MAX(ITABL))  117,117,116                                   *2D01440
```

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```
  116 MAX(ITABL) = II-1                                          *2D01450
      GO TO 100                                                  *2D01460
  117 IF (XXX(JJ,ITABL)-XA)  119,118,118                         *2D01470
  118 IF (XB-XXX(JJ,ITABL)) 119,120,120                          *2D01480
  119 XXX(II,ITABL) = XXX(JJ,ITABL)                              *2D01490
      YYY(II,ITABL) = YYY(JJ,ITABL)                              *2D01500
      II = II + 1                                                *2D01510
  120 JJ = JJ + 1                                                *2D01520
      GO TO 121                                                  *2D01530
C      CARD      A                                               *2D01540
  140 DO 142 I=1,7                                               *2D01550
  142 CPRIME(I) = CARD(I)                                        *2D01560
      GO TO 100                                                  *2D01570
C    CARD    B                                                   *2D01580
  180 DO 182 I=1,8                                               *2D01590
  182 EYE(I) = CARD(I)                                           *2D01600
      GO TO 100                                                  *2D01610
C    CARD      C                                                 *2D01620
  200 DO 202 I=1,7                                               *2D01630
  202 BIGKI(I) = CARD(I)                                         *2D01640
      GC TO 100                                                  *2D01650
C      CARD       D                                              *2D01660
  230 DO 232 I=1,8                                               *2D01670
  232 EL(I) = CARD(I)                                            *2D01680
      GO TO 100                                                  *2D01690
C     CARD          E                                            *2D01700
  260 DO 262 I=1,8                                               *2D01710
      EM(I) = CARD(I)                                            *2D01720
  262 CONTINUE                                                   *2D01730
      EMFVSX = EM(5) + EM(6)                                     *2D01740
      EMTHSX = EMFVSX + EM(3) + EM(4)                            *2D01750
      EMTWSX = EMTHSX + EM(2)                                    *2D01760
      GO TO 100                                                  *2D01770
C      CARD        F                                             *2D01780
  300 DO 302 I=1,8                                               *2D01790
  302 AR(I) = CARD(I)                                            *2D01800
      GO TO 100                                                  *2D01810
C      CARD      G                                               *2D01820
  330 DO 332 I=1,7                                               *2D01830
  332 TPRIME(I) = CARD(I)                                        *2D01840
      GO TO 100                                                  *2D01850
C      CARD      H                                               *2D01860
  360 ALFAI(1) = CARD(1)*DTR                                     *2D01870
      DO 362 I=5,7                                               *2D01880
  362 ALFAI(I) = CARD(I-3)*DTR                                   *2D01890
      THATPW = CARD(5)                                           *2D01900
      THATPV = CARD(6)                                           *2D01910
      THATPX = CARD(7)                                           *2D01920
      THATPS = CARD(8)                                           *2D01930
      GO TO 100                                                  *2D01940
```

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```
C         CARD        I                                                  *2D01950
   400   DO 402 I=1,7                                                    *2D01960
   402   OMEGAI(I) = CARD(I)*DTR                                         *2D01970
         GO TO 100                                                       *2D01980
C         CARD       J                                                   *2D01990
   430   DO 432 I=1,7                                                    *2D02000
   432   RPSI(I) = CARD(I)*DTR                                           *2D02010
         GO TO 100                                                       *2D02020
C        CARD       K                                                    *2D02030
   460   DO 462 I=1,8                                                    *2D02040
   462   RHO(I) = CARD(I)                                                *2D02050
         GO TO 100                                                       *2D02060
C        CARD      L                                                     *2D02070
   500   DO 502 I=1,8                                                    *2D02080
         THETAZ(I) = CARD(I)*DTR                                         *2D02090
         STHETZ(I) = SIN(THETAZ(I))                                      *2D02100
         CTHETZ(I) = COS(THETAZ(I))                                      *2D02110
   502   CONTINUE                                                        *2D02120
         GO TO 100                                                       *2D02130
C        CARD       M                                                    *2D02140
   530   FSPRMZ = CARD(1)                                                *2D02150
         RH = CARD(2)                                                    *2D02160
         WZERO = CARD(4)                                                 *2D02170
         RHOPTZ = CARD(5)                                                *2D02180
         RHOPFZ = CARD(6)                                                *2D02190
         GAMZER = CARD(7)*DTR                                            *2D02200
         LCONTL = ABS(CARD(8)) + .5                                      *2D02210
         GO TO 100                                                       *2D02220
C         CARD        N                                                  *2D02230
   560   CS = CARD(1)                                                    *2D02240
         S = CARD(2)                                                     *2D02250
         RPSI(8) = CARD(3)                                               *2D02260
         FMUS = CARD(4)                                                  *2D02270
         BETA(1) = CARD(5)                                               *2D02280
         BETA(2) = CARD(6)                                               *2D02290
         BETA(3) = CARD(7)                                               *2D02300
         ZZERO = CARD(8)                                                 *2D02310
         GO TO 100                                                       *2D02320
C          CARD        O                                                 *2D02330
   600   ELPTEN = CARD(1)                                                *2D02340
         ELTWTY = CARD(2)                                                *2D02350
         ELTHRY = CARD(3)                                                *2D02360
         H = CARD(4)                                                     *2D02370
         FEPTEN = CARD(5)*DTR                                            *2D02380
         DESTEP = CARD(6)                                                *2D02390
         DELTAT = DESTEP                                                 *2D02400
         RZ=CARD(7)                                                      *2D02410
         SZ=CARD(8)                                                      *2D02420
         GO TO 100                                                       *2D02430
C        CARD       P                                                    *2D02440
```

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```
  630 M = CARD(1) + .5                                          *2D02450
      IF (M) 102,102,631                                        *2D02460
  631 IF (M-3)  632,632,102                                     *2D02470
  632 G(M) = CARD(2)                                            *2D02480
      R(M) = CARD(3)                                            *2D02490
      PHIZ(M) = CARD(4)*DTR                                     *2D02500
      DELTA(M) = CARD(5)                                        *2D02510
      SIGMA(1,M) = CARD(6)                                      *2D02520
      SIGMA(2,M) = CARD(7)                                      *2D02530
      SIGMA(3,M) = CARD(8)                                      *2D02540
      GO TO 100                                                 *2D02550
C      CARD       Q                                             *2D02560
  660 M = CARD(1) + .5                                          *2D02570
      IF (M) 102,102,661                                        *2D02580
  661 IF (M-3) 662,662,102                                      *2D02590
  662 SIGMA(4,M) = CARD(2)                                      *2D02600
      SIGMA(5,M) = CARD(3)                                      *2D02610
      SIGMA(6,M) = CARD(4)                                      *2D02620
      SIGMA(7,M) = CARD(5)                                      *2D02630
      SIGMA(8,M) = CARD(6)                                      *2D02640
      SIGMA(9,M) = CARD(7)                                      *2D02650
      SIGMA(10,M)= CARD(8)                                      *2D02660
      GO TO 100                                                 *2D02670
C       CARD        R                                           *2D02680
  700 NPASGR = AMIN1(AMAX1(CARD(1),1.),3.)+.5                   *2D02690
      XPACZ = CARD(2)                                           *2D02700
      XVEHZ = CARD(3)                                           *2D02710
      NBELT = ABS(CARD(4))+.5                                   *2D02720
      APRNTD = CARD(5)                                          *2D02730
      TIMAX = CARD(6)                                           *2D02740
      EMC = CARD(7)                                             *2D02750
      PCNTL = ABS(CARD(8))                                      *2D02760
      DTPRNT = PCNTL*APRNTD                                     *2D02770
      BPRNTD = AMAX1(DTPRNT-APRNTD,APRNTD)                      *2D02780
      GO TO 100                                                 *2D02790
C    CARD      S                                                *2D02800
  730 IA = CARD(1) +1.5                                         *2D02810
      IF (IA) 102,102,731                                       *2D02820
  731 IF (IA-10) 732,732,102                                    *2D02830
  732 DA(IA) = CARD(2)                                          *2D02840
      GA(IA) = CARD(3)                                          *2D02850
      RA(IA) = CARD(4)                                          *2D02860
      XSMALA(IA) = CARD(5)                                      *2D02870
      YSMALA(IA) = CARD(6)                                      *2D02880
      XISMLA(IA) = CARD(7)                                      *2D02890
      PSIA(IA) = CARD(8)*DTR                                    *2D02900
      SPSIA(IA)=SIN(PSIA(IA))                                   *2D02910
      CPSIA(IA) = COS(PSIA(IA))                                 *2D02920
      GO TO 100                                                 *2D02930
C      CARD       T                                             *2D02940
```

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```
 760  IA = CARD(1) +1.5                                                    *2D02950
      IF (IA) 102,102,761                                                  *2D02960
 761  IF (IA-10) 762,762,102                                               *2D02970
 762  FMUA(IA) = CARD(2)                                                   *2D02980
      SIGMAA(1,IA) = CARD(3)                                               *2D02990
      SIGMAA(2,IA) = CARD(4)                                               *2D03000
      SIGMAA(3,IA) = CARD(5)                                               *2D03010
      SIGMAA(4,IA) = CARD(6)                                               *2D03020
      SIGMAA(5,IA) = CARD(7)                                               *2D03030
      SIGMAA(6,IA) = CARD(8)                                               *2D03040
      GO TO 100                                                            *2D03050
C     CARD       U                                                         *2D03060
 800  IA = CARD(1) +1.5                                                    *2D03070
      IF (IA) 102,102,801                                                  *2D03080
 801  IF (IA-10) 802,802,102                                               *2D03090
 802  SIGMAA(7,IA) = CARD(2)                                               *2D03100
      SIGMAA(8,IA) = CARD(3)                                               *2D03110
      SIGMAA(9,IA) = CARD(4)                                               *2D03120
      SIGMAA(10,IA)= CARD(5)                                               *2D03130
      GO TO 100                                                            *2D03140
C     CARD       X                                                         *2D03150
850   I=CARD(1)+1.5                                                        *2D03160
      IF(I.GT.10) GO TO 855                                                *2D03170
      FAB(I)=CARD(2)                                                       *2D03180
      SLOP(I)=CARD(3)                                                      *2D03190
      LSWT(I)=1                                                            *2D03200
      GO TO 100                                                            *2D03210
 855  J=I-11                                                               *2D03220
      FARB(J)=CARD(2)                                                      *2D03230
      SLOPE(J)=CARD(3)                                                     *2D03240
      LODSWT(J)=1                                                          *2D03250
      GO TO 100                                                            *2D03260
C      CARD       Y                                                        *2D03270
 900  CONTINUE                                                             *2D03280
      GO TO 100                                                            *2D03290
C      CARD   Z               GO                                           *2D03300
 1000 IF (CARD(1)) 3020,3000,3000                                          *2D03310
 3000 MAX(2) = 1                                                           *2D03320
      SWITCH(2) = 0.                                                       *2D03330
      YYY(1,2) = CARD(1)                                                   *2D03340
 3020 DO 1001 N=1,18                                                       *2D03350
 1001 SIGZ(N) = 0.                                                         *2D03360
      DO 5 I=1,2                                                           *2D03370
      DO 5 K=1,14                                                          *2D03380
 5    KTABLE(I,K) = 0                                                      *2D03390
      IF (NPASGR-2) 10,30,40                                               *2D03400
 10   DO 20 N=4,5                                                          *2D03410
      KTABLE(1,N) = 3                                                      *2D03420
 20   KTABLE(2,N) = 2*N-2                                                  *2D03430
      NS = 18                                                              *2D03440
```

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```
      K = 10                                                           *2D03450
      M = 6                                                            *2D03460
      GO TO 50                                                         *2D03470
   30 K = 7                                                            *2D03480
      M = 4                                                            *2D03490
      NS = 15                                                          *2D03500
      GO TO 50                                                         *2D03510
   40 K = 6                                                            *2D03520
      M = 4                                                            *2D03530
      J = 4                                                            *2D03540
      L = 0                                                            *2D03550
      NS = 14                                                          *2D03560
      GO TO 60                                                         *2D03570
   50 J = 7                                                            *2D03580
      L = 2                                                            *2D03590
   60 KTABLE(1,1) = 1                                                  *2D03600
      KTABLE(2,3) = 4                                                  *2D03610
      KTABLE(1,K+1) = 5                                                *2D03620
      KTABLE(1,K+2) = 7                                                *2D03630
      KTABLE(1,K+3) = 8                                                *2D03640
      KTABLE(1,K+4) = 8                                                *2D03650
      KTABLE(2,K+1) = 2                                                *2D03660
      KTABLE(2,K+2) = J                                                *2D03670
      KTABLE(2,K+3) = 1                                                *2D03680
      KTABLE(2,K+4) = J+L                                              *2D03690
      DO 70 N=M,K                                                      *2D03700
      KTABLE(1,N) = 4                                                  *2D03710
   70 KTABLE(2,N) = 2+N-M                                              *2D03720
      DO 80 N=1,2                                                      *2D03730
      KTABLE(1,N+1)=3                                                  *2D03740
   80 KTABLE(2,N) = 2                                                  *2D03750
      DO 90 N=5,NS                                                     *2D03760
      KN=KTABLE(2,N-4)                                                 *2D03770
      G(N)=GA(KN)                                                      *2D03780
      R(N)=RA(KN)                                                      *2D03790
      FARB(N)=FAB(KN)                                                  *2D03800
      SLOPE(N)=SLOP(KN)                                                *2D03810
      LODSWT(N)=LSWT(KN)                                               *2D03820
   90 MODE(N-4)=KN-1                                                   *2D03830
      N=N-4                                                            *2D03840
      PRINT 9916,N,(KTABLE(1,J),J=1,N)                                 *2D03850
 9916 FORMAT (44ONS=I3/3H I=14I5)                                      *2D03860
      PRINT 9912,(MODE(J),J=1,N)                                       *2D03870
 9912 FORMAT (3H A=14I5)                                               *2D03880
  910 DO 920 I=1,10                                                    *2D03890
      IF (FMUA(I)) 912,911,912                                         *2D03900
  911 IGNORE(I) = -1                                                   *2D03910
  912 IF (DA(I)) 915,915,913                                           *2D03920
  913 DO 914 J=1,10                                                    *2D03930
      IF (SIGMAA(J,I)) 920,914,920                                     *2D03940
```

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```
914  CONTINUE                                                           *2D03950
915  IGNORE(I) = 1                                                      *2D03960
920  CONTINUE                                                           *2D03970
     DO 1020 I=1,3                                                      *2D03980
     IPOST(I) = 1                                                       *2D03990
     IF (NEW(I))  1004,1020,1004                                        *2D04000
1004 IMAX = MAX(I)                                                      *2D04010
     J=2                                                                *2D04020
1005 IF (XXX(J-1,I)-XXX(J,I)) 1016,1009,1006                            *2D04030
1006 X(1)=XXX(J,I)                                                      *2D04040
     Y(1)=YYY(J,I)                                                      *2D04050
     JJ = J - 1                                                         *2D04060
1007 XXX(JJ+1,I) = XXX(JJ,I)                                            *2D04070
     YYY(JJ+1,I) = YYY(JJ,I)                                            *2D04080
     JJ = JJ - 1                                                        *2D04090
     IF (JJ-1) 1014,1008,1008                                           *2D04100
1008 IF (XXX(JJ,I)-X(1)) 1015,1010,1007                                 *2D04110
1009 JJ = J - 1                                                         *2D04120
     Y(1)=YYY(J,I)                                                      *2D04130
1010 YYY(JJ,I)=Y(1)                                                     *2D04140
1011 JJ = JJ + 1                                                        *2D04150
     IF (JJ-IMAX) 1012,1013,1013                                        *2D04160
1012 XXX(JJ,I) = XXX(JJ+1,I)                                            *2D04170
     YYY(JJ,I) = YYY(JJ+1,I)                                            *2D04180
     GO TO 1011                                                         *2D04190
1013 IMAX = IMAX - 1                                                    *2D04200
     GO TO 1017                                                         *2D04210
1014 JJ = 0                                                             *2D04220
1015 XXX(JJ+1,I)=X(1)                                                   *2D04230
     YYY(JJ+1,I)=Y(1)                                                   *2D04240
1016 J=J+1                                                              *2D04250
1017 IF (J-IMAX) 1005,1005,1018                                         *2D04260
1018 MAX(I) = IMAX                                                      *2D04270
     III = IMAX - 1                                                     *2D04280
     DO 1019 J=1,III                                                    *2D04290
     FMM(J,I) = (YYY(J+1,I)-YYY(J,I))/(XXX(J+1,I)-XXX(J,I))             *2D04300
1019 BBB(J,I) = YYY(J,I)-FMM(J,I)*XXX(J,I)                              *2D04310
     BBB(IMAX,I) = 0.                                                   *2D04320
     FMM(IMAX,I) = 0.                                                   *2D04330
1020 CONTINUE                                                           *2D04340
     PRINT 9905,IDATE                                                   *2D04350
9905 FORMAT (45X35HCRASH SIMULATION PROGRAM NUMBER ONE40X3A4/1H07X3HNO.*2D04360
    111X1HM20X1HI21X1HL20X3HRHO18X1HR17X5HTHETA)                        *2D04370
     DO 1040 I=1,8                                                      *2D04380
     TS = THETAZ(I)/DTR                                                 *2D04390
     PRINT 9906,I,EM(I),EYE(I),EL(I),RHO(I),AR(I),TS                    *2D04400
1040 CONTINUE                                                           *2D04410
9906 FORMAT (I10,6E20.8)                                                *2D04420
     PRINT 9907                                                         *2D04430
9907 FORMAT (1H07X3HNO.9X6HTPRIME15X5HALPHA15X5HOMEGA16X1HK16X6HCPRIME *2D04440
```

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```
      116X2HXI)                                                          *2D04450
       DO 1029 I=1,7                                                     *2D04460
       TSA = ALFAI(I)/DTR                                                *2D04470
       TSB = OMEGAI(I)/DTR                                               *2D04480
       TS=RPSI(I)/DTR                                                    *2D04490
       PRINT 9906,I,TPRIME(I),TSA,TSB,BIGKI(I),CPRIME(I),TS              *2D04500
 1029 CONTINUE                                                           *2D04510
       PRINT 9917,RZ,SZ,APRNTD,PCNTL,LCCNTL                              *2D04520
 9917 FORMAT(4H0RZ=E17.8,4H,SZ=E17.8,15H,DELTA T PRINT=F8.6,24H,N). PER *2D04530
      1PRINT INTERVAL=E12.3,8H,LCCNTL=I5)                                *2D04540
       TS = FEPTEN/DTR                                                   *2D04550
       TSA = GAMZER/DTR                                                  *2D04560
       PRINT 9908,FSPRMZ,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,TS,CS,S,RPSI(8),  *2D04570
      1FMUS,ZZERO,ELPTEN,ELTWTY,ELTHRY,H,TSA,XPACZ,NPASGR,NBELT,DELTAT,  *2D04580
      2TIMAX,EMC                                                         *2D04590
 9908 FORMAT (1H 7HFSPRMZ=E17.8,4H,RH=E17.8,8H,THATP5=E17.8,4H,W0=F17.8,*2D04600
      17H,RHOP3=E17.8/7H RHOP4=E17.8,7H,PHIP1=F12.3,4H,CS=F17.8,3H,S=F17.*2D04610
      28,5H,XIS=E17.8,5H,MUS=E17.8/4H Z0=F17.8,5H,LP1=F17.8,5H,LP2=F17.8,*2D04620
      35H,LP3=E17.8,3H,H=E17.8/8H GAMMA0=F12.3,4H,VC=E17.8,8H,NPASGR=I2,7*2D04630
      4H,NBELT=I2,9H,DELTA T=F8.4/10H MAX TIME=F10.4,4H,MC=F17.8/1H08X1HM*2D04640
      513X1HG19X1HR18X3HPHI16X5HDELTA16X4HBETA)                          *2D04650
       DO 1030 I=1,3                                                     *2D04660
       TS = PHIZ(I)/DTR                                                  *2D04670
       PRINT 9906,I,G(I),R(I),TS,DELTA(I),BETA(I)                        *2D04680
 1030 CONTINUE                                                           *2D04690
       PRINT 9909                                                        *2D04700
 9909 FORMAT (1H08X1HM51X5HSIGMA)                                        *2D04710
       DO 1031 I=1,3                                                     *2D04720
       PRINT 9910,I,(SIGMA(J,I),J=1,10)                                  *2D04730
 9910 FORMAT (1H0I9,5E20.8/10X5E20.8)                                    *2D04740
 1031 CONTINUE                                                           *2D04750
       PRINT 9913,(I,DA(I),GA(I),RA(I),XSMALA(I),YSMALA(I),FMUA(I),I=1,10*2D04760
      1)                                                                 *2D04770
 9913 FORMAT (1H08X1HA13X1HD19X1HG19X1HR19X1HX19X1HY18X3HMUA/(I10,6E20.8*2D04780
      1))                                                                *2D04790
       PRINT 9914                                                        *2D04800
 9914 FORMAT (1H08X1HA13X2HXI17X3HPSI)                                   *2D04810
       DO 1032 I=1,10                                                    *2D04820
       TS = XISMLA(I)                                                    *2D04830
       TSA=PSIA(I)/DTR                                                   *2D04840
       PRINT 9915,I,TS,TSA                                               *2D04850
 9915 FORMAT (I10,F17.3,F20.3)                                           *2D04860
 1032 CONTINUE                                                           *2D04870
       PRINT 9911                                                        *2D04880
 9911 FORMAT (1H08X1HA51X5HSIGMA)                                        *2D04890
       DO 1033 I=1,10                                                    *2D04900
       PRINT 9910,I,(SIGMAA(J,I),J=1,10)                                 *2D04910
 1033 CONTINUE                                                           *2D04920
       DO 1028 I=1,3                                                     *2D04930
       IF (SWITCH(I)) 1021,1023,1021                                     *2D04940
```

```
1021 IF (NEW(I)) 1022,1023,1022                                          *2D04950
1022 NEW(I) = 0                                                          *2D04960
1023 PRINT 9902,I,SWITCH(I)                                              *2D04970
9902 FORMAT (29HOPRINT OUT OF DATA TABLE NO. I5,15X17HWITH SCAN SWITCH   *2D04980
    1F3.0)                                                               *2D04990
     IF (SWITCH(I)) 1024,1025,1024                                       *2D05000
1024 NNK=MAX(I)                                                          *2D05010
     GO TO 1026                                                          *2D05020
1025 NNK=1                                                               *2D05030
1026 DO 1027 J=1,NNK                                                     *2D05040
     PRINT 9903,J,XXX(J,I),YYY(J,I),FMM(J,I),RRR(J,I)                    *2D05050
9903 FORMAT (I10,4E20.8)                                                 *2D05060
1027 CONTINUE                                                            *2D05070
1028 CONTINUE                                                            *2D05080
C    SECTION  2.1        MATRIX COEFFICIENTS                             *2D05090
     IF (FEPTEN) 2000,2010,2000                                          *2D05100
2000 PHIZ(1) = FEPTEN + ARCSIN(RH/ELPTEN)                                *2D05110
     GO TO 2100                                                          *2D05120
2010 FEPTEN = PHIZ(1)-ARCSIN(RH/ELPTEN)                                  *2D05130
2100 ELZTEN = SQRT(ELPTEN*ELPTEN-RH*RH)                                  *2D05140
     DO 2110 I=1,8                                                       *2D05150
2110 A(I) = FM(I)*RHO(I)                                                 *2D05160
     A(1) = A(1) + EL(1)*EMTWSX                                          *2D05170
     A(2) = A(2) + EL(2)*EMTHSX                                          *2D05180
     A(3) = A(3) + EM(4)*EL(3)+EMEVSX*EL(4)                              *2D05190
     A(5) = A(5) + EM(6)*EL(5)                                           *2D05200
     A(7) = A(7) + EM(8)*EL(7)                                           *2D05210
     A(9) = EMTWSX +EM(1)+EM(7)+EM(8)                                    *2D05220
     DO 2120 I=10,17                                                     *2D05230
     J = I - 9                                                           *2D05240
2120 A(I) = EYE(J) + EM(J)*RHO(J)*RHO(J)                                 *2D05250
     A(10) = A(10) + EL(1)*EL(1)*EMTWSX                                  *2D05260
     A(11) = A(11)+EL(2)*EL(2)*EMTHSX                                    *2D05270
     A(12)=A(12)+EM(4)*EL(3)*EL(3)+EMEVSX*EL(4)*EL(4)                    *2D05280
     A(14) = A(14) + EL(5)*EL(5)*EM(6)                                   *2D05290
     A(16)=A(16)+EL(7)*EL(7)*EM(8)                                       *2D05300
     DO 2130 I=1,10                                                      *2D05310
     GRAVA(I) = GRAVI *A(I)                                              *2D05320
2130 CONTINUE                                                            *2D05330
C    SECTION  2.2        USEFUL CONSTANTS                                *2D05340
     N=NBELT+1                                                           *2D05350
     GO TO (2150,2135,2140,2135),N                                       *2D05360
2135 ELAMB(1)=ELPTEN*COS(FEPTEN)                                         *2D05370
     ELAMB(2) = ELPTEN*SIN(FEPTEN)                                       *2D05380
     IF (NBELT-2) 2150,2140,2140                                         *2D05390
2140 ELAMB(3)=FL(1)*STHETZ(1)                                            *2D05400
     ELAMB(4) = FL(1)*CTHETZ(1)                                          *2D05410
     ELAMB(5)=ELAMB(3)+ EL(2)*STHETZ(2)+EL(4)*STHETZ(3)-ELTHRY*SIN(PHIZ(*2D05420
    13))                                                                 *2D05430
     ELAMB(6)=ELAMB(4)+FL(2)*CTHETZ(2)+EL(4)*CTHETZ(3)-FLTHRY*COS(PHIZ(*2D05440
```

MAIN Program (page 11 of 12)

```
      13))                                                              *2D05450
      ELAMB(3)=ELAMB(3)+F*STHETZ(2)-ELTWTY*SIN(PHIZ(2))                 *2D05460
      ELAMB(4)=ELAMB(4)+H*CTHETZ(2)-FLTWTY*COS(PHIZ(2))                 *2D05470
 2150 TIME=0.                                                           *2D05480
      REWIND 9                                                          *2D05490
      CALL KRUNCH                                                       *2D05500
      CALL SUMARY                                                       *2D05510
      GO TO 6                                                           *2D05520
 8150 STOP                                                              *2D05525
      END                                                               *2D05530
```

MAIN Program (page 12 of 12)

```
C DECK  MINV                                                            *2D37410
C                                                                       *2D37420
C     ..................................................................*2D37430
C                                                                       *2D37440
C        SUBROUTINE MINV                                                *2D37450
C                                                                       *2D37460
C        PURPOSE                                                        *2D37470
C           INVERT A MATRIX                                             *2D37480
C                                                                       *2D37490
C        USAGE                                                          *2D37500
C           CALL MINV(A,N,D,L,M)                                        *2D37510
C                                                                       *2D37520
C        DESCRIPTION OF PARAMETERS                                      *2D37530
C           A - INPUT MATRIX, DESTROYED IN COMPUTATION AND REPLACED BY  *2D37540
C               RESULTANT INVERSE.                                      *2D37550
C           N - ORDER OF MATRIX A                                       *2D37560
C           D - RESULTANT DETERMINANT                                   *2D37570
C           L - WORK VECTOR OF LENGTH N                                 *2D37580
C           M - WORK VECTOR OF LENGTH N                                 *2D37590
C                                                                       *2D37600
C        REMARKS                                                        *2D37610
C           MATRIX A MUST BE A GENERAL MATRIX                           *2D37620
C                                                                       *2D37630
C        SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                  *2D37640
C           NONE                                                        *2D37650
C                                                                       *2D37660
C        METHOD                                                         *2D37670
C           THE STANDARD GAUSS-JORDAN METHOD IS USED. THE DETERMINANT   *2D37680
C           IS ALSO CALCULATED. A DETERMINANT OF ZERO INDICATES THAT    *2D37690
C           THE MATRIX IS SINGULAR.                                     *2D37700
C                                                                       *2D37710
C     ..................................................................*2D37720
C                                                                       *2D37730
      SUBROUTINE MINV(A,N,D,L,M)                                        *2D37740
      DIMENSION A(1),L(1),M(1)                                          *2D37750
C                                                                       *2D37760
C        ...............................................................*2D37770
C                                                                       *2D37780
C        IF A DOUBLE PRECISION VERSION OF THIS ROUTINE IS DESIRED, THE  *2D37790
C        C IN COLUMN 1 SHOULD BE REMOVED FROM THE DOUBLE PRECISION      *2D37800
C        STATEMENT WHICH FOLLOWS.                                       *2D37810
C                                                                       *2D37820
C     DOUBLE PRECISION A,D,BIGA,HOLD                                    *2D37830
C                                                                       *2D37840
C        THE C MUST ALSO BE REMOVED FROM DOUBLE PRECISION STATEMENTS    *2D37850
C        APPEARING IN OTHER ROUTINES USED IN CONJUNCTION WITH THIS      *2D37860
C        ROUTINE.                                                       *2D37870
C                                                                       *2D37880
C        THE DOUBLE PRECISION VERSION OF THIS SUBROUTINE MUST ALSO      *2D37890
C        CONTAIN DOUBLE PRECISION FORTRAN FUNCTIONS.  ABS IN STATEMENT  *2D37900
```

Subroutine MINV (page 1 of 4)

```
C         10 MUST BE CHANGED TO DABS.                                  *2D37910
C                                                                      *2D37920
C         ...........................................................*2D37930
C                                                                      *2D37940
C         SEARCH FOR LARGEST ELEMENT                                   *2D37950
C                                                                      *2D37960
      D=1.0                                                            *2D37970
      NK=-N                                                            *2D37980
      DO 80 K=1,N                                                      *2D37990
      NK=NK+N                                                          *2D38000
      L(K)=K                                                           *2D38010
      M(K)=K                                                           *2D38020
      KK=NK+K                                                          *2D38030
      BIGA=A(KK)                                                       *2D38040
      DO 20 J=K,N                                                      *2D38050
      IZ=N*(J-1)                                                       *2D38060
      DO 20 I=K,N                                                      *2D38070
      IJ=IZ+I                                                          *2D38080
   10 IF( ABS(BIGA)- ABS(A(IJ))) 15,20,20                              *2D38090
   15 BIGA=A(IJ)                                                       *2D38100
      L(K)=I                                                           *2D38110
      M(K)=J                                                           *2D38120
   20 CONTINUE                                                         *2D38130
C                                                                      *2D38140
C         INTERCHANGE ROWS                                             *2D38150
C                                                                      *2D38160
      J=L(K)                                                           *2D38170
      IF(J-K) 35,35,25                                                 *2D38180
   25 KI=K-N                                                           *2D38190
      DO 30 I=1,N                                                      *2D38200
      KI=KI+N                                                          *2D38210
      HOLD=-A(KI)                                                      *2D38220
      JI=KI-K+J                                                        *2D38230
      A(KI)=A(JI)                                                      *2D38240
   30 A(JI) =HOLD                                                      *2D38250
C                                                                      *2D38260
C         INTERCHANGE COLUMNS                                          *2D38270
C                                                                      *2D38280
   35 I=M(K)                                                           *2D38290
      IF(I-K) 45,45,38                                                 *2D38300
   38 JP=N*(I-1)                                                       *2D38310
      DO 40 J=1,N                                                      *2D38320
      JK=NK+J                                                          *2D38330
      JI=JP+J                                                          *2D38340
      HOLD=-A(JK)                                                      *2D38350
      A(JK)=A(JI)                                                      *2D38360
   40 A(JI) =HOLD                                                      *2D38370
C                                                                      *2D38380
C         DIVIDE COLUMN BY MINUS PIVOT (VALUE OF PIVOT ELEMENT IS      *2D38390
C         CONTAINED IN BIGA)                                           *2D38400
```

Subroutine MINV (page 2 of 4)

```
C                                                                *2D38410
   45 IF(BIGA) 48,46,48                                          *2D38420
   46 D=0.0                                                      *2D38430
      RETURN                                                     *2D38440
   48 DO 55 I=1,N                                                *2D38450
      IF(I-K) 50,55,50                                           *2D38460
   50 IK=NK+I                                                    *2D38470
      A(IK)=A(IK)/(-BIGA)                                        *2D38480
   55 CONTINUE                                                   *2D38490
C                                                                *2D38500
C        REDUCE MATRIX                                           *2D38510
C                                                                *2D38520
      DO 65 I=1,N                                                *2D38530
      IK=NK+I                                                    *2D38540
      HOLD=A(IK)                                                 *2D38550
      IJ=I-N                                                     *2D38560
      DO 65 J=1,N                                                *2D38570
      IJ=IJ+N                                                    *2D38580
      IF(I-K) 60,65,60                                           *2D38590
   60 IF(J-K) 62,65,62                                           *2D38600
   62 KJ=IJ-I+K                                                  *2D38610
      A(IJ)=HOLD*A(KJ)+A(IJ)                                     *2D38620
   65 CONTINUE                                                   *2D38630
C                                                                *2D38640
C        DIVIDE ROW BY PIVOT                                     *2D38650
C                                                                *2D38660
      KJ=K-N                                                     *2D38670
      DO 75 J=1,N                                                *2D38680
      KJ=KJ+N                                                    *2D38690
      IF(J-K) 70,75,70                                           *2D38700
   70 A(KJ)=A(KJ)/BIGA                                           *2D38710
   75 CONTINUE                                                   *2D38720
C                                                                *2D38730
C        PRODUCT OF PIVOTS                                       *2D38740
C                                                                *2D38750
      D=D*BIGA                                                   *2D38760
C                                                                *2D38770
C        REPLACE PIVOT BY RECIPROCAL                             *2D38780
C                                                                *2D38790
      A(KK)=1.0/BIGA                                             *2D38800
   80 CONTINUE                                                   *2D38810
C                                                                *2D38820
C        FINAL ROW AND COLUMN INTERCHANGE                        *2D38830
C                                                                *2D38840
      K=N                                                        *2D38850
  100 K=(K-1)                                                    *2D38860
      IF(K) 150,150,105                                          *2D38870
  105 I=L(K)                                                     *2D38880
      IF(I-K) 120,120,108                                        *2D38890
  108 JQ=N*(K-1)                                                 *2D38900
```

Subroutine MINV (page 3 of 4)

```
      JR=N*(I-1)                                                        *2D38910
      DO 110 J=1,N                                                      *2D38920
      JK=JQ+J                                                           *2D38930
      HOLD=A(JK)                                                        *2D38940
      JI=JR+J                                                           *2D38950
      A(JK)=-A(JI)                                                      *2D38960
  110 A(JI) =HOLD                                                       *2D38970
  120 J=M(K)                                                            *2D38980
      IF(J-K) 100,100,125                                               *2D38990
  125 KI=K-N                                                            *2D39000
      DO 130 I=1,N                                                      *2D39010
      KI=KI+N                                                           *2D39020
      HOLD=A(KI)                                                        *2D39030
      JI=KI-K+J                                                         *2D39040
      A(KI)=-A(JI)                                                      *2D39050
  130 A(JI) =HOLD                                                       *2D39060
      GO TO 100                                                         *2D39070
  150 RETURN                                                            *2D39080
      END                                                               *2D39090
```

Subroutine MINV (page 4 of 4)

```
      SUBROUTINE MULLER(COE,N1,ROOTR,ROOTI)                            *2D26580
      DIMENSION COE(16),ROOTR(15),ROOTI(15)                            *2D26590
      N2=N1+1                                                          *2D26600
      IF (COE(1)) 400,300,400                                          *2D26610
  300 DO 310 I=1,N1                                                    *2D26620
      J = I                                                            *2D26630
      IF (COE(I)) 320,310,320                                          *2D26640
  310 CONTINUE                                                         *2D26650
      N1 = 0                                                           *2D26660
      ROOTR(1) = 0.                                                    *2D26670
      ROOTI(1) = 0.                                                    *2D26680
      GO TO 37                                                         *2D26690
  320 JJ = 0                                                           *2D26700
      DO 330 I=J,N2                                                    *2D26710
      JJ = JJ + 1                                                      *2D26720
  330 COE(JJ) = COE(I)                                                 *2D26730
      N2 = JJ                                                          *2D26740
      N1 = JJ-1                                                        *2D26750
      IF (N1-1) 400,340,400                                            *2D26760
  340 ROOTR(1) = -COE(2)/COE(1)                                        *2D26770
      ROOTI(1) = 0.                                                    *2D26780
      GO TO 37                                                         *2D26790
  400 N4 = 0                                                           *2D26800
      I=N1+1                                                           *2D26810
   19 IF(COE(I))9,7,9                                                  *2D26820
    7 N4=N4+1                                                          *2D26830
      ROOTR(N4)=0.                                                     *2D26840
      ROOTI(N4)=0.                                                     *2D26850
      I=I-1                                                            *2D26860
      IF(N4-N1)19,37,19                                                *2D26870
    9 CONTINUE                                                         *2D26880
   10 AXR=0.8                                                          *2D26890
      AXI=0.                                                           *2D26900
      L=1                                                              *2D26910
      N3=1                                                             *2D26920
      ALP1R=AXR                                                        *2D26930
      ALP1I=AXI                                                        *2D26940
      M=1                                                              *2D26950
      GOTO99                                                           *2D26960
   11 BET1R=TEMR                                                       *2D26970
      BET1I=TEMI                                                       *2D26980
      AXR=0.85                                                         *2D26990
      ALP2R=AXR                                                        *2D27000
      ALP2I=AXI                                                        *2D27010
      M=2                                                              *2D27020
      GOTO99                                                           *2D27030
   12 BET2R=TEMR                                                       *2D27040
      BET2I=TEMI                                                       *2D27050
      AXR=0.9                                                          *2D27060
                                                                       *2D27070
```

Subroutine MULLER (page 1 of 4)

```
      ALP3R=AXR                                                    *2D27080
      ALP3I=AXI                                                    *2D27090
      M=3                                                          *2D27100
      GOTO99                                                       *2D27110
   13 BET3R=TEMR                                                   *2D27120
      BET3I=TEMI                                                   *2D27130
   14 TE1=ALP1R-ALP3R                                              *2D27140
      TE2=ALP1I-ALP3I                                              *2D27150
      TE5=ALP3R-ALP2R                                              *2D27160
      TE6=ALP3I-ALP2I                                              *2D27170
      TEM=TE5*TE5+TE6*TE6                                          *2D27180
      IF(TEM.EQ.0.) GO TO 1200                                     *2D27190
      TE3=(TE1*TE5+TE2*TE6)/TEM                                    *2D27200
      TE4=(TE2*TE5-TE1*TE6)/TEM                                    *2D27210
 1250 TE7=TE3+1.                                                   *2D27220
      TE9=TE3*TE3-TE4*TE4                                          *2D27230
      TE10=2.*TE3*TE4                                              *2D27240
      DE15=TE7*BET3R-TE4*BET3I                                     *2D27250
      DE16=TE7*BET3I+TE4*BET3R                                     *2D27260
      TE11=TE3*BET2R-TE4*BET2I+BET1R-DE15                          *2D27270
      TE12=TE3*BET2I+TE4*BET2R+BET1I-DE16                          *2D27280
      TE7=TE9-1.                                                   *2D27290
      TE1=TE9*BET2R-TE10*BET2I                                     *2D27300
      TE2=TE9*BET2I+TE10*BET2R                                     *2D27310
      TE13=TE1-BET1R-TE7*BET3R+TE10*BET3I                          *2D27320
      TE14=TE2-BET1I-TE7*BET3I-TE10*BET3R                          *2D27330
      TE15=DE15*TE3-DE16*TE4                                       *2D27340
      TE16=DE15*TE4+DE16*TE3                                       *2D27350
      TE1=TE13*TE13-TE14*TE14-4.*(TE11*TE15-TE12*TE16)             *2D27360
      TE2=2.*TE13*TE14-4.*(TE12*TE15+TE11*TE16)                    *2D27370
      TEM=SQRT (TE1*TE1+TE2*TE2)                                   *2D27380
      IF(TE1)113,113,112                                           *2D27390
  113 TE4=SQRT (.5*(TEM-TE1))                                      *2D27400
      IF(TE4.EQ.0.) GO TO 1000                                     *2D27410
      TE3=.5*TE2/TE4                                               *2D27420
      GO TO 111                                                    *2D27430
 1000 TE3=0.                                                       *2D27440
      GO TO 111                                                    *2D27450
 1200 TE3=0.                                                       *2D27460
      TE4=0.                                                       *2D27470
      GO TO 1250                                                   *2D27480
  112 TE3=SQRT (.5*(TEM+TE1))                                      *2D27490
      IF(TE2)110,200,200                                           *2D27500
  110 TE3=-TE3                                                     *2D27510
  200 TE4=.5*TE2/TE3                                               *2D27520
  111 TE7=TE13+TE3                                                 *2D27530
      TE8=TE14+TE4                                                 *2D27540
      TE9=TE13-TE3                                                 *2D27550
      TE10=TE14-TE4                                                *2D27560
      TE1=2.*TE15                                                  *2D27570
```

Subroutine MULLER (page 2 of 4)

```
      TE2=2.*TE16                                                        *2D27580
      IF(TE7*TE7+TE8*TE8-TE9*TE9-TE10*TE10)204,204,205                   *2D27590
  204 TE7=TE9                                                            *2D27600
      TE8=TE10                                                           *2D27610
  205 TEM=TE7*TE7+TE8*TE8                                                *2D27620
      IF(TEM.EQ.0.) GO TO 1100                                           *2D27630
      TE3=(TE1*TE7+TE2*TE8)/TEM                                          *2D27640
      TE4=(TE2*TE7-TE1*TE8)/TEM                                          *2D27650
 1050 AXR=ALP3R+TE3*TE5-TE4*TE6                                          *2D27660
      AXI=ALP3I+TE3*TE6+TE4*TE5                                          *2D27670
      ALP4R=AXR                                                          *2D27680
      ALP4I=AXI                                                          *2D27690
      M=4                                                                *2D27700
      GO TO 99                                                           *2D27710
 1100 TE3=0.                                                             *2D27720
      TE4=0.                                                             *2D27730
      GO TO 1050                                                         *2D27740
   15 N6=1                                                               *2D27750
38    IF(ABS(HELL)+ABS(BELL)-1.E-20) 18,18,16                            *2D27760
16    TE7=ABS(ALP3R-AXR)+ABS(ALP3I-AXI)                                  *2D27770
      IF(TE7/(ABS(AXR)+ABS(AXI))-1.E-7) 18,18,17                         *2D27780
   17 N3=N3+1                                                            *2D27790
      ALP1R=ALP2R                                                        *2D27800
      ALP1I=ALP2I                                                        *2D27810
      ALP2R=ALP3R                                                        *2D27820
      ALP2I=ALP3I                                                        *2D27830
      ALP3R=ALP4R                                                        *2D27840
      ALP3I=ALP4I                                                        *2D27850
      BET1R=BET2R                                                        *2D27860
      BET1I=BET2I                                                        *2D27870
      BET2R=BET3R                                                        *2D27880
      BET2I=BET3I                                                        *2D27890
      BET3R=TEMR                                                         *2D27900
      BET3I=TEMI                                                         *2D27910
      IF(N3-100)14,18,18                                                 *2D27920
   18 N4=N4+1                                                            *2D27930
      ROOTR(N4)=ALP4R                                                    *2D27940
      ROOTI(N4)=ALP4I                                                    *2D27950
      N3=0                                                               *2D27960
   41 IF(N4-N1)30,37,37                                                  *2D27970
   37 RETURN                                                             *2D27980
30    IF(ABS(ROOTI(N4))-1.E-5)10,10,31                                   *2D27990
   31 GO TO(32,10),L                                                     *2D28000
   32 AXR=ALP1R                                                          *2D28010
      AXI=-ALP1I                                                         *2D28020
      ALP1I=-ALP1I                                                       *2D28030
      M=5                                                                *2D28040
      GO TO 99                                                           *2D28050
   33 BET1R=TEMR                                                         *2D28060
      BET1I=TEMI                                                         *2D28070
```

Subroutine MULLER (page 3 of 4)

```
      AXR=ALP2R                                            *2D28080
      AXI=-ALP2I                                           *2D28090
      ALP2I=-ALP2I                                         *2D28100
      M=6                                                  *2D28110
      GO TO 99                                             *2D28120
   34 BET2R=TEMR                                           *2D28130
      BET2I=TEMI                                           *2D28140
      AXR=ALP3R                                            *2D28150
      AXI=-ALP3I                                           *2D28160
      ALP3I=-ALP3I                                         *2D28170
      L=2                                                  *2D28180
      M=3                                                  *2D28190
   99 TEMR=COE(1)                                          *2D28200
      TEMI=0.0                                             *2D28210
      DO100I=1,N1                                          *2D28220
      TE1=TEMR*AXR-TEMI*AXI                                *2D28230
      TEMI=TEMI*AXR+TEMR*AXI                               *2D28240
  100 TEMR=      TE1+COE(I+1)                              *2D28250
      HELL=TEMR                                            *2D28260
      BELL=TEMI                                            *2D28270
   42 IF(N4)102,103,102                                    *2D28280
  102 DO101I=1,N4                                          *2D28290
      TEM1=AXR-ROOTR(I)                                    *2D28300
      TEM2=AXI-ROOTI(I)                                    *2D28310
      TE1=TEM1*TEM1+TEM2*TEM2                              *2D28320
      IF(TE1.EQ.0.0) GO TO 1300                            *2D28330
      TE2=(TEMR*TEM1+TEMI*TEM2)/TE1                        *2D28340
      TEMI=(TEMI*TEM1-TEMR*TEM2)/TE1                       *2D28350
  101 TEMR=TE2                                             *2D28360
  103 GO TO(11,12,13,15,33,34),M                           *2D28370
 1300 TEMR=0.                                              *2D28380
      TEMI=0.                                              *2D28390
      GO TO 103                                            *2D28400
      END                                                  *2D28410
```


Subroutine MULLER (page 4 of 4)

```
                                                                        *2D07960
      SUBROUTINE NORMUT                                                 *2D07970
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D07980
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D07990
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D08000
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D08010
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D08020
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D08030
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D08040
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,         BIGMI,TMATII,*2D08050
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEF,RH*2D08060
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D08070
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D08080
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D08090
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D08100
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D08110
                                                                        *2D08120
                                                                        *2D08130
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D08140
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D08150
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D08160
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(3),THEDSQ(8),CTHETA(8*2D08170
     4),STHETA(8),         BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D08180
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D08190
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D08200
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D08210
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(15),RVEL(16),MODF(16),TIMTJZ(*2D08220
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D08230
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D08240
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D08250
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),       SIGMAA(10,1*2D08260
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D08270
     4LE(2,14),ZPPP(128),BL(3)                                          *2D08280
                                                                        *2D08290
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D08300
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D08310
      COMMON NONO(1402)                                                 *2D08320
      DIMENSION TT(8),TV(8),TA(8),KI(8),KA(8),PP(8)                     *2D08330
C     6.2   HEAD AND CHEST ACCELERATIONS                                *2D08340
      TS=ZVECPP(9)-EL(1)*(ZVECPP(1)*STHETA(1)+THEDSQ(1)*CTHETA(1))-EL(2)*2D08350
     1*(ZVECPP(2)*STHETA(2)+THEDSQ(2)*CTHETA(2))                        *2D08360
      TSA=ZVECPP(3)*STHETA(3)+THEDSQ(3)*CTHETA(3)                       *2D08370
      XCHEST=TS-RHO(3)*TSA                                              *2D08380
      XHEAD=TS-EL(3)*TSA-RHO(4)*(ZVECPP(4)*STHETA(4)+THEDSQ(4)*CTHETA(4)*2D08390
     1)                                                                 *2D08400
      ACH = TS/GRAVIT                                                   *2D08410
      BCH = TSA/GRAVIT                                                  *2D08420
      AH = ACH-EL(3)*BCH                                                *2D08430
      BH=(ZVECPP(4)*STHETA(4)+THEDSQ(4)*CTHETA(4))/GRAVIT               *2D08440
      TS=ZVECPP(10)+EL(1)*(ZVECPP(1)*CTHETA(1)-THEDSQ(1)*STHETA(1))+EL(2*2D08450
```

Subroutine NORMUT (page 1 of 3)

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      1)*(ZVECPP(2)*CTHETA(2)-THEDSQ(2)*STHETA(2))                       *2D08460
       TSA=ZVECPP(3)*CTHETA(3)-THEDSQ(3)*STHETA(3)                       *2D08470
       YCHEST=TS+RHO(3)*TSA                                              *2D08480
       YHEAD=TS+EL(3)*TSA+RHO(4)*(ZVECPP(4)*CTHETA(4)-THEDSQ(4)*STHETA(4)*2D08490
      1)                                                                 *2D08500
       CCH = TS/GRAVIT                                                   *2D08510
       DCH = TSA/GRAVIT                                                  *2D08520
       CH = CCH+EL(3)*DCH                                                *2D08530
       DH = (ZVECPP(4)*CTHETA(4)-THEDSQ(4)*STHETA(4))/GRAVIT             *2D08540
       ACHEST=SQRT(XCHEST*XCHEST+YCHEST*YCHEST)                          *2D08550
       AHEAD=SQRT(XHEAD*XHEAD+YHEAD*YHEAD)                               *2D08560
       GCHEST = ATAN2(YCHEST,XCHEST)/DTR                                 *2D08570
       GHEAD = ATAN2(YHEAD,XHEAD)/DTR                                    *2D08580
  6705 IF (IBUG) 6710,6715,6710                                          *2D08600
  6710 WRITE(6,9925)TIME                                                 *2D08610
  9925 FORMAT (57X9HAT TIME =F10.4)                                      *2D08620
       WRITE(6,9916)                                                     *2D08630
  9916 FORMAT (1H044X5HTHETA49X5HX HIP7X5HY HIP7X5HX CAR)                *2D08640
  6715 DO 6720 I=1,8                                                     *2D08650
       TT(I) = ZVEC(I)/DTR                                               *2D08660
  6720 CONTINUE                                                          *2D08670
       IF (IBUG.EQ.0) GO TO 6721                                         *2D08675
       WRITE(6,9924)TT,ZVEC(9),ZVEC(10),ZVEC(11)                         *2D08680
  9924 FORMAT (1XF11.3,7F12.3,3E12.4)                                    *2D08690
  6721 DO 6722 I=1,8                                                     *2D08700
       TV(I) = ZVECP(I)/DTR                                              *2D08710
  6722 CONTINUE                                                          *2D08720
       IF (IBUG.EQ.0) GO TO 6723                                         *2D08725
       WRITE(6,9924)TV,ZVECP(9),ZVECP(10),ZVECP(11)                      *2D08730
  6723 DO 6724 I=1,8                                                     *2D08740
       TA(I) = ZVECPP(I)/DTR                                             *2D08750
  6724 CONTINUE                                                          *2D08755
       IF (IBUG.EQ.0) GO TO 6800                                         *2D08760
       WRITE(6,9928)TA,ZVECPP(9),ZVECPP(10),ZVECPP(11)                   *2D08770
  9928 FORMAT (11E12.4)                                                  *2D08780
       WRITE(6,9919)TIME,FS,FSPRM,SMALLF,XHEAD,YHEAD,AHEAD,GHEAD,        *2D08790
      1XCHEST,YCHEST,ACHEST,GCHEST                                       *2D08800
  9919 FORMAT (640TIME=F8.4,4H,FS=E17.8,7H,FSPRM=E17.8,8H,SMALLF=        *2D08810
      1E17.8/1H019X1HX19X1                                               *2D08820
      2HY19X1HA17X5HGAMMA/3X4HHEAD3X3E20.8,F17.3/2X5HCHEST3X3E20.8,F17.3)*2D08830
       WRITE(6,9921)                                                     *2D08840
  9921 FORMAT (1H03X1HM8X5HDELTA12X9HDELTA DOT13X2HFM10X3HPHI12X3HE1M14X7*2D08850
      1HEPSILON14X3HDEM)                                                 *2D08860
       DO 6750 I=1,3                                                     *2D08870
       TS = PHI(I)/DTR                                                   *2D08880
       WRITE(6,9920)I,SDELTA(I),SDELTD(I),PN(I),TS,EONE(I),EPSLNY(I)     *2D08890
  9920 FORMAT (I5,3E18.8,F10.3,2E18.8)                                   *2D08900
  6750 CONTINUE                                                          *2D08910
  6800 IF (KPRINT) 7000,7200,7000                                        *2D08920
  7000 IF (LCONTL-1) 7010,7010,7200                                      *2D08930
```

Subroutine NORMUT (page 2 of 3)

```
 7010 DISP = ZVEC(9) - ZVEC(11)                                          *2D08940
      PLX = ZVECPP(9)/GRAVIT                                             *2D08950
      PLY = ZVECPP(10)/GRAVIT                                            *2D08960
      PLC = ZVECPP(11)/GRAVIT                                            *2D08970
      HEADX = X(4) + RHO(4)*CTHETA(4)                                    *2D08980
      HEADY = Y(4) + RHO(4)*STHETA(4)                                    *2D08990
      JJ = 0                                                             *2D09000
      DO 7120 N=5,NS                                                     *2D09010
      IF (PN(N)) 7120,7120,7110                                          *2D09020
 7110 JJ = JJ+1                                                          *2D09030
      KI(JJ) = KTABLE(1,N-4)                                             *2D09040
      KA(JJ) = KTABLE(2,N-4)                                             *2D09050
      PP(JJ) = PN(N)                                                     *2D09060
 7120 CONTINUE                                                           *2D09070
      IF (TIME .NE. 0.) GO TO 7130                                       *2D09080
      WRITE(9)ELAMB,XSMALA,YSMALA,AR,RHOPFZ,RHOPTZ,EL,DA,CPSIA,          *2D09090
     1SPSIA,TGAMZ,ZZERO,NBELT,IGNORE,RHO                                 *2D09100
 7130 WRITE(9)TIME,TT,TV,TA,DISP,ZVECP(9),PLX,ZVEC(10),ZVECP(10),        *2D09110
     1PLY,ZVEC(11),ZVECP(11),PLC,AH,BH,CH,DH,ACH,BCH,CCH,DCH,JJ,         *2D09120
     2(KI(I),KA(I),PP(I),I=1,JJ),(PN(N),N=1,3),FSPRM,FS,HEADX,HEADY      *2D09130
     3,PHI,BL                                                            *2D09140
 7200 RETURN                                                             *2D09150
      END                                                                *2D09160
```

Subroutine NORMUT (page 3 of 3)

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                                                                        *2D37090
      SUBROUTINE PAGE4                                                  *2D37100
      DIMENSION A(36,3),AA(6)                                           *2D37110
      DATA A/4HFRON,4HT CO,4HLLIS,3HIGN,2*1H ,4HREAR,4H COL,4HLISI,2HON,*2D37120
     12*1H ,4HSIDE,4H COL,4HLISI,2HON,2*1H ,4H45 D,4HEGRE,4HE LE,4HFT O,*2D37130
     24HBLIQ,2HUE,4H45 D,4HEGRE,4HE RI,3HGHT,4HOBLI,3HQUE,4HROLL,4HOVER,*2D37140
     34*1H ,4HDRIV,2HER,4*1H ,4HRIGH,4HT FR,3HONT,4HPASS,4HENGE,1HR,4HRI*2D37150
     4GH,4HT RE,4HAR P,4HASSE,4HNGER,1H ,4HLEFT,4H REA,4HR PA,4HSSEN,3HG*2D37160
     5ER,13*1H ,4HNO B,3HELT,3HUSE,3*1H ,3HLAP,4HBELT,4H USE,3*1H ,4HSHO*2D37170
     6U,4HLDER,4H HAR,4HNESS,4H USE,1H ,4HSHOU,4HLDER,4H & L,4HAP B,3HEL*2D37180
     7T,3HUSE,4HAIRB,4HAG A,4HND L,4HAP B,3HELT,3HUSE,4HYOKE,4H AND,4H L*2D37190
     8AP,4H BEL,4HT US,1HE/                                             *2D37200
      COMMON/IO/INN                                                     *2D37205
      PRINT 9901                                                        *2D37210
      PR = 1.                                                           *2D37220
      DO 40 I=1,3                                                       *2D37230
      READ (INN,9900)PI,QI,AA                                           *2D37240
 9900 FORMAT (2E10.0,6A4)                                               *2D37250
      IF (QI.EQ.0.) GO TO 30                                            *2D37260
      J = 6.*QI                                                         *2D37270
      K = J-6                                                           *2D37280
      DO 20 L=1,6                                                       *2D37290
      M = L+K                                                           *2D37300
   20 AA(L) = A(M,I)                                                    *2D37310
   30 PRINT 9902,I,(AA(J),J=1,6),PI                                     *2D37320
   40 PR = PR*PI                                                        *2D37330
      PRINT 9903,PR                                                     *2D37340
 9901 FORMAT (1H0,/45X25HPROBABILITY OF OCCURRENCE///24X42HTHE PROBABILI*2D37350
     1TY OF OCCURRENCE IS BASED ON://)                                  *2D37360
 9902 FORMAT (1H0,8XI1,17H. PROBABILITY OF ,6A4,2H =,F8.4)              *2D37370
 9903 FORMAT (1H0,//30X28HPROBABILITY OF OCCURRENCE = ,F8.4)            *2D37380
      RETURN                                                            *2D37390
      END                                                               *2D37400
```

Subroutine PAGE4

```
                                                                        *2D13080
      SUBROUTINE RELSEL(ZP,K,ZPP)                                       *2D13090
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D13100
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D13110
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D13120
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D13130
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D13140
     5,XPACZ,NBELT,APRNTC,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D13150
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D13160
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D13170
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDFLTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D13180
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ   *2D13190
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D13200
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVFLB,CVELC,AACCA,*2D13210
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D13220
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ   *2D13230
                                                                        *2D13240
                                                                        *2D13250
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D13260
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D13270
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D13280
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D13290
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D13300
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D13310
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D13320
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D13330
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(15),RVEL(16),MODE(16),TIMTJZ(*2D13340
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D13350
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D13360
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D13370
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D13380
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D13390
     4LE(2,14),ZPPP(128),BL(3)                                          *2D13400
                                                                        *2D13410
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D13420
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D13430
      COMMON NONO(1402)                                                 *2D13440
      DIMENSION ZP(11)                                                  *2D13450
      CALL RELVEL(K,ZP,ZPP)                                             *2D13460
      IF (K-8) 100,100,50                                               *2D13470
   50 ZPP = ZPP + BASIC(11,K-8)                                         *2D13480
  100 RETURN                                                            *2D13490
      END                                                               *2D13500
```

Subroutine RELSEL

```
                                                                        *2D13510
      SUBROUTINE RELVEL(K,ZP,RV)                                        *2D13520
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D13530
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D13540
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RH),THETAZ,*2D13550
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D13560
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D13570
     5,XPACZ,NBELT,APRNTC,TIMAX,DTPRNT,HPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D13580
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D13590
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D13600
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFFE,RH*2D13610
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELOOD,EPSLNY,FTOLD,FSPRMZ  *2D13620
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEF,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D13630
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D13640
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D13650
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D13660
                                                                        *2D13670
                                                                        *2D13680
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D13690
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D13700
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),FL(8),AR(*2D13710
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D13720
     4),STHETA(8),        BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D13730
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D13740
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D13750
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D13760
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(15),RVEL(16),MODE(16),TIMTJZ(*2D13770
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D13780
      DIMENSION DELOLD(18),DELOOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D13790
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D13800
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),         SIGMAA(10,1*2D13810
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D13820
     4LE(2,14),ZPPP(128),BL(3)                                          *2D13830
                                                                        *2D13840
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D13850
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D13860
      COMMON NONO(1402)                                                 *2D13870
      DIMENSION ZP(11)                                                  *2D13880
      IF (K-8) 10,20,30                                                 *2D13890
   10 M = MFORI(K)                                                      *2D13900
      RV = ZP(M) - ZP(K)                                                *2D13910
      GO TO 900                                                         *2D13920
   20 RV = ZP(9)-ZP(11)                                                 *2D13930
      GO TO 900                                                         *2D13940
   30 II = IFORK(1,K-8)                                                 *2D13950
      IF (II) 40,900,40                                                 *2D13960
   40 IA = IFORK(2,K-8)                                                 *2D13970
      TS = (ZP(9)-ZP(11))*CPSIA(IA)+ZP(10)*SPSIA(IA)                    *2D13980
      GO TO (100,900,300,400,400,900,700,800),II                        *2D13990
  100 RV = TS + AR(1)*ZP(1)                                             *2D14000
```

Subroutine RELVEL (page 1 of 2)

```
      GO TO 900                                                        *2D14010
  300 RV = TS + BASIC(1,K-8)*ZP(1)+BASIC(2,K-8)*ZP(2)+BASIC(3,K-8)*ZP(3)*2D14020
      GO TO 900                                                        *2D14030
  400 RV = TS + BASIC(1,K-8)*ZP(1)+BASIC(2,K-8)*ZP(2)+BASIC(3,K-8)*ZP(3)*2D14040
     1+BASIC(II,K-8)*ZP(II)                                            *2D14050
      GO TO 900                                                        *2D14060
  700 RV = TS + BASIC(1,K-8)*ZP(7)                                     *2D14070
      GO TO 900                                                        *2D14080
  800 RV = TS+BASIC(1,K-8)*ZP(7)+BASIC(2,K-8)*ZP(8)                    *2D14090
  900 RETURN                                                           *2D14100
      END                                                              *2D14110
```

Subroutine RELVFL (page 2 of 2)

```
                                                                        *2D23070
      SUBROUTINE SEAT                                                   *2D23080
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D23090
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D23100
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D23110
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D23120
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DFSTEP,DELTAT,PHIZ,DELTA,NPASGR*2D23130
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D23140
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D23150
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,         BIGMI,TMATII,*2D23160
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFFE,PH*2D23170
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D23180
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D23190
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D23200
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D23210
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSR,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D23220
                                                                        *2D23230
                                                                        *2D23240
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D23250
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D23260
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D23270
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D23280
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D23290
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D23300
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D23310
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D23320
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D23330
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D23340
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D23350
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D23360
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D23370
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D23380
     4LE(2,14),ZPPP(128),BL(3)                                          *2D23390
                                                                        *2D23400
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D23410
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D23420
      COMMON NOVO(1402)                                                 *2D23430
      DO 10 I=1,10                                                      *2D23440
   10 DEE(I) = 0.                                                       *2D23450
      TANTEG = STHETA(8)/CTHETA(8)                                      *2D23460
      IF(ABS(ZVEC(8)).GT.PITWO) TANTEG=-TANTEG                          *2D23470
      Z = ZZERO-ZVEC(9)+ZVEC(11)                                        *2D23480
      IF (Z) 4110,4120,4120                                             *2D23490
 4110 FS = 0.                                                           *2D23500
      FSPRM = 0.                                                        *2D23510
      SMALLF = 0.                                                       *2D23520
      GO TO 4190                                                        *2D23530
 4120 YS = ZVEC(10)+(ZVEC(11)-ZVEC(9))*TGAMZ                            *2D23540
      YSP = ZVECP(10)+(ZVECP(11)-ZVECP(9))*TGAMZ                        *2D23550
      SUMBY=((BETA(3)*YS+BETA(2))*YS+BETA(1))*YS                        *2D23560
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Subroutine SEAT (page 1 of 2)

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      FS = WZERO - CS*YSP - SUMBY                                        *2D23570
      IF (FS) 4130,4140,4140                                             *2D23580
 4130 FS = 0.                                                            *2D23590
 4140 ZMLCTS = Z - EL(7)*CTHETA(7)                                       *2D23600
      IF (ZMLCTS) 4142,4142,4144                                         *2D23610
 4142 TANTSV = STHETA(7)/CTHETA(7)                                       *2D23620
      FSPRM = FSZCNS-S*(ZVEC(10)+Z*TANTSV)                               *2D23630
      IF (FSPRM) 4150,4150,4143                                          *2D23640
 4143 DEE(7) = FSPRM/CTHETA(7)*Z/CTHETA(7)                               *2D23650
      DEE(9) = -FSPRM*TANTSV                                             *2D23660
      GO TO 4155                                                         *2D23670
 4144 FSPRM=FSZCNS-S*(ZVEC(10)+EL(7)*STHETA(7)+ZMLCTS*TANTEG)            *2D23680
      IF (FSPRM) 4150,4150,4146                                          *2D23690
 4146 DEE(7)=EL(7)*FSPRM*(CTHETA(7)+STHETA(7)*TANTEG)                    *2D23700
      DEE(8) = FSPRM/CTHETA(8)*ZMLCTS/CTHETA(8)                          *2D23710
      DEE(9)=-FSPRM*TANTEG                                               *2D23720
      GO TO 4155                                                         *2D23730
 4150 FSPRM = 0.                                                         *2D23740
 4155 DEE(10) = FS+FSPRM                                                 *2D23750
      IF(ZVEC(8).GE.0.) GO TO 4170                                       *2D23760
      XZ=(YZZERO-ZVEC(10)-EL(7)*STHETA(7))/TANTEG-ZMLCTS                 *2D23770
      IF (XZ-RZ) 4160,4170,4170                                          *2D23780
 4160 FZ = SZ*(RZ-XZ)                                                    *2D23790
      DEE(7)=DEE(7)-FZ*EL(7)*(STHETA(7)+CTHETA(7)/TANTEG)                *2D23800
      DEE(8)=DEE(8)+FZ/STHETA(8)*(ZVEC(10)+EL(7)*STHETA(7)-YZZERO)       *2D23810
     1/STHETA(8)                                                         *2D23820
      DEE(9) = DEE(9)+FZ                                                 *2D23830
      DEE(10) = DEE(10)-FZ/TANTEG                                        *2D23840
      GO TO 4180                                                         *2D23850
 4170 FZ = 0.                                                            *2D23860
 4180 SMALLF = (FS+FSPRM)*FMLS                                           *2D23870
 4190 IF (IBUG-2) 4194,4192,4192                                         *2D23880
 4192 WRITE(6,9951)Z,FS,FSPRM,FZ,SMALLF,SUMBY,ZMLCTS                     *2D23890
 9951 FORMAT (6HOSEAT 7E17.8)                                            *2D23900
 4194 RETURN                                                             *2D23910
      END                                                                *2D23920
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Subroutine SEAT (page 2 of 2)

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                                                                        *2D35080
      SUBROUTINE SIPP(IPAGE,K,THETA,STIME)                              *2D35090
      COMMON/INJ/HFA(200),HLA(200),CFA(200),CKF(200),CCF(200,4),IDATE(3)*2D35100
     1,MM,MN,BELTA(200),BELTB(200),BELTC(200),CUA(200),NPROB            *2D35110
      DIMENSION STIME(200),THETA(200,3,8),TOL(22),ITOL(14),B(4,2),C(3,7)*2D35120
      DATA TOL/1000.,2000.,1800.,1800.,5000.,1500.,45.,25.              *2D35130
     1,0.,45.,30.,60.,60.,0.,0.,120.,20.,20.,60.,180.,135.,135./        *2D35140
      DATA B/4HFLEX,3HION,2*1H ,4HHYPE,4HREXT,4HENSI,2HON/              *2D35150
      DATA C/3HHIP,2*1H ,4HLOWE,4HR SP,3HINE,4HUPPE,4HR SP,3HINE,4HNECK,*2D35160
     12*1H ,4HSHOU,4HLDER,1H ,4HELBO,1HW,1H ,4HKNEE,2*1H /              *2D35170
      COMMON/IO/INN                                                     *2D35175
  100 READ (INN,9999)CI,TSA                                             *2D35180
 9999 FORMAT(2E10.0)                                                    *2D35190
      IF(CI.LE.0) GO TO 110                                             *2D35200
      I=CI+.5                                                           *2D35210
      TOL(I)=TSA                                                        *2D35220
      GO TO 100                                                         *2D35230
  110 PRINT 9998,IDATE,IPAGE                                            *2D35240
      LINE = 2                                                          *2D35250
 9998 FORMAT (1H1,28X52HTWO DIMENSIONAL CRASH VICTIM SIMULATOR   OUTPUT *2D35260
     1DATA,20X3A4,11X4HPAGE,I3)                                         *2D35270
      DO 120 I=1,8                                                      *2D35280
  120 ITOL(I) = TOL(I)                                                  *2D35290
      PRINT 9010,(ITOL(I),I=1,4)                                        *2D35300
      PRINT 9011,(ITOL(I),I=5,8)                                        *2D35310
      PRINT 9012                                                        *2D35320
      PRINT 9013                                                        *2D35330
      PRINT 9014                                                        *2D35340
 9010 FORMAT (1H0,35X49HSUMMARY OF TOLERANCE DATA USED IN INJURY CRITERI*2D35350
     1A//13X8HQUANTITY,11X24HMAXIMUM ACCEPTABLE VALUE,13X24HNATURE OF IN*2D35360
     2JURY OR DATA,12X14HWEIGHTING CODE//4X17H1. SEVERITY INDEX,14X2H1.,*2D35370
     3I5,17X43H1. INTERNAL HEAD INJURY. DANGEROUS TO LIFE.,6X8H1. 22/26/*2D35380
     44X33H2. HEAD PITCH ACCELERATION      2.,I5,12H RAD/SEC/SEC,5X37H2. *2D35390
     550% CHANCE OF CEREBRAL CONCUSSION.,12X8H2. 12/26/                 *2D35400
     64X13H3. CHEST LOAD,18X2H3.,I5,3H LB,14X27H3. RIB FRACTURE OF CADAV*2D35410
     7ER,22X8H3. 13/26/4X21H4. SHOULDER BELT LOAD,10X2H4.,I5, 12H LB COM*2D35420
     8BINED,5X44H4. PREDICTED TOLERANCE LEVEL WITHOUT INJURY.,5X8H4.  1/*2D35430
     926)                                                               *2D35440
 9011 FORMAT (4X19H5. PELVIC BELT LOAD,12X2H5.,I5,3H LB,14X26H5. MAXIMUM*2D35450
     1 VOLUNTARY LOAD.,23X8H5.  1/26/4X19H6. KNEE LOAD (EACH),12X2H6.,I5*2D35460
     2,3H LB,14X31H6. COMMINUTED PATELLA FRACTURE.,18X8H6. 12/26/       *2D35470
     34X19H7. CHEST A-P G-LOAD,12X                                      *2D35480
     52H7.,I5,7H G-PEAK,10X33H7. VOLUNTEER DATA WITH NO INJURY.,16X8H7. *2D35490
     6 4/26/62X39H(DURATION=.09 SEC, RISE TIME=500 G/SEC)/62X41HHIGHER R*2D35500
     7ISE TIMES OR LONGER DURATIONS CAN/62X34HDECREASE THIS VALUE SIGNIF*2D35510
     8ICANTLY./4X19H8. CHEST S-I G-LOAD,12X2H8.,I5,7H G-PEAK,10X38H8. VO*2D35520
     9LUNTEER DATA. FRACTURED VERTEBRAE,11X8H8. 16/26)                  *2D35530
 9012 FORMAT (1H0,//51X18HLIST OF REFERENCES///                       4*2D35540
     1X117H1. GADD, C.W., "USE OF A WEIGHTED-IMPULSE CRITERION FOR ESTIM*2D35550
     2ATING INJURY HAZARD", PROC. 10TH. STAPP CAR CRASH CONF.,/7X20HNOV.*2D35560
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Subroutine SIPP (page 1 of 5)

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     3 1966, P.95-100./4X108H2. OMMAYA, A.K. ET AL, "COMPARATIVE TOLERAN*2D35570
     4CES FOR CEREBRAL CONCUSSION BY HEAD IMPACT AND WHIPLASH INJURY IN/*2D35580
     57X100HPRIMATES", 1970 INTERNATIONAL AUTOMOBILE SAFETY CONFERENCE C*2D35590
     6OMPENDIUM, SAE PUB. NO. P-30, P.808-817.)                          *2D35600
9013 FORMAT (4X112H3. GADD, C.W. AND PATRICK, L.M., "SYSTEM VERSUS LABO*2D35610
     1RATORY IMPACT TESTS FOR ESTIMATING INJURY HAZARD", SAE PAPER/7X22H*2D35620
     2NO. 680053, JAN. 1968./4X119H4. -, ESTIMATED PROBABLE THRESHOLD OF*2D35630
     3 INJURY BY BIOMECHANICS TASK FORCE OF SAE OCCUPANT RESTRAINT SYSTE*2D35640
     4MS SUBCOMMITTEE./4X108H5. STAPP, J.P. AND ENFIELD, D.L., "EVALUATI*2D35650
     5ON OF THE LAP-TYPE AUTOMOBILE SAFETY BELT WITH REFERENCE TO HUMAN/*2D35660
     67X36HTOLERANCE", SAE PAPER NO. 62A, 1958./4X115H6. SNYDER, R.G., "*2D35670
     7HUMAN IMPACT TOLERANCE", 1970 INTERNATIONAL AUTOMOBILE SAFETY CONF*2D35680
     8ERENCE COMPENDIUM, SAE PUB. NO./7X16HP-30, P.712-782./4X8H7. IBID.*2D35690
     9/4X8H8. IBID.//)                                                   *2D35700
9014 FORMAT (4X106HNOTE: THE WEIGHTING CODE IS BASED ON VAN KIRK, D.J. *2D35710
     1AND LANGE, W.A., "A DETAILED INJURY SCALE FOR ACCIDENT/10X84HINVES*2D35720
     2TIGATION", PROC. OF THE 12TH. STAPP CAR CRASH CONFERENCE, OCT. 196*2D35730
     38, P.240-259./10X86HMINOR INJURY = 1-4/26, MODERATE INJURY = 8-10/*2D35740
     426, MODERATELY SEVERE INJURY = 12-14/26,/10X,78HSEVERE INJURY = 16*2D35750
     5-18/26, CRITICAL INJURY = 20-22/26, FATAL INJURY = 24-26/26.)     *2D35760
      IPAGE = IPAGE+1                                                   *2D35770
      DO 130 I=1,7                                                      *2D35780
      RTM=A                                                             *2D35790
      J=I+I                                                             *2D35795
      ITOL(J)=TOL(I+15)                                                 *2D35800
 130  ITOL(J-1)=TOL(I+8)                                                *2D35810
      PRINT 9998,IDATE,IPAGE                                            *2D35820
      PRINT 9001,(ITOL(I),I=1,14)                                       *2D35830
9001 FORMAT (1H0,32X56HSUMMARY OF ANGULAR MOTION LIMITS USED IN INJURY *2D35840
     1CRITERIA//36X5HJOINT,15X7HFLEXION,10X14HHYPEREXTENSION//32X6H1. HI*2D35850
     2P,17XI4,4H DEG,13XI4,4H DEG/32X14H2. LOWER SPINE,9XI4,4H DEG,13XI4*2D35860
     3,4H DEG/32X14H3. UPPER SPINE,9XI4,4H DEG,13XI4,4H DEG/32X7H4. NECK*2D35870
     4,16XI4,4H DEG,13XI4,4H DEG/32X11H5. SHOULDER,12XI4,4H DEG,13XI4,4H*2D35880
     5 DEG/32X8H6. ELBOW,15XI4,4H DEG,13XI4,4H DEG/32X7H7. KNEE,16XI4,4H*2D35890
     6 DEG,13XI4,4H DEG//19X81HNOTE: ALL QUANTITIES MEASURED FROM AN ERE*2D35900
     7CT STANDING POSITION WITH ARMS AT SIDES.)                         *2D35910
      TOL(9)=90.-TOL(9)                                                 *2D35920
      TOL(14)=90.-TOL(14)                                               *2D35930
      TOL(15)=90.-TOL(15)                                               *2D35940
      TOL(16)=TOL(16)-90.                                               *2D35950
      TOL(21)=TOL(21)-90.                                               *2D35960
      TOL(22) = TOL(22)-90.                                             *2D35970
9997 FORMAT (1H0,39X42HSUMMARY OF QUANTITIES EXCEEDING TOLERANCES//11X8*2D35980
     1HQUANTITY,14X37HPEAK     TIME OF OCCURRENCE    DURATION,7X10HTIME ST*2D35990
     2ART,7X27HTIME END     WEIGHTING CODE//)                            *2D36000
      ISWT=0                                                            *2D36010
      L=0                                                               *2D36020
      SI=0.                                                             *2D36030
      DO 550 J=1,15                                                     *2D36040
 200  IF (J.EQ.4) L=L+1                                                 *2D36050
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Subroutine SIPP (page 2 of 5)

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      PVAR=0.                                                            *2D36060
      TSB=0.                                                             *2D36070
      TON=0.                                                             *2D36080
      ISON=0                                                             *2D36090
      DO 540 I=1,K                                                       *2D36100
      JJ = J                                                             *2D36110
      GO TO (210,220,230,240,250,260,270,280,290,300,300,300,310,320,320*2D36120
     1),J                                                                *2D36130
  210 IF(I.NE.1) SI=SI+(STIME(I)-STIME(I-1))*ABS(HFA(I))**2.5            *2D36140
      VAR=SI                                                             *2D36150
      GO TO 330                                                          *2D36160
  220 VAR=THETA(I,3,4)*.01745329                                         *2D36170
      GO TO 330                                                          *2D36180
  230 IF(MM.LE.0) GO TO 550                                              *2D36190
      VAR=CCF(I,L)                                                       *2D36200
      GO TO 330                                                          *2D36210
  240 VAR=BELTB(I)+BELTC(I)                                              *2D36220
      GO TO 330                                                          *2D36230
  250 VAR=BELTA(I)                                                       *2D36240
      GO TO 330                                                          *2D36250
  260 IF(MN.LE.0) GO TO 550                                              *2D36260
      VAR=CKF(I)                                                         *2D36270
      GO TO 330                                                          *2D36280
  270 VAR=CFA(I)                                                         *2D36290
      GO TO 330                                                          *2D36300
  280 VAR = CUA(I)                                                       *2D36310
      GO TO 330                                                          *2D36320
  290 VAR = THETA(I,1,1)-THETA(I,1,7)-90.                                *2D36330
      GO TO 327                                                          *2D36340
  300 VAR = THETA(I,1,J-8)-THETA(I,1,J-9)                                *2D36350
      GO TO 327                                                          *2D36360
  310 VAR = THETA(I,1,3)-THETA(I,1,5)-180.                               *2D36370
      GO TO 327                                                          *2D36380
  320 VAR = THETA(I,1,3*J-37)-THETA(I,1,J-8)+90.                         *2D36390
  327 IF (VAR.LT.0.) JJ=J+7                                              *2D36400
  330 TSA=ABS(VAR)                                                       *2D36410
      IF(TSA.LE.TOL(JJ)) GO TO 350                                       *2D36420
      IF (ISON.NE.0) GO TO 340                                           *2D36430
      ISON=1                                                             *2D36440
      IF (I.EQ.1) GO TO 340                                              *2D36450
      TON=STIME(I)-(STIME(I)-STIME(I-1))/(TSA-PVAR)*(TSA-TOL(JJ))        *2D36460
  340 IF(TSA.LE.TSB) GO TO 535                                           *2D36470
      TSB=TSA                                                            *2D36480
      PEAK=VAR                                                           *2D36490
      PTIM=STIME(I)                                                      *2D36500
      GO TO 535                                                          *2D36510
  350 IF(ISON.EQ.0) GO TO 535                                            *2D36520
      ISON=0                                                             *2D36530
      TOF=STIME(I)-(STIME(I)-STIME(I-1))/(PVAR-TSA)*(TOL(JJ)-TSA)        *2D36540
      DUR=TOF-TON                                                        *2D36550
```

Subroutine SIPP (page 3 of 5).

```
      IF (ISWT.NE.0) GO TO 390                                          *2D36560
      ISWT=1.                                                           *2D36570
 360  IPAGE = IPAGE+1                                                   *2D36580
      PRINT 9998,IDATE,IPAGE                                            *2D36590
      PRINT 9997                                                        *2D36600
      LINE = 7                                                          *2D36610
 390  IF (LINE.GT.60) GO TO 360                                         *2D36620
      JL=2                                                              *2D36630
      IF (JJ.LT.16) JL=1                                                *2D36640
      GO TO (410,420,430,440,450,460,470,480,500,520,520,520,520,500,500*2D36650
     1),J                                                               *2D36660
  410 PRINT9901,PEAK,PTIM,DUR,TON,TOF                                   *2D36670
 9901 FORMAT (3X19HHEAD SEVERITY INDEX,7XF9.0,4F16.6,10X5H22/26)        *2D36680
      GO TO 530                                                         *2D36690
  420 PRINT 9902,PEAK,PTIM,DUR,TON,TOF                                  *2D36700
 9902 FORMAT (3X23HHEAD PITCH ACCELERATION,3XF9.0,4F16.6,10X5H12/26)    *2D36710
      GO TO 530                                                         *2D36720
  430 PRINT 9903,PEAK,PTIM,DUR,TON,TOF                                  *2D36730
 9903 FORMAT (3X10HCHEST LOAD,16XF9.0,4F16.6,10X5H13/26)                *2D36740
      GO TO 530                                                         *2D36750
  440 PRINT 9904,PEAK,PTIM,DUR,TON,TOF                                  *2D36760
 9904 FORMAT (3X18HSHOULDER BELT LOAD,8XF9.0,4F16.6,11X4H1/26)          *2D36770
      GO TO 530                                                         *2D36780
  450 PRINT 9905,PEAK,PTIM,DUR,TON,TOF                                  *2D36790
 9905 FORMAT (3X16HPELVIC BELT LOAD,10XF9.0,4F16.6,11X4H1/26)           *2D36800
      GO TO 530                                                         *2D36810
  460 PRINT 9906,PEAK,PTIM,DUR,TON,TOF                                  *2D36820
 9906 FORMAT (3X16HKNEE LOAD (EACH),10XF9.0,4F16.6,10X5H12/26)          *2D36830
      GO TO 530                                                         *2D36840
  470 PRINT 9907,PEAK,PTIM,DUR,TON,TOF                                  *2D36850
 9907 FORMAT (3X16HCHEST A-P G-LOAD,10XF9.0,4F16.6,11X4H4/26)           *2D36860
      GO TO 530                                                         *2D36870
  480 PRINT 9908,PEAK,PTIM,DUR,TON,TOF                                  *2D36880
 9908 FORMAT (3X16HCHEST S-I G-LOAD,10XF9.0,4F16.6,10X5H16/26)          *2D36890
      GO TO 530                                                         *2D36900
 500  PEAK = 90.-PEAK                                                   *2D36910
 520  PEAK = ABS(PEAK)                                                  *2D36920
      PRINT 9910,(C(M,J-8),M=1,3),(B(L,JL),L=1,4),PEAK,PTIM,DUR,TON,TOF *2D36930
 9910 FORMAT (3X7A4,F7.0,4F16.6,10X5H-----)                             *2D36940
 530  TSB=0.                                                            *2D36950
      LINE = LINE+1                                                     *2D36960
 535  PVAR=TSA                                                          *2D36970
  540 CONTINUE                                                          *2D36980
      IF (J.NE.4) GO TO 550                                             *2D36990
      IF(MM.GE.L) GO TO 200                                             *2D37000
  550 CONTINUE                                                          *2D37010
      IPAGE=IPAGE+1                                                     *2D37020
      IF (NPROB.NE.0) RETURN                                            *2D37030
      PRINT 9998,IDATE,IPAGE                                            *2D37040
      CALL PAGE4                                                        *2D37050
```

Subroutine SIPP (page 4 of 5)

```
      IPAGE = IPAGE+1                                                  *2037060
      RETURN                                                           *2037070
      END                                                              *2037080
```

Subroutine SIPP (page 5 of 5)

```
      SUBROUTINE STYX                                                   *2D32660
      DIMENSION XJOINT(9),YJOINT(9),CZVFC(8),SZVEC(8),XLEN(8),YLEN(8),N(*2D32670
     18),XMAN(64),YMAN(64),IMAGE(1500),NSCALE(5),JOINT(9),STEPS(200)    *2D32680
     2,VZERO(50),HZERO(130),ZERO(130)                                   *2D32690
      DIMENSION NCNTCT(8),XHIP(5),YHIP(5),XCHT(6),YCHT(6),XELB(3),      *2D32700
     1YELB(3),XHND(5),YHND(5),XKNE(3),YKNE(3),XFT(5),YFT(5)             *2D32710
      DIMENSION IDATE(3)                                                *2D32720
      COMMON XLAP(2),YLAP(2),XL(2),YL(2),XU(1),YU(1),XFLOOR(2),YFLOOR(2)*2D32730
     1,XSEAT(3),YSEAT(3),XR(2),YR(2),XUSDF(2),YUSDF(2),XWS(2),YWS(2),   *2D32740
     2XLSW(2),YLSW(2),XLP(2),YLP(2),XSC(2),YSC(2),XTOE(2),YTOE(2),      *2D32750
     3POST(200,9),THETA(200,3,8),AR(8),RHOPFZ,RHOPTZ,CPSIA(10),         *2D32760
     4SPSIA(10),CA(10),TGAMZ,ZZERO,PHI1(200),PHI2(200),PHI3(200),       *2D32770
     5BL1(200),BL2(200),BL3(200),IPAGE,STIME(200),NBELT,IGNORE(10),     *2D32780
     6EL(8),KTOTAL                                                      *2D32790
      COMMON/IO/INN                                                     *2D32795
      DATA JOINT/1H1,1H2,1H3,1H4,1H5,1H6,1H0,1H7,1H0/                   *2D32800
      READ (INN,9999)NHL,NSBH,NVL,NSBV,IZERO,ISTEP,MFTH                 *2D32810
      READ (INN,9998)XMIN,XMAX,YMIN,YMAX,FIRST,DELTA                    *2D32820
      ISTEP = MINO(ISTEP,200)                                           *2D32830
      IF (MFTH .EQ. 0) GO TO 4010                                       *2D32840
      STEPS(1) = FIRST                                                  *2D32850
      DO 4000 I=2,ISTEP                                                 *2D32860
 4000 STEPS(I) = STEPS(I-1) + DELTA                                     *2D32870
      GO TO 4030                                                        *2D32880
 4010 DO 4020 I=1,ISTEP                                                 *2D32890
 4020 READ (INN,9992)STEPS(I)                                           *2D32900
 4030 READ (INN,9995)NCNTCT                                             *2D32910
      CALL DATE(IDATE)                                                  *2D32920
      NCHAR=0                                                           *2D32930
      LABEL=0                                                           *2D32940
      INT=4                                                             *2D32950
      PTLEN=.25                                                         *2D32960
      ANG=45.                                                           *2D32970
      NSCALE(1)=0                                                       *2D32980
      MSBH = NSBH*(NHL-1)                                               *2D32990
      MSBV = NSBV*(NVL-1)                                               *2D33000
      RNSBH = MSBH + NHL                                                *2D33010
      RNSBV = MSBV + NVL                                                *2D33020
      L = 1                                                             *2D33030
      IF (IZERO .NE. C) GO TO 7                                         *2D33040
      DO 6 I=1,110                                                      *2D33050
    6 ZERO(I) = 0.0                                                     *2D33060
      VZERO(1) = YMIN                                                   *2D33070
      HZERO(1) = XMIN                                                   *2D33080
      VLINE = (YMAX - YMIN)/RNSBH                                       *2D33090
      HLINE = (XMAX - XMIN)/RNSBV                                       *2D33100
      DO 3 I=2,MSBH                                                     *2D33110
    3 VZERO(I) = VZERC(I-1) + VLINF                                     *2D33120
      DO 5 I=2,MSBV                                                     *2D33130
    5 HZERO(I) = HZERO(I-1) + HLINE                                     *2D33140
```

Subroutine STYX (page 1 of 5)

```
      7 SCALEY = (YMAX - YMIN)/(RNSBH/6.)                                   *2D33150
        SCALEX=(XMAX-XMIN)/(RNSBV/10.)                                      *2D33160
        XFLOOR(2) = XFLOOR(1) - DA(1)*CPSIA(1)                              *2D33170
        YFLOOR(2) = YFLOOR(1) - DA(1)*SPSIA(1)                              *2D33180
        XSEAT(2) = XSEAT(1) - DA(2)*CPSIA(2)                                *2D33190
        YSEAT(2) = YSEAT(1) - DA(2)*SPSIA(2)                                *2D33200
        XSEAT(3) = XSEAT(1) + ZZERO                                         *2D33210
        YSEAT(3) = YSEAT(1) + ZZERO*TGAMZ                                   *2D33220
        XR(2) = XR(1) - DA(3)*CPSIA(3)                                      *2D33230
        YR(2) = YR(1) - DA(3)*SPSIA(3)                                      *2D33240
        XUSDF(2) = XUSDF(1) - DA(4)*CPSIA(4)                                *2D33250
        YUSDF(2) = YUSDF(1) - DA(4)*SPSIA(4)                                *2D33260
        XWS(2) = XWS(1) - DA(5)*CPSIA(5)                                    *2D33270
        YWS(2) = YWS(1) - DA(5)*SPSIA(5)                                    *2D33280
        XLSW(2) = XLSW(1) - DA(6)*CPSIA(6)                                  *2D33290
        YLSW(2) = YLSW(1) - DA(6)*SPSIA(6)                                  *2D33300
        XLP(2) = XLP(1) - DA(7)*CPSIA(7)                                    *2D33310
        YLP(2) = YLP(1) - DA(7)*SPSIA(7)                                    *2D33320
        XSC(2) = XSC(1) - DA(8)*CPSIA(8)                                    *2D33330
        YSC(2) = YSC(1) - DA(8)*SPSIA(8)                                    *2D33340
        XTOE(2) = XTOE(1) -DA(9)*CPSIA(9)                                   *2D33350
        YTOE(2) = YTOE(1) - DA(9)*SPSIA(9)                                  *2D33360
        XLAP(1) = -XLAP(1)                                                  *2D33370
        YLAP(1) = -YLAP(1)                                                  *2D33380
        DO 110 K=1,KTOTAL                                                   *2D33390
        IF (K .EQ. KTOTAL) GO TO 4                                          *2D33400
        IF (STEPS(L) .GT. (STIME(K)+STIME(K+1))/2.) GO TO 110               *2D33410
      4 XJOINT(1) = POST(K,1)                                               *2D33420
        YJOINT(1) = POST(K,4)                                               *2D33430
        DO 1 I=1,8                                                          *2D33440
        DTR=THETA(K,1,I)*.0174532925                                        *2D33450
        CZVEC(I)=COS(DTR)                                                   *2D33460
      1 SZVEC(I)=SIN(DTR)                                                   *2D33470
        XJOINT(2) = XJOINT(1) + EL(1)*CZVEC(1)                              *2D33480
        XJOINT(3) = XJOINT(2) + EL(2)*CZVEC(2)                              *2D33490
        XJOINT(4) = XJOINT(3) + EL(3)*CZVEC(3)                              *2D33500
        XJOINT(5) = XJOINT(3) + EL(4)*CZVEC(3)                              *2D33510
        XJOINT(6) = XJOINT(5) + EL(5)*CZVEC(5)                              *2D33520
        XJOINT(7) = XJOINT(6) + EL(6)*CZVEC(6)                              *2D33530
        XJOINT(8) = XJOINT(1) + EL(7)*CZVEC(7)                              *2D33540
        XJOINT(9) = XJOINT(8) + EL(8)*CZVEC(8)                              *2D33550
        YJOINT(2) = YJOINT(1) + EL(1)*SZVEC(1)                              *2D33560
        YJOINT(3) = YJOINT(2) + EL(2)*SZVEC(2)                              *2D33570
        YJOINT(4) = YJOINT(3) + EL(3)*SZVEC(3)                              *2D33580
        YJOINT(5) = YJOINT(3) + EL(4)*SZVEC(3)                              *2D33590
        YJOINT(6) = YJOINT(5) + EL(5)*SZVEC(5)                              *2D33600
        YJOINT(7) = YJOINT(6) + EL(6)*SZVEC(6)                              *2D33610
        YJOINT(8) = YJOINT(1) + EL(7)*SZVEC(7)                              *2D33620
        YJOINT(9) = YJOINT(8) + EL(8)*SZVEC(8)                              *2D33630
        DO 10 I=1,8                                                         *2D33640
```

Subroutine STYX (page 2 of 5)

```
      XLEN(I) = CZVEC(I)/PTLEN                                          *2D33650
      YLEN(I) = SZVEC(I)/PTLEN                                          *2D33660
   10 N(I) = PTLEN*EL(I) + 1.                                           *2D33670
      N(4) = 360./ANG                                                   *2D33680
      NT = 0                                                            *2D33690
      DO 80 J=1,8                                                       *2D33700
      JJ = N(J)                                                         *2D33710
      GO TO (20,20,20,40,20,20,60,20),J                                 *2D33720
   20 DO 30 I = 1,JJ                                                    *2D33730
      NST=NT+I                                                          *2D33740
      R=I-1                                                             *2D33750
      XMAN(NST) = XJOINT(J) + R*XLEN(J)                                 *2D33760
   30 YMAN(NST) = YJOINT(J) + R*YLEN(J)                                 *2D33770
      GO TO 80                                                          *2D33780
   40 HEADX = XJOINT(4) + RHOPFZ*CZVEC(4)                               *2D33790
      HEADY = YJOINT(4) + RHOPFZ*SZVEC(4)                               *2D33800
      DO 50 I=1,JJ                                                      *2D33810
      R=I-1                                                             *2D33820
      RANG = R*ANG*.0174532925                                          *2D33830
      NST=NT+I                                                          *2D33840
      XMAN(NST) = HEADX + AR(4)*COS(RANG)                               *2D33850
   50 YMAN(NST) = HEADY + AR(4)*SIN(RANG)                               *2D33860
      GO TO 80                                                          *2D33870
   60 DO 70 I=1,JJ                                                      *2D33880
      R=I-1                                                             *2D33890
      NST=NT+I                                                          *2D33900
      XMAN(NST) = XJOINT(1) + R*XLEN(7)                                 *2D33910
   70 YMAN(NST) = YJOINT(1) + R*YLEN(7)                                 *2D33920
   80 NT = NT+N(J)                                                      *2D33930
      NPTS1=1                                                           *2D33940
      NPTS2=2                                                           *2D33950
      NPTS3=3                                                           *2D33960
      PRINT 9997,IDATE,IPAGE                                            *2D33970
      PRINT 9996,STIME(K)                                               *2D33980
      CALL PLOT1(NSCALE(1),NHL,NSBH,NVL,NSBV)                           *2D33990
      CALL PLOT2(IMAGE,XMAX,XMIN,YMAX,YMIN)                             *2D34000
      IF (IZERO .NE. 0) GO TO 100                                       *2D34010
      CALL PLOT3('|',ZERO(1),VZERO(1),MSBH,INT)                         *2D34020
      CALL PLOT3('-',HZERO(1),ZERO(1),MSBV,INT)                         *2D34030
  100 IF (NCNTCT(1) .NE. 0) GO TO 130                                   *2D34040
      ANGLE = ((360.-THETA(K,1,1)+THETA(K,1,7))/6.)*.0174532925         *2D34050
      TS = THETA(K,1,1)*.0174532925                                     *2D34060
      DO 125 J=1,5                                                      *2D34070
      TS = TS + ANGLE                                                   *2D34080
      XHIP(J) = XJOINT(1) + AR(1)*COS(TS)                               *2D34090
  125 YHIP(J) = YJOINT(1) + AR(1)*SIN(TS)                               *2D34100
      CALL PLOT3('+',XHIP(1),YHIP(1),5,INT)                             *2D34110
  130 IF (NCNTCT(3) .NE.0) GO TO 145                                    *2D34120
      XRHO = XJOINT(3) + RHOPTZ*CZVEC(3)                                *2D34130
      YRHO = YJOINT(3) + RHOPTZ*SZVEC(3)                                *2D34140
```

Subroutine STYX (page 3 of 5)

```
      FRTYFV = 45.*.0174532925)                                          *2D34150
      TS = -FRTYFV                                                       *2D34160
      DO 135 J=1,3                                                       *2D34170
      XCHT(J) = XRHO + AR(3)*COS(TS)                                     *2D34180
      YCHT(J) = YRHO + AR(3)*SIN(TS)                                     *2D34190
  135 TS = TS + FRTYFV                                                   *2D34200
      DO 140 J=4,6                                                       *2D34210
      TS = TS + FRTYFV                                                   *2D34220
      XCHT(J) = XRHO + AR(3)*COS(TS)                                     *2D34230
  140 YCHT(J) = YRHO + AR(3)*SIN(TS)                                     *2D34240
      CALL PLOT3('+',XCHT(1),YCHT(1),6,INT)                              *2D34250
  145 IF (NCNTCT(5) .NE. 0) GO TO 155                                    *2D34260
      TS = (180. + THETA(K,1,5))*.0174532925                             *2D34270
      ANGLE = ((180. + (THETA(K,1,6)-THETA(K,1,5))/4.)*.0174532925       *2D34280
      DO 150 J=1,3                                                       *2D34290
      TS = TS + ANGLE                                                    *2D34300
      XELB(J) = XJOINT(6) + AR(5)*COS(TS)                                *2D34310
  150 YELB(J) = YJOINT(6) + AR(5)*SIN(TS)                                *2D34320
      CALL PLOT3('+',XELB(1),YELB(1),3,INT)                              *2D34330
  155 IF (NCNTCT(6) .NE. 0) GO TO 165                                    *2D34340
      TS = (THETA(K,1,6)-180.)*.0174532925                               *2D34350
      SIXTY = 60.*.0174532925                                            *2D34360
      DO 160 J=1,5                                                       *2D34370
      TS = TS + SIXTY                                                    *2D34380
      XHND(J) = XJOINT(7) + AR(6)*COS(TS)                                *2D34390
  160 YHND(J) = YJOINT(7) + AR(6)*SIN(TS)                                *2D34400
      CALL PLOT3('+',XHND(1),YHND(1),5,INT)                              *2D34410
  165 IF (NCNTCT(7) .NE.0) GO TO 175                                     *2D34420
      TS = THETA(K,1,8)*.0174532925                                      *2D34430
      ANGLE = ((180.+THETA(K,1,7)-THETA(K,1,8))/4.)*.0174532925          *2D34440
      DO 170 J=1,3                                                       *2D34450
      TS = TS + ANGLE                                                    *2D34460
      XKNE(J) = XJOINT(8) + AR(7)*COS(TS)                                *2D34470
  170 YKNE(J) = YJOINT(8) + AR(7)*SIN(TS)                                *2D34480
      CALL PLOT3('+',XKNE(1),YKNE(1),3,INT)                              *2D34490
  175 IF (NCNTCT(8) .NE.0) GO TO 185                                     *2D34500
      TS = (THETA(K,1,8)-180.)*.0174532925                               *2D34510
      DO 180 J=1,5                                                       *2D34520
      TS = TS + SIXTY                                                    *2D34530
      XFT(J) = XJOINT(9) + AR(8)*COS(TS)                                 *2D34540
  180 YFT(J) = YJOINT(9) + AR(8)*SIN(TS)                                 *2D34550
      CALL PLOT3('+',XFT(1),YFT(1),5,INT)                                *2D34560
  185 CONTINUE                                                           *2D34570
      CALL PLOT3('.',XMAN(1),YMAN(1),NT,INT)                             *2D34580
      IF (IGNORE(1) .GT. 0) GO TO 200                                    *2D34590
      CALL PLOT3('F',XFLOOR(1),YFLOOR(1),2,INT)                          *2D34600
  200 IF (IGNORE(2) .GT. 0) GO TO 210                                    *2D34610
      CALL PLOT3('S',XSEAT(1),YSEAT(1),3,INT)                            *2D34620
  210 IF (IGNORE(3) .GT. 0) GO TO 220                                    *2D34630
      CALL PLOT3('R',XR(1),YR(1),2,INT)                                  *2D34640
```

Subroutine STYX (page 4 of 5)

```
220  IF (IGNORE(4) .GT. 0) GO TO 230                                  *2D34650
     CALL PLOT3('*',XUSDF(1),YUSDF(1),2,INT)                          *2D34660
230  IF (IGNORE(5) .GT. 0) GO TO 240                                  *2D34670
     CALL PLOT3('*',XWS(1),YWS(1),2,INT)                              *2D34680
 240 IF (IGNORE(6) .GT. 0) GO TO 250                                  *2D34690
     CALL PLOT3('*',XLSW(1),YLSW(1),2,INT)                            *2D34700
250  IF (IGNORE(7) .GT. 0) GO TO 260                                  *2D34710
     CALL PLOT3('*',XLP(1),YLP(1),2,INT)                              *2D34720
260  IF (IGNORE(8) .GT. 0) GO TO 270                                  *2D34730
     CALL PLOT3('*',XSC(1),YSC(1),2,INT)                              *2D34740
270  IF (IGNORE(9) .GT. 0) GO TO 280                                  *2D34750
     CALL PLOT3('T',XTOE(1),YTOE(1),2,INT)                            *2D34760
280  IF ((NBELT .NE. 1) .AND. (NBELT .NE. 3)) GO TO 84                *2D34770
     XLAP(2) = XLAP(1) + BL1(K)*COS(PHI1(K))                          *2D34780
     YLAP(2) = YLAP(1) + BL1(K)*SIN(PHI1(K))                          *2D34790
     CALL PLOT3('B',XLAP(1),YLAP(1),NPTS2,INT)                        *2D34800
 83  IF ((NBELT .NE. 2) .AND. (NBELT .NE. 3)) GO TO 84                *2D34810
     XL(2) = XL(1) + BL2(K)*COS(PHI2(K))                              *2D34820
     YL(2) = YL(1) + BL2(K)*SIN(PHI2(K))                              *2D34830
     CALL PLOT3('L',XL(1),YL(1),NPTS2,INT)                            *2D34840
     CALL PLOT3('U',XU(1),YU(1),NPTS1,INT)                            *2D34850
 84  DO 90 I=1,9                                                      *2D34860
90   CALL PLOT3(JOINT(I),XJOINT(I),YJOINT(I),NPTS1,INT)               *2D34870
     CALL PLOT4(NCHAR,LABEL)                                          *2D34880
     PRINT 9993                                                       *2D34890
     PRINT 9994,SCALEX,SCALEY                                         *2D34900
     IPAGE = IPAGE + 1                                                *2D34910
     L=L+1                                                            *2D34920
     IF (L .GT. ISTFP) GO TO 120                                      *2D34930
 110 CONTINUE                                                         *2D34940
 120 RETURN                                                           *2D34950
9992 FORMAT(F8.6)                                                     *2D34960
9993 FORMAT(1H-,36HINDICATED MEASUREMENTS ARE IN INCHES)              *2D34970
9994 FORMAT(1H ,23HSCALING FACTORS:  1 TO ,F5.2,19H IN THE X DIRECTION/*2D34980
    119X,5H1 TO ,F5.2,19H IN THE Y DIRECTION)                         *2D34990
9995 FORMAT(8I5)                                                      *2D35000
9996 FORMAT(1H ,26X,39HSTICK FIGURE REPRESENTATION FOR TIME = ,F5.3,  *2D35010
    18H SECONDS/1H0)                                                  *2D35020
9997 FORMAT (1H1,28X52HTWO DIMENSIONAL CRASH VICTIM SIMULATOR   OUTPUT *2D35030
    1DATA,20X3A4,11X4HPAGE,I3)                                        *2D35040
9998 FORMAT(6F10.4)                                                   *2D35050
9999 FORMAT(8I5)                                                      *2D35060
     END                                                              *2D35070
```

Subroutine STYX (page 5 of 5)

```
                                                                                *2D28650
      SUBROUTINE SUMARY                                                         *2D28660
      COMMON XLAP(2),YLAP(2),XL(2),YL(2),XU(2),YU(2),XFLOOR(2),                 *2D28670
     1YFLOOR(2),XSEAT(3),YSEAT(3),XR(2),YR(2),X     (2),YUSDF(2),               *2D28680
     2XWS(2),YWS(2),XLSW(2),YLSW(2),XLP(2),YLP(2),XSC(2),YSC(2),                *2D28690
     3XTOE(2),YTOE(2),POST,THETA,AR(8),RHOPFZ,RHOPTZ,                           *2D28700
     3CPSIA(10),SPSIA(10),                                                      *2D28710
     4DA(10),TGAMZ,ZZERO,PHI1(200),PHI2(200),PHI3(200),BL1(200),                *2D28720
     5BL2(200),BL3(200),IPAGE,STIME,NBELT,IGNORE(10),EL(8),K                    *2D28730
      COMMON/INJ/HEA(200),HLA(200),CFA(200),C   (200),CCF(200,4),IDATE(4)*2D28740
     1,MM,MN,BELTA(200),BELTB(200),BELTC(200),  A(200),NPROB                    *2D28750
      COMMON/IO/INN                                                             *2D28755
      DIMENSION PHI(3),BL(3)                                                    *2D28760
      DIMENSION TI(8),TV(8),TA(8),KI(8),KA(8),  (8),  M(3),STIME(200)           *2D28770
      DIMENSION THETA(200,3,8),POST(200,9),A    (200),ACHEST(200),LI(21)*2D28780
      DIMENSION ACOM(5,11),CCMI(3,8),GHEAD(200),SCHEST(200),DESPA(3,6)          *2D28790
      DIMENSION DESPH(6),DESPC(5,6)                                             *2D28800
      DIMENSION LA(21),CONTAC(200,21),RH (8)                                    *2D28810
      DIMENSION SETFRT(200),SETBCK(200)                                         *2D28820
      DIMENSION XHEAD(200),YHEAD(200)                                           *2D28830
      DIMENSION NS(5),IMAGE(1392),T(200),P(200,9)                               *2D28840
      DIMENSION CARD(5)                                                         *2D28850
      EQUIVALENCE (STIME(1),T(1)),(P(1,1),POST(1,1))                            *2D28860
      DATA COMI/1H ,4H HIP,4*1H ,4HUPPE,4HR TO,3HRSO,1H ,4HHEAD,2*1H ,          *2D28870
     14HELBO,1HW,1H ,4HHAND,2*1H ,4HKNEE,2*1H ,4HFOOT,1H /                      *2D28880
      DATA ACOM/1H ,4H    F,4HLOOR,3*1H ,4HSEAT,4H BAC,1HK,3*1H ,4HROOF,        *2D28890
     12*1H ,4H   U,4HPPER,4H PAN,2HEL,2*1H ,4HWIND,4HSHIF,2HLD,1H ,             *2D28900
     24H   ST,4HEERI,4HNG W,4HHEEL,1H ,4H    L,4HOWER,4H PAN,2HEL,1H ,          *2D28910
     34H STE,4HERIN,4HG CO,4HLUMN,2*1H ,3HTOE,4HBOAR,1HD,1H ,4H   ST,           *2D28920
     44HEERI,4HNG W,4HHEEL,1H ,4HBACK,3H OF,4HFRON,4HT SE,2HAT/                 *2D28930
      DATA ON/2HON/                                                             *2D28940
      DO 1500 N=1,200                                                           *2D28950
 1500 STIME(N)=0.                                                               *2D28960
      TS=-1.                                                                    *2D28970
      WRITE(9)TS,STIME                                                          *2D28980
      REWIND 9                                                                  *2D28990
      READ(9)XLAP(1),YLAP(1),YL(1),XL(1),YU(1),XU(1),XFLOOR(1),XSEAT(1),*2D29000
     1XR(1),XUSDF(1),XWS(1),XLSW(1),XLP(1),XSC(1),XTOE(1),AR,YFLOOR(1),         *2D29010
     2YSEAT(1),YR(1),YUSDF(1),YWS(1),YLSW(1),YLP(1),YSC(1),YTOE(1),DEF,         *2D29020
     3AR,RHOPFZ,RHOPTZ,EL,DA,CPSIA,SPSIA,TGAMZ,ZZERO,NBELT,IGNORE,RHO           *2D29030
      READ (INN,9999)PHEAD,PCHEST,NPASGR,NGRAPH,NSTICK,NINJ,NPROB               *2D29040
 9999 FORMAT (2E10.0,5I5)                                                       *2D29050
 2100 READ (INN,9900)IA,CARD                                                    *2D29060
 9900 FORMAT (I2,8X,5A4)                                                        *2D29070
      IA=IA+1.5                                                                 *2D29080
      IF (IA.LE.0) GO TO 2200                                                   *2D29090
      IF (IA.GT.11) GO TO 2100                                                  *2D29100
      DO 2150 I=1,5                                                             *2D29110
 2150 ACOM(I,IA)=CARD(I)                                                        *2D29120
      GO TO 2100                                                                *2D29130
```

Subroutine SUMARY (page 1 of 9)

```
2200 LL=0                                                                    *2D29140
     M = 0                                                                   *2D29150
     K = 0                                                                   *2D29160
     DO 90  I=1,200                                                          *2D29170
     DO 90  J=1,21                                                           *2D29180
90   CONTAC(I,J)=0.                                                          *2D29190
100  READ(9)TIME,TT,TV,TA,DISP,XAP,PLX,YA,YAP,PLY,XC,XCP,PLC,AH,             *2D29200
    1BH,CH,DH,ACH,BCH,CCH,DCH,JJ,(KI(I),KA(I),PP(I),I=1,JJ),FFM,FSPRM,       *2D29210
    2FS,HEADX,HEADY,PHI,BL                                                   *2D29220
     IF (TIME+.5) 300,110,110                                                *2D29230
110  K = K+1                                                                 *2D29240
     IF (K-200) 120,120,300                                                  *2D29250
120  STIME(K) = TIME                                                         *2D29260
     DO 130 I=1,8                                                            *2D29270
     THETA(K,1,I) = TT(I)                                                    *2D29280
     THETA(K,2,I) = TV(I)                                                    *2D29290
130  THETA(K,3,I) = TA(I)                                                    *2D29300
     POST(K,1) = DISP                                                        *2D29310
     POST(K,2) = XAP                                                         *2D29320
     POST(K,3) = PLX                                                         *2D29330
     POST(K,4) = YA                                                          *2D29340
     POST(K,5) = YAP                                                         *2D29350
     POST(K,6) = PLY                                                         *2D29360
     POST(K,7) = XC                                                          *2D29370
     POST(K,8) = XCP                                                         *2D29380
     POST(K,9) = PLC                                                         *2D29390
     XHEAD(K) = HEADX                                                        *2D29400
     YHEAD(K) = HEADY                                                        *2D29410
     PHI1(K)=PHI(1)                                                          *2D29420
     PHI2(K)=PHI(2)                                                          *2D29430
     PHI3(K)=PHI(3)                                                          *2D29440
     BL1(K)=BL(1)                                                            *2D29450
     BL2(K)=BL(2)                                                            *2D29460
     BL3(K)=BL(3)                                                            *2D29470
     X=AH-PHEAD*BH                                                           *2D29480
     Y=CH+PHEAD*DH                                                           *2D29490
     AHEAD(K) = SQRT(X*X+Y*Y)                                                *2D29500
     GHEAD(K)=ATAN2(Y,X)/.01745329                                           *2D29510
     X=ACH-PCHEST*BCH                                                        *2D29520
     Y=CCH+PCHEST*DCH                                                        *2D29530
     ACHEST(K) = SQRT(X*X+Y*Y)                                               *2D29540
     GCHEST(K)=ATAN2(Y,X)/.01745329                                          *2D29550
     TSA=SIN(TT(4))                                                          *2D29560
     TSB=COS(TT(4))                                                          *2D29570
     X=AH-RHO(4)*BH                                                          *2D29580
     Y=CH+RHO(4)*DH                                                          *2D29590
     HFA(K)=X*TSA-Y*TSB                                                      *2D29600
     HLA(K)=X*TSB+Y*TSA                                                      *2D29610
     TSA = SIN(TT(3))                                                        *2D29620
     TSB = COS(TT(3))                                                        *2D29630
```

Subroutine SUMARY (page 2 of 9)

```
      X = ACH-RHO(3)*BCH                                          *2D29640
      Y = CCH+RHO(3)*DCH                                          *2D29650
      CFA(K) = X*TSA-Y*TSB                                        *2D29660
      CUA(K) = X*TSB+Y*TSA                                        *2D29670
      IF (JJ) 210,210,140                                         *2D29680
  140 IF(M) 150,150,160                                           *2D29690
  150 M=1                                                         *2D29700
      LI(M) = KI(1)                                               *2D29710
      LA(M) = KA(1)                                               *2D29720
      CONTAC(K,M) = PP(1)                                         *2D29730
  160 DO 200 I=1,JJ                                               *2D29740
      DO 180 J=1,M                                                *2D29750
      IF (LI(J)-KI(I)) 180,170,180                                *2D29760
  170 IF (LA(J)-KA(I)) 180,190,180                                *2D29770
  180 CONTINUE                                                    *2D29780
      M = M+1                                                     *2D29790
      LI(M) = KI(I)                                               *2D29800
      LA(M) = KA(I)                                               *2D29810
      CONTAC(K,M) = PP(I)                                         *2D29820
      GO TO 200                                                   *2D29830
  190 CONTAC(K,J) = PP(I)                                         *2D29840
  200 CONTINUE                                                    *2D29850
  210 BELTA(K) = FFM(1)                                           *2D29860
      BELTB(K) = FFM(2)                                           *2D29870
      BELTC(K) = FFM(3)                                           *2D29880
      SETFRT(K) = FSPRM                                           *2D29890
      SETBCK(K) = FS                                              *2D29900
      GO TO 100                                                   *2D29910
  300 REWIND 9                                                    *2D29920
      MN=0                                                        *2D29930
      MM=0                                                        *2D29940
      DO 250 I=1,M                                                *2D29950
      IF(LI(I).NE.3) GO TO 230                                    *2D29960
      IF(LA(I).EQ.2) GO TO 230                                    *2D29970
      MM=MM+1                                                     *2D29980
      DO 220 J=1,K                                                *2D29990
  220 CCF(J,MM)=CONTAC(J,I)                                       *2D30000
      GO TO 250                                                   *2D30010
  230 IF (LI(I).NE.7) GO TO 250                                   *2D30020
      MN=1                                                        *2D30030
      DO 240 J=1,K                                                *2D30040
  240 CKF(J)=CONTAC(J,I)                                          *2D30050
  250 CONTINUE                                                    *2D30060
      CALL DATE(IDATE)                                            *2D30070
      MMAX=M                                                      *2D30080
      LINE = 52                                                   *2D30090
      IPAGE = 1                                                   *2D30100
      ISTART = 1                                                  *2D30110
      IF (K-52) 310,320,320                                       *2D30120
  310 ISTOP = K                                                   *2D30130
```

Subroutine SUMARY (page 3 of 9)

```
      GO TO 400                                                         *2D30140
  320 ISTOP = 52                                                        *2D30150
  400 PRINT 9000,IDATE,IPAGE                                            *2D30160
      PRINT 9950                                                        *2D30170
 9950 FORMAT(16X20HBELT FORCES (POUNDS)16X21HBELT ANGLES (DEGREES)      *2D30180
     110X21HRELATIVE HIP POSITION2X22HRELATIVE HEAD POSITION/           *2D30190
     24X4HTIME4X8HLAP BELT2X18HSHOULDER RESTRAINT8X8HLAP BELT,          *2D30200
     32X18HSHOULDER RESTRAINT14X8H(INCHES)14X8H(INCHES)/3X6H(SEC.)      *2D30210
     414X5HLOWER5X5HUPPER21X5HLOWER5X5HUPPER9X                          *2D30220
     51X20HHORIZONTAL  VERTICAL,4X20HHORIZONTAL  VERTICAL)              *2D30230
      DO 405 I=ISTART,ISTOP                                             *2D30240
      TSA = PHI1(I)/.01745329                                           *2D30250
      TSB = PHI2(I)/.01745329                                           *2D30260
      TSC = PHI3(I)/.01745329                                           *2D30270
      PRINT 9951,STIME(I),BELTA(I),BELTB(I),BELTC(I),TSA,TSB,TSC,       *2D30280
     1POST(I,1),POST(I,4),XHEAD(I),YHEAD(I)                             *2D30290
 9951 FORMAT(1X,F7.3,F9.0,2F10.0,7X,3F10.1,7X,F10.2,F11.2,1X,2F11.2)    *2D30300
  405 CONTINUE                                                          *2D30310
      IPAGE = IPAGE + 1                                                 *2D30320
      PRINT 9000,IDATE,IPAGE                                            *2D30330
      PRINT 9001                                                        *2D30340
      PRINT 9004                                                        *2D30350
      PRINT 9003                                                        *2D30360
      DO 410 I=ISTART,ISTOP                                             *2D30370
      PRINT 9002,STIME(I),((THETA(I,J,L),J=1,3),L=1,4)                  *2D30380
  410 CONTINUE                                                          *2D30390
      IPAGE = IPAGE + 1                                                 *2D30400
      PRINT 9000,IDATE,IPAGE                                            *2D30410
      PRINT 9001                                                        *2D30420
      PRINT 9005                                                        *2D30430
      PRINT 9003                                                        *2D30440
      DO 420 I=ISTART,ISTOP                                             *2D30450
      PRINT 9002,STIME(I),((THETA(I,J,L),J=1,3),L=5,8)                  *2D30460
  420 CONTINUE                                                          *2D30470
      IPAGE = IPAGE + 1                                                 *2D30480
      PRINT 9000,IDATE,IPAGE                                            *2D30490
      PRINT 9006                                                        *2D30500
      DO 430 I=ISTART,ISTOP                                             *2D30510
      PRINT 9007,STIME(I),POST(I,7),POST(I,8),POST(I,9),(POST(I,J),J=1,6*2D30520
     1)                                                                 *2D30530
  430 CONTINUE                                                          *2D30540
      IPAGE = IPAGE + 1                                                 *2D30550
      PRINT 9000,IDATE,IPAGE                                            *2D30560
      PRINT 9009                                                        *2D30570
      DO 440 I=ISTART,ISTOP                                             *2D30580
      PRINT 9008,STIME(I),AHEAD(I),GHEAD(I),ACHEST(I),GCHEST(I),BELTA(I)*2D30590
     1,BELTB(I),BELTC(I),SETBCK(I),SETFRT(I)                            *2D30600
  440 CONTINUE                                                          *2D30610
      M=MMAX                                                            *2D30620
      MSTEP = 0                                                         *2D30630
```

Subroutine SUMARY (page 4 of 9)

```
  445   IF (M) 905,905,450                                                *2030640
  450   IF (M-6) 460,470,470                                              *2030650
  460   MSTOP = M+MSTEP                                                   *2030660
        NSTOP = M                                                         *2030670
        GO TO 480                                                         *2030680
  470   MSTOP = 6+MSTEP                                                   *2030690
        NSTOP = 6                                                         *2030700
  480   MSTART = 1+MSTEP                                                  *2030710
  490   IPAGE = IPAGE + 1                                                 *2030720
        PRINT 9000,IDATE,IPAGE                                            *2030730
        PRINT 9010                                                        *2030740
        DO 540 I=1,NSTOP                                                  *2030750
        J = I+MSTEP                                                       *2030760
        II = LI(J)                                                        *2030770
        IA = LA(J)                                                        *2030780
        DESPA(1,I) = COMI(1,II)                                           *2030790
        DESPA(2,I) = COMI(2,II)                                           *2030800
        DESPA(3,I) =COMI(3,II)                                            *2030810
        IF (IA-4) 530,500,530                                             *2030820
  500   IF (NPASGR-2) 510,530,520                                         *2030830
  510   IA = 10                                                           *2030840
        GO TO 530                                                         *2030850
  520   IA = 11                                                           *2030860
  530   DESPC(1,I) = ACOM(1,IA)                                           *2030870
        DESPC(2,I) = ACOM(2,IA)                                           *2030880
        DESPC(3,I) = ACOM(3,IA)                                           *2030890
        DESPC(4,I) =ACOM(4,IA)                                            *2030900
        DESPC(5,I) = ACOM(5,IA)                                           *2030910
  540   CONTINUE                                                          *2030920
        PRINT 9011,((DESPA(J,I),J=1,3),I=1,NSTOP)                         *2030930
        PRINT 9012,(ON,I=1,NSTOP)                                         *2030940
        PRINT 9013,((DESPC(J,I),J=1,5),I=1,NSTOP)                         *2030950
        DO 900 I=ISTART,ISTOP                                             *2030960
        PRINT 9014,STIME(I),(CONTAC(I,J),J=MSTART,MSTOP)                  *2030970
   900 CONTINUE                                                           *2030980
        MSTEP = MSTEP+6                                                   *2030990
        M=M-6                                                             *2031000
        GO TO 445                                                         *2031010
   905 LINE=51                                                            *2031020
        IPAGE=IPAGE+1                                                     *2031030
        ISTART=ISTOP                                                      *2031040
        IF (ISTOP-K) 910,1000,1000                                        *2031050
  910   IF (ISTOP+50-K) 930,920,920                                       *2031060
   920 ISTOP=K                                                            *2031070
        GO TO 400                                                         *2031080
   930 ISTOP=ISTOP+50                                                     *2031090
        GO TO 400                                                         *2031100
  1000 IF(NINJ.EQ.0) CALL SIPP(IPAGE,K,THETA,STIME)                       *2031110
        IF (NGRAPH.NE.0) GO TO 3000                                       *2031120
  10    FORMAT(1H1,2X,38HTWO DIMENSIONAL CRASH VICTIM SIMULATOR, 3X,19HPLO*2031130
```

Subroutine SUMARY (page 5 of 9)

```
     1T OF OUTPUT DATA,61X,4HPAGE,I3)                                    *2031140
      FMAX1=BELTA(1)                                                    *2031150
      FMIN1=BELTA(1)                                                    *2031160
      DO 20 I=1,K                                                       *2031170
      FMAX1=AMAX1(FMAX1,BELTA(I),BELTB(I),BELTC(I))                     *2031180
   20 FMIN1=AMIN1(FMIN1,BELTA(I),BELTB(I),BELTC(I))                     *2031190
      INT=4                                                             *2031200
      NS(1)=1                                                           *2031210
      NS(2)=0                                                           *2031220
      NS(3)=2                                                           *2031230
      NS(4)=0                                                           *2031240
      NS(5)=4                                                           *2031250
      NHL=6                                                             *2031260
      NSBH=7                                                            *2031270
      NVL=11                                                            *2031280
      NSBV=9                                                            *2031290
      NC=0                                                              *2031300
      PRINT 10, IPAGE                                                   *2031310
      PRINT 30                                                          *2031320
   30 FORMAT(1H0,53X,19HBELT FORCES IN LBS./)                           *2031330
      CALL PLOT1(NS(1),NHL,NSBH,NVL,NSBV)                               *2031340
      CALL PLOT2(IMAGE,T(K),T(1),FMAX1,FMIN1)                           *2031350
      CALL PLOT3('*',T(1),BELTA(1),K,INT)                               *2031360
      CALL PLOT3('X',T(1),BELTB(1),K,INT)                               *2031370
      CALL PLOT3('=',T(1),BELTC(1),K,INT)                               *2031380
      CALL PLOT4(NC,NS(1))                                              *2031390
      PRINT 40                                                          *2031400
   40 FORMAT(1H0,55X,15HTIME IN SECONDS/1H0)                            *2031410
      PRINT 50                                                          *2031420
   50 FORMAT(5X,13H* IS LAP BELT/5X,29HX IS LOWER SHOULDER RESTRAINT/   *2031430
     15X,29H= IS UPPER SHOULDER RESTRAINT)                              *2031440
      FMAX2=AHEAD(1)                                                    *2031450
      FMIN2=AHEAD(1)                                                    *2031460
      DO 60 I=1,K                                                       *2031470
      FMAX2=AMAX1(FMAX2,AHEAD(I),ACHEST(I))                             *2031480
   60 FMIN2=AMIN1(FMIN2,AHEAD(I),ACHEST(I))                             *2031490
      IPAGE=IPAGE+1                                                     *2031500
      PRINT 10, IPAGE                                                   *2031510
      PRINT 70                                                          *2031520
   70 FORMAT(1H0,51X,24HACCELERATIONS IN G-UNITS/)                      *2031530
      CALL PLOT1(NS(1),NHL,NSBH,NVL,NSBV)                               *2031540
      CALL PLOT2(IMAGE,T(K),T(1),FMAX2,FMIN2)                           *2031550
      CALL PLOT3('*',T(1),AHEAD(1),K,INT)                               *2031560
      CALL PLOT3('X',T(1),ACHEST(1),K,INT)                              *2031570
      CALL PLOT4(NC,NS(1))                                              *2031580
      PRINT 40                                                          *2031590
      PRINT 80                                                          *2031600
   80 FORMAT(5X,22H* IS HEAD ACCELERATION/5X,23HX IS CHEST ACCELERATION)*2031610
      IPAGE=IPAGE+1                                                     *2031620
      FMAX3=POST(1,1)                                                   *2031630
```

Subroutine SUMARY (page 6 of 9)

```
      FMIN3=POST(1,1)                                                  *2D31640
      DO 15 I=1,K                                                      *2D31650
      FMAX3=AMAX1(FMAX3,POST(I,1),POST(I,4))                           *2D31660
   15 FMIN3=AMIN1(FMIN3,POST(I,1),POST(I,4))                           *2D31670
      PRINT 10, IPAGE                                                  *2D31680
      PRINT 25                                                         *2D31690
   25 FORMAT(1H0,52X,22HHIP POSITION IN INCHES/)                       *2D31700
      CALL PLOT1(NS(1),NHL,NSBH,NVL,NSBV)                              *2D31710
      CALL PLOT2(IMAGE,T(K),T(1),FMAX3,FMIN3)                          *2D31720
      CALL PLOT3('*',T(1),POST(1,1),K,INT)                             *2D31730
      CALL PLOT3('X',T(1),POST(1,4),K,INT)                             *2D31740
      CALL PLOT4(NC,NS(1))                                             *2D31750
      PRINT 40                                                         *2D31760
      PRINT 35                                                         *2D31770
   35 FORMAT(5X,28H* IS HORIZONTAL HIP POSITION/5X,26HX IS VERTICAL HIP *2D31780
     1POSITION)                                                        *2D31790
      IPAGE =IPAGE +1                                                  *2D31800
      FMAX4=P(1,9)                                                     *2D31810
      FMIN4=P(1,9)                                                     *2D31820
      DO 45 I=1,K                                                      *2D31830
      FMAX4=AMAX1(FMAX4,P(I,9))                                        *2D31840
   45 FMIN4=AMIN1(FMIN4,P(I,9))                                        *2D31850
      PRINT 10, IPAGE                                                  *2D31860
      PRINT 55                                                         *2D31870
   55 FORMAT(1H0,47X,30HVEHICLE INPUT PULSE IN G-UNITS/)               *2D31880
      CALL PLOT1(NS(1),NHL,NSBH,NVL,NSBV)                              *2D31890
      CALL PLOT2(IMAGE,T(K),T(1),FMAX4,FMIN4)                          *2D31900
      CALL PLOT3('X',T(1),P(1,9),K,INT)                                *2D31910
      CALL PLOT4(NC,NS(1))                                             *2D31920
      PRINT 40                                                         *2D31930
      IPAGE =IPAGE+1                                                   *2D31940
      FMAX5=GHEAD(1)                                                   *2D31950
      FMIN5=GHEAD(1)                                                   *2D31960
      DO 65 I=1,K                                                      *2D31970
      FMAX5=AMAX1(FMAX5,GHEAD(I),GCHEST(I))                            *2D31980
   65 FMIN5=AMIN1(FMIN5,GHEAD(I),GCHEST(I))                            *2D31990
      PRINT 10,IPAGE                                                   *2D32000
      PRINT 75                                                         *2D32010
   75 FORMAT(1H0,46X,32HANGLE OF ACCELERATION IN DEGREES/)             *2D32020
      CALL PLOT1(NS(1),NHL,NSBH,NVL,NSBV)                              *2D32030
      CALL PLOT2(IMAGE,T(K),T(1),FMAX5,FMIN5)                          *2D32040
      CALL PLOT3('*',T(1),GHEAD(1),K,INT)                              *2D32050
      CALL PLOT3('X',T(1),GCHEST(1),K,INT)                             *2D32060
      CALL PLOT4(NC,NS(1))                                             *2D32070
      PRINT 40                                                         *2D32080
      PRINT 85                                                         *2D32090
   85 FORMAT(5X,31H* IS ANGLE OF HEAD ACCELERATION/5X,32HX IS ANGLE OF C*2D32100
     1HEST ACCELERATION)                                               *2D32110
      IPAGE=IPAGE+1                                                    *2D32120
      FMAX6=SETFRT(1)                                                  *2D32130
```

Subroutine SUMARY (page 7 of 9)

```
      FMIN6=SETFRT(1)                                                   *2D32140
      DO 95 I=1,K                                                       *2D32150
      FMAX6=AMAX1(FMAX6,SETFRT(I),SETBCK(I))                            *2D32160
   95 FMIN6=AMIN1(FMIN6,SETFRT(I),SETBCK(I))                            *2D32170
      PRINT 10, IPAGE                                                   *2D32180
      PRINT 105                                                         *2D32190
  105 FORMAT(1H0,53X,19HSEAT FORCES IN LBS./)                           *2D32200
      CALL PLOT1(NS(1),NHL,NSBH,NVL,NSBV)                               *2D32210
      CALL PLOT2(IMAGE,T(K),T(1),FMAX6,FMIN6)                           *2D32220
      CALL PLOT3('*',T(1),SETFRT(1),K,INT)                              *2D32230
      CALL PLOT3('X',T(1),SETBCK(1),K,INT)                              *2D32240
      CALL PLOT4(NC,NS(1))                                              *2D32250
      PRINT 40                                                          *2D32260
      PRINT 115                                                         *2D32270
  115 FORMAT(5X,32H* IS SEAT FORCE AT FRONT OF SEAT/5X,22HX IS SEAT FORC*2D32280
     1E AT HIP)                                                         *2D32290
      IPAGE = IPAGE + 1                                                 *2D32300
 3000 IF (NSTICK .EQ. 0) CALL STYX                                      *2D32310
      RETURN                                                            *2D32320
 9000 FORMAT (1H1,28X52HTWO DIMENSIONAL CRASH VICTIM SIMULATOR   OUTPUT *2D32330
     1DATA,20X3A4,11X4HPAGE,I3)                                         *2D32340
 9001 FORMAT (45X42HBODY SEGMENT ANGULAR ORIENTATION (DEGREES))         *2D32350
 9002 FORMAT (1XF7.4,F10.2,F9.2,E12.4,F10.2,F9.2,E12.4,F10.2,F9.2,E12.4,*2D32360
     1F10.2,F9.2,E12.4)                                                 *2D32370
 9003 FORMAT (10X26HPOSITION VELOCITY   ACCEL.,5X26HPOSITION VELOCITY   *2D32380
     1ACCEL.,5X26HPOSITION VELOCITY   ACCEL.,5X26HPOSITION VELOCITY   AC*2D32390
     2CEL.)                                                             *2D32400
 9004 FORMAT (4X4HTIME,9X11HLOWER TORSO,20X12HCENTER TORSO,19X11HUPPER T*2D32410
     1ORSO,23X4HHEAD)                                                   *2D32420
 9005 FORMAT (4X4HTIME,10X9HUPPER ARM,22X9HLOWER ARM,22X9HUPPER LEG,21X9*2D32430
     1HLOWER LEG)                                                       *2D32440
 9006 FORMAT (20X16HVEHICULAR MOTION,44X24HBODY MOTION AT HIP JOINT/67X,*2D32450
     1'HORIZONTAL',33X8HVERTICAL/4X4HTIME,3X8HPOSITION,5X8HVELOCITY,6X6H*2D32460
     2ACCEL.,11X8HRELATIVE,5X8HVELOCITY,6X6HACCEL.,9X8HRELATIVE,5X8HVELO*2D32470
     3CITY,6X6HACCEL./56X6HDISPL.,36X6HDISPL./12X5H(IN.),6X10H(IN./SEC.)*2D32480
     4,4X9H(G-UNITS),10X5H(IN.),6X10H(IN./SEC.),4X9H(G-UNITS),8X5H(IN.),*2D32490
     56X10H(IN./SEC.),4X9H(G-UNITS))                                    *2D32500
 9007 FORMAT (1XF7.4,F9.3,F13.2,F13.3,F18.3,F13.2,F13.3,F16.3,F13.2,F13.*2D32510
     13)                                                                *2D32520
 9008 FORMAT (1XF7.4,F14.1,F11.1,F14.1,F11.1,F18.1,F12.1,F12.1,F16.2,F13*2D32530
     1.2)                                                               *2D32540
 9009 FORMAT (25X22HACCELEROMETER READINGS,27X18HBELT FORCES (LBS),17X17*2D32550
     1HSEAT FORCES (LBS)/4X4HTIME,14X4HHEAD,19X5HCHEST/15X9HRESULTANT,4X*2D32560
     25HANGLE,8X9HRESULTANT,4X5HANGLE,13X3HLAP,3X18HSHOULDER RESTRAINT,1*2D32570
     33X6HAT HIP,9X2HAT/15X9H(G-UNITS),4X6H(DEG.),6X9H(G-UNITS),4X5H(DEG*2D32580
     4.),25X5HLOWER,7X5HUPPER,20X10HFRONT EDGE)                         *2D32590
 9010 FORMAT (55X21HCONTACT FORCES (LBS.))                              *2D32600
 9011 FORMAT (16X,3A4,8X,3A4,8X,3A4,8X,3A4,8X,3A4,8X,3A4)               *2D32610
 9012 FORMAT (4X,4HTIME,13X,A2,18X,A2,18X,A2,18X,A2,18X,A2,18X,A2)      *2D32620
 9013 FORMAT(12X,6(2X,4A4,A2))                                          *2D32630
```

Subroutine SUMARY (page 8 of 9)

```
 9014 FORMAT (1XF7.4,F17.1,5F20.1)                                    *20326400
      END                                                            *20326500
```

Subroutine SUMARY (page 9 of 9)

```
                                                                        *2D14120
      SUBROUTINE TAUMAK(ZKB)                                            *2D14130
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D14140
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D14150
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D14160
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D14170
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D14180
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D14190
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D14200
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,       BIGMI,TMATII,*2D14210
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D14220
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D14230
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D14240
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D14250
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSCLI,ATDSQ,TIMT*2D14260
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D14270
                                                                        *2D14280
                                                                        *2D14290
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D14300
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D14310
     2TPRIME(7),ALFAI(7),OMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),FL(8),AP(*2D14320
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D14330
     4),STHETA(8),         BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D14340
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D14350
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D14360
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D14370
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(15),RVEL(16),MODE(16),TIMTJZ(*2D14380
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D14390
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D14400
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D14410
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D14420
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D14430
     4LE(2,14),ZPPP(128),BL(3)                                          *2D14440
                                                                        *2D14450
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D14460
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D14470
      COMMON NONO(1402)                                                 *2D14480
      DIMENSION TAUI(16),ZKB(11)                                        *2D14490
      ISTAR = 0                                                         *2D14500
      DO 10 I=1,16                                                      *2D14510
   10 TAUI(I) = 0.                                                      *2D14520
   70 TAUHAT = 1.E38                                                    *2D14530
      ITAU = 0                                                          *2D14540
      DO 210 I=1,MAXR                                                   *2D14550
      IF (MODE(I)) 120,155,90                                           *2D14560
   90 IF (RVEL(I)*RSEL(I)) 110,110,155                                  *2D14570
  110 ETA = RVEL(I)                                                     *2D14580
      GO TO 130                                                         *2D14590
  120 ETA = RSEL(I)                                                     *2D14600
  130 TAUI(I) = (SIGN(RPSI(I),ETA)-RVEL(I))/RSEL(I)                     *2D14610
```

Subroutine TAUMAK (page 1 of 3)

```
      IF(FMM(KPOST,1)) 135,180,135                                   *2D14620
135   TS=RSEL(I)/FMM(KPOST,1)                                        *2D14630
      IF (I-8) 180, 150, 140                                         *2D14640
140   IA = IFORK(2,I-8)                                              *2D14650
      TS = TS/CPSIA(IA)                                              *2D14660
150   TSA = 1. - 2./TS*TAUI(I)                                       *2D14670
      IF (TSA) 155,170,170                                           *2D14680
155   IF (I-LITGAM) 160,165,160                                      *2D14690
160   TAUI(I) = C.                                                   *2D14700
      GO TO 210                                                      *2D14710
165   TAUI(I) = TAHATZ                                               *2D14720
      GO TO 180                                                      *2D14730
170   TAUI(I) = TS*(1.-SQRT(TSA))                                    *2D14740
180   IF (TAUI(I)) 160,160,190                                       *2D14750
190   IF (TAUHAT-TAUI(I)) 210,210,200                                *2D14760
200   TAUHAT = TAUI(I)                                               *2D14770
      ITAU = I                                                       *2D14780
210   CONTINUE                                                       *2D14790
      IF(TAUHAT.LT..000001) TAUHAT=.000001                           *2D14795
      IF (IBUG) 220,230,220                                          *2D14800
220   WRITE(6,9999)ITAU,TAUHAT,TAUI                                  *2D14810
9999  FORMAT (7H0TAUMAK5XI10,10XE20.8/(1X8E15.6))                    *2D14820
      WRITE(6,9997)MODE                                              *2D14830
9997  FORMAT (5H MODE5X16I5)                                         *2D14840
230   IF (ISTAR) 305,235,305                                         *2D14850
235   JPRINT=0                                                       *2D14860
      JSTEP=0                                                        *2D14870
      JINFL=0                                                        *2D14880
      IF (ABS(TINFL-TPRINT)-1.E-6) 270,270,240                       *2D14890
240   IF (TINFL-TPRINT) 260,270,250                                  *2D14900
250   JPRINT=1                                                       *2D14910
      TIMASK = TPRINT - TIME                                         *2D14920
      GO TO 280                                                      *2D14930
260   JINFL=1                                                        *2D14940
      TIMASK = TINFL - TIME                                          *2D14950
      GO TO 280                                                      *2D14960
270   JPRINT=1                                                       *2D14970
      GO TO 260                                                      *2D14980
280   IF (TIMASK-DESTEP-1.E-6) 300,300,290                           *2D14990
290   JSTEP=1                                                        *2D15000
      TIMASK = DESTEP                                                *2D15010
      JPRINT=0                                                       *2D15020
      JINFL=0                                                        *2D15030
300   DELTAT = AMIN1(TIMASK,TAUHAT)                                  *2D15040
      CALL LIMIDT(JPRINT,JINFL,JSTEP)                                *2D15050
      ISTAR = 1                                                      *2D15060
305   IF (ITAU) 310,360,310                                          *2D15070
310   TS = TAUHAT - TIMASK                                           *2D15080
      IF (ABS(TS) - 1.E-6) 390,390,320                               *2D15090
320   IF (TS) 400,390,330                                            *2D15100
```

Subroutine TAUMAK (page 2 of 3)

```
330   ITAU = 0                                                          *2D15110
      IF (LITGAM) 350,360,350                                           *2D15120
350   IF (ABS(TIMASK-TAHATZ)-EPSLNZ) 360,360,370                        *2D15130
360   DELTAT = TIMASK                                                   *2D15140
      GO TO 680                                                         *2D15150
370   K = LITGAM                                                        *2D15160
      CALL RELSEL(ZKB,K,ZRV)                                            *2D15170
      CALL RELSEL(ZK(1,1),K,ZPPP(1))                                    *2D15180
      CALL RELSEL(ZK(1,2),K,ZPPP(2))                                    *2D15190
      AK=(ZRV+ZPPP(1)-TIMASK/TAHATZ*(ZRV+ZPPP(2))/2.)/(ZPPP(1)-ZPPP(2)) *2D15200
      DO 380 J=1,10                                                     *2D15210
380   ZVECPP(J)=ZKB(J)+ZK(J,1)+AK*(ZK(J,2)-ZK(J,1))                     *2D15220
      GO TO 360                                                         *2D15230
390   INDIC = 0                                                         *2D15240
      GO TO 410                                                         *2D15250
400   INDIC = 1                                                         *2D15260
410   IF (INDIC) 550,560,550                                            *2D15270
550   JPRINT=0                                                          *2D15280
      JINFL=0                                                           *2D15290
      JSTEP=0                                                           *2D15300
560   IF (LITGAM) 570,630,570                                           *2D15310
570   IF (ABS(TAUHAT-TAHATZ)-EPSLNZ) 630,630,580                        *2D15320
580   K = LITGAM                                                        *2D15330
      CALL RELSEL(ZKB,K,ZRV)                                            *2D15340
      CALL RELSEL (ZK(1,1),K,ZPPP(1))                                   *2D15350
      CALL RELSEL (ZK(1,2),K,ZPPP(2))                                   *2D15360
      ZPPP(2) = ZPPP(2)*TAUHAT/TAHATZ                                   *2D15370
      TAHATZ = TAUHAT                                                   *2D15380
      AK = (ZRV/2.+ZPPP(1)-ZPPP(2)/2.)/(ZPPP(1)-ZPPP(2))                *2D15390
      DO 590 J=1,10                                                     *2D15400
590   ZVECPP(J)=ZKB(J)+ZK(J,1)+AK*(ZK(J,2)-ZK(J,1))                     *2D15410
      DO 600 J=1,MAXR                                                   *2D15420
600   CALL RELSEL(ZVECPP,J,RSEL(J))                                     *2D15430
      GO TO 70                                                          *2D15440
630   DELTAT = TAUHAT                                                   *2D15450
      MODE(ITAU) = 0                                                    *2D15460
      IF (IBUG.EQ.0) GO TO 680                                          *2D15465
      WRITE(6,9996)ITAU                                                 *2D15470
9996  FORMAT (12H RESET MODE(I2,10H ) TO ZERO)                          *2D15480
680   CALL NORMUT                                                       *2D15490
      KPRINT=JPRINT                                                     *2D15500
      KSTEP=JSTEP                                                       *2D15510
      KINFL=JINFL                                                       *2D15520
      RETURN                                                            *2D15530
      END                                                               *2D15540
```

Subroutine TAUMAK (page 3 of 3)

```
      SUBROUTINE YPRINT(IA,N)                                            *2D39100
C                     DUMMY PRINTOUT ROUTINE                             *2D39110
      DIMENSION IA(3),IFM(34),IB(6)                                      *2D39120
      INTEGER*2 N                                                        *2D39130
      DATA IB/4H A1),4H A2),4H A3),4H A4),4H    (,4H A4,/                *2D39140
      DATA IZERO,IONE,MASK1,MASK2,MASK3/ZF0000000,ZF1000000,ZFF000000,   *2D39141
     1 Z00FFFFFF,Z40000000/                                              *2D39142
      IDUM=LAND(IA(1),MASK1)                                             *2D39143
      IF(IDUM.EQ.IZERO)GO TO 9                                           *2D39144
      IF(IDUM.EQ.IONE)GO TO 9                                            *2D39145
      IF(IDUM.EQ.MASK3)GO TO 9                                           *2D39146
      IDUM=LAND(IA(1),MASK2)                                             *2D39147
      IA(1)=LOR(IDUM,MASK3)                                              *2D39148
    9 CONTINUE                                                           *2D39149
      I=N                                                                *2D39150
      IF(I.LE.0) GO TO 40                                                *2D39160
      IF(I.GT.132) I=132                                                 *2D39170
      J=I/4                                                              *2D39180
      JL=J+1                                                             *2D39190
      K=I-4*J                                                            *2D39200
      IF(K.NE.0) GO TO 10                                                *2D39210
      K=4                                                                *2D39220
      JL=JL-1                                                            *2D39230
      J=J-1                                                              *2D39240
   10 IFM(1)=IB(5)                                                       *2D39250
      JJ=1                                                               *2D39260
      IF(J.EQ.0) GO TO 30                                                *2D39270
      JJ=J+1                                                             *2D39280
      DO 20 L=2,JJ                                                       *2D39290
      IFM(L)=IB(6)                                                       *2D39300
   20 CONTINUE                                                           *2D39310
   30 IFM(JJ+1)=IB(K)                                                    *2D39320
      PRINT IFM,(IA(L),L=1,JL)                                           *2D39330
   40 RETURN                                                             *2D39340
      END                                                                *2D39350
```

Subroutine YPRINT

```
                                                                        *2D09170
      SUBROUTINE ZKMAKR(K,ZQ)                                           *2D09180
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D09190
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTP,PI*2D09200
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D09210
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D09220
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGP*2D09230
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D09240
     6,ELAMB,TIME,IBUG,MAXR,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D09250
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,       BIGMI,TMATII,*2D09260
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFEE,RH*2D09270
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D09280
      COMMON CZERUN,CUNEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D09290
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,RVELB,CVELC,AACCA,*2D09300
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D09310
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D09320
                                                                        *2D09330
                                                                        *2D09340
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D09350
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D09360
     2TPRIME(7),ALFAI(7),CMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D09370
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D09380
     4),STHETA(8),         BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D09390
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D09400
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D09410
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D09420
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D09430
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D09440
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D09450
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D09460
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D09470
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D09480
     4LE(2,14),ZPPP(128),BL(3)                                          *2D09490
                                                                        *2D09500
                                                                        *2D09510
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D09520
      COMMON FARB(18),SLOPF(18),ISWT(18),LODSWT(18)                     *2D09530
      COMMON NUNO(1402)                                                 *2D09540
      DIMENSION MASK(8),ZQ(11)                                          *2D09550
      DATA MASK/Z00000001,Z00000002,Z00000004,Z00000008,                *2D09560
     1Z00000010,Z00000020,Z00000040,Z00000080/                          *2D09570
      L = K-1                                                           *2D09580
      DO 5 I=1,10                                                       *2D09590
    5 ZQ(I) = 0.                                                        *2D09600
      IF (L.LE.0) RETURN                                                *2D09610
      DO 20 I=2,MAXI                                                    *2D09620
      ISW = LAND(MASK(I-1),L)                                           *2D09630
      IF (ISW.EQ.0) GO TO 20                                            *2D09640
      J = MAXI-I+2                                                      *2D09650
      IND = IBIG(J)                                                     *2D09660
      DO 10 N=1,10
```

Subroutine ZKMAKR (page 1 of 2)

```
      ZQ(N) = ZQ(N)+DELZ(K,IND)                                   *2D09670
   10 CONTINUE                                                    *2D09680
   20 CONTINUE                                                    *2D09690
      RETURN                                                      *2D09700
      END                                                         *2D09710
```

Subroutine ZKMAKR (page 2 of 2)

```
                                                                        *2D09720
      SUBROUTINE ZMAKER                                                 *2D09730
      COMMON SWITCH,NEW,MAX,IPOST,XXX,YYY,FMM,BBB,IGNORE,DA,XSMALA,YSMAL*2D09740
     1A,XISMLA,PSIA,SPSIA,CPSIA,FMUA,SIGMAA,SIGMA,AA,KTABLE,MFORI,DTR,PI*2D09750
     2TWO,GRAVIT,CPRIME,BIGKI,EL,AR,TPRIME,ALFAI,OMEGAI,RPSI,RHO,THETAZ,*2D09760
     3STHETZ,CTHETZ,FSPRM,RH,THATPV,WZERO,RHOPTZ,RHOPFZ,GAMZER,LCONTL,CS*2D09770
     4,S,FMUS,BETA,ZZERO,ELTWTY,ELTHRY,H,DESTEP,DELTAT,PHIZ,DELTA,NPASGR*2D09780
     5,XPACZ,NBELT,APRNTD,TIMAX,DTPRNT,BPRNTD,G,R,NS,SIGZ,ELZTEN,A,GRAVA*2D09790
     6,ELAMB,TIME,IBUG,MAXP,LITGAM,EPSLNZ,RSEL,RVEL,IBIG,IFORK,BASIC,FS,*2D09800
     7SMALLF,ZVEC,ZVECP,ZVECPP,THEDSQ,CTHETA,STHETA,        BIGMI,TMATII,*2D09810
     8XIDOT,YIDOT,PHI,EONE,SDELTA,SDELTD,BL,PN, MODE,OMEGA,X,Y,THEFFE,RH*2D09820
     9OPRM,XPRM,YPRM,BEE,CEE,DEE,QUE,DELOLD,DELDOD,EPSLNY,FTOLD,FSPRMZ  *2D09830
      COMMON CZERON,CONEN,CTWON,ET,EHAT,GEE,SMALLB,AEL,TIMTJZ,TGAMZ,YZZE*2D09840
     1RO,FSZCNS,ANVERS,TINFL,KPOST,TPRINT,TSTEP,AVELA,BVELB,CVELC,AACCA,*2D09850
     2BACCB,CACCC,DACCD,MAXI,KPRINT,KSTEP,KINFL,TIMASK,TDSQLI,ATDSQ,TIMT*2D09860
     3J,STIMTJ,DELZ,ZK,ZPPP,TAHATZ,TS,TSA,TSB,SIGMAC,ITAU,TAUHAT,RZ,SZ  *2D09870
                                                                        *2D09880
                                                                        *2D09890
      DIMENSION SWITCH(3),NEW(3),MAX(3),IPOST(3),BETA(3),PHIZ(3),DELTA(3*2D09900
     1),PHI(3),SDELTA(3),SDELTD(3),ELAMB(6),MFORI(7),CPRIME(7),BIGKI(7),*2D09910
     2TPRIME(7),ALFAI(7),CMEGAI(7),XIDOT(7),YIDOT(7),X(7),Y(7),EL(8),AR(*2D09920
     38),RHO(8),THETAZ(8),STHETZ(8),CTHETZ(8),IBIG(8),THEDSQ(8),CTHETA(8*2D09930
     4),STHETA(8),          BIGMI(8),TMATII(8),RHOPRM(8),XPRM(8),YPRM(8)*2D09940
     5,TDSQLI(8),ATDSQ(8),IGNORE(10),DA(10),XSMALA(10),YSMALA(10),XISMLA*2D09950
     6(10),PSIA(10),CPSIA(10),SPSIA(10),SIGMAC(10),FMUA(10),GRAVA(10),BE*2D09960
     7E(10),CEE(10),QUE(10),DEE(10),GEE(10),SMALLB(10),ZVEC(11),ZVECP(11*2D09970
     8),ZVECPP(11),STIMTJ(13),AEL(14),RSEL(16),RVEL(16),MODE(16),TIMTJZ(*2D09980
     916),TIMTJ(16),RPSI(16),A(17),G(18),R(18),SIGZ(18),EONE(18),PN(18) *2D09990
      DIMENSION DELOLD(18),DELDOD(18),EPSLNY(18),FTOLD(18),OMEGA(18),CZE*2D10000
     1RON(18),CONEN(18),CTWON(18),ET(18),EHAT(18),IFORK(3,8),SIGMA(10,3)*2D10010
     2,XXX(300,3),YYY(300,3),FMM(300,3),BBB(300,3),        SIGMAA(10,1*2D10020
     30),AA(10,10),ANVERS(10,10),DELZ(11,16),ZK(11,128),BASIC(11,8),KTAB*2D10030
     4LE(2,14),ZPPP(128),BL(3)                                          *2D10040
                                                                        *2D10050
      COMMON THATPW,THATPX,THATPS,XVEHZ                                 *2D10060
      COMMON FARB(18),SLOPE(18),ISWT(18),LODSWT(18)                     *2D10070
      COMMON NONO(1402)                                                 *2D10080
      DIMENSION ZR(10),WORKA(10),WORKB(10),CK(10,10)                    *2D10090
      ZPAR=10.                                                          *2D10100
      DO 10 I=1,10                                                      *2D10110
      DO 10 J=1,I                                                       *2D10120
      ANVERS(I,J) = AA(I,J)                                             *2D10130
      ANVERS(J,I)=AA(I,J)                                               *2D10140
      AA(J,I)=AA(I,J)                                                   *2D10150
   10 CONTINUE                                                          *2D10160
      IF (IBUG-2) 30,20,20                                              *2D10170
   20 WRITE (6,9997)AA                                                  *2D10180
 9997 FORMAT (9H0A MATRIX/(1X,10E13.4))                                 *2D10190
   30 CALL MINV(ANVERS,10,DETERM,WORKA,WORKB)                           *2D10200
      IF (DETERM) 50,40,50                                              *2D10210
```

Subroutine ZMAKER (page 1 of 2)

```
40    PRINT 9996                                                        *2010220
9996  FORMAT (19HOBAD MATRIX.  DUMP.)                                   *2010230
      GO TO 90                                                          *2010240
50    DO 70 I=1,10                                                      *2010250
      ZR(I) = 0.                                                        *2010260
      DO 60 J=1,10                                                      *2010270
60    ZR(I)=ZR(I)+SMALLB(J)*ANVERS(I,J)                                 *2010280
70    ZVECPP(I)=ZR(I)                                                   *2010290
      IF (IBUG-2) 980,960,960                                           *2010300
960   WRITE (6,9995) ANVERS                                             *2010310
9995  FORMAT (10HOA INVERSE/(1X,10E13.4))                               *2010320
      DO 970 I=1,10                                                     *2010330
      DO 970 J=1,10                                                     *2010340
      CK(I,J) = 0.                                                      *2010350
      DO 970 K=1,10                                                     *2010360
      CK(I,J)=CK(I,J)+ANVERS(I,K)*AA(K,J)+AA(I,K)*ANVERS(K,J)           *2010370
970   CONTINUE                                                          *2010380
      WRITE (6,9994)CK                                                  *2010390
9994  FORMAT (17HOCHECK OF INVERSE/(1X,10E13.4))                        *2010400
980   RETURN                                                            *2010410
80    PRINT 9998,TIME                                                   *2010420
9998  FORMAT (38HOLARGE CHANGE IN ACCELERATION AT TIME=F8.6,            *2010430
     125H LOOK FOR SPURIOUS FORCE.)                                     *2010440
90    PRINT 9999                                                        *2010450
9999  FORMAT(1H1)                                                       *2010460
      CALL SUMARY                                                       *2010470
      CALL ERROR                                                        *2010480
      END                                                               *2010490
```

Subroutine ZMAKER (page 2 of 2)

```
GDIS     TITLE 'OS DUMMY FILE OR DEVICE INFORMATION ROUTINE'           *2D65740
         ENTRY XDINFO                                                  *2D65750
GDIS     START 0                                                       *2D65760
         USING *,15                                                    *2D65770
XCINFO   L     1,REG                                                   *2D65780
         SR    15,15                                                   *2D65790
         BCR   15,14                                                   *2D65800
         CNOP  0,8                                                     *2D65810
REGA     DC    F'0'                                                    *2D65820
         DC    CL4'DUMY'                                               *2D65830
         DC    F'32767'                                                *2D65840
         DC    8F'0'                                                   *2D65850
REG      DC    A(REGA)                                                 *2D65860
         END                                                           *2D65870
```

Subroutine XDINFO

```
                                                                        *2065880
         XERS     TITLE 'OS VERSION OF DUMMY XERCOM AND XPRINT'        *2065890
                  ENTRY XERCOM                                          *2065900
                  ENTRY XPRINT                                          *2065910
         XERS     START 0                                               *2065920
                  USING *,15                                            *2065930
         XPRINT   ST    14,SAVE                                         *2065940
         XERCOM   EQU   XPRINT                                          *2065950
                  L     15,=V(XPRINT)                                   *2065960
                  BALR  14,15                                           *2065970
                  DROP  15                                              *2065980
                  USING *,14                                            *2065990
                  L     14,SAVE                                         *2066000
                  SR    15,15                                           *2066010
                  BCR   15,14                                           *2066020
                  CNOP  0,4                                             *2066030
         SAVE     DS    F                                               *2066040
                  END                                                   *2066050
```

Subroutine XPRINT and XERCOM

```
IFCL     TITLE 'BITWISE LOGICAL ROUTINES'                              *2D39560
         MACRO                                                         *2D39570
&NAME    SAVE  &REG,&CODE,&ID                                          *2D39580
         LCLA  &A,&B,&C                                                *2D39590
         LCLC  &E,&F,&G,&H                                             *2D39600
         AIF   ('&REG' EQ '').E1                                       *2D39610
         AIF   ('&ID' EQ '').NULLID                                    *2D39620
         AIF   ('&ID' EQ '*').SPECID                                   *2D39630
&A       SETA  ((K'&ID+2)/2)*2+4                                       *2D39640
&NAME    B     &A.(0,15)                 BRANCH AROUND ID              *2D39650
&A       SETA  K'&ID                                                   *2D39660
         DC    AL1(&A)                   LENGTH OF IDENTIFIER          *2D39670
.CONTB   AIF   (&A GT 32).SPLITUP                                      *2D39680
.CONTAA  AIF   (&A GT 8).BRAKDWN                                       *2D39690
&E       SETC  '&ID'(&B+1,&A)                                          *2D39700
         DC    CL&A'&E'                  IDENTIFIER                    *2D39710
         AGO   .CONTA                                                  *2D39720
.BRAKDWN ANOP                                                          *2D39730
&E       SETC  '&ID'(&B+1,8)                                           *2D39740
         DC    CL8'&E'                   IDENTIFIER                    *2D39750
&B       SETA  &B+8                                                    *2D39760
&A       SETA  &A-8                                                    *2D39770
         AGO   .CONTAA                                                 *2D39780
.SPLITUP ANOP                                                          *2D39790
&E       SETC  '&ID'(&B+1,8)                                           *2D39800
&F       SETC  '&ID'(&B+9,8)                                           *2D39810
&G       SETC  '&ID'(&B+17,8)                                          *2D39820
&H       SETC  '&ID'(&B+25,8)                                          *2D39830
         DC    CL32'&E.&F.&G.&H'                   IDENTIFIER          *2D39840
&B       SETA  &B+32                                                   *2D39850
&A       SETA  &A-32                                                   *2D39860
         AGO   .CONTB                                                  *2D39870
.NULLID  ANOP                                                          *2D39880
&NAME    DS    0H                                                      *2D39890
         AGO   .CONTA                                                  *2D39900
.SPECID  AIF   ('&NAME' EQ '').CSECTN                                  *2D39910
&E       SETC  '&NAME'                                                 *2D39920
&A       SETA  1                                                       *2D39930
.CONTQ   AIF   ('&E'(1,&A) EQ '&E').LEAVE                              *2D39940
&A       SETA  &A+1                                                    *2D39950
         AGO   .CONTQ                                                  *2D39960
.LEAVE   ANOP                                                          *2D39970
&B       SETA  ((&A+2)/2)*2+4                                          *2D39980
&NAME    B     &B.(0,15)                 BRANCH AROUND ID              *2D39990
         DC    AL1(&A)                                                 *2D40000
         DC    CL&A'&E'                  IDENTIFIER                    *2D40010
         AGO   .CONTA                                                  *2D40020
.CSECTN  AIF   ('&SYSECT' EQ '').E4                                    *2D40030
&E       SETC  '&SYSECT'                                               *2D40040
&A       SETA  1                                                       *2D40050
```

Bitwise Logical Routines (LAND and LOR) (page 1 of 15)

```
         AGO   .CONTA                                                     *2D40060
.E4      IHBERMAC 78,360                        SELECT NAME NULL          *2D40070
.CONTA   AIF   (T'&REG(1) NE 'N').E3                                      *2D40080
         AIF   ('&CODE' EQ 'T').CONTC                                     *2D40090
         AIF   ('&CODE' NE '').E2                                         *2D40100
&A       SETA  &REG(1)*4+20                                               *2D40110
         AIF   (&A LE 75).CONTD                                           *2D40120
&A       SETA  &A-64                                                      *2D40130
.CONTD   AIF   (N'&REG NE 2).CONTE                                        *2D40140
         STM   &REG(1),&REG(2),&A.(13)              SAVE REGISTERS        *2D40150
         MEXIT                                                            *2D40160
.CONTE   AIF   (N'&REG NE 1).E3                                           *2D40170
         ST    &REG(1),&A.(13,0)                    SAVE REGISTER         *2D40180
         MEXIT                                                            *2D40190
.CONTC   AIF   (&REG(1) GE 14 OR &REG(1) LE 2).CONTF                      *2D40200
         STM   14,15,12(13)                         SAVE REGISTERS        *2D40210
&A       SETA  &REG(1)*4+20                                               *2D40220
         AIF   (N'&REG NE 2).CONTG                                        *2D40230
         STM   &REG(1),&REG(2),&A.(13)              SAVE REGISTERS        *2D40240
         MEXIT                                                            *2D40250
.CONTG   AIF   (N'&REG NE 1).E3                                           *2D40260
         ST    &REG(1),&A.(13,0)                    SAVE REGISTER         *2D40270
         MEXIT                                                            *2D40280
.CONTF   AIF   (N'&REG NE 2).CONTH                                        *2D40290
         STM   14,&REG(2),12(13)                    SAVE REGISTERS        *2D40300
         MEXIT                                                            *2D40310
.CONTH   AIF   (N'&REG NE 1).E3                                           *2D40320
         STM   14,&REG(1),12(13)                    SAVE REGISTERS        *2D40330
         MEXIT                                                            *2D40340
.E1      IHBERMAC 18,360                        REG PARAM MISSING         *2D40350
         MEXIT                                                            *2D40360
.E2      IHBERMAC 37,360,&CODE                  INVALID CODE SPECIFIED    *2D40370
         MEXIT                                                            *2D40380
.E3      IHBERMAC 36,360,&REG                   INVALID REGS. SPECIFIED   *2D40390
         MEND                                                             *2D40400
         MACRO                                                            *2D40410
&NAME    RETURN &REG,&PARA,&RC=0                                          *2D40420
         LCLA  &A                                                         *2D40430
         AIF   ('&NAME' EQ '').GO                                         *2D40440
&NAME    DS    0H                                                         *2D40450
.GO      AIF   ('&REG' EQ '').CONTA                                       *2D40460
         AIF   ('&RC' EQ '(15)').SPECRT                                   *2D40470
.COMBACK ANOP                                                             *2D40480
&A       SETA  &REG(1)*4+20                                               *2D40490
         AIF   (&A LE 75).CONTB                                           *2D40500
&A       SETA  &A-64                                                      *2D40510
.CONTB   AIF   (N'&REG NE 2).CONTC                                        *2D40520
         LM    &REG(1),&REG(2),&A.(13)              RESTORE THE REGISTERS *2D40530
         AGO   .CONTA                                                     *2D40540
.SPECRT  AIF   ('&REG(1)' NE '14' AND '&REG(1)' NE '15').COMBACK          *2D40550
```

Bitwise Logical Routines (LAND and LOR) (page 2 of 15)

```
         AIF   ('&REG(1)' EQ '14' AND N'&REG  EQ 1).COMBACK                 *2D040560
         AIF   ('&REG(1)' EQ '15' AND N'&REG EQ 1).CONTA                    *2D040570
         AIF   ('&REG(1)' EQ '14').SKIP                                     *2D040580
         AIF   ('&REG(2)' EQ '0').ZTWO                                      *2D040590
.LM      LM    0,&REG(2),20(13)                 RESTORE THE REGISTERS       *2D040600
         AGO   .CONTA                                                       *2D040610
.ZTWO    L     0,20(13,0)                       RESTORE REGISTER ZERO       *2D040620
         AGO   .CONTA                                                       *2D040630
.SKIP    L     14,12(13,0)                      RESTORE REGISTER 14         *2D040640
         AIF   ('&REG(2)' EQ '15').CONTA                                    *2D040650
         AIF   ('&REG(2)' EQ '0').ZTWO                                      *2D040660
         AGO   .LM                                                          *2D040670
.CONTC   AIF   (N'&REG NE 1).ERROR1                                         *2D040680
         L     &REG(1),&A.(13,0)                RESTORE REGISTER            *2D040690
.CONTA   AIF   ('&PARA' EQ '').CONTD                                        *2D040700
         AIF   ('&PARA' NE 'T').ERROR2                                      *2D040710
         MVI   12(13),X'FF'                     SET RETURN INDICATION       *2D040720
.CONTD   AIF   ('&RC' EQ '0').CONTE                                         *2D040730
         AIF   ('&RC'(1,1) EQ '(').ISAREG                                   *2D040740
         LA    15,&RC.(0,0)                     LOAD RETURN CODE            *2D040750
         AGO   .CONTE                                                       *2D040760
.ISAREG  AIF   ('&RC(1)' EQ '15').CONTE                                     *2D040770
         IHBERMAC 61,,&RC                                                   *2D040780
         MEXIT                                                              *2D040790
.CONTE   BR    14                               RETURN                      *2D040800
         AGO   .END                                                         *2D040810
.ERROR1  IHBERMAC 36,,&REG                                                  *2D040820
         MEXIT                                                              *2D040830
.ERROR2  IHBERMAC 37,,&PARA                                                 *2D040840
.END     MEND                                                               *2D040850
         MACRO                                                              *2D040860
&NAME    CALL  &ENTRY,&OPRNDS,&VLPARA,&ID=,&MF=I                            *2D040870
         GBLB  &IHBSWA,&IHBSWB                                              *2D040880
         GBLC  &IHBNO                                                       *2D040890
         LCLC  &GNAME                                                       *2D040900
&IHBNO   SETC  '309'                                                        *2D040910
&GNAME   SETC  'IHB'.'&SYSNDX'                                              *2D040920
&IHBSWA  SETB  ('&VLPARA' EQ 'VL')                                          *2D040930
&IHBSWB  SETB  ('&ENTRY' EQ '(15)')                                         *2D040940
         AIF   ('&MF' EQ 'L' AND '&ENTRY' NE '').ERROR1                     *2D040950
         AIF   ('&MF' EQ 'L' AND '&ID' NE '').ERROR2                        *2D040960
         AIF   ('&MF' NE 'L' AND '&ENTRY' EQ '').ERROR3                     *2D040970
         AIF   ('&MF' EQ 'L' ).CONTC                                        *2D040980
         AIF   (&IHBSWB).CONTCC                                             *2D040990
         CNOP  0,4                                                          *2D041000
&NAME    B     *+8                              BRANCH AROUND VCON          *2D041010
&GNAME.B DC    V(&ENTRY)                        ENTRY POINT ADDRESS         *2D041020
.CONTC   AIF   ('&OPRNDS' EQ '' AND '&MF(1)' NE 'E').CONTB                  *2D041030
.CONTA   IHBOPLST &ENTRY,&OPRNDS,&NAME,MF=&MF                               *2D041040
.CONTB   AIF   ('&MF' EQ 'L').EXIT                                          *2D041050
```

Bitwise Logical Routines (LAND and LOR) (page 3 of 15)

```
         AI    (&IHBSW+3).CONTD                                              *2041060
         L     15,&NAME.3                      LOAD 15 WITH ENTRY ADR        *2041070
.CONTD   BAL   14,15                           BRANCH TO ENTRY POINT         *2041080
         AIF   ('&ID' EQ '').EXIT                                            *2041090
         DC    X'4700'                         NOP INSTRUCTION WITH          *2041100
         DC    AL2(&ID)                        ID IN LAST TWO BYTES          *2041110
.EXIT    MEXIT                                                               *2041120
.CONTCC  ANOP                                                                *2041130
&NAME    DS    0H                                                            *2041140
         AGO   .CONTC                                                        *2041150
.ERROR1  IHBERMAC 73,&IHBNO,&ENTRY             ENTRY W/ MF=L                 *2041160
         MEXIT                                                               *2041170
.ERROR2  IHBERMAC 74,&IHBNO,&ID                ID W/ MF=L                    *2041180
         MEXIT                                                               *2041190
.ERROR3  IHBERMAC 26,&IHBNO                    ENTRY SYMBOL MISSING          *2041200
         MEND                                                                *2041210
         MACRO                                                               *2041220
         IHBOPLST &NULL,&OPRNDS,&NAME,&MF=I                                  *2041230
         GBLB  &IHBSWA,&IHBSWB                                               *2041240
         GBLC  &IHBNO                                                        *2041250
         LCLC  &GNAME,&AA,&BB                                                *2041260
         LCLA  &A,&B,&C,&D,&E,&ATTRN                                         *2041270
&ATTRN   SETA  N'&OPRNDS                                                     *2041280
&GNAME   SETC  'IHB'.'&SYSNDX'                                               *2041290
         AIF   ('&MF' EQ 'L').CONTA                                          *2041300
         AIF   ('&MF' EQ 'I').LROUT                                          *2041310
         AGO   .FROUT                                                        *2041320
.ERROR1  IHBERMAC 35,&IHBNO,&MF                MF PARAMETER BAD              *2041330
         MEXIT                                                               *2041340
.ERROR2  IHBERMAC 69,&IHBNO                    REG. NOT. W/ MF=L             *2041350
         MEXIT                                                               *2041360
.CONTA   AIF   ('&NAME' EQ '').NONAME                                        *2041370
&NAME    DS    0F                                                            *2041380
.NONAME  ANOP                                                                *2041390
         AIF   ('&OPRNDS'(1,1) NE '(').CONTXY                                *2041400
         AIF   ('&OPRNDS'(2,1) EQ ',').SKIPC                                 *2041410
.CONTXY  AIF   (&ATTRN GT 1).LROUT                                           *2041420
&B       SETA  0-1                                                           *2041430
         AGO   .NEAREND                                                      *2041440
.LROUT   AIF   ('&OPRNDS(&B+1)' EQ '').SKIPC                                 *2041450
&AA      SETC  '&OPRNDS(&B+1)'                                               *2041460
         AIF   ('&AA'(1,1) EQ '(').ERROR2                                    *2041470
         DC    A(&OPRNDS(&B+1))        PROB.PROG.PARAMETER                   *2041480
         AGO   .AROUND                                                       *2041490
.SKIPC   DC    A(0)                              PROB. PROG. PARAMETER       *2041500
.AROUND  AIF   (&B+2 EQ &ATTRN).NEAREND                                      *2041510
&B       SETA  &B+1                                                          *2041520
         AGO   .LROUT                                                        *2041530
.NEAREND AIF   ('&OPRNDS(&B+2)' EQ '').SKIPD                                 *2041540
&AA      SETC  '&OPRNDS(&B+2)'                                               *2041550
```

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```
         AIF   ('&AA'(1,1) EQ '(').ERROR2                                          *2041560
         DC    B'&IHBSWA.C00000'                      SET VL SWITCH BIT            *2041570
         DC    AL3(&OPRNDS(&B+2))    PROB.PROG.PARAMETER                           *2041580
         AGO   .END                                                                *2041590
.SKIPC   DC    B'&IHBSWA.0000000'                     SET VL SWITCH BIT            *2041600
         DC    AL3(0)                                 PROB. PROG. PARAMETER        *2041610
         AGO   .END                                                                *2041620
.IROUT   AIF   ('&OPRNDS'(1,1) NE '(').LOOPC                                       *2041630
         AIF   ('&OPRNDS'(2,1) EQ ',').SKIPA                                       *2041640
.LOOPC   AIF   ('&OPRNDS(&B+1)' EQ '').SKIPA                                       *2041650
&AA      SETC  '&OPRNDS(&B+1)'                                                     *2041660
         AIF   ('&AA'(1,1) NE '(').SKIPA                                           *2041670
&A       SETA  K'&OPRNDS(&B+1)                                                     *2041680
&A       SETA  &A-2                                                                *2041690
&BB      SETC  '&OPRNDS(&B+1)'(2,&A)                                               *2041700
         ST    &BB,&GNAME+&C                          STORE INTO PARAM. LIST       *2041710
.SKIPA   AIF   (&B+1 EQ &ATTRN).THRU                                               *2041720
&B       SETA  &B+1                                                                *2041730
&C       SETA  &C+4                                                                *2041740
         AGO   .LOOPC                                                              *2041750
.THRU    AIF   (NOT &IHBSWA).CONTON                                                *2041760
         AIF   ('&OPRNDS(&B+1)' EQ '').CONTON                                      *2041770
         AIF   ('&OPRNDS(&B+1)'(1,1) NE '(').CONTON                                *2041780
         MVI   &GNAME+&C,X'80'                        SET LAST WORD BIT ON         *2041790
.CONTON  CNOP  0,4                                                                 *2041800
         BAL   1,&GNAME.A                             LOAD LIST ADDR IN REG1       *2041810
&GNAME   EQU   *                                                                   *2041820
         AIF   (&ATTRN GT 1).LOOP2                                                 *2041830
&C       SETA  0-1                                                                 *2041840
         AGO   .NEARDON                                                            *2041850
.LOOP2   AIF   ('&OPRNDS'(1,2) EQ '(,').SKIPB                                      *2041860
.LOOPD   AIF   ('&OPRNDS(&D+1)' EQ '').SKIPB                                       *2041870
&AA      SETC  '&OPRNDS(&D+1)'                                                     *2041880
         AIF   ('&AA'(1,1) EQ '(').SKIPB                                           *2041890
         DC    A(&OPRNDS(&D+1))      PROB.PROG.PARAMETER                           *2041900
         AGO   .NEXTSTP                                                            *2041910
.SKIPB   DC    A(0)                                   PROB. PROG. PARAMETER        *2041920
.NEXTSTP AIF   (&D+2 EQ &ATTRN).NEARDON                                            *2041930
&D       SETA  &D+1                                                                *2041940
         AGO   .LOOPD                                                              *2041950
.NEARDON AIF   ('&OPRNDS(&D+2)' EQ '').SKIPF                                       *2041960
         AIF   ('&OPRNDS(&D+2)'(1,1) EQ '(').SKIPF                                 *2041970
         DC    B'&IHBSWA.000000'                      SET VL SWITCH BIT            *2041980
         DC    AL3(&OPRNDS(&D+2))                     PROB. PROG. PARAMETER        *2041990
         AGO   .ENDOF                                                              *2042000
.SKIPE   DC    B'&IHBSWA.0000000'                     SET VL SWITCH BIT            *2042010
         DC    AL3(0)                                 PROB. PROG. PARAMETER        *2042020
         AGO   .ENDOF                                                              *2042030
.SKIPF   DC    A(0)                                   PROB. PROG. PARAMETER        *2042040
.ENDOF   ANOP                                                                      *2042050
```

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```
&NAME.A  EQU   *                                                               *2D42060
         AGO   .END                                                            *2D42070
.ERROUT  AIF   (N'&MF NE 2).ERROR1                                             *2D42080
         AIF   ('&MF(1)' NE 'E').ERROR1                                        *2D42090
         IHBINNRA &MF(2)                         LOAD REG 1 WITH LIST ADDR     *2D42100
.CONTB   AIF   ('&OPRNDS' EQ '').END                                           *2D42110
         AIF   (&IHBSWB).CONTC                                                 *2D42120
         AIF   ('&OPRNDS'(1,1) NE '(').LOOPA                                   *2D42130
         AIF   ('&OPRNDS'(2,1) EQ ',').CONTD                                   *2D42140
.LOOPA   AIF   ('&OPRNDS(&B+1)' EQ '').CONTD                                   *2D42150
&AA      SETC  '&OPRNDS(&B+1)'                                                 *2D42160
         AIF   ('&AA'(1,1) EQ '(').ISREG                                       *2D42170
&A       SETA  &C+14                                                           *2D42180
         LA    &A,&OPRNDS(&B+1)    PICKUP PARAMETER                            *2D42190
         AGO   .CONTF                                                          *2D42200
.ISREG   ANOP                                                                  *2D42210
&A       SETA  K'&OPRNDS(&B+1)                                                 *2D42220
&A       SETA  &A-2                                                            *2D42230
&BB      SETC  '&OPRNDS(&B+1)'(2,&A)                                           *2D42240
         AIF   (&C EQ 0).CONTGO                                                *2D42250
.GOBACK  ANOP                                                                  *2D42260
&A       SETA  &C+14                                                           *2D42270
         LR    &A,&BB                            PICK UP PARAMETER             *2D42280
.CONTE   AIF   (&B+1 EQ &ATTRN).ALLDUN                                         *2D42290
         AIF   (&C EQ 0-14).CONTF                                              *2D42300
         AIF   (&C EQ 1).CONTG                                                 *2D42310
&C       SETA  &C+1                                                            *2D42320
         AGO   .CONTH                                                          *2D42330
.CONTGO  AIF   (&B+1 EQ &ATTRN).CONTXX                                         *2D42340
         AIF   ('&OPRNDS(&B+2)' NE '').GOBACK                                  *2D42350
.CONTXX  ANOP                                                                  *2D42360
         ST    &BB,&E.(0,1)                      STORE INTO PARAM. LIST *2D42370
         AGO   .INCRMT                                                         *2D42380
.CONTC   ANOP                                                                  *2D42390
&C       SETA  0-14                                                            *2D42400
.CONTF   ANOP                                                                  *2D42410
&B       SETA  &B+1                                                            *2D42420
&D       SETA  &D+4                                                            *2D42430
         AGO   .LOOPA                                                          *2D42440
.CONTD   AIF   (&C EQ 0).INCRMT                                                *2D42450
         AIF   (&C NE 1).PUTTWO                                                *2D42460
         ST    14,&E.(0,1)                       STORE INTO PARAM. LIST *2D42470
         AGO   .INCRMT                                                         *2D42480
.PUTTWO  STM   14,15,&E.(1)                      STORE INTO PARAM. LIST *2D42490
         AGO   .INCRMT                                                         *2D42500
.CONTF   STM   14,0,&E.(1)                       STORE INTO PARAM. LIST *2D42510
.INCRMT  AIF   (&B+1 EQ &ATTRN).QUIT                                           *2D42520
&C       SETA  0                                                               *2D42530
&B       SETA  &B+1                                                            *2D42540
&D       SETA  &D+4                                                            *2D42550
```

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```
&E       SETA  &D                                                      *2D42560
         AGO   .LOOPA                                                  *2D42570
.ALLDUN  AIF   (&C NE 0).CONTJ                                         *2D42580
         ST    14,&F.(0,1)                     STORE INTO PARAM. LIST  *2D42590
         AGO   .QUIT                                                   *2D42600
.CONTJ   ANOP                                                          *2D42610
&A       SETA  &C+14                                                   *2D42620
         STM   14,&A,&E.(1)                    STORE INTO PARAM. LIST  *2D42630
         AGO   .QUIT                                                   *2D42640
.CONTC   AIF   ('&OPRNDS'(1,1) NE '(').LOOPB                           *2D42650
         AIF   ('&OPRNDS'(2,1) EQ ',').CONTK                           *2D42660
.LOOPB   AIF   ('&OPRNDS(&B+1)' EQ '').CONTK                           *2D42670
&AA      SETC  '&OPRNDS(&B+1)'                                         *2D42680
         AIF   ('&AA'(1,1) EQ '(').ISAREGA                             *2D42690
         LA    0,&OPRNDS(&B+1)     PICKUP  PARAMETER                   *2D42700
         ST    0,&D.(0,1)                      STORE INTO PARAM. LIST  *2D42710
         AGO   .CONTK                                                  *2D42720
.ISAREGA ANOP                                                          *2D42730
&A       SETA  K'&OPRNDS(&B+1)                                         *2D42740
&A       SETA  &A-2                                                    *2D42750
&BB      SETC  '&OPRNDS(&B+1)'(2,&A)                                   *2D42760
         ST    &BB,&D.(0,1)                    STORE INTO PARAM. LIST  *2D42770
.CONTK   AIF   (&B+1 EQ &ATTRN).QUIT                                   *2D42780
&B       SETA  &B+1                                                    *2D42790
&D       SETA  &D+4                                                    *2D42800
         AGO   .LOOPB                                                  *2D42810
.QUIT    AIF   (NOT &IHBSWA).END                                       *2D42820
&A       SETA  &ATTRN*4-4                                              *2D42830
         MVI   &A.(1),X'80'                    SET LAST WORD BIT ON    *2D42840
         AGO   .END                                                    *2D42850
.END     ANOP                                                          *2D42860
         MEND                                                          *2D42870
         MACRO                                                         *2D42880
&NAME    IHBINNRA &A,&B                                                *2D42890
         AIF   ('&A' EQ '' OR '&A' EQ '(1)').NAMEIT                    *2D42900
         AIF ('&A'(1,1) EQ '(').REGA                                   *2D42910
&NAME    LA    1,&A                  LOAD PARAMETER REG 1              *2D42920
         AGO   .CHKB                                                   *2D42930
.REGA    ANOP                                                          *2D42940
&NAME    LR    1,&A(1)               LOAD PARAMETER REG 1              *2D42950
         AGO   .CHKB                                                   *2D42960
.NAMEIT  AIF   ('&NAME' EQ '').CHKB                                    *2D42970
&NAME    DS    0H                                                      *2D42980
.CHKB    AIF   ('&B' EQ '' OR '&B' EQ '(0)').END                       *2D42990
         AIF   ('&B'(1,1) EQ '(').REGB                                 *2D43000
         LA    0,&B                  LOAD PARAMETER REG 0              *2D43010
         AGO   .END                                                    *2D43020
.REGB    LR    0,&B(1)          LOAD PARAMETER REG 0                   *2D43030
.END     MEND                                                          *2D43040
         MACRO                                                         *2D43050
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```
         [illegible]  &A,&B,&C,&D,&E   [illegible]
         LCLC  &C(1+)                   *2043070
         LCLC  &C                       *2043080
&C       SETC  '**  [illegible]'        *2043090
         AIF   (&A GT 170).GRAP         *2043100
         AIF   (&A GT 94).NEXT          *2043110
         AIF   (&A EQ 1).E24            *2043120
         AIF   (&A LE 13).E13           *2043130
         AIF   (&A EQ 24).E24           *2043140
         AIF   (&A LE 25).E25           *2043150
         AIF   (&A EQ 26).E26           *2043160
         AIF   (&A EQ 27).E27           *2043170
         AIF   (&A EQ 31).E31           *2043180
         AIF   (&A LE 34).E34           *2043190
         AIF   (&A EQ 42).E42           *2043200
         AIF   (&A LE 46).E46           *2043210
         AIF   (&A EQ 47).E47           *2043220
         AIF   (&A EQ 52).E52           *2043230
         AIF   (&A LE 57).E57           *2043240
         AIF   (&A EQ 60).E60           *2043250
         AIF   (&A EQ 61).E61           *2043260
         AIF   (&A LE 67).E67           *2043270
         AIF   (&A EQ 69).E69           *2043280
         AIF   (&A EQ 71).E71           *2043290
         AIF   (&A EQ 72).E72           *2043300
         AIF   (&A EQ 73).E73           *2043310
         AIF   (&A EQ 73).E74           *2043320
         AIF   (&A EQ 75).E75           *2043330
         AIF   (&A EQ 78).E78           *2043340
         AIF   (&A EQ 84).E84           *2043350
         AIF   (&A EQ 87).E87           *2043360
         AIF   (&A EQ 88).E88           *2043370
         AIF   (&A EQ 89).E89           *2043380
         AIF   (&A EQ 90).E90           *2043390
         AIF   (&A EQ 91).E91           *2043400
         AIF   (&A EQ 92).E92           *2043410
         AIF   (&A EQ 93).E93           *2043420
         AIF   (&A EQ 94).E94           *2043430
         AIF   (&A EQ 95).E95           *2043440
.NEXT    AIF   (&A LE 147).DCBA         *2043450
         AIF   (&A LE 157).DCBB         *2043460
         AIF   (&A EQ 158).DCBC         *2043470
         AIF   (&A EQ 159).DCBD         *2043480
         AIF   (&A EQ 160).DCBE         *2043490
         AIF   (&A EQ 161).DCBF         *2043500
         AIF   (&A EQ 162).DCBG         *2043510
         AIF   (&A EQ 163).DCBH         *2043520
         AIF   (&A EQ 164).DCBI         *2043530
         AIF   (&A EQ 165).DCBJ         *2043540
         AIF   (&A EQ 166).DCBK         *2043550
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```
              AIF   (&A EQ 167).DCBQ                                              *2D43560
              AIF   (&A EQ 168).DCBR                                              *2D43570
              AIF   (&A EQ 169).DCBS                                              *2D43580
              AIF   (&A EQ 170).DCBL                                              *2D43590
              AIF   (&A EQ 171).DCBM                                              *2D43600
              AIF   (&A EQ 172).DCBN                                              *2D43610
              AIF   (&A EQ 173).DCBO                                              *2D43620
              AIF   (&A EQ 174).DCBP                                              *2D43630
              AIF   (&A EQ 175).DCBAE                                             *2D43640
              AIF   (&A EQ 176).DCBAA                                             *2D43650
              AIF   (&A EQ 177).DCBAB                                             *2D43660
              AIF   (&A EQ 178).DCBAC                                             *2D43670
              AIF   (&A EQ 179).DCBAD                                             *2D43680
.GRAP         AIF   (&A EQ 180).E180                                              *2D43690
              AIF   (&A EQ 181).E181                                              *2D43700
              AIF   (&A EQ 182).E182                                              *2D43710
              AIF   (&A EQ 183).E183                                              *2D43720
              AIF   (&A EQ 184).E184                                              *2D43730
              AIF   (&A EQ 185).E185                                              *2D43740
              AIF   (&A EQ 186).E186                                              *2D43750
.DCBAE        MNOTE 8,'&C.064  UMSK OPERAND REQUIRES AERR OPERAND'                *2D43760
              MEXIT                                                               *2D43770
.DCBA         MNOTE 4,'&C.050  &B OPERAND INCONSISTENT-IGNORED'                   *2D43780
              MEXIT                                                               *2D43790
.DCBB         MNOTE 8,'&C.051  &D INVALID CODE FOR &B-IGNORED'                    *2D43800
              MEXIT                                                               *2D43810
.DCBC         MNOTE 12,'&C.052  DSORG OMITTED'                                    *2D43820
              MEXIT                                                               *2D43830
.DCBD         MNOTE 12,'&C.053  &D INVALID CODE FOR DSORG'                        *2D43840
              MEXIT                                                               *2D43850
.DCBE         MNOTE 8,'&C.054  &D INVALID DSORG QUALIFIER-IGNORED'                *2D43860
              MEXIT                                                               *2D43870
.DCBF         MNOTE 8,'&C.055  MACRF NOT SPECIFIED-EXCP ASSUMED'                  *2D43880
              MEXIT                                                               *2D43890
.DCBG         MNOTE 8,'&C.056  &D OF MACRF INVALID WITH DSORG=&E-IGNORED'         *2D43900
              MEXIT                                                               *2D43910
.DCBH         MNOTE 8,'&C.057  &D INVALID QUALIFIER FOR &E OF MACRF IF DSORGX*2D43920
                    =&F-IGNORED'                                                  *2D43930
              MEXIT                                                               *2D43940
.DCBI         MNOTE 8,'&C.058  &D OF RECFM INVALID WITH DSORG=&E-IGNORED'         *2D43950
              MEXIT                                                               *2D43960
.DCBJ         MNOTE 8,'&C.059  &D OF OPTCD INVALID WITH DSORG=&E-IGNORED'         *2D43970
              MEXIT                                                               *2D43980
.DCBK         MNOTE 8,'&C.060  &D INVALID CODE FOR DEVD WITH DSORG=&E-IGNOREX*2D43990
                    D'                                                            *2D44000
              MEXIT                                                               *2D44010
.DCBL         MNOTE 8,'&C.065  MACRF=&D INVALID-EXCP ASSUMED'                     *2D44020
              MEXIT                                                               *2D44030
.DCBM         MNOTE 12,'&C.066  INCONSISTENT OPERAND'                             *2D44040
              MEXIT                                                               *2D44050
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.DCBN    MNOTE *,'&C.067  DCBD MACRO PREVIOUSLY USED'                   *2D44060
         MEXIT                                                          *2D44070
.DCBO    MNOTE *,'&C.063  NO VALID DSORG SPECIFIED-EXCP ASSUMED'        *2D44080
         MEXIT                                                          *2D44090
.DCBP    MNOTE *,'&C.069  DEVD NOT SPECIFIED-ALL ASSUMED'               *2D44100
         MEXIT                                                          *2D44110
.DCBQ    MNOTE *,'&C.061  DDNAME NOT SPECIFIED'                         *2D44120
         MEXIT                                                          *2D44130
.DCBR    MNOTE *,'&C.062  DDNAME LONG-TRUNCATED TO 8 CHAR'              *2D44140
         MEXIT                                                          *2D44150
.DCBS    MNOTE *,'&C.063  DDNAME SHORT-PADDED TO 8 CHAR'                *2D44160
         MEXIT                                                          *2D44170
.DCBAA   MNOTE *,'&C.070  &D TOO LONG FOR &B-TRUNCATED TO 2 CHAR'       *2D44180
         MEXIT                                                          *2D44190
.DCBAB   MNOTE *,'&C.C71  &D TOO SHORT FOR &B-PADDED TO 2 CHAR'         *2D44200
         MEXIT                                                          *2D44210
.DCBAC   MNOTE *,'&C.C72  &B NOT SPECIFIED-PRESET TO &D'                *2D44220
         MEXIT                                                          *2D44230
.DCBAE   MNOTE 4,'&C.073  AERR OPERAND REQUIRES UMSK OPERAND'           *2D44240
         MEXIT                                                          *2D44250
.E13     ANOP                                                           *2D44260
&G(1)    SETC 'FIRST'                                                   *2D44270
&C(2)    SETC 'SECOND'                                                  *2D44280
&G(3)    SETC 'THIRD'                                                   *2D44290
&G(4)    SETC 'FOURTH'                                                  *2D44300
&G(5)    SETC 'DCB'                                                     *2D44310
&G(6)    SETC 'DECB'                                                    *2D44320
&C(7)    SETC 'KEY'                                                     *2D44330
&C(8)    SETC 'SEEKADDR'                                                *2D44340
&C(9)    SETC  'LOW.LIM.'                                               *2D44350
&G(10)   SETC  'ECB'                                                    *2D44360
&G(11)   SETC  'BLKREF'                                                 *2D44370
&C(12)   SETC  'AREA'                                                   *2D44380
         MNOTE 12,'&C.001  &G(&A-1) OPERAND REQ''D-NOT SPECIFIED'       *2D44390
         MEXIT                                                          *2D44400
.E25     ANOP                                                           *2D44410
&C(1)    SETC  'LENGTH'                                                 *2D44420
&C(2)    SETC  'VALUE'                                                  *2D44430
&C(3)    SETC  'QCB'                                                    *2D44440
&G(4)    SETC  'MODE'                                                   *2D44450
&G(5)    SETC  'REGISTER'                                               *2D44460
&G(6)    SETC  'MESSAGE'                                                *2D44470
&G(7)    SETC  'ABEXF'                                                  *2D44480
&C(8)    SETC  'LABEL'                                                  *2D44490
&G(9)    SETC  'TPLOC'                                                  *2D44500
&G(10)   SETC  'FIELDS'                                                 *2D44510
&G(12)   SETC  'TYPE'                                                   *2D44520
         MNOTE 12,'&C.001  &G(&A-13) OPERAND REQ''D-NOT SPECIFIED'      *2D44530
         MEXIT                                                          *2D44540
.E24     MNOTE 12,'&C.004  REQUIRED OPERAND(S) NOT SPECIFIED'           *2D44550
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                 MEXIT                                                               *2D044560
         .E26    MNOTE 12,'&C.001  ENTRY SYMBOL REQ''D-NOT SPECIFIED'                *2D044570
                 MEXIT                                                               *2D044580
         .E27    MNOTE 12,'&C.001  ENTRY PT. ADR. OPERAND REQ''D-NOT SPECIFIED'      *2D044590
                 MEXIT                                                               *2D044600
         .E31    MNOTE 12,'&C.001  EP,EPLOC,OR DE OPERAND REQ''D-NOT SPECIFIED'      *2D044610
                 MEXIT                                                               *2D044620
         .E34    ANOP                                                                *2D044630
         &G(1)   SETC  'CODE'                                                        *2D044640
         &G(2)   SETC  'COUNT'                                                       *2D044650
         &G(3)   SETC  'QEL'                                                         *2D044660
         &G(5)   SETC  'TERMINAL'                                                    *2D044670
         &G(6)   SETC  'LINE'                                                        *2D044680
         &G(7)   SETC  'LIST'                                                        *2D044690
         &G(12)  SETC  'LIST'                                                        *2D044700
         &G(13)  SETC  'NUMBER'                                                      *2D044710
                 MNOTE 12,'&C.001  &G(&A-27) &G(&A-20) OPERAND REQ''D-NOT SPECIX*2D044720
                       FIED'                                                         *2D044730
                 MEXIT                                                               *2D044740
         .E42    MNOTE 12,'&C.002  INVALID EP OR EPLOC OPERAND SPECIFIED-&D'         *2D044750
                 MEXIT                                                               *2D044760
         .E46    ANOP                                                                *2D044770
         &G(1)   SETC  'MF'                                                          *2D044780
         &G(2)   SETC  'FIRST'                                                       *2D044790
         &G(3)   SETC  'SECOND'                                                      *2D044800
         &G(4)   SETC  'THIRD'                                                       *2D044810
         &G(5)   SETC  'FOURTH'                                                      *2D044820
         &G(6)   SETC  'IOB'                                                         *2D044830
         &G(7)   SETC  'SF'                                                          *2D044840
         &G(9)   SETC  'FUNCTION'                                                    *2D044850
         &G(10)  SETC  'LENGTH'                                                      *2D044860
         &G(11)  SETC  'MODE'                                                        *2D044870
                 MNOTE 12,'&C.002  INVALID &G(&A-34) OPERAND SPECIFIED-&D'           *2D044880
                 MEXIT                                                               *2D044890
         .E47    MNOTE 12,'&C.002  INVALID AREA OR LENGTH OPERAND SPECIFIED-&D'      *2D044900
                 MEXIT                                                               *2D044910
         .E52    MNOTE 12,'&C.001  OPTION THREE OPERAND REQ''D-NOT SPECIFIED'        *2D044920
                 MEXIT                                                               *2D044930
         .E57    ANOP                                                                *2D044940
         &G(1)   SETC  'TYPE'                                                        *2D044950
         &G(2)   SETC  'OPTION'                                                      *2D044960
         &G(3)   SETC  'OPTION 1'                                                    *2D044970
         &G(4)   SETC  'OPTION 2'                                                    *2D044980
         &G(6)   SETC  'OPTION 3'                                                    *2D044990
         &G(7)   SETC  'KEYWORD'                                                     *2D045000
                 MNOTE 12,'&C.002  INVALID &G(&A-47) OPERAND SPECIFIED-&D'           *2D045010
                 MEXIT                                                               *2D045020
         .E60    MNOTE 12,'&C.023  INVALID OPERAND THREE W/SCRATCH SPEC.-&D'         *2D045030
                 MEXIT                                                               *2D045040
         .E61    MNOTE 12,'&C.005  INVALID REGISTER NOTATION IN RC OPERAND-&D'       *2D045050
```

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         MEXIT                                                              *2D045060
.F67     ANOP                                                               *2D045070
&G(1)    SETC  'OP CODE'                                                    *2D045080
&G(2)    SETC  'TYPE'                                                       *2D045090
&G(3)    SETC  'TYPE'                                                       *2D045100
&G(4)    SETC  'TYPE'                                                       *2D045110
&G(5)    SETC  'TYPE'                                                       *2D045120
&G(6)    SETC  'FIELDS'                                                     *2D045130
         MNOTE 12,'&C.003  INVALID &G(&A-61) OPERAND SPECIFIED-&D'          *2D045140
         MEXIT                                                              *2D045150
.F69     MNOTE 12,'&C.005  INVALID REGISTER NOTATION W/MF=L'                *2D045160
         MEXIT                                                              *2D045170
.F71     MNOTE 12,'&C.007  PARAM= OPERAND INVALID W/SF=L'                   *2D045180
         MEXIT                                                              *2D045190
.F72     MNOTE 12,'&C.008  INVALID REGISTER NOTATION W/SF=L'                *2D045200
         MEXIT                                                              *2D045210
.F73     MNOTE 12,'&C.009  ENTRY SYMBOL NOT ALLOWED W/MF=L'                 *2D045220
         MEXIT                                                              *2D045230
.F74     MNOTE 12,'&C.010  ID= OPERAND INVALID W/MF=L'                      *2D045240
         MEXIT                                                              *2D045250
.F75     MNOTE 12,'&C.011  INVALID OPERAND SPECIFIED W/SF=L'                *2D045260
         MEXIT                                                              *2D045270
.F78     MNOTE *,'&C.024  CSECT NAME OMITTED, MACRO NAME FIELD BLANK'       *2D045280
         MEXIT                                                              *2D045290
.F84     MNOTE 12,'&C.013  MF=L NOT ALLOWED'                                *2D045300
         MEXIT                                                              *2D045310
.F87     MNOTE 12,'&C.014  DECB NOT SPECIFIED AS SYMBOL'                    *2D045320
         MEXIT                                                              *2D045330
.E88     MNOTE 12,'&C.015  MORE THAN ONE OF EP,EPLOC OR DE PRESENT'         *2D045340
         MEXIT                                                              *2D045350
.E89     MNOTE 12,'&C.016  LV OPERAND NOT ALLOWED W/SPECIFIED MODE'         *2D045360
         MEXIT                                                              *2D045370
.E90     MNOTE 12,'&C.017  LA OPERAND NOT ALLOWED W/SPECIFIED MODE'         *2D045380
         MEXIT                                                              *2D045390
.E91     MNOTE 12,'&C.018  BOTH LV AND LA OPERANDS SPECIFIED'               *2D045400
         MEXIT                                                              *2D045410
.E92     MNOTE 12,'&C.019  SP NOT ALLOWED W/LV SPECIAL REG. NOTATION'       *2D045420
         MEXIT                                                              *2D045430
.E93     MNOTE 12,'&C.020  A= OPERAND NOT ALLOWED IN R-TYPE MACRO'          *2D045440
         MEXIT                                                              *2D045450
.E94     MNOTE 12,'&C.021  MORE THAN 7 VALUES IN FIELDS OPERAND'            *2D045460
         MEXIT                                                              *2D045470
.E95     MNOTE 12,'&C.012  PARAM OR VL ALLOWED ONLY WITH MF=(E,ADDR)'       *2D045480
         MEXIT                                                              *2D045490
.F180    MNOTE *,'&C.074  &B OPERAND INVALID OR NOT SPECIFIED-PRESET TOX*2D045500
               &D'                                                          *2D045510
         MEXIT                                                              *2D045520
.F181    MNOTE *,'&C.075  WARNING-WRAP AROUND TO TOP OF CRT'                *2D045530
         MEXIT                                                              *2D045540
.F182    MNOTE *,'&C.C76  BUFFER LOCATION COUNTER EXCEEDS MAXIMUM LIMITX*2D045550
```

Bitwise Logical Routines (LAND and LOR) (page 12 of 15)

```
                      S'                                             *2D45560
           MEXIT                                                     *2D45570
.E183      MNOTE *,'&C.077  &B INVALID-PRESET TO &D'                 *2D45580
           MEXIT                                                     *2D45590
.E184      MNOTE *,'&C.078  CURRENT BUFFER &B = &D'                  *2D45600
           MEXIT                                                     *2D45610
.E185      MNOTE *,'&C.079  CURRENT BEAM POSITION COUNTER IS X=&B, Y=&D' *2D45620
           MEXIT                                                     *2D45630
.E186      MNOTE *,'&C.080  &B COUNTER EXCEEDS CRT LIMITS'           *2D45640
           MEND                                                      *2D45650
IHCLLGIC   START 0                                                   *2D45660
           ENTRY AND,LAND,OR,LOR,XOR,LXOR,COMPL,LCOMPL,SHFTL,SHFTR   *2D45670
*                                                                    *2D45680
*                                                                    *2D45690
*CALLING SEQUENCE                                                    *2D45700
*          LA    S,SAVLOC                                            *2D45710
*          LA    A,ARGLST                                            *2D45720
*          L     L,=V(FCN)                                           *2D45730
*          BALR  R,L                                                 *2D45740
*          SAVLOC IS THE LOCATION OF A REGISTER STORAGE AREA,        *2D45750
*          AND ARGLST IS OF THE FOLLOWING FORM...                    *2D45760
*          DC    AL4(ARG1)                                           *2D45770
*          DC    AL4(ARG2)                                           *2D45780
*                                                                    *2D45790
*ERROR CONDITIONS                                                    *2D45800
*          NONE                                                      *2D45810
*                                                                    *2D45820
*          REGISTER DEFINITIONS                                      *2D45830
*                                                                    *2D45840
S          EQU 13                 SAVE AREA POINTER                  *2D45850
R          EQU   14                RETURN REGISTER                   *2D45860
L          EQU   15                LINKAGE REGISTER                  *2D45870
A          EQU   1                 ARGUMENT LIST POINTER             *2D45880
ARGADD1    EQU   2                 ADDRESS OF FIRST ARGUMENT         *2D45890
ARGADD2    EQU   3                 ADDRESS OF SECOND ARGUMENT        *2D45900
RESULT     EQU   0                 RESULT REGISTER                   *2D45910
FXEC       EQU   4                 ADDRESS OF AN INSTRUCTION FOR "EX" *2D45920
INTEGER    EQU   0                 INTEGER MODE                      *2D45930
REAL       EQU   1                 REAL MODE                         *2D45940
           EJECT                                                     *2D45950
*                                                                    *2D45960
           USING AND,L                                               *2D45970
AND        SAVE  (14,4),T,AND     SAVE MAIN REGISTERS                *2D45980
           MVI   SWITCH,REAL      AND SET MODE                       *2D45990
           LA    EXEC,FXNR                                           *2D46000
           B     COMMON                                              *2D46010
*                                                                    *2D46020
           USING LAND,L                                              *2D46030
LAND       SAVE  (14,4),T,LAND                                       *2D46040
           MVI   SWITCH,INTEGER                                      *2D46050
```

```
         LA    EXEC,EXXN                                              *2D46060
         B     COMMON                                                 *2D46070
*                                                                     *2D46080
         USING OR,L                                                   *2D46090
OR       SAVE  (14,4),T,OR                                            *2D46100
         MVI   SWITCH,REAL                                            *2D46110
         LA    EXEC,EXOR         BITWISE OR                           *2D46120
         B     COMMON                                                 *2D46130
*                                                                     *2D46140
         USING LOR,L                                                  *2D46150
LOR      SAVE  (14,4),T,LOR                                           *2D46160
         MVI   SWITCH,INTEGER                                         *2D46170
         LA    EXEC,EXOR                                              *2D46180
         B     COMMON                                                 *2D46190
*                                                                     *2D46200
         USING XOR,L                                                  *2D46210
XOR      SAVE  (14,4),T,XOR                                           *2D46220
         MVI   SWITCH,REAL                                            *2D46230
         LA    EXEC,EXXR         EXCLUSIVE OR (BITWISE)               *2D46240
         B     COMMON                                                 *2D46250
*                                                                     *2D46260
         USING LXOR,L                                                 *2D46270
LXOR     SAVE  (14,4),T,LXOR                                          *2D46280
         MVI   SWITCH,INTEGER                                         *2D46290
         LA    EXEC,EXXR                                              *2D46300
         B     COMMON                                                 *2D46310
*                                                                     *2D46320
         USING COMPL,L                                                *2D46330
COMPL    SAVE  (14,4),T,COMPL                                         *2D46340
         MVI   SWITCH,REAL                                            *2D46350
         LA    EXEC,EXXR         IS ACTUALLY A BITWISE XOR WITH -1.   *2D46360
         B     COMMON1                                                *2D46370
*                                                                     *2D46380
         USING LCOMPL,L                                               *2D46390
LCOMPL   SAVE  (14,4),T,LCOMPL                                        *2D46400
         MVI   SWITCH,INTEGER                                         *2D46410
         LA    EXEC,EXXR                                              *2D46420
COMMON1  BALR  L,0                                                    *2D46430
         USING *,L                                                    *2D46440
         L     ARGADD1,0(A)      LOAD ADDRESS OF FIRST ARGUMENT       *2D46450
         LA    ARGADD2,ALLONES                                        *2D46460
         B     COMMON#                                                *2D46470
*                                                                     *2D46480
         USING SHFTL,L                                                *2D46490
SHFTL    SAVE  (14,4),T,SHFTL                                         *2D46500
         MVI   SWITCH,INTEGER                                         *2D46510
         LA    EXEC,EXSLL                                             *2D46520
         B     COMMON                                                 *2D46530
*                                                                     *2D46540
         USING SHFTR,L                                                *2D46550
```

Bitwise Logical Routines (LAND and LOR) (page 14 of 15)

```
SHFTR    SAVE  (14,4),T,SHFTR                                    *2D46560
         MVI   SWITCH,INTEGER                                    *2D46570
         LA    EXEC,FXSRL                                        *2D46580
*                                                                *2D46590
COMMON   LM    ARGADD1,ARGADD2,0(A)                              *2D46600
COMMON#  L     0,0(,ARGADD1)                                     *2D46610
         L     1,0(,ARGADD2)                                     *2D46620
         BALR  L,0                                               *2D46630
         USING *,L                                               *2D46640
         EX    0,0(,EXEC)                                        *2D46650
         ST    RESULT,TEMP                                       *2D46660
         TM    SWITCH,REAL                                       *2D46670
         BZ    NOTREAL                                           *2D46680
         LE    RESULT,TEMP                                       *2D46690
         RETURN (0,4),T                                          *2D46700
*                                                                *2D46710
NOTREAL  RETURN (1,4),T                                          *2D46720
*                                                                *2D46730
TEMP     DS    F                                                 *2D46740
ALLONES  DC    F'-1'                                             *2D46750
EXNR     NR    0,1                                               *2D46760
EXOR     OR    0,1                                               *2D46770
EXXR     XR    0,1                                               *2D46780
FXSLL    SLL   0,0(1)                                            *2D46790
EXSRL    SRL   0,0(1)                                            *2D46800
SWITCH   DS    X                                                 *2D46810
         END                                                     *2D46820
```

```
PLOT     TITLE    'UNIVERSITY OF MICHIGAN SYSTEM /360 PRINTER PLOT ROUTINES' *2046830
*                                                                           *2046840
*                                                                           *2046850
*      PROGRAMMED BY VICTOR J. STREETER                                     *2046860
*                  COMPUTING CENTER                                         *2046870
*                  UNIVERSITY OF MICHIGAN                                   *2046880
*                  ANN ARBOR, MICHIGAN                                      *2046890
*    CORRECTED 6/69 BY R. H. HIEBER, U. OF MICH. COMPUTER CENTER      RHH   *2046900
*    CAUTION:  LINKAGES ARE HORRIBLE.                                 RHH   *2046910
*   CAUTION: 1ST PAGE ALMOST FULL, + LOTTP ASSUMED AT PLOT+4096       RHH   *2046920
*                                                                           *2046930
*                              MACRO DEFINITIONS                      *     *2046940
*                                                                           *2046950
*                                                                           *2046960
         MACRO                                                              *2046970
&NAME    CALL  &ENTRY,&OPRNDS,&VLPARA,&ID=,&MF=I                            *2046980
         GBLB  &IHBSWA,&IHBSWB                                              *2046990
         GBLC  &IHBNO                                                       *2047000
         LCLC  &GNAME                                                       *2047010
&IHBNO   SETC  '309'                                                        *2047020
&GNAME   SETC  'IHB'.'&SYSNDX'                                              *2047030
&IHBSWA  SETB  ('&VLPARA' EQ 'VL')                                          *2047040
&IHBSWB  SETB  ('&ENTRY' EQ '(15)')                                         *2047050
         AIF   ('&MF' EQ 'L' AND '&ENTRY' NE '').ERROR1                     *2047060
         AIF   ('&MF' EQ 'L' AND '&ID' NE '').ERROR2                        *2047070
         AIF   ('&MF' NE 'L' AND '&ENTRY' EQ '').ERROR3                     *2047080
         AIF   ('&MF' EQ 'L' ).CONTC                                        *2047090
         AIF   (&IHBSWB).CONTCC                                             *2047100
         CNOP  0,4                                                          *2047110
&NAME    B     *+8                               BRANCH AROUND VCON         *2047120
&GNAME.B DC    V(&ENTRY)                         ENTRY POINT ADDRESS        *2047130
.CONTC   AIF   ('&OPRNDS' EQ '' AND '&MF(1)' NE 'E').CONTB                  *2047140
.CONTA   IHBOPLST &ENTRY,&OPRNDS,&NAME,MF=&MF                               *2047150
.CONTB   AIF   ('&MF' EQ 'L').EXIT                                          *2047160
         AIF   (&IHBSWB).CONTD                                              *2047170
         L     15,&GNAME.B                       LOAD 15 WITH ENTRY ADR     *2047180
.CONTD   BALR  14,15                             BRANCH TO ENTRY POINT      *2047190
         AIF   ('&ID' EQ '').EXIT                                           *2047200
         DC    X'4700'                           NOP INSTRUCTION WITH       *2047210
         DC    AL2(&ID)                          ID IN LAST TWO BYTES       *2047220
.EXIT    MEXIT                                                              *2047230
.CONTCC  ANOP                                                               *2047240
&NAME    DS    0H                                                           *2047250
         AGO   .CONTC                                                       *2047260
.ERROR1  IHBERMAC 73,&IHBNO,&ENTRY          ENTRY  W/ MF=L                  *2047270
         MEXIT                                                              *2047280
.ERROR2  IHBERMAC 74,&IHBNO,&ID             ID W/ MF=L                      *2047290
         MEXIT                                                              *2047300
.ERROR3  IHBERMAC 26,&IHBNO                 ENTRY SYMBOL MISSING            *2047310
         MEND                                                               *2047320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 1 of 38)

```
         MACRO                                                      *2D47330
         IHBOPLST &NULL,&OPRNDS,&NAME,&MF=I                         *2D47340
         GBLB  &IHBSWA,&IHBSWB                                      *2D47350
         GBLC  &IHBNO                                               *2D47360
         LCLC  &GNAME,&AA,&BB                                       *2D47370
         LCLA  &A,&B,&C,&D,&F,&ATTRN                                *2D47380
&ATTRN   SETA  N'&OPRNDS                                            *2D47390
&GNAME   SETC  'IHB'.'&SYSNDX'                                      *2D47400
         AIF   ('&MF' EQ 'L').CONTA                                 *2D47410
         AIF   ('&MF' EQ 'I').IROUT                                 *2D47420
         AGO   .EROUT                                               *2D47430
.ERROR1  IHBERMAC 35,&IHBNO,&MF              MF PARAMETER BAD       *2D47440
         MEXIT                                                      *2D47450
.ERROR2  IHBERMAC 69,&IHBNO                  REG. NOT. W/ MF=L      *2D47460
         MEXIT                                                      *2D47470
.CONTA   AIF   ('&NAME' EQ '').NONAME                               *2D47480
&NAME    DS    0F                                                   *2D47490
.NONAME  ANOP                                                       *2D47500
         AIF   ('&OPRNDS'(1,1) NE '(').CONTXY                       *2D47510
         AIF   ('&OPRNDS'(2,1) EQ ',').SKIPC                        *2D47520
.CONTXY  AIF   (&ATTRN GT 1).LROUT                                  *2D47530
&B       SETA  0-1                                                  *2D47540
         AGO   .NEAREND                                             *2D47550
.LROUT   AIF   ('&OPRNDS(&B+1)' EQ '').SKIPC                        *2D47560
&AA      SETC  '&OPRNDS(&B+1)'                                      *2D47570
         AIF   ('&AA'(1,1) EQ '(').ERROR2                           *2D47580
         DC    A(&OPRNDS(&B+1))       PROB.PROG.PARAMETER           *2D47590
         AGO   .AROUND                                              *2D47600
.SKIPC   DC    A(0)                          PROB. PROG. PARAMETER  *2D47610
.AROUND  AIF   (&B+2 EQ &ATTRN).NEAREND                             *2D47620
&B       SETA  &B+1                                                 *2D47630
         AGO   .LROUT                                               *2D47640
.NEAREND AIF   ('&OPRNDS(&B+2)' EQ '').SKIPD                        *2D47650
&AA      SETC  '&OPRNDS(&B+2)'                                      *2D47660
         AIF   ('&AA'(1,1) EQ '(').ERROR2                           *2D47670
         DC    B'&IHBSWA.0000000'            SET VL SWITCH BIT      *2D47680
         DC    AL3(&OPRNDS(&B+2))   PROB.PROG.PARAMETER             *2D47690
         AGO   .END                                                 *2D47700
.SKIPD   DC    B'&IHBSWA.0000000'            SET VL SWITCH BIT      *2D47710
         DC    AL3(0)                        PROB. PROG. PARAMETER  *2D47720
         AGO   .END                                                 *2D47730
.IROUT   AIF   ('&OPRNDS'(1,1) NE '(').LOOPC                        *2D47740
         AIF   ('&OPRNDS'(2,1) EQ ',').SKIPA                        *2D47750
.LOOPC   AIF   ('&OPRNDS(&B+1)' EQ '').SKIPA                        *2D47760
&AA      SETC  '&OPRNDS(&B+1)'                                      *2D47770
         AIF   ('&AA'(1,1) NE '(').SKIPA                            *2D47780
&A       SETA  K'&OPRNDS(&B+1)                                      *2D47790
&A       SETA  &A-2                                                 *2D47800
&BB      SETC  '&OPRNDS(&B+1)'(2,&A)                                *2D47810
         ST    &BB,&GNAME+&C                 STORE INTO PARAM. LIST *2D47820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 2 of 38)

```
.SKIPA   AIF    (&B+1 EQ &ATTRN).THRU                                     *2D047830
&B       SETA   &B+1                                                      *2D047840
&C       SETA   &C+4                                                      *2D047850
         AGO    .LOOPC                                                    *2D047860
.THRU    AIF    (NOT &IHBSWA).CONTIN                                      *2D047870
         AIF    ('&OPRNDS(&B+1)' EQ '').CONTIN                            *2D047880
         AIF    ('&OPRNDS(&B+1)'(1,1) NE '(').CONTIN                      *2D047890
         MVI    &GNAME+&C,X'80'                  SET LAST WORD BIT ON     *2D047900
.CONTIN  CNOP   0,4                                                       *2D047910
         BAL    1,&GNAME.A                       LOAD LIST ADR IN REG 1   *2D047920
&GNAME   EQU    *                                                         *2D047930
         AIF    (&ATTRN GT 1).LOOP2                                       *2D047940
&D       SETA   0-1                                                       *2D047950
         AGO    .NEARDON                                                  *2D047960
.LOOP2   AIF    ('&OPRNDS'(1,2) EQ '(,').SKIPB                            *2D047970
.LOOPP   AIF    ('&OPRNDS(&D+1)' EQ '').SKIPB                             *2D047980
&AA      SETC   '&OPRNDS(&D+1)'                                           *2D047990
         AIF    ('&AA'(1,1) EQ '(').SKIPB                                 *2D048000
         DC     A(&OPRNDS(&D+1))       PROB.PROG.PARAMETER                *2D048010
         AGO    .NEXTSTP                                                  *2D048020
.SKIPB   DC     A(0)                             PROB. PROG. PARAMETER    *2D048030
.NEXTSTP AIF    (&D+2 EQ &ATTRN).NEARDON                                  *2D048040
&D       SETA   &D+1                                                      *2D048050
         AGO    .LOOPP                                                    *2D048060
.NEARDON AIF    ('&OPRNDS(&D+2)' EQ '').SKIPE                             *2D048070
         AIF    ('&OPRNDS(&D+2)'(1,1) EQ '(').SKIPF                       *2D048080
         DC     B'&IHBSWA.0000000'               SET VL SWITCH BIT        *2D048090
         DC     AL3(&OPRNDS(&D+2))               PROB. PROG. PARAMETER    *2D048100
         AGO    .ENDCF                                                    *2D048110
.SKIPF   DC     B'&IHBSWA.0000000'               SET VL SWITCH BIT        *2D048120
         DC     AL3(0)                           PROB. PROG. PARAMETER    *2D048130
         AGO    .ENDCF                                                    *2D048140
.SKIPE   DC     A(0)                             PROB. PROG. PARAMETER    *2D048150
.ENDCF   ANOP                                                             *2D048160
&GNAME.A EQU    *                                                         *2D048170
         AGO    .END                                                      *2D048180
.EROUT   AIF    (N'&ME NE 2).ERROR1                                       *2D048190
         AIF    ('&ME(1)' NE 'E').ERROR1                                  *2D048200
         IHBINNRA &ME(2)                      LOAD REG 1 WITH LIST ADDR   *2D048210
.CONTB   AIF    ('&OPRNDS' EQ '').END                                     *2D048220
         AIF    (&IHBSWB).CONTC                                           *2D048230
         AIF    ('&OPRNDS'(1,1) NE '(').LOOPA                             *2D048240
         AIF    ('&OPRNDS'(2,1) EQ ',').CONTD                             *2D048250
.LOOPA   AIF    ('&OPRNDS(&B+1)' EQ '').CONTD                             *2D048260
&AA      SETC   '&OPRNDS(&B+1)'                                           *2D048270
         AIF    ('&AA'(1,1) EQ '(').ISREG                                 *2D048280
&A       SETA   &C+14                                                     *2D048290
         LA     &A,&OPRNDS(&B+1)       PICKUP PARAMETER                   *2D048300
         AGO    .CONTE                                                    *2D048310
.ISREG   ANOP                                                             *2D048320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 3 of 38)

```
&A       SETA  <'&OPRNDS(&B+1)                                            *2D48330
&A       SETA  &A-2                                                       *2D48340
&BB      SETC  '&OPRNDS(&B+1)'(2,&A)                                      *2D48350
         AIF   (&C EQ 0).CONTQQ                                           *2D48360
.GOBACK  ANOP                                                             *2D48370
&A       SETA  &C+14                                                      *2D48380
         LR    &A,&BB                          PICK UP PARAMETER          *2D48390
.CONTE   AIF   (&B+1 EQ &ATTRN).ALLDUN                                    *2D48400
         AIF   (&C EQ 0-14).CONTF                                         *2D48410
         AIF   (&C EQ 1).CONTG                                            *2D48420
&C       SETA  &C+1                                                       *2D48430
         AGO   .CONTH                                                     *2D48440
.CONTQQ  AIF   (&B+1 EQ &ATTRN).CONTXX                                    *2D48450
         AIF   ('&OPRNDS(&B+2)' NE '').GOBACK                             *2D48460
.CONTXX  ANOP                                                             *2D48470
         ST    &BB,&E.(0,1)                    STORE INTO PARAM. LIST     *2D48480
         AGO   .INCRMT                                                    *2D48490
.CONTG   ANOP                                                             *2D48500
&C       SETA  0-14                                                       *2D48510
.CONTH   ANOP                                                             *2D48520
&B       SETA  &B+1                                                       *2D48530
&D       SETA  &D+4                                                       *2D48540
         AGO   .LOOPA                                                     *2D48550
.CONTC   AIF   (&C EQ 0).INCRMT                                           *2D48560
         AIF   (&C NE 1).PUTTWO                                           *2D48570
         ST    14,&E.(0,1)                     STORE INTO PARAM. LIST     *2D48580
         AGO   .INCRMT                                                    *2D48590
.PUTTWO  STM   14,15,&E.(1)                    STORE INTO PARAM. LIST     *2D48600
         AGO   .INCRMT                                                    *2D48610
.CONTF   STM   14,0,&E.(1)                     STORE INTO PARAM. LIST     *2D48620
.INCRMT  AIF   (&B+1 EQ &ATTRN).QUIT                                      *2D48630
&C       SETA  0                                                          *2D48640
&B       SETA  &B+1                                                       *2D48650
&D       SETA  &D+4                                                       *2D48660
&E       SETA  &D                                                         *2D48670
         AGO   .LOOPA                                                     *2D48680
.ALLDUN  AIF   (&C NE 0).CONTJ                                            *2D48690
         ST    14,&E.(0,1)                     STORE INTO PARAM. LIST     *2D48700
         AGO   .QUIT                                                      *2D48710
.CONTJ   ANOP                                                             *2D48720
&A       SETA  &C+14                                                      *2D48730
         STM   14,&A,&E.(1)                    STORE INTO PARAM. LIST     *2D48740
         AGO   .QUIT                                                      *2D48750
.CONTC   AIF   ('&OPRNDS'(1,1) NE '(').LOOPB                              *2D48760
         AIF   ('&OPRNDS'(2,1) EQ ',').CONTK                              *2D48770
.LOOPB   AIF   ('&OPRNDS(&B+1)' EQ '').CONTK                              *2D48780
&AA      SETC  '&OPRNDS(&B+1)'                                            *2D48790
         AIF   ('&AA'(1,1) EQ '(').ISAREGA                                *2D48800
         LA    0,&OPRNDS(&B+1)     PICKUP   PARAMETER                     *2D48810
         ST    0,&D.(0,1)                      STORE INTO PARAM. LIST     *2D48820
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Printer Plot Routines (PLOT1 through PLOT4) (page 4 of 38)

```
         AGO   .CONTK                                                    *2D048830
.ISAREGA ANOP                                                            *2D048840
&A       SETA  K'&OPRNDS(&B+1)                                           *2D048850
&A       SETA  &A-2                                                      *2D048860
&EP      SETC  '&OPRNDS(&B+1)'(2,&A)                                     *2D048870
         ST    &EP,&D.(0,1)                     STORE INTO PARAM. LIST   *2D048880
.CONTK   AIF   (&B+1 EQ &ATTRN).QUIT                                     *2D048890
&B       SETA  &B+1                                                      *2D048900
&D       SETA  &D+4                                                      *2D048910
         AGO   .LOOPB                                                    *2D048920
.QUIT    AIF   (NOT &IHBSWA).END                                         *2D048930
&A       SETA  &ATTRN*4-4                                                *2D048940
         MVI   &A.(1),X'80'                     SET LAST WORD BIT ON     *2D048950
         AGO   .END                                                      *2D048960
.END     ANOP                                                            *2D048970
         MEND                                                            *2D048980
         MACRO                                                           *2D048990
&NAME    THRINNRA &A,&B                                                  *2D049000
         AIF   ('&A' EQ '' OR '&A' EQ '(1)').NAMEIT                      *2D049010
         AIF   ('&A'(1,1) EQ '(').REGA                                   *2D049020
&NAME    LA    1,&A                 LOAD PARAMETER REG 1                 *2D049030
         AGO   .CHKB                                                     *2D049040
.REGA    ANOP                                                            *2D049050
&NAME    LR    1,&A(1)              LOAD PARAMETER REG 1                 *2D049060
         AGO   .CHKB                                                     *2D049070
.NAMEIT  AIF   ('&NAME' EQ '').CHKB                                      *2D049080
&NAME    DS    0H                                                        *2D049090
.CHKB    AIF   ('&B' EQ '' OR '&B' EQ '(0)').END                         *2D049100
         AIF   ('&B'(1,1) EQ '(').REGB                                   *2D049110
         LA    0,&B                 LOAD PARAMETER REG 0                 *2D049120
         AGO   .END                                                      *2D049130
.REGB    LR    0,&B(1)        LOAD PARAMETER REG 0                       *2D049140
.END     MEND                                                            *2D049150
         MACRO                                                           *2D049160
         THRERMAC &A,&B,&D,&E,&F                                         *2D049170
         LCLC  &G(14)                                                    *2D049180
         LCLC  &C                                                        *2D049190
&C       SETC  '***  IHB'                                                *2D049200
         AIF   (&A GT 179).GRAP                                          *2D049210
         AIF   (&A GT 99).NEXT                                           *2D049220
         AIF   (&A EQ 1).E24                                             *2D049230
         AIF   (&A LE 13).E13                                            *2D049240
         AIF   (&A EQ 24).E24                                            *2D049250
         AIF   (&A LE 25).E25                                            *2D049260
         AIF   (&A EQ 26).E26                                            *2D049270
         AIF   (&A EQ 27).E27                                            *2D049280
         AIF   (&A EQ 31).E31                                            *2D049290
         AIF   (&A LE 34).E34                                            *2D049300
         AIF   (&A EQ 42).E42                                            *2D049310
         AIF   (&A LE 46).E46                                            *2D049320
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Printer Plot Routines (PLOT1 through PLOT4) (page 5 of 38)

```
          AIF   (&A EQ 47).E47                                      *2D049330
          AIF   (&A EQ 52).E52                                      *2D049340
          AIF   (&A LE 57).E57                                      *2D049350
          AIF   (&A EQ 60).E60                                      *2D049360
          AIF   (&A EQ 61).E61                                      *2D049370
          AIF   (&A LE 67).E67                                      *2D049380
          AIF   (&A EQ 69).E69                                      *2D049390
          AIF   (&A EQ 71).E71                                      *2D049400
          AIF   (&A EQ 72).E72                                      *2D049410
          AIF   (&A EQ 73).E73                                      *2D049420
          AIF   (&A EQ 73).E74                                      *2D049430
          AIF   (&A EQ 75).E75                                      *2D049440
          AIF   (&A EQ 78).E78                                      *2D049450
          AIF   (&A EQ 84).E84                                      *2D049460
          AIF   (&A EQ 87).E87                                      *2D049470
          AIF   (&A EQ 88).E88                                      *2D049480
          AIF   (&A EQ 89).E89                                      *2D049490
          AIF   (&A EQ 90).E90                                      *2D049500
          AIF   (&A EQ 91).E91                                      *2D049510
          AIF   (&A EQ 92).E92                                      *2D049520
          AIF   (&A EQ 93).E93                                      *2D049530
          AIF   (&A EQ 94).E94                                      *2D049540
          AIF   (&A EQ 95).E95                                      *2D049550
.NEXT     AIF   (&A LE 147).DCBA                                    *2D049560
          AIF   (&A LE 157).DCBB                                    *2D049570
          AIF   (&A EQ 158).DCBC                                    *2D049580
          AIF   (&A EQ 159).DCBD                                    *2D049590
          AIF   (&A EQ 160).DCBE                                    *2D049600
          AIF   (&A EQ 161).DCBF                                    *2D049610
          AIF   (&A EQ 162).DCBG                                    *2D049620
          AIF   (&A EQ 163).DCBH                                    *2D049630
          AIF   (&A EQ 164).DCBI                                    *2D049640
          AIF   (&A EQ 165).DCBJ                                    *2D049650
          AIF   (&A EQ 166).DCBK                                    *2D049660
          AIF   (&A EQ 167).DCBQ                                    *2D049670
          AIF   (&A EQ 168).DCBR                                    *2D049680
          AIF   (&A EQ 169).DCBS                                    *2D049690
          AIF   (&A EQ 170).DCBL                                    *2D049700
          AIF   (&A EQ 171).DCBM                                    *2D049710
          AIF   (&A EQ 172).DCBN                                    *2D049720
          AIF   (&A EQ 173).DCBO                                    *2D049730
          AIF   (&A EQ 174).DCBP                                    *2D049740
          AIF   (&A EQ 175).DCBAE                                   *2D049750
          AIF   (&A EQ 176).DCBAA                                   *2D049760
          AIF   (&A EQ 177).DCBAB                                   *2D049770
          AIF   (&A EQ 178).DCBAC                                   *2D049780
          AIF   (&A EQ 179).DCBAD                                   *2D049790
.GRAP     AIF   (&A EQ 180).E180                                    *2D049800
          AIF   (&A EQ 181).E181                                    *2D049810
          AIF   (&A EQ 182).E182                                    *2D049820
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```
         AIF   (&A EQ 183).E183                                        *2D49830
         AIF   (&A EQ 184).E184                                        *2D49840
         AIF   (&A EQ 185).E185                                        *2D49850
         AIF   (&A EQ 186).E186                                        *2D49860
.DCBAE   MNOTE 8,'&C.064  UMSK OPERAND REQUIRES AERR OPERAND'          *2D49870
         MEXIT                                                         *2D49880
.DCBA    MNOTE 4,'&C.050  &B OPERAND INCONSISTENT-IGNORED'             *2D49890
         MEXIT                                                         *2D49900
.DCBB    MNOTE 8,'&C.051  &D INVALID CODE FOR &B-IGNORED'              *2D49910
         MEXIT                                                         *2D49920
.DCBC    MNOTE 12,'&C.052  DSORG OMITTED'                              *2D49930
         MEXIT                                                         *2D49940
.DCBD    MNOTE 12,'&C.053  &D INVALID CODE FOR DSORG'                  *2D49950
         MEXIT                                                         *2D49960
.DCBE    MNOTE 8,'&C.054  &D INVALID DSORG QUALIFIER-IGNORED'          *2D49970
         MEXIT                                                         *2D49980
.DCBF    MNOTE 8,'&C.055  MACRF NOT SPECIFIED-EXCP ASSUMED'            *2D49990
         MEXIT                                                         *2D50000
.DCBG    MNOTE 8,'&C.056  &D OF MACRF INVALID WITH DSORG=&F-IGNORED'   *2D50010
         MEXIT                                                         *2D50020
.DCBH    MNOTE 8,'&C.057  &D INVALID QUALIFIER FOR &E OF MACRF IF DSORGX*2D50030
               =&F-IGNORED'                                            *2D50040
         MEXIT                                                         *2D50050
.DCBI    MNOTE 8,'&C.058  &D OF RECFM INVALID WITH DSORG=&E-IGNORED'   *2D50060
         MEXIT                                                         *2D50070
.DCBJ    MNOTE 8,'&C.059  &D OF OPTCD INVALID WITH DSORG=&F-IGNORED'   *2D50080
         MEXIT                                                         *2D50090
.DCBK    MNOTE 8,'&C.060  &D INVALID CODE FOR DEVD WITH DSORG=&F-IGNOREX*2D50100
               D'                                                      *2D50110
         MEXIT                                                         *2D50120
.DCBL    MNOTE 8,'&C.065  MACRF=&D INVALID-EXCP ASSUMED'               *2D50130
         MEXIT                                                         *2D50140
.DCBM    MNOTE 12,'&C.066  INCONSISTENT OPERAND'                       *2D50150
         MEXIT                                                         *2D50160
.DCBN    MNOTE 4,'&C.067  DCBD MACRO PREVIOUSLY USED'                  *2D50170
         MEXIT                                                         *2D50180
.DCBO    MNOTE *,'&C.068  NO VALID DSORG SPECIFIED-EXCP ASSUMED'       *2D50190
         MEXIT                                                         *2D50200
.DCBP    MNOTE *,'&C.069  DEVD NOT SPECIFIED-ALL ASSUMED'              *2D50210
         MEXIT                                                         *2D50220
.DCBQ    MNOTE *,'&C.061  DDNAME NOT SPECIFIED'                        *2D50230
         MEXIT                                                         *2D50240
.DCBR    MNOTE 4,'&C.062  DDNAME LONG-TRUNCATED TO 8 CHAR'             *2D50250
         MEXIT                                                         *2D50260
.DCBS    MNOTE *,'&C.063  DDNAME SHORT-PADDED TO 8 CHAR'               *2D50270
         MEXIT                                                         *2D50280
.DC3AA   MNOTE *,'&C.070  &D TOO LONG FOR &B-TRUNCATED TO 2 CHAR'      *2D50290
         MEXIT                                                         *2D50300
.DC3AB   MNOTE *,'&C.071  &D TOO SHORT FOR &B-PADDED TO 2 CHAR'        *2D50310
         MEXIT                                                         *2D50320
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Printer Plot Routines (PLOT1 through PLOT4) (page 7 of 38)

```
.DCBAC    MNOTE *,'&C.C72   &B NOT SPECIFIED-PRESET TO &0'                 *2D50330
          MEXIT                                                            *2D50340
.DCBAC    MNOTE 4,'&C.C73   AEPP OPERAND REQUIRES UMSK OPERAND'            *2D50350
          MEXIT                                                            *2D50360
.E13      ANOP                                                             *2D50370
&G(1)     SETC 'FIRST'                                                     *2D50380
&G(2)     SETC 'SECOND'                                                    *2D50390
&G(3)     SETC 'THIRD'                                                     *2D50400
&G(4)     SETC 'FOURTH'                                                    *2D50410
&G(5)     SETC 'DCB'                                                       *2D50420
&G(6)     SETC 'DECB'                                                      *2D50430
&G(7)     SETC 'KEY'                                                       *2D50440
&G(8)     SETC 'SEEKADDR'                                                  *2D50450
&G(9)     SETC  'LOW.LIM.'                                                 *2D50460
&G(10)    SETC  'ECB'                                                      *2D50470
&G(11)    SETC  'BLKREF'                                                   *2D50480
&G(12)    SETC  'AREA'                                                     *2D50490
          MNOTE 12,'&C.001  &G(&A-1) OPERAND REQ''D-NOT SPECIFIED'         *2D50500
          MEXIT                                                            *2D50510
.F25      ANOP                                                             *2D50520
&G(1)     SETC  'LENGTH'                                                   *2D50530
&G(2)     SETC  'VALUE'                                                    *2D50540
&G(3)     SETC  'QCB'                                                      *2D50550
&G(4)     SETC  'MODE'                                                     *2D50560
&G(5)     SETC  'REGISTER'                                                 *2D50570
&G(6)     SETC  'MESSAGE'                                                  *2D50580
&G(7)     SETC  'ABEXR'                                                    *2D50590
&C(8)     SETC  'LABEL'                                                    *2D50600
&C(9)     SETC  'TBLOC'                                                    *2D50610
&G(10)    SETC  'FIFLDS'                                                   *2D50620
&G(12)    SETC  'TYPE'                                                     *2D50630
          MNOTE 12,'&C.001  &G(&A-13) OPERAND REQ''D-NOT SPECIFIED'        *2D50640
          MEXIT                                                            *2D50650
.E24      MNOTE 12,'&C.004  REQUIRED OPERAND(S) NOT SPECIFIED'             *2D50660
          MEXIT                                                            *2D50670
.F26      MNOTE 12,'&C.001  ENTRY SYMBOL REQ''D-NOT SPECIFIED'             *2D50680
          MEXIT                                                            *2D50690
.F27      MNOTE 12,'&C.001  ENTRY PT. ADR. OPERAND REQ''D-NOT SPECIFIED'   *2D50700
          MEXIT                                                            *2D50710
.E31      MNOTE 12,'&C.001  FP,EPLOC,OR DE OPERAND REQ''D-NOT SPECIFIED'   *2D50720
          MEXIT                                                            *2D50730
.F34      ANOP                                                             *2D50740
&G(1)     SETC  'CODE'                                                     *2D50750
&G(2)     SETC  'COUNT'                                                    *2D50760
&G(3)     SETC  'QFL'                                                      *2D50770
&G(5)     SETC  'TERMINAL'                                                 *2D50780
&G(6)     SETC  'LINE'                                                     *2D50790
&G(7)     SETC  'LIST'                                                     *2D50800
&G(12)    SETC  'LIST'                                                     *2D50810
&G(13)    SETC  'NUMBER'                                                   *2D50820
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```
         MNOTE 12,'&C.00?  [illegible]                                      *2050[illegible]
               FIED'                                                         *2050[illegible]
         MEXIT                                                               *2050[illegible]
.E4?     MNOTE 12,'&C.00?  INVALID FP      FOUR OPERAND SPECIFIED)-&)'       *2050860
         MEXIT                                                               *2050870
.E44     ANOP                                                                *2050880
&C(1)    SETC  'AF'                                                          *2050890
&G(2)    SETC  'FIRST'                                                       *2050900
&C(3)    SETC  'SECOND'                                                      *2050910
&G(4)    SETC  'THIRD'                                                       *2050920
&G(5)    SETC  'FOURTH'                                                      *2050930
&C(6)    SETC  'IOB'                                                         *2050940
&G(7)    SETC  'SF'                                                          *2050950
&C(?)    SETC  '[illegible]'                                                 *2050960
&C(1?)   SETC  'LENGTH'                                                      *2050970
&C(1?)   SETC  'MODE'                                                        *2050980
         MNOTE 12,'&C.00?  INVALID &G(&A-34) OPERAND SPECIFIED)-&)'          *2050990
         MEXIT                                                               *2051000
.E47     MNOTE 12,'&C.00?  INVALID AREA OR LENGTH OPERAND SPECIFIED)-&)'     *2051010
         MEXIT                                                               *2051020
.E52     MNOTE 12,'&C.001  OPTION THREE OPERAND FE??)-NOT SPECIFIED'        *2051030
         MEXIT                                                               *2051040
.E57     ANOP                                                                *2051050
&C(1)    SETC  'TYPE'                                                        *2051060
&C(2)    SETC  'OPTION'                                                      *2051070
&G(3)    SETC  'OPTION 1'                                                    *2051080
&G(4)    SETC  'OPTION 2'                                                    *2051090
&C(5)    SETC  'OPTION 3'                                                    *2051100
&G(7)    SETC  'KEYWORD'                                                     *2051110
         MNOTE 12,'&C.002  INVALID &G(&A-47) OPERAND SPECIFIED-&)'           *2051120
         MEXIT                                                               *2051130
.E50     MNOTE 12,'&C.023  INVALID OPERAND THREE W/SCRATCH SPEC.-&D'         *2051140
         MEXIT                                                               *2051150
.E61     MNOTE 12,'&C.005  INVALID REGISTER NOTATION IN RC OPERAND-&D'       *2051160
         MEXIT                                                               *2051170
.E67     ANOP                                                                *2051180
&C(1)    SETC  'OP CODE'                                                     *2051190
&C(2)    SETC  'TYPE'                                                        *2051200
&G(3)    SETC  'TYPE'                                                        *2051210
&G(4)    SETC  'TYPE'                                                        *2051220
&G(5)    SETC  'TYPE'                                                        *2051230
&G(6)    SETC  'FIELDS'                                                      *2051240
         MNOTE 12,'&C.002  INVALID &G(&A-61) OPERAND SPECIFIED)-&)'          *2051250
         MEXIT                                                               *2051260
.E6?     MNOTE 12,'&C.006  INVALID REGISTER NOTATION W/ AF=L'                *2051270
         MEXIT                                                               *2051280
.E71     MNOTE 12,'&C.007  PARAM= OPERAND INVALID W/SF=L'                    *2051290
         MEXIT                                                               *2051300
.E72     MNOTE 12,'&C.00?  INVALID REGISTER NOTATION W/SF=L'                 *2051310
         MEXIT                                                               *2051320
```

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```
.E73     MNOTE 12,'&C.009  ENTRY SYMBOL NOT ALLOWED W/MF=L'               *2051330
         MEXIT                                                          *2051340
.E74     MNOTE 12,'&C.010  ID= OPERAND INVALID W/MF=L'                    *2051350
         MEXIT                                                          *2051360
.E75     MNOTE 12,'&C.011  INVALID OPERAND SPECIFIED W/SF=L'              *2051370
         MEXIT                                                          *2051380
.E78     MNOTE 4,'&C.024  CSECT NAME OMITTED. MACRO NAME FIELD BLANK'     *2051390
         MEXIT                                                          *2051400
.E84     MNOTE 12,'&C.013  MF=L NOT ALLOWED'                              *2051410
         MEXIT                                                          *2051420
.E87     MNOTE 12,'&C.014  DECB NOT SPECIFIED AS SYMBOL'                  *2051430
         MEXIT                                                          *2051440
.E88     MNOTE 12,'&C.015  MORE THAN ONE OF EP,EPLOC OR DE PRESENT'       *2051450
         MEXIT                                                          *2051460
.E89     MNOTE 12,'&C.016  LV OPERAND NOT ALLOWED W/SPECIFIED MODE'       *2051470
         MEXIT                                                          *2051480
.E90     MNOTE 12,'&C.017  LA OPERAND NOT ALLOWED W/SPECIFIED MODE'       *2051490
         MEXIT                                                          *2051500
.E91     MNOTE 12,'&C.018  BOTH LV AND LA OPERANDS SPECIFIED'             *2051510
         MEXIT                                                          *2051520
.E92     MNOTE 12,'&C.019  SP NOT ALLOWED W/LV SPECIAL REG. NOTATION'     *2051530
         MEXIT                                                          *2051540
.E93     MNOTE 12,'&C.020  A= OPERAND NOT ALLOWED IN R-TYPE MACRO'        *2051550
         MEXIT                                                          *2051560
.E94     MNOTE 12,'&C.021  MORE THAN 7 VALUES IN FIELDS OPERAND'          *2051570
         MEXIT                                                          *2051580
.E95     MNOTE 12,'&C.012  PARAM OR VL ALLOWED ONLY WITH MF=(E,ADDR)'     *2051590
         MEXIT                                                          *2051600
.E180    MNOTE *,'&C.074  &B OPERAND INVALID OR NOT SPECIFIED-PRESET TOX*2051610
               &D'                                                      *2051620
         MEXIT                                                          *2051630
.E181    MNOTE *,'&C.075  WARNING-WRAP AROUND TO TOP OF CRT'              *2051640
         MEXIT                                                          *2051650
.E182    MNOTE *,'&C.076  BUFFER LOCATION COUNTER EXCEEDS MAXIMUM LIMITX*2051660
               S'                                                       *2051670
         MEXIT                                                          *2051680
.E183    MNOTE *,'&C.077  &B INVALID-PRESET TO &D'                        *2051690
         MEXIT                                                          *2051700
.E184    MNOTE *,'&C.078  CURRENT BUFFER &B = &D'                         *2051710
         MEXIT                                                          *2051720
.E185    MNOTE *,'&C.079  CURRENT BEAM POSITION COUNTER IS X=&B, Y=&D'    *2051730
         MEXIT                                                          *2051740
.E186    MNOTE *,'&C.080  &B COUNTER EXCEEDS CRT LIMITS'                  *2051750
         MEND                                                           *2051760
        MACRO                                                           *2051770
&NAME   ASSIGN  &MODE,&ARGS                                             *2051780
        LCLA    &NUM,&I                                                 *2051790
        LCLC    &M                                                      *2051800
        LCLC    &L,&R                                                   *2051810
        AIF     ('&MODE' NE 'A').L1                                     *2051820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 10 of 38)

```
&L       SETC     '('                                           *2D51830
&R       SETC     ')'                                           *2D51840
.L15     ANOP                                                   *2D51850
&M       SETC     'F'                                           *2D51860
         AGO      .L2                                           *2D51870
.L1      ANOP                                                   *2D51880
&L       SETC     ''''                                          *2D51890
&R       SETC     ''''                                          *2D51900
           AIF    ('&MODE' EQ 'Y' OR '&MODE' EQ 'U').L4         *2D51910
           AIF    ('&MODE' NE 'S').L5                           *2D51920
.L4        ANOP                                                 *2D51930
&L          SETC  '('                                           *2D51940
&R          SETC  ')'                                           *2D51950
.L5        ANOP                                                 *2D51960
         AIF      ('&MODE' EQ 'E').L15                          *2D51970
&M       SETC     '&MODE'                                       *2D51980
.L2      ANOP                                                   *2D51990
&NAME    DS       0&M                                           *2D52000
&I       SETA     1                                             *2D52010
&NUM     SETA     N'&ARGS                                       *2D52020
.L3      DC       &M&L&ARGS(&I)&R                               *2D52030
&I       SETA     &I+1                                          *2D52040
         AIF      (&I LE &NUM).L3                               *2D52050
         MEND                                                   *2D52060
         MACRO                                                  *2D52070
&NAME    CALLI    &ENT,&ARGS                                    *2D52080
         GBLA     &K                                            *2D52090
&K       SETA     &K+1                                          *2D52100
         CNOP     0,4                                           *2D52110
&NAME    L        14,&ENT                                       *2D52120
         LA       13,P4SA                                       *2D52130
         ST       14,72(13)                                     *2D52140
         BAS      1,DS&K                                        *2D52150
         ASSIGN   A,&ARGS                                       *2D52160
         DC       A(FIVE)                                       *2D52170
DS&K     L        15,&ENT+4                                     *2D52180
         BASR     14,15                                         *2D52190
         MEND                                                   *2D52200
*                                                               *2D52210
         MACRO                                                  *2D52220
&N       BN       &A                                            *2D52230
&N       BM       &A                                            *2D52240
         MEND                                                   *2D52250
*                                                               *2D52260
         MACRO                                                  *2D52270
&N       BOR      &A                                            *2D52280
&N       BCR      1,&A                                          *2D52290
         MEND                                                   *2D52300
*                                                               *2D52310
         MACRO                                                  *2D52320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 11 of 38)

```
&N       BNN      &A                                                *2D52330
&N       BNM      &A                                                *2D52340
         MEND                                                       *2D52350
*                                                                   *2D52360
         MACRO                                                      *2D52370
&N       BZR      &A                                                *2D52380
&N       BCR      8,&A                                              *2D52390
         MEND                                                       *2D52400
*                                                                   *2D52410
         MACRO                                                      *2D52420
&N       BEP      &A                                                *2D52430
&N       BCR      9,&A                                              *2D52440
         MEND                                                       *2D52450
*                                                                   *2D52460
         MACRO                                                      *2D52470
&NAME    BAS      &A,&B                                             *2D52480
&NAME    BAL      &A,&B                                             *2D52490
         MEND                                                       *2D52500
         MACRO                                                      *2D52510
&NAME    BASR     &A,&B                                             *2D52520
&NAME    BALR     &A,&B                                             *2D52530
         MEND                                                       *2D52540
*                                                                   *2D52550
         MACRO                                                      *2D52560
         BINFPT   &A,&B,&C,&D                                       *2D52570
         L        &B,&A                                             *2D52580
         O        &B,CNVRT                                          *2D52590
         ST       &B,T                                              *2D52600
         LE       &C,ZEROF                                          *2D52610
         AE       &C,T                                              *2D52620
         SE       &C,DNEF                                           *2D52630
         STE      &C,&D                                             *2D52640
         MEND                                                       *2D52650
*                                                                   *2D52660
         MACRO                                                      *2D52670
         FPBNRD   &FPR,&CPR                                         *2D52680
         AE       &FPR,HALF                                         *2D52690
         AU       &FPR,CNVRT                                        *2D52700
         STE      &FPR,T                                            *2D52710
         L        &GPR,T                                            *2D52720
         SLL      &GPR,8(0)                                         *2D52730
         SRL      &GPR,8(0)                                         *2D52740
         MEND                                                       *2D52750
*                                                                   *2D52760
         MACRO                                                      *2D52770
         BNFP     &GPR,&FPR                                         *2D52780
         BCTR     &GPR,0                                        RHH *2D52790
         O        &GPR,CNVRT                                        *2D52800
         LE       &FPR,ZEROF                                        *2D52810
         ST       &GPR,T                                            *2D52820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 12 of 38)

```
         A     4,FPR,1                                                  *2052830
         MEND                                                           *2052840
*                                                                       *2052850
         MACRO                                                          *2052860
         CHECKK                                                         *2052870
         A     4,ONE                                                    *2052880
         CR    *,2                                                      *2052890
         BE    FIN                                                      *2052900
         MEND                                                           *2052910
*                                                                       *2052920
         MACRO                                                          *2052930
         STSKL &AA,&A,&B,&CX,&DX,&E                                     *2052940
           LT  2,2                                                      *2052950
         BZ    &ZA                                                      *2052960
         MVI   &A,255                                                   *2052970
         BP    &F                                                       *2052980
         MVI   &DX,C'-'                                                 *2052990
           LCR 2,2                                                      *2053000
&F       LR    5,2                                                      *2053010
           SR  4,4                                                      *2053020
           D   4,TEN                                                    *2053030
          STC  4,&CX                                                    *2053040
          STC  5,&B                                                     *2053050
          OI   &B,X'F0'                                                 *2053060
          OI   &CX,X'F0'                                                *2053070
         MEND                                                           *2053080
         SPACE                                                          *2053090
PLOT     START 0                                                        *2053100
         EXTRN XPRINT                                                   *2053110
         ENTRY OMIT                                                     *2053120
         ENTRY SETLOG                                                   *2053130
         ENTRY PLOT1                                                    *2053140
         ENTRY PLOT2                                                    *2053150
         ENTRY PLOT3                                                    *2053160
         ENTRY PLOT4                                                    *2053170
         ENTRY PLOT14                                                   *2053180
         ENTRY STPLT1                                                   *2053190
         ENTRY STPLT2                                                   *2053200
         ENTRY PLOTP                                                    *2053210
*********************************************************************** *2053220
*                                                                     * *2053230
*    OMIT IS CALLED BY THE USER TO SET A SWITCH (OMITSW) WHICH        * *2053240
*    WILL DETERMINE WHETHER THE LAST GRAPH LINE, THE VERTICAL GRID    * *2053250
*    VALUES, OR THE HORIZONTAL GRID VALUES WILL BE PRINTED.           * *2053260
*                                                                     * *2053270
*                         CALLING SEQUENCE IS                         * *2053280
*     CALL     OMIT(ARG)                                              * *2053290
*                                                                     * *2053300
*********************************************************************** *2053310
          SPACE                                                         *2053320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 13 of 38)

```
         USING  *,15                                                       *2D53330
OMIT     ST     2,28(13)                                                   *2D53340
         L      2,PSKT          GET PSECT MTS STYLE                        *2D53350
         USING  PLOTP,2                                                    *2D53360
         L      1,0(1)                                                     *2D53370
         L      1,0(1)          GET ARG                                    *2D53380
         SR     0,0                                                        *2D53390
         IC     0,OMITSW                                                   *2D53400
         LTR    1,1                                                        *2D53410
         BN     NEGARG                                                     *2D53420
         OR     1,0             IF ARG NOT NEGATIVE, OR WITH OMITWD        *2D53430
         B      ARGSET                                                     *2D53440
NEGARG   LCR    1,1             IF ARG NEGATIVE, TAKE COMPLEMENT           *2D53450
         XR     1,0             EXOR TO TURN OFF BITS                      *2D53460
         NR     1,0             AND TO RESTORE BITS NOT TURNED ON BEFORE   *2D53470
ARGSET   STC    1,OMITSW                                                   *2D53480
         L      2,28(13)                                                   *2D53490
         SR     15,15           RETURN CODE IS ALWAYS ZERO                 *2D53500
         BR     14                                                         *2D53510
         DROP   2                                                          *2D53520
         EJECT                                                             *2D53530
************************************************************************** *2D53540
*                                                                        * *2D53550
*    SETLOG ALLOWS THE USER TO SPECIFY WHETHER HE WANTS A NORMAL,        * *2D53560
*    SEMI-LOG, OR LOG-LOG PLOT.                                          * *2D53570
*                                                                        * *2D53580
*                               CALLING SEQUENCE IS                      * *2D53590
*        CALL     SETLOG(ARG)                                            * *2D53600
*                                                                        * *2D53610
************************************************************************** *2D53620
         SPACE                                                             *2D53630
         USING  *,15                                                       *2D53640
SETLOC   L      15,PSKT         GET PSECT MTS STYLE                        *2D53650
         USING  PLOTP,15                                                   *2D53660
         L      1,0(1)                                                     *2D53670
         IC     1,0(1)                                                     *2D53680
         STC    1,LOGSW                                                    *2D53690
         SR     15,15           RETURN CODE IS ALWAYS ZERO                 *2D53700
         BR     14                                                         *2D53710
         EJECT                                                             *2D53720
************************************************************************** *2D53730
*                                                                        * *2D53740
*    PLOT1 SETS UP THE INFORMATION REQUIRED TO CONSTRUCT THE             * *2D53750
*    GRAPH AND PRINT OUT VALUES ALONG THE X AND Y AXES.                  * *2D53760
*                                                                        * *2D53770
*                               CALLING SEQUENCE IS                      * *2D53780
*        CALL     PLOT1(NSCALE,NHL,NSBH,NVL,NSBV)                        * *2D53790
*                                                                        * *2D53800
************************************************************************** *2D53810
         SPACE                                                             *2D53820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 14 of 38)

```
         USING *,15                                                         *2D53830
PLOT1    STM   14,12,12(13)  SAVE ALL IN CASE FOR RETURN               PLL *2D53840
         L     3,PSKT          GET PSECT ITS STYLE                          *2D53850
         USING PLOTP,3                                                      *2D53860
         ST    3,8(13)                                                      *2D53870
         ST    13,4(3)       FRR WILL NEED BACKWARD POINTER            RHH *2D53880
PLT1     L     5,0(1)          ENTRY POINT FROM PLOT14                      *2D53890
         L     4,0(5)                                                       *2D53900
         MVI   PLT1SW,1      SAY NEVER BEEN HERE IF THIS CALL BAD      RHH *2D53910
         LTR   4,4             TEST NSCALE                                  *2D53920
         BZ    STNDRD                                                       *2D53930
         L     4,4(5)          IF NON-ZERO PICK UP ARGS FOR SCALE, PLACE    *2D53940
         ST    4,YSCALE                                                     *2D53950
         L     4,8(5)                                                       *2D53960
         ST    4,YPLACE                                                     *2D53970
         L     4,12(5)                                                      *2D53980
         ST    4,XSCALE                                                     *2D53990
         L     4,16(5)                                                      *2D54000
         ST    4,XPLACE                                                     *2D54010
         B     GETNHL                                                       *2D54020
STNDRD   L     0,THREE         IF ZERO, TAKE STANDARD VALUES                *2D54030
         ST    0,YPLACE        FOR PLACE                                    *2D54040
         ST    0,XPLACE                                                     *2D54050
         SR    0,0                                                          *2D54060
         ST    0,YSCALE        AND FOR SCALE                                *2D54070
         ST    0,XSCALE                                                     *2D54080
GETNHL   L     5,4(1)                                                       *2D54090
         L     5,0(5)          GET NHL                                      *2D54100
         LTR   5,5                                                          *2D54110
         BNP   ERPLT1          ERROR RETURN IF  NHL NOT POSITIVE            *2D54120
         ST    5,NHL                                                        *2D54130
         L     5,8(1)                                                       *2D54140
         L     5,0(5)          GET NSBH                                     *2D54150
         LTR   5,5                                                          *2D54160
         BNP   ERPLT1          ERROR RETURN IF NSBH NOT POSITIVE            *2D54170
         ST    5,NSBH                                                       *2D54180
         M     4,NHL                                                        *2D54190
         S     5,NSBH                                                       *2D54200
         A     5,NHL                                                        *2D54210
         C     5,TWO                                                        *2D54220
         BL    ERPLT1          IF LENGTH LESS THAN 2, ERROR RETURN          *2D54230
         ST    5,L             PLOT LENGTH = NSBH*NHL-NSBH+NHL              *2D54240
         L     5,12(1)                                                      *2D54250
         L     5,0(5)          GET NVL                                      *2D54260
         LTR   5,5                                                          *2D54270
         BNP   ERPLT1          ERROR RETURN IF  NVL NOT POSITIVE            *2D54280
         ST    5,NVL                                                        *2D54290
         L     5,16(1)                                                      *2D54300
         L     5,0(5)          GET NSBV                                     *2D54310
         LTR   5,5                                                          *2D54320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 15 of 38)

```
         BNP   ERPLT1          ERROR RETURN IF NSBV NOT POSITIVE           *2D54330
         ST    5,NSBV                                                      *2D54340
         M     4,NVL                                                       *2D54350
         S     5,NSBV                                                      *2D54360
         A     5,NVL                                                       *2D54370
         C     5,TWO                                                       *2D54380
         BL    ERPLT1          IF WIDTH LESS THAN 2, ERROR RETURN          *2D54390
         ST    5,W             PLOT WIDTH = NSBV*NVL-NSBV+NVL              *2D54400
         L     4,EIGHT                                                     *2D54410
FDWNO    CR    4,5             FIND FIRST                                  *2D54420
         BNL   STDWNO          MULTIPLE                                    *2D54430
         A     4,EIGHT         OF 8                                        *2D54440
         B     FDWNO           .GE. W                                      *2D54450
STDWNO   C     4,=F'120'                                                   *2D54460
         BH    ERPLT1          ERROR RETURN IF GRAPH WIDER THAN 120        *2D54470
         ST    4,WD            SET WD                                      *2D54480
         SRL   4,3(0)                                                      *2D54490
         S     4,ONE                                                       *2D54500
         ST    4,DWNO          SET DWNO                                    *2D54510
         TM    PT14SW,255      TEST SWITCH FOR PLOT14 ENTRY                *2D54520
         BOR   14              IF ON RETURN IMMEDIATELY                    *2D54530
         MVI   PLT1SW,255      TURN ON PLOT1 EXECUTED SWITCH               *2D54540
         SR    15,15           NORMAL RETURN CODE IS ZERO                  *2D54550
         LM    3,5,32(13)                                                  *2D54560
         BR    14              RETURN                                      *2D54570
ERPLT1   MVI   ERRNO,4      ERROR RETURN FROM PLOT1,PLOT14 CALLS       RHH *2D54580
         B     ERP                                                     RHH *2D54590
         EJECT                                                             *2D54600
*********************************************************************      *2D54610
*                                                                   *      *2D54620
*       PLOT2 PREPARES THE GRID AND SETS UP THE INFORMATION REQUIRED *     *2D54630
*       BY PLOT3 TO PLACE A POINT IN THE PROPER POSITION IN THE GRAPH. *   *2D54640
*                                                                   *      *2D54650
*                             CALLING SEQUENCE IS                   *      *2D54660
*        CALL     PLOT2(IMAGE,XMAX,XMIN,YMAX,YMIN)                  *      *2D54670
*                                                                   *      *2D54680
*********************************************************************      *2D54690
         SPACE                                                             *2D54700
         USING *,15                                                        *2D54710
PLOT2    STM   14,12,12(13)                                                *2D54720
         L     3,PSKT          GET PSECT MTS STYLE                         *2D54730
         USING PLOTP,3                                                     *2D54740
         ST    13,4(3)                                                     *2D54750
         ST    3,8(13)                                                     *2D54760
PLT2     TM    PT14SW,255      ENTRY POINT FROM PLOT14                     *2D54770
         BZ    TESTSW                                                      *2D54780
         ST    14,SAV14                                                    *2D54790
         ST    1,SAV1                                                      *2D54800
         B     GETIM           PLOT1 ALREADY EXECUTED                      *2D54810
TESTSW   TM    PLT1SW,255      SEE IF PLOT1 EXECUTED                       *2D54820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 16 of 38)

```
         BL    GETIM                                                          *2D054830
         L     0,THETA        IF NOT, TAKE STANDARD PLOT                      *2D054840
         ST    0,YPLACE                                                       *2D054850
         ST    0,XPLACE                                                       *2D054860
         SR    0,0                                                            *2D054870
         ST    0,YSCALE                                                       *2D054880
         ST    0,XSCALE                                                       *2D054890
STENT    ST    14,SAV14       ENTRY POINT FROM SETPLOT                        *2D054900
         ST    1,SAV1                                                         *2D054910
         LM    0,1,SPDEV                                                      *2D054920
         LA    13,P4SA                                                        *2D054930
         LR    4,15                                                           *2D054940
         CALL  XDINFO                                                         *2D054950
         L     1,4(1)              GET DEVICE TYPE NAME                       *2D054960
         LR    15,4                                                           *2D054970
         C     1,TTY               IS IT A TELETYPE?                          *2D054980
         BNE   SETP1SW             NO                                         *2D054990
         MVI   NVL+3,6             YES                                        *2D055000
         MVI   W+3,51                                                         *2D055010
         MVI   WD+3,56                                                        *2D055020
         MVI   DWND+3,6                                                       *2D055030
SETP1SW  MVI   PLT1SW,255     TURN ON SWITCH FOR PLOT1 EXECUTED               *2D055040
         TM    STSW,255       IF ENTERED BY SETPLOT, PLOT2 ARGS ARE SET       *2D055050
         BO    GETIM2                                                         *2D055060
         L     1,SAV1         RESTORE REG 1                                   *2D055070
GETIM    L     2,0(1)         GET IMAGE ADDRESS                               *2D055080
         ST    2,IMAGE                                                        *2D055090
         MVI   ERRNO,3        SET ERROR CODE TO 8                             *2D055100
         MVI   PLT2SW,1     + ASSUME WILL BE HAD CALL ON PLOT2            RHH *2D055110
         L     2,4(1)                                                         *2D055120
         LE    0,0(2)         GET XMAX                                        *2D055130
         STE   0,XMAX                                                         *2D055140
         L     2,8(1)                                                         *2D055150
         LE    0,0(2)         GET XMIN                                        *2D055160
         STE   0,XMIN       (RESTORING TO HELP DEBUG)                     RHH *2D055170
         CE    0,XMAX                                                         *2D055180
         BNL   ERR            IF XMIN NOT LESS THAN XMAX, ERROR RETURN        *2D055190
         L     2,12(1)                                                        *2D055200
         LE    0,0(2)         GET YMAX                                        *2D055210
         STE   0,YMAX                                                         *2D055220
         L     2,16(1)                                                        *2D055230
         LE    0,0(2)         GET YMIN                                        *2D055240
         STE   0,YMIN                                                     RHH *2D055250
         CE    0,YMAX                                                         *2D055260
         BNL   ERR            IF YMIN NOT LESS THAN YMAX, ERROR RETURN        *2D055270
GETIM2   TM    IMAGE+3,7      SEE IF IMAGE REGION BEGINS ON                   *2D055280
         BZ    GTDASH         DOUBLE WORD BOUNDARY                            *2D055290
         NI    IMAGE+3,X'F8'  IF NOT,                                         *2D055300
         L     7,IMAGE                                                        *2D055310
         A     7,EIGHT        MAKE IT                                         *2D055320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 17 of 38)

```
         ST    7,IMAGE                                                    *2D55330
GTDASH   IC    6,DASH           INSERT                                    *2D55340
         IC    14,I             GRID CHARACTERS                           *2D55350
         IC    9,PLUS           INTO                                      *2D55360
         IC    7,BLNK           GPRS                                      *2D55370
         L     7,IMAGE          GET IMAGE ADDRESS                         *2D55380
         L     2,ONE                                                      *2D55390
         L     4,NVL                                                      *2D55400
         SR    4,2              GPR 4 = NVL-1                             *2D55410
         L     13,W                                                       *2D55420
         SR    13,2             GPR 13 = W-1                              *2D55430
         STC   9,PLLINE(13)     STORE +                                   *2D55440
         STC   14,IILINE(13)    STORE I                                   *2D55450
         L     11,NSBV                                                    *2D55460
STPLI    LR    1,11                                                       *2D55470
STDSBK   SR    13,2             GPR 13 DECREASED BY 1                     *2D55480
         STC   6,PLLINE(13)     STORE -                                   *2D55490
         STC   7,IILINE(13)     STORE BLANK                               *2D55500
         BCT   1,STDSBK                                                   *2D55510
         SR    13,2             GPR 13 DECREASED BY 1                     *2D55520
         STC   9,PLLINE(13)     STORE +                                   *2D55530
         STC   14,IILINE(13)    STORE I                                   *2D55540
         BCT   4,STPLI          LOOP TO PREPARE THE 2 LINES               *2D55550
         L     1,WD                                                       *2D55560
         L     13,NHL                                                     *2D55570
         SR    13,2             GPR 13 = NHL-1                            *2D55580
         EX    1,MVPLUS         MOVE FIRST GRID LINE TO GRAPH             *2D55590
         L     6,NSBH                                                     *2D55600
STLNS    LR    11,6                                                       *2D55610
STILIN   AR    7,1              GPR 7 POINTS TO NEXT GRAPH LINE           *2D55620
         EX    1,MVILIN         MOVE NON-GRID LINE TO GRAPH               *2D55630
         BCT   11,STILIN        LOOP TO INSERT NSBH NON-GRID LINES        *2D55640
         AR    7,1              GPR 7 POINTS TO NEXT GRAPH LINE           *2D55650
         EX    1,MVPLUS         MOVE GRID LINE TO GRAPH                   *2D55660
         BCT   13,STLNS         LOOP TO MOVE GRID AND NON-GRID LINES      *2D55670
*                                                                         *2D55680
THRU     MVI   PLT2SW,255       TURN ON PLOT2 EXECUTED SWITCH             *2D55690
         TM    PT14SW,255       IF ENTERED BY PLOT14 OR SETPLOT           *2D55700
         BZ    RETURN                                                     *2D55710
         L     14,SAV14         RESTORE ONLY 14                           *2D55720
         L     1,SAV1           AND 1                                     *2D55730
         BR    14                                                         *2D55740
RETURN   L     13,4(3)                                                    *2D55750
         LM    14,12,12(13)                                               *2D55760
         SR    15,15            NORMAL RETURN CODE IS ZERO                *2D55770
         BR    14               RETURN                                    *2D55780
         DROP  3                                                          *2D55790
         EJECT                                                            *2D55800
************************************************************************ *2D55810
*                                                                      * *2D55820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 18 of 38)

```
*        PL    TS    L      S TH    PLOTTING CHARACT     I         DATA       *   *2055840
*        F   EACH POINT (X,Y).                                                *   *2055850
*                                                                             *   *2055860
*                          CALLING SEQUENCE IS                                *   *2055870
*        CALL      PLOT3(320,X,Y,NDATA,INT)                                   *   *2055880
*                                                                             *   *2055880
*******************************************************************************   *2055890
         SPACE                                                                    *2055900
         USING     *,15                                                           *2055910
PLOT3    STM       14,12,12(13)  SAVE ALL IN CAS      E   EXIT                    *2055920
         L         3,PSKT          GET PSECT ITS STYLE                            *2055930
         USING     PLOTP,3                                                        *2055940
         ST        13,4(3)                                                        *2055950
         ST        3,8(13)                                                        *2055960
         LR        13,15                                                          *2055970
         DROP      15                                                             *2055980
         USING     PLOT3,13                                                       *2055990
         TM        PLT2SW,255       SEE IF PLOT2 EXECUTED                         *2056000
         BO        GTPT4                                                          *2056010
         MVI       ERRNO,16         IF NOT, ERROR CODE SET TO 16                  *2056020
         B         ERR            FOR EXIT VIA SERCOM CALL                   RHH  *2056030
GTPT4    L         15,PT4ADD        ESTABLISH PLOT4 ADDRESSABILITY FOR LOG USE    *2056040
         USING     PLOT4,15                                                       *2056050
PLT3     L         5,12(1)          ENTRY POINT FROM PLOT15                       *2056060
         L         5,0(5)           GET NDATA                                     *2056070
         LTR       5,5              TEST NDATA                                    *2056080
         BNP       OUTP3            IF NDATA LESS THAN 1, RETURN                  *2056090
         S         5,ONE                                                          *2056100
         L         9,16(1)                                                        *2056110
         L         9,0(9)           GET INTERVAL BETWEEN WORDS                    *2056120
         MR        4,9              (NDATA-1)*INT PUT IN GR5                      *2056130
         LR        4,9              INT PUT INTO GR4                              *2056140
         L         9,0(1)                                                         *2056150
         IC        9,0(9)           GET PLOTTING CHARACTER                        *2056160
STENT3   SR        11,11            ENTRY POINT FROM SETPLOT                      *2056170
         ST        1,SAV1                                                         *2056180
         BINFPT    W,2,0,WFP        CONVERT WIDTH TO FLOATING POINT               *2056190
         BINFPT    L,2,0,LFP        CONVERT LENGTH TO FLOATING POINT              *2056200
         MVI       ERRNO,12       RC=12 IF XMIN, ETC. ARE <= 0               RHH  *2056210
         BAS       5,LOGS         GO GET LOGS OF YMAX...XMIN IF LOG SCALE    RHH  *2056220
GTXMAX   LE        2,XMAX                                                         *2056230
         SE        2,XMIN           FPR 2 = XMAX-XMIN                             *2056240
         LE        4,YMAX                                                         *2056250
         SE        4,YMIN           FPR 4 = YMAX-YMIN                             *2056260
         L         2,4(1)           GPR 2 = X ADDRESS                             *2056270
         L         6,8(1)           GPR 6 = Y ADDRESS                             *2056280
         L         10,IMAGE         GPR 10 = IMAGE ADDRESS                        *2056290
GO       LE        0,0(11,2)        PICK UP X VALUE                               *2056300
         TM        LOGSW,2          TEST LOG SWITCH FOR X                         *2056310
         BZ        SUBXMN           IF OFF, GO TO NEXT STEP                       *2056320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 19 of 38)

```
         LTER   0,0                                                        *2D56330
         BNP    LOOP               IF ARG NOT POSITIVE, DISREGARD POINT    *2D56340
         BAS    12,LOG             REPLACE X WITH LOG X                    *2D56350
SUBXMN   CE     0,XMAX                                                     *2D56360
         BH     LOOP               IF X GREATER THAN XMAX, DISREGARD POINT *2D56370
         SE     0,XMIN             FPR 0 = X-XMIN                          *2D56380
         BN     LOOP               IF X LESS THAN XMIN, DISREGARD POINT    *2D56390
         DER    0,2                FPR 0 = (X-XMIN)/(XMAX-XMIN)            *2D56400
         LE     6,0(11,6)          PICK UP Y VALUE                         *2D56410
         TM     LOGSW,1            TEST LOG SWITCH FOR Y                   *2D56420
         BZ     SUBYMN             IF OFF, GO TO NEXT STEP                 *2D56430
         LTER   6,6                                                        *2D56440
         BNP    LOOP               IF ARG NOT POSITIVE, DISREGARD POINT    *2D56450
         STE    0,T                                                        *2D56460
         LER    0,6                                                        *2D56470
         BAS    12,LOG             REPLACE Y WITH LOG Y                    *2D56480
         LER    6,0                                                        *2D56490
         LE     0,T                                                        *2D56500
SUBYMN   CE     6,YMAX                                                     *2D56510
         BH     LOOP               IF Y GREATER THAN YMAX, DISREGARD POINT *2D56520
         SE     6,YMIN             FPR 6 = Y-YMIN                          *2D56530
         BN     LOOP               IF Y LESS THAN YMIN, DISREGARD POINT    *2D56540
         DER    6,4                FPR 6 = (Y-YMIN)/(YMAX-YMIN)            *2D56550
         ME     0,WFP              FPR 0 = COLUMN CORRESPONDING TO X       *2D56560
         MF     6,LFP              FPR 6 = ROW CORRESPONDING TO Y FROM BELOW *2D56570
         FPBNRD 6,12               GPR 12 = FPR 6 IN INTEGER MODE, ROUNDED *2D56580
         L      1,L                                                        *2D56590
         S      1,ONE                                                      *2D56600
         SR     1,12               GPR 1 = ROW CORRESPONDING TO Y FROM TOP *2D56610
         M      0,WD                                                       *2D56620
         FPBNRD 0,8                GPR 8 = FPR 0 IN INTEGER MODE, ROUNDED  *2D56630
         AR     8,1                GPR 8 = LINEAR SUBSCRIPT FROM ROW AND COL *2D56640
         STC    9,0(10,8)          INSERT PLOTTING CHARACTER IN GRAPH      *2D56650
LOOP     BXLE   11,4,GC            LOOP TO HANDLE ALL POINTS               *2D56660
         TM     LOGSW,1            TEST LOG SWITCH FOR Y                   *2D56670
         BZ     CHECKX                                                     *2D56680
         LE     0,TYMAX            IF ON,                                  *2D56690
         STE    0,YMAX             RESTORE                                 *2D56700
         LE     0,TYMIN            ORIGINAL                                *2D56710
         STE    0,YMIN             YMAX AND YMIN                           *2D56720
CHECKX   TM     LOGSW,2            TEST LOG SWITCH FOR X                   *2D56730
         BZ     OUTP3                                                      *2D56740
         LE     0,TXMAX            IF ON,                                  *2D56750
         STE    0,XMAX             RESTORE                                 *2D56760
         LE     0,TXMIN            ORIGINAL                                *2D56770
         STE    0,XMIN             XMAX AND XMIN                           *2D56780
OUTP3    TM     PT14SW,255         IF ENTERED BY PLOT14 OR SETPLOT         *2D56790
         L      1,SAV1             RESTORE ONLY 1                          *2D56800
         BOR    14               AND RETURN                            RHH *2D56810
OUTP31   L      13,4(3)                                                    *2D56820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 20 of 38)

```
         LM    0,12,20(13)                                             *2D56830
         SR    15,15                                               RHH *2D56840
         BR    14                                                      *2D56850
         DROP  3                                                       *2D56860
         DROP  13                                                      *2D56870
         EJECT                                                         *2D56880
***********************************************************************2D56890
*                                                                    * *2D56900
*    PLOT4 PRINTS THE COMPLETED GRAPH WITH VALUES ALONG THE X AND    * *2D56910
*    Y AXES, AND A CENTERED VERTICAL LABEL DOWN THE LEFT SIDE.       * *2D56920
*                                                                    * *2D56930
*                             CALLING SEQUENCE IS                    * *2D56940
*        CALL     PLOT4(NCHAR,LABEL)                                 * *2D56950
*                                                                    * *2D56960
***********************************************************************2D56970
         SPACE                                                         *2D56980
*                                                                      *2D56990
         USING *,15                                                    *2D57000
PLOT4    STM   14,12,12(13)                                            *2D57010
         L     3,PSKT            GET PSECT MTS STYLE                   *2D57020
         USING PLCTP,3                                                 *2D57030
         ST    3,8(13)                                                 *2D57040
         ST    13,4(3)                                                 *2D57050
         TM    PLT2SW,255        SEE IF PLOT2 EXECUTED                 *2D57060
         BO    PLT4                                                    *2D57070
         MVI   ERRNO,20          ERROR CODE SET TO 20                  *2D57080
         B     ERR               ERROR EXIT                            *2D57090
PLT4     MVI   ERRNO,24       ADDED RETURN CODE FOR LL, ARG <= 0   RHH *2D57100
         BAS   5,LOGS         GO GET LOGS OF YMAX...XMIN IF LOG SCALE  RHH *2D57110
GETW     L     12,W                                                    *2D57120
         A     12,TWELVE                                               *2D57130
         STH   12,LL20           LENGTH OF PRINT LINE IS W+12          *2D57140
         L     14,IMAGE          GET IMAGE ADDRESS                     *2D57150
         L     5,0(1)                                                  *2D57160
         L     5,0(5)            GET NCHAR                             *2D57170
         L     7,L                                                     *2D57180
         LTR   5,5               TEST NCHAR                            *2D57190
         BN    NCHROK            IF NEGATIVE, MAKE IT 0                *2D57200
         SR    7,5                                                     *2D57210
         BNN   NCHROK            IF GREATER THAN L, MAKE IT L          *2D57220
         SR    7,7                                                     *2D57230
         L     5,L               HERE TOO                              *2D57240
NCHROK   SRL   7,1(0)            GPR 7 = (L-NCHAR)/2                   *2D57250
         L     6,ONE                                                   *2D57260
         L     9,4(1)            GET LABEL ADDRESS                     *2D57270
         SR    1,1                                                     *2D57280
         SR    8,8                                                     *2D57290
         L     0,BLNKWD          BLANK                                 *2D57300
         ST    0,LINE            OUT                                   *2D57310
         ST    0,LINE+4          BEGINNING                             *2D57320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 21 of 38)

```
         ST     0,LINE+8         OF                                              *2057330
         ST     0,LINE+12        PRINT LINE                                      *2057340
         MVI    LINE,C'9'        SET UP CARRIAGE CONTROL                         *2057350
         L      0,YSCALE         SET UP                                          *2057360
         ST     0,SCALE          SCALE                                           *2057370
         L      0,YPLACE         AND PLACE                                       *2057380
         ST     0,PLACE          FOR FPBCD                                       *2057390
         TM     OMITSW,4         TEST NO LAST GRAPH LINE SWITCH                  *2057400
         BZ     OM4                                                              *2057410
         SR     10,10            IF ON, ZERO GPR 10                              *2057420
         B      L55                                                              *2057430
OM4      L      10,EIGHT         IF OFF, SET GPR 10 = 8                          *2057440
         B      L55                                                              *2057450
L5       B      L50(10)                                                          *2057460
L50      C      8,L              CHECK FOR LAST LINE                             *2057470
         BE     LSTLIN           BRANCH OUT IF IT IS                             *2057480
         BAS    4,ORDNUM                                                         *2057490
         BAS    4,PRINT                                                          *2057500
L55      BXLE   8,6,L5           LOOP TO SEND OUT LINES WITH NO LABEL            *2057510
         C      7,L                                                              *2057520
         BE     LSTLIN           GRAPH HAS BEEN PRINTED                          *2057530
         AR     7,5              ADD NCHAR TO LINE COUNTER                       *2057540
         S      8,ONE                                                            *2057550
         SR     5,5                                                              *2057560
         B      L66                                                              *2057570
L6       B      L60(10)                                                          *2057580
L60      C      8,L              CHECK FOR LAST LINE                             *2057590
         BE     LSTLIN           BRANCH OUT IF IT IS                             *2057600
         BAS    4,ORDNUM                                                         *2057610
         IC     0,0(9,5)                                                         *2057620
         STC    0,LINE+1         STORE LABEL CHARACTER ALONG LEFT MARGIN         *2057630
         A      5,ONE                                                            *2057640
         BAS    4,PRINT                                                          *2057650
L66      BXLE   8,6,L6           LOOP TO SEND OUT LINES WITH LABEL               *2057660
         L      7,L                                                              *2057670
         S      8,ONE                                                            *2057680
         B      L55              GO BACK TO FINISH PRINTING GRAPH                *2057690
*                ROUTINE TO SET UP AND PRINT X GRID VALUES IF SWITCH ON          *2057700
LSTLIN   TM     OMITSW,1         IF X GRID VALUE SWITCH TURNED OFF               *2057710
         BO     DONE             GO TO EXIT SEQUENCE                             *2057720
         LE     6,XMAX                                                           *2057730
         SE     6,XMIN           FPR 6 = XMAX-XMIN                               *2057740
         L      10,NSBV                                                          *2057750
         A      10,ONE           GPR 10 = NSBV+1                                 *2057760
         L      9,TWELVE                                                         *2057770
         L      11,W                                                             *2057780
         LR     12,11                                                            *2057790
         BNFP   12,4             CONVERT W TO FLOATING POINT                     *2057800
         A      11,ELEVEN                                                        *2057810
         L      0,XSCALE         SET UP                                          *2057820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 22 of 38)

```
         ST    0,SCALE            SCALE                                    *2D57830
         L     0,XPLACE           AND PLACE                                *2D57840
         ST    0,PLACE            FOR FPR0                                 *2D57850
         L     1,THIRTY                                                    *2D57860
         L     0,BLNKWD                                                    *2D57870
BLNKLN   LR    2,1                                                         *2D57880
         SLL   2,2(0)                                                      *2D57890
         S     2,FOUR                                                      *2D57900
         ST    0,LINE(2)          STORE 4 BLANKS AT A TIME                 *2D57910
         BCT   1,BLNKLN           LOOP TO BLANK OUT PRINT LINE             *2D57920
HORLIN   LR    14,9                                                        *2D57930
         S     14,ELEVEN                                                   *2D57940
         BNER  14,0                                                        *2D57950
         DER   0,4                                                         *2D57960
         MER   0,6                                                         *2D57970
         AE    0,XMIN             FPR 0 = X VALUE                          *2D57980
         TM    LOGSW,2            TEST LOG SWITCH FOR X                    *2D57990
         BZ    CONVX                                                       *2D58000
         BAS   12,EXP             IF ON, TAKE EXP(X)                       *2D58010
CONVX    BAS   12,FPBCD           SET UP                                   *2D58020
         BAS   12,SETRND          BCD CHARACTERS                           *2D58030
         ST    4,T                                                         *2D58040
         LR    5,4                GPR 4 = NUMBER OF CHARS                  *2D58050
         SRL   5,1(0)             CENTER                                   *2D58060
         SR    0,0                                                         *2D58070
         L     1,NSAV             NUMBER                                   *2D58080
         D     0,TWO                                                       *2D58090
         LTR   0,0                UNDER                                    *2D58100
         BNZ   FIELD                                                       *2D58110
         S     1,ONE              VERTICAL                                 *2D58120
FIELD    CR    5,1                                                         *2D58130
         BL    SET                GRID                                     *2D58140
         LR    5,1                                                         *2D58150
SET      LR    14,9               LINE                                     *2D58160
         AR    14,5                                                        *2D58170
MVCH     STC   7,LINE(14)                                                  *2D58180
         SRDL  6,8(0)                                                      *2D58190
         S     14,ONE                                                      *2D58200
         BCT   4,MVCH             LOOP TO SEND OUT CHARS                   *2D58210
         TM    MINUS,255                                                   *2D58220
         BZ    HRNLP                                                       *2D58230
         TM    T+3,8                                                       *2D58240
         BZ    HRNLP                                                       *2D58250
         IC    4,DASH                                                      *2D58260
         STC   4,LINE(14)         ADD - IF NECESSARY                       *2D58270
HRNLP    BXLE  9,10,HORLIN        LOOP TO MOVE ALONG X AXIS                *2D58280
         MVI   LINE,C'0'          SET UP CARRIAGE CONTROL                  *2D58290
         MVI   L120+1,120         PRINT LINE LENGTH IS 120 CHARS           *2D58300
         ST    15,SV1415                                                   *2D58310
         CALL  SPRNT,(LINE,L120)                                           *2D58320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 23 of 38)

```
         L     15,SV1415                                                 *2D58330
*              EXIT SEQUENCE                                             *2D58340
DONE     TM    LOGSW,1         TEST LOG SWITCH FOR Y                     *2D58350
         BZ    NOWX                                                      *2D58360
         LE    0,TYMAX         IF ON,                                    *2D58370
         STE   0,YMAX          RESTORE                                   *2D58380
         LE    0,TYMIN         ORIGINAL                                  *2D58390
         STE   0,YMIN          YMAX AND YMIN                             *2D58400
NOWX     TM    LOGSW,2         TEST LOG SWITCH FOR X                     *2D58410
         BZ    OUTP4                                                     *2D58420
         LE    0,TXMAX         IF ON,                                    *2D58430
         STE   0,XMAX          RESTORE                                   *2D58440
         LE    0,TXMIN         ORIGINAL                                  *2D58450
         STE   0,XMIN          XMAX AND XMIN                             *2D58460
OUTP4    TM    XSKSW,255       TEST X SCALE SWITCH (SETPLOT)             *2D58470
         BZ    OUTP41                                                    *2D58480
         ST    15,SV1415                                                 *2D58490
         CALLL SPRNT,(XCCM,FIFTY7)                                       *2D58500
         L     15,SV1415                                                 *2D58510
         MVI   XSI,C' '        RESET XSI TO A BLANK                      *2D58520
         MVI   XDIG1,C'0'      RESET XDIG1 TO A 0                        *2D58530
         MVI   XSKSW,0         TURN OFF X SCALE SWITCH (SETPLOT)         *2D58540
OUTP41   TM    YSKSW,255       TEST Y SCALE SWITCH (SETPLOT)             *2D58550
         BZ    OUTP42                                                    *2D58560
         CALLL SPRNT,(YCCM,FIFTY7)                                       *2D58570
         MVI   YSI,C' '        RESET YSI TO A BLANK                      *2D58580
         MVI   YDIG1,C'0'      RESET YDIG1 TO A 0                        *2D58590
         MVI   YSKSW,0         TURN OFF Y SCALE SWITCH (SETPLOT)         *2D58600
OUTP42   L     13,4(3)         NORMAL RETURN SEQUENCE                    *2D58610
         MVI   ST2SW,0         MAKE SURE SETPLOT2 SWITCH IS OFF          *2D58620
         LM    14,12,12(13)                                              *2D58630
         SR    15,15                                                     *2D58640
         BR    14                                                        *2D58650
*   ERROR RETURN, PLUS PRINT RETURN CODES ON SERCOM                  RHH *2D58660
ERR      LR    13,3        POINT GR13 AT INTERNAL PLOTP SAVEAREA     RHH *2D58670
         L     1,ERRSW     USE RETURN CODE                           RHH *2D58680
         SRA   1,2                                                   RHH *2D58690
         IC    0,PLOTNR(1)  TO FIND WHICH ROUTINE IT WAS IN          RHH *2D58700
         STC   0,ERRMSG+15  FOR PRINTING                             RHH *2D58710
         SLA   1,1                                                   RHH *2D58720
         LH    0,RC(1)     AND THE RETURN CODE IN CHARACTER FORM     RHH *2D58730
         STH   0,ERRMSG+20                                           RHH *2D58740
         LA    1,=A(ERRMSG,H23,0)                                    RHH *2D58750
         L     15,=V(XERCOM)                                             *2D58760
         BASR  14,15                                                 RHH *2D58770
         L     13,4(3)     ORIG GR13 FROM BACKWARD LINK              RHH *2D58780
         MVI   ST2SW,0         MAKE SURE SETPLOT2 SWITCH IS OFF          *2D58790
         L     15,ERRSW        LOAD RETURN CODE                          *2D58800
         LM    0,12,20(13)                                           RHH *2D58810
         L     14,12(13)       LOAD RETURN                               *2D58820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 24 of 38)

```
         BR    14                                                      *2D58830
*              ROUTINE TO PRINT GRAPH LINES                            *2D58840
PRINT    L     12,WD            SET R12 TO PLOT LINE LENGTH            *2D58850
         EX    12,MVPTLN        MOVE PLOT LINE TO PRINT LINE           *2D58860
         STM   14,15,SV1415                                            *2D58870
         CALLL SPRNT,(LINE,L120)                                       *2D58880
         LM    14,15,SV1415                                            *2D58890
         AR    14,12            GPR 14 POINTS TO NEXT GRAPH LINE       *2D58900
         BR    14                                                      *2D58910
*              ROUTINE TO SUPPLY Y GRID VALUES                         *2D58920
YGRDNUM  MVI   LINE+1,C' '                                             *2D58930
         MVC   LINE+2(131),LINE+1    BLANK BEGINNING OF PRINT LINE     *2D58940
         TM    OMIT,WYL         TEST SWITCH FOR NO Y GRID VALUES       *2D58950
         BOR   14               IF ON, RETURN                          *2D58960
         SR    12,12                                                   *2D58970
         LR    13,8                                                    *2D58980
         L     0,NSPH                                                  *2D58990
         A     0,ONE                                                   *2D59000
         DR    12,0             GPR 13 = (LINE NO.)/(NSPH+1)           *2D59010
         S     12,ONE           IF REMAINDER IS 1                      *2D59020
         BZ    FIND             PUT OUT Y GRID VALUE                   *2D59030
         BR    4                AND RETURN                             *2D59040
FIND     LE    0,YMAX                                                  *2D59050
         LER   2,0                                                     *2D59060
         SE    2,YMIN           FPR 2 = YMAX-YMIN                      *2D59070
         STM   4,8,REGSAV                                              *2D59080
         BNFP  8,4              CONVERT LINE NO. TO FLOATING POINT     *2D59090
         L     0,L                                                     *2D59100
         BNFP  0,6              CONVERT L TO FLOATING POINT            *2D59110
         DER   4,6              FPR 4 = PROPORTION DOWN Y              *2D59120
         MER   2,4                                                     *2D59130
         SER   0,2              FPR 0 = Y VALUE                        *2D59140
         TM    LOGSW,1          TEST LOG SWITCH FOR Y                  *2D59150
         BZ    CONVY                                                   *2D59160
         BAS   12,EXP           IF ON, TAKE EXP(Y)                     *2D59170
CONVY    BAS   12,FPBCD                                                *2D59180
         BAS   12,SETRND                                               *2D59190
         LR    5,4              GPR 5 = NUMBER OF CHARACTERS           *2D59200
         L     2,TEN                                                   *2D59210
YGRDNO   STC   7,LINE(2)         STORE Y GRID VALUE CHARS              *2D59220
         SRDL  6,8(0)                                                  *2D59230
         S     2,ONE                                                   *2D59240
         BCT   5,YGRDNO                                                *2D59250
         TM    MINUS,255                                               *2D59260
         BZ    RET                                                     *2D59270
         S     4,EIGHT                                                 *2D59280
         BNZ   RET                                                     *2D59290
         MVI   LINE+2,C'-'       ADD - IF NECESSARY                    *2D59300
RET      LM    4,8,REGSAV                                              *2D59310
         BR    4                                                       *2D59320
```

```
*                   ROUTINE TO CONVERT FLOATING POINT NUMBER TO BCD                 *2D59330
FPBCD    LTER   0,0                                                                  *2D59340
         BZ     ZERO                                                                 *2D59350
         BM     MISIGN                                                               *2D59360
         MVI    MINUS,0                                                              *2D59370
         B      STRT                                                                 *2D59380
MISIGN   MVI    MINUS,255                                                            *2D59390
STRT     SDR    2,2                                                                  *2D59400
         LPER   2,0                                                                  *2D59410
         SR     4,4                                                                  *2D59420
GOGO     CD     2,FPTBND                                                             *2D59430
         BL     GO1                                                                  *2D59440
         DD     2,FPTBND                                                             *2D59450
         A      4,TWENTY                                                             *2D59460
         B      GOGO                                                                 *2D59470
GO1      LA     2,FPTAB+64      GET END OF TABLE                                     *2D59480
         LA     1,FPTAB         GET BEGINNING OF TABLE                               *2D59490
         LR     0,1                                                                  *2D59500
GO2      CD     2,0(2)          COMPARE WITH TABLE ENTRY                             *2D59510
         BH     GO3                                                                  *2D59520
         S      2,EIGHT         PREPARE FOR NEXT ENTRY                               *2D59530
         CR     2,0             STILL IN TABLE?                                      *2D59540
         BNL    GO2             YES                                                  *2D59550
         MD     2,FPTBND        NO, NUMBER STILL < 10**-20                           *2D59560
         S      4,TWENTY        SO MULTIPLY AND ADJUST SCALE FACTOR                  *2D59570
         B      GO1             AND TRY AGAIN                                        *2D59580
GO3      SR     2,1                                                                  *2D59590
         C      2,THIRTY2       READY TO EXIT OUT OF THIS PHASE                      *2D59600
         BE     TRY1            YES                                                  *2D59610
         AR     2,1             RESTORE GR2                                          *2D59620
         DD     2,0(2)          DIVIDE BY TABLE ENTRY                                *2D59630
         SR     2,1                                                                  *2D59640
         SRL    2,2(0)          THIS IS TO REFERENCE SKFAC                           *2D59650
         LA     1,SKFAC                                                              *2D59660
         AH     4,0(1,2)        ADD CORRECT AMOUNT TO SCALE FACTOR                   *2D59670
         B      GO1             BACK TO TRY AGAIN                                    *2D59680
DIV      DD     2,TEND                                                               *2D59690
         A      4,ONE                                                                *2D59700
TRY1     CD     2,ONED                                                               *2D59710
         BNL    DIV             NUMBER STILL NOT LESS THAN 1                         *2D59720
TRY2     CD     2,TENTHD                                                             *2D59730
         BNL    READY           NUMBER FINALLY BETWEEN .1 AND 1                      *2D59740
         MD     2,TEND                                                               *2D59750
         S      4,ONE                                                                *2D59760
         B      TRY2            NUMBER STILL < .1                                    *2D59770
READY    LER    0,2                                                                  *2D59780
         A      4,SCALE                                                              *2D59790
         LR     1,4                                                                  *2D59800
         A      1,PLACE                                                              *2D59810
         C      1,=F'100'       CHECK FOR REASONABLENESS                             *2D59820
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Printer Plot Routines (PLOT1 through PLOT4) (page 26 of 38)

```
         BL    CHKSP                                                            *2D59830
         MVI   ERRNO,28     "SOMETHING WRONG WITH SCALE OR PLACE"          ...  *2D59840
         B     ERR                 AWAY WE GO                                   *2D59850
CHKSP    LTR   1,1                                                              *2D59860
         BNM   GTHALF              IF SCALE LESS THAN PLACE AND                 *2D59870
         TM    ST2SW,255           NOT USING SETPLOT, RESULT                    *2D59880
         BZ    ZERO                IS 0.                                        *2D59890
         L     1,THREE             ALWAYS 3 DIGITS IN E CONVERSION              *2D59900
GTHALF   LE    0,HALF                                                           *2D59910
         LTR   1,1                 ROUND                                        *2D59920
         BZ    ADD                 ARG                                          *2D59930
DVD      DE    0,TENE              BY                                           *2D59940
         BCT   1,DVD               ADDING                                       *2D59950
ADD      AER   0,2                 .5*10**-(SCALE+PLACE)                        *2D59960
         STE   0,T                                                              *2D59970
         TM    T,1                 TEST FOR SPILL                               *2D59980
         BO    SPILL                                                            *2D59990
         L     2,T                                                              *2D60000
         N     2,MSK               MASK OUT CHARACTERISTIC                      *2D60010
         CVD   2,DECLOC            CONVERT MANTISSA TO DECIMAL                  *2D60020
         L     0,DECLOC            PROVIDE                                      *2D60030
         L     1,DECLOC+4                                                       *2D60040
         SLDL  0,28(0)             LEADING                                      *2D60050
         SRL   1,28(0)                                                          *2D60060
         ST    1,DECLOC+8          ZEROS                                        *2D60070
         SR    1,1                                                              *2D60080
         SRDL  0,8(0)              FOR                                          *2D60090
         ST    1,DECLOC+4                                                       *2D60100
         ST    0,DECLOC            DECIMAL DIVISION                             *2D60110
         DP    DECLOC(12),DECCON(5)           DIVIDE MANTISSA BY 2**24          *2D60120
         UNPK  RESULT(13),DECLOC(7)           BCD CHARS IN RESULT               *2D60130
         BR    12                                                               *2D60140
*              ROUTINE TO SET UP 10000000 IF ROUNDED RESULT GOES OVER 1.        *2D60150
SPILL    L     0,DECONE                                                         *2D60160
         L     1,DECZER                                                         *2D60170
         ST    0,RESULT                                                         *2D60180
         ST    1,RESULT+4                                                       *2D60190
         A     4,ONE               SCALE INCREASED BY 1                         *2D60200
         BR    12                                                               *2D60210
*              ROUTINE TO SET UP 00000000 IF NO SIGNIFICANT DIGITS              *2D60220
ZERO     L     0,DECZER                                                         *2D60230
         ST    0,RESULT                                                         *2D60240
         ST    0,RESULT+4                                                       *2D60250
         L     4,ONE               SCALE SET TO 1                               *2D60260
         MVI   MINUS,0             ZERO ALWAYS POSITIVE                         *2D60270
         BR    12                                                               *2D60280
*              ROUTINE TO SET UP DECIMAL NO. WITH DECIMAL PT. IN POS.           *2D60290
SETRND   L     0,ONE                                                            *2D60300
         LR    1,4                 GPR 1 = SCALE                                *2D60310
         L     7,BLNKWD            LOAD BLANKS IN GPRS 6                        *2D60320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 27 of 38)

```
         LR    6,7             AND 7                                   *2D060330
         SR    4,4                                                     *2D060340
         SR    5,5                                                     *2D060350
         L     2,EIGHT         NO MORE THAN 8 CHARS POSSIBLE           *2D060360
*                                                                      *2D060370
         TM    ST2SW,255       USE E CONVERSION                        *2D060380
         BZ    NOECON          IF COMING FROM SETPLOT                  *2D060390
         LTR   1,1             AND SCLAE FOR THIS NUMBER               *2D060400
         BM    ECON            IS NEGATIVE                             *2D060410
         C     1,SEVEN         OR GREATER THAN 7                       *2D060420
         BH    ECON                                                    *2D060430
         B     NOECON                                                  *2D060440
ECON     S     1,ONE                                                   *2D060450
         IC    7,RESULT        FIRST SIGNIFICANT DIGIT                 *2D060460
         SLDL  6,8(0)                                                  *2D060470
         IC    7,DOT           THEN THE DECIMAL POINT                  *2D060480
         L     2,TWO           THEN                                    *2D060490
FLOOP    A     5,ONE           THE                                     *2D060500
         SLDL  6,8(0)          NEXT                                    *2D060510
         IC    7,RESULT(5)     TWO                                     *2D060520
         BCT   2,ELOOP         SIGNIFICANT DIGITS                      *2D060530
         SLDL  6,8(0)                                                  *2D060540
         IC    7,ECHAR         THEN THE LETTER E                       *2D060550
         SLDL  6,8(0)                                                  *2D060560
         LTR   1,1             CHECK THE SIGN OF THE SCALE             *2D060570
         BP    EXPOS                                                   *2D060580
         LPR   1,1             COMPLEMENT IF NEGATIVE                  *2D060590
         IC    7,DASH          AND INSERT MINUS SIGN                   *2D060600
         B     EXDIGS                                                  *2D060610
EXPOS    IC    7,PLUS          INSERT PLUS SIGN                        *2D060620
EXDIGS   SR    0,0                                                     *2D060630
         D     0,TEN           CONVERT                                 *2D060640
         STC   1,T             SCALE                                   *2D060650
         OI    T,X'F0'         TO                                      *2D060660
         SLDL  6,8(0)          BCD                                     *2D060670
         IC    7,T             CHARACTERS                              *2D060680
         STC   0,T             AND                                     *2D060690
         OI    T,X'F0'         INSERT                                  *2D060700
         SLDL  6,8(0)                                                  *2D060710
         IC    7,T             THEM                                    *2D060720
         L     4,EIGHT         ALWAYS 8 CHARACTERS                     *2D060730
         BR    12                                                      *2D060740
*                                                                      *2D060750
NOECON   TM    MINUS,255       TEST THE SIGN                           *2D060760
         BZ    TST                                                     *2D060770
         IC    7,DASH          IF NEGATIVE, INSERT -                   *2D060780
TST      LTR   1,1             TEST THE SCALE                          *2D060790
         BNN   NLOOP                                                   *2D060800
         SLDL  6,8(0)          IF NEGATIVE                             *2D060810
         IC    7,DOT           INSERT .                                *2D060820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 28 of 38)

```
         A     .,.F                                             *2D60930
         LCR   1,1           TAKE COMPLEMENT                    *2D60940
INZER    SLDL  ,,R(0)                                           *2D60950
         IC    7,DECZ..      INSERT A 0                         *2D60960
         CHECKK                                                 *2D60870
         C     .,PLACE       IF NUMBER OF LEADING XEROS IS      *2D60880
         BH    FIN           EQUAL TO REQUESTED PLACES, EXIT    *2D60890
         BCT   1,INZER       LOOP TO INSERT LEADING ZEROS       *2D60900
         SR    ,,8                                              *2D60910
         L     1,PLACE                                          *2D60920
         LR    5,4                                              *2D60930
         B     NXT1                                             *2D60940
NXT      SLDL  6,R(0)                                           *2D60950
         IC    7,RESULT(4)   INSERT DIGIT                       *2D60960
         CHECKK                                                 *2D60970
NLOOP    BXLE  5,0,NXT       LOOP TO INSERT DIGITS LEFT OF .    *2D60980
         SLDL  6,R(0)                                           *2D60990
         IC    7,DUT         INSERT .                           *2D61000
         LR    3,4                                              *2D61010
         CHECKK                                                 *2D61020
         SR    5,5                                              *2D61030
         L     1,PLACE                                          *2D61040
         B     NLOOP1                                           *2D61050
NXT1     SLDL  6,8(0)                                           *2D61060
         IC    7,RESULT(R)   INSERT DIGIT                       *2D61070
         CHECKK                                                 *2D61080
         A     3,ONE                                            *2D61090
NLOOP1   BXLE  5,0,NXT1      LOOP TO INSERT DIGITS RIGHT OF .   *2D61100
FIN      TM    MINUS,255                                        *2D61110
         BZR   12            IF SIGN IS +, RETURN               *2D61120
         CR    4,2           IF - AND MORE THAN 8 CHARS         *2D61130
         BER   12            RETURN                             *2D61140
         A     4,ONE         IF LESS THAN 8, MINUS IS STILL THERE,  *2D61150
         MVI   MINUS,0       SO TURN OFF SWITCH                 *2D61160
         BR    12                                               *2D61170
*    ROUTINE TO CHECK IF LOG SCALE AND TAKE LOG OF YMAX...XMIN      RHH *2D61180
LOGS     TM    LOGSW,1          TEST LOG SWITCH FOR Y           RHH *2D61190
         BZ    TESTX1                                           *2D61200
*                        DO MAX AFTER MIN IN CASE BOTH < 0      RHH *2D61210
         LE    0,YMIN                                           *2D61220
         LTER  0,0           ALSO NEED CHECK <=0 LIM AS LOG ARG RHH *2D61230
         BNP   ERR           IN PLOT4                           RHH *2D61240
         STE   0,TYMIN                                          *2D61250
         BAS   12,LOG                                           *2D61260
         STE   0,TLYMIN      HOLD LOG UNTIL SURE NO ERRORS      RHH *2D61270
         LE    0,YMAX          IF ON,                           *2D61280
         STE   0,TYMAX                                          *2D61290
         BAS   12,LOG                                           *2D61300
         STE   0,TLYMAX      HOLD LOG UNTIL SURE NO ERRORS      RHH *2D61310
TESTX1   TM    LOGSW,2          TEST LOG SWITCH FOR X           *2D61320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 29 of 38)

```
         BZ    GOTLM4                                             RHH *2D61330
*                           DO MAX AFTER MIN IN CASE BOTH < 0     RHH *2D61340
         LE    0,XMIN                                                 *2D61350
         LTER  0,0          ALSO NEED CHECK <=0 LIM AS LOG ARG    RHH *2D61360
         BNP   ERR          IN PLOT4                              RHH *2D61370
         STE   0,TXMIN                                                *2D61380
         BAS   12,LOG                                                 *2D61390
         STE   0,XMIN         AND XMIN WITH LOG XMIN                  *2D61400
         LE    0,XMAX         IF ON.                                  *2D61410
         STE   0,TXMAX                                                *2D61420
         BAS   12,LOG                                                 *2D61430
         STE   0,XMAX         REPLACE XMAX WITH LOG XMAX              *2D61440
GOTLM4   TM    LOGSW,1      IF Y-->LOG Y, CAN NOW MOVE LOGS       RHH *2D61450
         BZR   6            INTO YMAX AND YMIN WITHOUT HAVING     RHH *2D61460
         MVC   YMAX(8),TLYMAX  DESTROYED THEM IN CASE OF ERR      RHH *2D61470
         BR    6                                                  RHH *2D61480
*              NATURAL LOG ROUTINE                                    *2D61490
LOG      STE   0,TT                                                   *2D61500
         LTER  0,0          REDUNDANT CHECK FOR BUM LOG ARG       RHH *2D61510
         BP    LOGOK                                              RHH *2D61520
         DC    H'0'         HARD STOP IF I MISSED BAD LOG ARG     RHH *2D61530
LOGOK    DS    0H                                                 RHH *2D61540
         STE   2,FPR2                                                 *2D61550
         SE    0,ONEF                                                 *2D61560
         STE   0,AP                                                   *2D61570
         LPER  0,0                                                    *2D61580
         CE    0,SML                                                  *2D61590
         BH    ARGBIG                                                 *2D61600
         LE    0,AP           IF .ABS.(ARG-1.) LESS THAN 1E-4         *2D61610
         LER   2,0            LOG ARG GIVEN BY                        *2D61620
         MER   2,0            -((ARG-1.)**2)/2+(ARG-1.)               *2D61630
         DE    2,MITWOF                                               *2D61640
         AER   0,2                                                    *2D61650
         LE    2,FPR2                                                 *2D61660
         BR    12             RETURN                                  *2D61670
ARGBIG   STM   0,1,LOGSAV                                             *2D61680
         L     0,TT                                                   *2D61690
         SRDL  0,24(0)        ISOLATE CHARACTERISTIC                  *2D61700
         S     0,HEX40        FIND IMPLIED EXPONENT                   *2D61710
         SLL   0,2(0)         MULTIPLY BY 4 TO GET BASE 2 EXPONENT    *2D61720
SITST    LTR   1,1            SHIFT MANTISSA                          *2D61730
         BN    RDY            LEFT UNTIL                              *2D61740
         SLL   1,1(0)         SIGN BIT                                *2D61750
         S     0,ONE          IS ON.                                  *2D61760
         B     SITST          REDUCING EXPONENT BY 1                  *2D61770
RDY      LTR   0,0            IF EXPONENT                             *2D61780
         BNN   EXPNN          IS NEGATIVE                             *2D61790
         MVI   MINUS,255      SET SIGN SWITCH TO -                    *2D61800
         LCR   0,0            AND COMPLEMENT                          *2D61810
         B     GOLOG                                                  *2D61820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 30 of 38)

```
EXPAN  MVI    MINUS,0                                                        *2061830
GCLOG  E      0,CNVRT                                                        *2061840
       ST     0,TT                                                           *2061850
       LE     0,ZERO E            FLOAT THE EXPONENT                         *2061860
       AE     0,TT                                                           *2061870
       TM     MINUS,255                                                      *2061880
       BZ     NOTNEG                                                         *2061890
       LCER   0,0                 RECOMPLEMENT                               *2061900
NOTNEG SE     0,HALF                                                         *2061910
       STE    0,HPWR              HPWR = EXPONENT-.5                         *2061920
       L      0,HEX40             WITH 40 AS CHARACTERISTIC                  *2061930
       SLDL   0,24(0)             BRING OVER MANTISSA                        *2061940
       ST     0,TT                                                           *2061950
       LE     0,TT                FR. 0 = FRACTIONAL PART, CALL IT F         *2061960
       LER    2,0                                                            *2061970
       SE     0,RSQRT2                                                       *2061980
       AE     2,RSQRT2                                                       *2061990
       DER    0,2                                                            *2062000
       STE    0,V                 V = (F-2**-.5)/(F+2**-.5)                  *2062010
       MER    0,0                                                            *2062020
       STE    0,VV                VV = V*V                                   *2062030
       ME     0,C1                                                           *2062040
       AE     0,C2                                                           *2062050
       ME     0,VV                                                           *2062060
       AE     0,C3                LOG ARG BASE 2 =                           *2062070
       ME     0,V                 V*(VV*((VV*.5999787)+.9614706)+2.885391)   *2062080
       AE     0,HPWR              +HPWR                                      *2062090
       ME     0,C4                NATURAL LOG = LOG BASE 2 * .6931472        *2062100
       LM     0,1,LOGSAV                                                     *2062110
       LE     2,FPR2                                                         *2062120
       BR     12                                                             *2062130
*             EXPONENTIAL ROUTINE - RAISES E TO A GIVEN POWER                *2062140
EXP    STE    2,FPR2                                                         *2062150
       STE    4,FPR4                                                         *2062160
       STE    6,FPR6                                                         *2062170
       LER    2,0                                                            *2062180
       LER    4,0                                                            *2062190
       LE     6,ONEE              I = 1                                      *2062200
       AER    0,6                 FIRST 2 TERMS ARE 1 AND X                  *2062210
EXPLP  STE    0,EXPANS                                                       *2062220
       AE     6,ONEE              I = I + 1                                  *2062230
       MER    4,2                 NEW TERM IS (X * OLD TERM)/I               *2062240
       DER    4,6                                                            *2062250
       AER    0,4                 ADD TO CUMULATIVE SUM                      *2062260
       CE     0,EXPANS            WHEN SUM IS NOT CHANGED BY ADDITION,       *2062270
       BNE    EXPLP               RETURN, OTHERWISE GET NEXT TERM            *2062280
       LE     2,FPR2                                                         *2062290
       LE     4,FPR4                                                         *2062300
       LE     6,FPR6                                                         *2062310
       BR     12                                                             *2062320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 31 of 38)

```
         EJECT                                                          *2D62330
*********************************************************************** *2D62340
*                                                                     * *2D62350
*    PLOT14 ALLOWS THE USER TO COMBINE SUCCESSIVE CALLS ON PLOT1,     * *2D62360
*    PLOT2, PLOT3, AND PLOT4 INTO ONE CALL ON PLOT14.                 * *2D62370
*                                                                     * *2D62380
*                        CALLING SEQUENCE IS                          * *2D62390
*        CALL     PLOT14(NSCALE,NHL,NSBH,NVL,NSBV,IMAGE,XMAX,XMIN,    * *2D62400
*                 YMAX,YMIN,BCD,X,Y,NDATA,INT,NCHAR,LABEL)            * *2D62410
*                                                                     * *2D62420
*********************************************************************** *2D62430
         SPACE                                                          *2D62440
         USING    *,15                                                  *2D62450
PLOT14   STM      14,12,12(13)                                          *2D62460
         L        3,PSKT              GET PSECT MTS STYLE               *2D62470
         USING    PLOTP,3                                               *2D62480
         ST       3,8(13)                                               *2D62490
         ST       13,4(3)                                               *2D62500
         MVI      PT14SW,255          TURN ON PLOT14 SWITCH             *2D62510
         L        15,PT1ADD                                             *2D62520
         USING    PLOT1,15            ESTABLISH ADDRESSABILITY FOR PLOT1 *2D62530
         BAS      14,PLT1             EXECUTE PLOT1                     *2D62540
         A        1,TWENTY            BUMP GPR 1 TO POINT TO PLOT2 ARGS *2D62550
         L        15,PT2ADD                                             *2D62560
         USING    PLOT2,15            ESTABLISH PLOT2 ADDRESSABILITY    *2D62570
         BAS      14,PLT2             EXECUTE PLOT2                     *2D62580
         A        1,TWENTY            BUMP GPR 1 TO POINT TO PLOT3 ARGS *2D62590
         L        13,PT3ADD                                             *2D62600
         USING    PLOT3,13            ESTABLISH ADDRESSABILITY FOR PLOT3 *2D62610
         L        15,PT4ADD                                             *2D62620
         USING    PLOT4,15            AND PLOT4 (THE LATTER FOR LOG USE) *2D62630
         BAS      14,PLT3             EXECUTE PLOT3                     *2D62640
         DROP     13                                                    *2D62650
         A        1,TWENTY                                              *2D62660
         MVI      PT14SW,0            TURN OFF PLOT14 SWITCH            *2D62670
         B        PLT4                EXECUTE PLOT4, RETURN FROM THERE  *2D62680
         EJECT                                                          *2D62690
*********************************************************************** *2D62700
*                                                                     * *2D62710
*      STPLT1 IS CALLED BY THE USER WHO WISHES THE PLOT ROUTINE       * *2D62720
*    TO INSPECT HIS DATA AND THEN MAKE APPROPRIATE CALLS ON           * *2D62730
*    PLOT1 AND PLOT2.  STPLT2 DOES THE WORK OF STPLT1 AND IN          * *2D62740
*    ADDITION CALLS ON PLOT3 AND PLOT4 TO OBTAIN A GRAPH.             * *2D62750
*                                                                     * *2D62760
*                        CALLING SEQUENCE IS                          * *2D62770
*        CALL     STPLT1(IMAGE,X,Y,NDATA,INT)                         * *2D62780
*    OR                                                               * *2D62790
*        CALL     STPLT2(IMAGE,X,Y,NDATA,INT,BCD,NCHAR,LABEL)         * *2D62800
*                                                                     * *2D62810
*********************************************************************** *2D62820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 32 of 38)

```
         SPAC
         USING *,15                                                    *2D62830
STPLT2   STM   14,12,12(13)                                        RHH *2D62840
         L     3,PSKT                                              RHH *2D62850
         USING PLCTP,3                                                 *2D62860
         MVI   ST2SW,255        TURN ON SETPLOT2 SWITCH                *2D62870
         B     SVRS                                                    *2D62880
STPLT1   STM   14,12,12(13)                                        RHH *2D62890
*  FOLLOWING WAS ERRONEOUSLY USING *,15 IN VERSION SENT OUT TO SOME    *2D62900
            USING STPLT1,15                                            *2D62910
         L     15,ASP2          ESTABLISH ADDRESSABILITY               *2D62920
         USING STPLT2,15                                           RHH *2D62930
         L     3,PSKT                                                  *2D62940
         MVI   ST2SW,0          TURN OFF SETPLOT2 SWITCH               *2D62950
SVRS     DS    0H                                                  RHH *2D62960
         ST    3,8(,13)                                            RHH *2D62970
         ST    13,4(3)                                                 *2D62980
         MVI   STSW,255         TURN ON SETPLOT SWITCH                 *2D62990
         L     15,PT2ADD                                               *2D63000
         USING PLOT2,15         ESTABLISH PLOT2 ADDRESSABILITY         *2D63010
         L     5,0(1)           GET IMAGE ADDRESS                      *2D63020
         ST    5,IMAGE                                                 *2D63030
         L     5,16(1)          GET INTERVAL IN WORDS                  *2D63040
         L     6,0(6)           BETWEEN X AND Y VALUES                 *2D63050
         L     5,12(1)                                                 *2D63060
         L     5,0(5)           GET NDATA                              *2D63070
         S     5,ONE            SUBTRACT 1                             *2D63080
         MR    4,6              GPR 5 = (NDATA-1)*INT*4                *2D63090
         LR    4,6              GPR 4 = INT*4                          *2D63100
         L     2,4(1)           GET X ADDRESS                          *2D63110
TSTXY    LE    0,0(2)           GET FIRST X OR Y VALUE                 *2D63120
         LER   2,0                                                     *2D63130
         SR    6,6                                                     *2D63140
STGO     LE    4,0(2,6)         GET NEXT VALUE                         *2D63150
         CER   0,4                                                     *2D63160
         BNL   STRYMN                                                  *2D63170
         LER   0,4              KEEP GREATER VALUE IN FPR 0            *2D63180
         B     SLOOP                                                   *2D63190
STRYMN   CER   2,4                                                     *2D63200
         BNH   SLOOP                                                   *2D63210
         LER   2,4              KEEP SMALLER VALUE IN FPR 2            *2D63220
SLOOP    BXLE  6,4,STGO         LOOP TO INSPECT ALL X AND Y VALUES     *2D63230
         TM    YSW,255          TEST TO SEE IF VALUES ARE Y            *2D63240
         BO    YTHRU                                                   *2D63250
         STE   0,XMAX           SET XMAX                               *2D63260
         STE   2,XMIN           SET XMIN                               *2D63270
         MVI   YSW,255          NOW DO Y                               *2D63280
         L     2,8(1)           GET Y ADDRESS                          *2D63290
         B     TSTXY                                                   *2D63300
YTHRU    STE   0,YMAX           SET YMAX                               *2D63310
                                                                       *2D63320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 33 of 38)

```
         STE    2,YMIN          SET YMIN                                     *2D63330
         MVI    YSW,0           TURN OFF Y SWITCH                            *2D63340
         ST     4,SAV4          SAVE GPRS 4                                  *2D63350
         ST     5,SAV5          AND 5                                        *2D63360
*                                                                            *2D63370
         LE     0,XMIN                                                       *2D63380
         LE     2,XMAX                                                       *2D63390
GOSKL    LPER   0,0             FPR 0 = .ABS.(XMIN OR YMIN)                  *2D63400
         LPER   2,2             FPR 2 = .ABS.(XMAX OR YMAX)                  *2D63410
         L      4,THREE         ASSUME 3 DECIMAL PLACES                      *2D63420
         SR     2,2             AND 0 SCALE FACTOR TO START                  *2D63430
         CER    0,2                                                          *2D63440
         BNL    CMMAG                                                        *2D63450
         LER    0,2             FPR 0 = VALUE OF GREATER MAGNITUDE           *2D63460
CMMAG    LTER   0,0            IF LARGEST VALUE IS 0                     RHH *2D63470
         BE     TOUT            DO NOT TRY TO SCALE IT                       *2D63480
         CE     0,ONEE                                                   RHH *2D63490
         BNL    T1                                                           *2D63500
         CE     0,SML                                                        *2D63510
         BL     T2                                                           *2D63520
         L      4,SEVEN         IF VALUE GREATER THAN OR = 1E-4 AND LESS     *2D63530
         B      TOUT            THAN 1, USE 7 DECIMAL PLACES AND 0 SCALE     *2D63540
T2       ME     0,MILL          IF VALUE LESS THAN 1E-4, MULTIPLY BY 1E6     *2D63550
         A      2,SIX           UNTIL VALUE IS GREATER THAN 1, INCREASING    *2D63560
         CE     0,ONEE          SCALE FACTOR BY 6 EACH TIME                  *2D63570
         BL     T2                                                           *2D63580
T1       CE     0,MILL          IF VALUE IS GREATER THAN OR = 1E6,           *2D63590
         BL     TOUT            DIVIDE VALUE BY 1E6 UNTIL VALUE IS LESS      *2D63600
         DE     0,MILL          THAN 1E6, DECREASING SCALE FACTOR            *2D63610
         S      2,SIX           BY 6 EACH TIME                               *2D63620
         B      T1                                                           *2D63630
TOUT     TM     YSW,255         TEST TO SEE IF VALUES ARE Y                  *2D63640
         BO     YSLOUT                                                       *2D63650
         ST     2,XSCALE        SET XSCALE                                   *2D63660
         ST     4,XPLACE        SET XPLACE                                   *2D63670
         STSKL  T3,XSKSW,XDIG1,XDIG2,XSI,LOC1                                *2D63680
T3       LE     0,YMIN                                                       *2D63690
         LE     2,YMAX                                                       *2D63700
         MVI    YSW,255         NOW DO Y                                     *2D63710
         B      GOSKL                                                        *2D63720
YSLOUT   ST     2,YSCALE        SET YSCALE                                   *2D63730
         ST     4,YPLACE        SET YPLACE                                   *2D63740
         STSKL  T6,YSKSW,YDIG1,YDIG2,YSI,LOC2                                *2D63750
T6       MVI    YSW,0           TURN OFF Y SWITCH                            *2D63760
*                                                                            *2D63770
         MVI    PT14SW,255      TURN ON PLOT14 SWITCH                        *2D63780
         BAS    14,STENT        EXECUTE PLOT2                                *2D63790
         TM     ST2SW,255       IF SETPLOT1 ENTERED                          *2D63800
         BO     GTCHR           TURN OFF                                     *2D63810
         MVI    PT14SW,0        PLOT14                                       *2D63820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 34 of 38)

```
         MVI   STSW,0         AND SETPLOT SWITCHES                          *2D063830
         B     OUTP42         AND RETURN                                    *2D063840
GTCHR    L     2,20(1)                                                      *2D063850
         IC    2,0(9)         GET PLOTTING CHARACTER                        *2D063860
         L     13,PT3ADD                                                    *2D063870
         USING PLOT3,13       ESTABLISH PLOT3                               *2D063880
         L     15,PT4ADD                                                    *2D063890
         USING PLOT4,15       AND PLOT4 ADDRESSABILITY                      *2D063900
         L     4,SAV4         RESTORE GPRS 4                                *2D063910
         L     5,SAV5         AND 5                                         *2D063920
         BAS   14,STENT3      EXECUTE PLOT3                                 *2D063930
         A     1,TWNTY4       BUMP GPR 1 TO POINT TO PLOT4 ARGS             *2D063940
         MVI   PT14SW,0       TURN OFF ALL RELEVANT                         *2D063950
         MVI   STSW,0         SWITCHES                                      *2D063960
         B     PLT4           EXECUTE PLOT4 AND RETURN FROM THERE           *2D063970
         EJECT                                                              *2D063980
TEND     DC    D'10.'                                                       *2D063990
TENTHD   DC    D'.1'                                                        *2D064000
ONED     DC    D'1.'                                                        *2D064010
SKFAC    DC    H'-20'                                                       *2D064020
         DC    H'-10'                                                       *2D064030
         DC    H'-6'                                                        *2D064040
         DC    H'-4'                                                        *2D064050
         DC    H'-2'                                                        *2D064060
         DC    H'2'                                                         *2D064070
         DC    H'4'                                                         *2D064080
         DC    H'6'                                                         *2D064090
         DC    H'10'                                                        *2D064100
ONE      DC    F'1'                                                         *2D064110
TWO      DC    F'2'                                                         *2D064120
THREE    DC    F'3'                                                         *2D064130
FOUR     DC    F'4'                                                         *2D064140
FIVE     DC    F'5'                                                         *2D064150
SIX      DC    F'6'                                                         *2D064160
SEVEN    DC    F'7'                                                         *2D064170
EIGHT    DC    F'8'                                                         *2D064180
NINE     DC    F'9'                                                         *2D064190
TEN      DC    F'10'                                                        *2D064200
ELEVEN   DC    F'11'                                                        *2D064210
TWELVE   DC    F'12'                                                        *2D064220
TWENTY   DC    F'20'                                                        *2D064230
TWNTY4   DC    F'24'                                                        *2D064240
TWNTY8   DC    F'28'                                                        *2D064250
THIRTY   DC    F'30'                                                        *2D064260
THIRTY2  DC    F'32'                                                        *2D064270
FIFTY1   DC    F'51'                                                        *2D064280
ONEOH1   DC    F'101'                                                       *2D064290
ONEOH4   DC    F'104'                                                       *2D064300
MITWOF   DC    E'-2.'                                                       *2D064310
ZEROF    DC    E'0.'                                                        *2D064320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 35 of 38)

```
SML      DC     E'1E-4'                                       *2D64330
TENTH    DC     E'.1'                                         *2D64340
HALF     DC     E'.5'                                         *2D64350
ONEF     DC     E'1.'                                         *2D64360
TENF     DC     E'10.'                                        *2D64370
MILL     DC     E'1.E6'                                       *2D64380
C1       DC     E'.5989787'                                   *2D64390
C2       DC     E'.9614706'                                   *2D64400
C3       DC     E'2.885391'                                   *2D64410
C4       DC     E'.6931472'                                   *2D64420
I        DC     C'I'                                          *2D64430
DASH     DC     C'-'                                          *2D64440
PLUS     DC     C'+'                                          *2D64450
BLNK     DC     C' '                                          *2D64460
DECONE   DC     C'1000'                                       *2D64470
DECZER   DC     C'0000'                                       *2D64480
BLNKWD   DC     C'    '                                       *2D64490
RSQRT2   DC     X'40B504F3'                                   *2D64500
HEX40    DC     X'00000040'                                   *2D64510
CNVRT    DC     X'46000000'                                   *2D64520
MSK      DC     X'00FFFFFF'                                   *2D64530
DECCON   DC     X'0167772 16C'                                *2D64540
FIFTY7   DC     H'57'                                         *2D64550
DOT      DC     C'.'                                          *2D64560
ECHAR    DC     C'E'                                          *2D64570
PSKT     DC     A(PLOTP)        PSECT ADDRESS                 *2D64580
ASP2     DC     A(STPLT2)                                     *2D64590
***                                                       RHH *2D64600
**  CAUTION:  ALMOST OUT OF ROOM HERE                     RHH *2D64610
***                                                       RHH *2D64620
         EJECT                                                *2D64630
         ORG    PLOT+4096                                     *2D64640
PLOTP    DS     19F                                           *2D64650
IMAGE    DS     1F                                            *2D64660
MVPLUS   MVC    0(0,7),PLLINE                                 *2D64670
MVILIN   MVC    0(0,7),IILINE                                 *2D64680
MVPTLN   MVC    LINE+12,0(14)                                 *2D64690
FPTAB    DC     D'1E-20'                                      *2D64700
         DC     D'1E-10'                                      *2D64710
         DC     D'1E-6'                                       *2D64720
         DC     D'1E-4'                                       *2D64730
         DC     D'1E-2'                                       *2D64740
         DC     D'1E2'                                        *2D64750
         DC     D'1E4'                                        *2D64760
         DC     D'1E6'                                        *2D64770
         DC     D'1E10'                                       *2D64780
FPTBND   DC     D'1E20'                                       *2D64790
NHL         DC  F'6'                                          *2D64800
NSBH        DC  F'9'                                          *2D64810
NVL         DC  F'11'                                         *2D64820
```

Printer Plot Routines (PLOT1 through PLOT4) (page 36 of 38)

```
NSAV     DC     F'0'                                                        *2D64830
W        DC     F'101'                                                      *2D64840
L        DC     F'51'                                                       *2D64850
WC       DC     F'104'                                                      *2D64860
DWNO     DC     F'12'                                                       *2D64870
T         DS     1F                                                         *2D64880
XMAX     DS     1F                                                          *2D64890
XMIN     DS     1F                                                          *2D64900
YMAX     DS     1F                                                          *2D64910
YMIN     DS     1F                                                          *2D64920
WFP      DS     1F                                                          *2D64930
LFP      DS     1F                                                          *2D64940
TYMAX    DS     1F                                                          *2D64950
TYMIN    DS     1F                                                          *2D64960
TXMAX    DS     1F                                                          *2D64970
TXMIN    DS     1F                                                          *2D64980
PLOTNR   DC     C'-1233444' PLOT# INDEXED BY RC; + SPARES              RHH *2D64990
RC       DC     0H'0',C'00040812162024283?' RETURN CODES, + SPARES    RHH *2D65000
H23      DC     H'23'          LENGTH OF ERRMSG                        RHH *2D65010
ERRMSG DC       0H'0',C'0**PRINTER PLOT* RC=**.'                       RHH *2D65020
*PRESERVE ORDER YMAX,YMIN & TLYMAX,TLYMIN FOR MVC YMAX(8),TLYMAX      RHH *2D65030
TLYMAX DS       2F             HOLD LOGS HERE UNTIL SURE NO ERROR     RHH *2D65040
TLYMIN EQU      TLYMAX+4       SO WON'T LEAVE YMAX, YMIN CHANGED      RHH *2D65050
LINE        DC     12CL12' '                                                *2D65060
L120     DC     H'0'                                                        *2D65070
MINUS    DS     1C                                                          *2D65080
RESULT DS       1D                                                          *2D65090
         DS     1D                                                          *2D65100
         DS     1D                                                          *2D65110
DECLOC DS       1D                                                          *2D65120
         DS     1D                                                          *2D65130
SPDEV       DC     CL8'SPRINT'                                              *2D65140
EXPANS DS       1F                                                          *2D65150
TT       DS     1F                                                          *2D65160
TTT      DS     1F                                                          *2D65170
HEWR     DS     1F                                                          *2D65180
AF       DS     1F                                                          *2D65190
V        DS     1F                                                          *2D65200
VV       DS     1F                                                          *2D65210
LOGSAV DS       1F                                                          *2D65220
         DS     1F                                                          *2D65230
FPR2     DS     1F                                                          *2D65240
FPR4     DS     1F                                                          *2D65250
FPR6     DS     1F                                                          *2D65260
SAV1     DS     1F                                                          *2D65270
SAV4     DS     1F                                                          *2D65280
SAV5     DS     1F                                                          *2D65290
SAV14    DS     1F                                                          *2D65300
SV1415 DS       2F                                                          *2D65310
P4SA     DS     19F                                                         *2D65320
```

Printer Plot Routines (PLOT1 through PLOT4) (page 37 of 38)

```
PT1ADD DC    A(PLOT1)                                                    *2065330
PT2ADD DC    A(PLOT2)                                                    *2065340
PT3ADD DC    A(PLOT3)                                                    *2065350
PT4ADD DC    A(PLOT4)                                                    *2065360
SPRNT  DC    F'0'                                                        *2065370
       DC    A(XPRINT)                                                   *2065380
PLLINE DS    15D                                                         *2065390
IILINE DS    15D                                                         *2065400
REGSAV DS    9F                                                          *2065410
ERRSW  DC    X'000000'                                                   *2065420
ERRNO  DC    X'00'                                                       *2065430
OMITSW DC    X'00'                                                       *2065440
PLT1SW DC    X'00'  PLOT1 CALLED?: 0=NEVER, 1=LAST BAD, 255=OK       RHH *2065450
PLT2SW DC    X'00'  PLOT2 CALLED?: 0=NEVER, 1=LAST BAD, 255=OK       RHH *2065460
LOGSW  DC    X'00'                                                       *2065470
PT14SW DC    X'00'                                                       *2065480
YSW    DC    X'00'                                                       *2065490
STSW   DC    X'00'                                                       *2065500
ST2SW  DC    X'00'                                                       *2065510
XSKSW  DC    X'00'                                                       *2065520
YSKSW  DC    X'00'                                                       *2065530
       DS    0F                                                          *2065540
TTY    DC    CL4'TTY'                                                    *2065550
YSCALE DS    1F                                                          *2065560
YPLACE DS    1F                                                          *2065570
XSCALE DS    1F                                                          *2065580
XPLACE DS    1F                                                          *2065590
SCALE  DS    1F                                                          *2065600
PLACE  DS    1F                                                          *2065610
XCOM   DC    C'0 PRINTED VALUES OF X ARE 1E'                             *2065620
XSI    DC    C' '                                                        *2065630
XDIG1  DC    C'0'                                                        *2065640
XDIG2  DS    1C                                                          *2065650
       DC    C' TIMES THEIR ACTUAL VALUES'                               *2065660
YCOM   DC    C'0 PRINTED VALUES OF Y ARE 1E'                             *2065670
YSI    DC    C' '                                                        *2065680
YDIG1  DC    C'0'                                                        *2065690
YDIG2  DS    1C                                                          *2065700
       DC    C' TIMES THEIR ACTUAL VALUES'                               *2065710
       DS    10F                                                         *2065720
       END                                                               *2065730
```

Printer Plot Routines (PLOT1 through PLOT4) (page 38 of 38)

```
      DIMENSION V11(61),V12(61),V13(61),V14(61),V21(61),V22(61),        TALK2000
     1V23(61),V31(61),V32(61),V33(61),V34(61),H(11,82),IN(4),OUT(4),    TALK2010
     2IG(3),T(82),DUM(22),B(54),V(82,65),AH(82),BH(82),CH(82),          TALK2020
     3DH(82),ACH(82),BCH(82),CCH(82),DCH(82),BL(3),KI(8),KA(8),         TALK2030
     4PP(8),LA(61),BJ(8,20),BI(8,60)                                    TALK2040
      DATA V11/30*4H    B,3*1H ,3*4H    B,2*4H    S,2*4H  RE,3*4H    B,4*4H TALK2050
     . AC,1H ,4*4H    U,9*1H /                                          TALK2060
      DATA V12/30*3HODY,3*4H VEH,3*3HELT,2*3HEAT,2*4HLATI,3*3HFLT,4*4HCETALK2070
     .LE,4H    H,4*4HPPER,5*4H  HE,'  EL   KN',2*4H  FO/                TALK2080
      DATA V13/24*4HANGL,6*4HMOTI,3*4HICLE,5*4HFURC,2*4HVF H,3*4HANGL,4*TALK2090
     .4HROME,2HIP,4*4H TOR,5*2HAD,3HBOW,2HEE,2*2HOT/                    TALK2100
      DATA V34/16*1H ,8*2HON,2*1H ,2HON,2*1H ,2HON,2*1H ,2HON,5*1H ,1HL,TALK2110
     .4*1H ,1HT,1H ,1HT,2*1H ,1HK,1H ,2HEL,1HD,3HEEL,2HEL,4HLUMN,       TALK2120
     .1HD,3HEEL,4HBACK/                                                 TALK2130
      DATA V14/24*2HES,6*2HUN,3*1H ,5*2HES,2*3HEAD,3*2HES,4*3HTER,1H ,  TALK2140
     .4*2HSU,9*1H /                                                     TALK2150
      DATA V21/' LOWCENT UPP       UP  LO  UP  LO LOWCENT UPP      UP',' TALK2160
     . LO  UP  LO LOWCENT UPP       UP  LO  UP  LO',3*4H HOR,3*4H  VE,3*4TALK2170
     .H   M,4H  LA,3*1H ,4H FRO,2*4H  PD,4H  LA,20*1H /                 TALK2180
      DATA V22/3*4HER T,4HHEAD,'PER WER PER WER ',3*4HER T,4HHEAD,'PER WTALK2190
     .ER PER WER ',3*4HER T,4HHEAD,'PER WER PER WER ',3*4HIZON,3*4HRTIC,TALK2200
     .3*4HOTIO,'P BELOWEUPPE HIPNT ESITISITIP BELOWEUPPEHEAD',4HHEAD,2*4TALK2210
     .HCHES,14*3H ON/                                                   TALK2220
      DATA V23/3*4HORSO,1H , 2*3HARM,2*3HLEG,3*4HORSO,1H ,2*3HARM,2*3HLETALK2230
     .G,3*4HORSO,1H ,2*3HARM,2*3HLEG,3*3HTAL,3*2HAL,3*1HN,2HLT,2*1HR,1H TALK2240
     .,3HDGE,2*2HON,2HLT,2*1HR,2*1H ,2*1HT,14*1H /                      TALK2250
      DATA V31/16*1H ,8*4H  AC,2*1H ,4H  AC,2*1H ,4H  AC,2*1H ,4H  AC,5*TALK2260
     .1H ,4H    H,11*1H ,'   U   W STE   L STE      STE FRO'/           TALK2270
      DATA V32/8*4HPOSI,8*4HVELO,8*4HCELE,'POSIVELOCELEPOSIVELOCELEPUSI'TALK2280
     .,'VELOCELE',1H ,2*4HSHOU,2*1H ,'ORIZVERT',1H ,2*4HSHOU,'RESU  AN',TALK2290
     .'RESU  AN  FLSEAT  ROPPERINDSERINOWERERINTOE ERINNT S'/           TALK2300
      DATA V33/8*4HTION,8*4HCITY,8*4HRATI,'TIONCITYRATITIONCITYRATITION'TALK2310
     .,'CITYRATI',1H ,2*4HLDER,2*1H ,4HONTA,4HICAL,1H ,2*4HLDER,  'LTANGTALK2320
     .LE LTANGLE OOR  BACOF   PANHIELG WH PANG COBOARG WHEAT '/         TALK2330
      EQUIVALENCE(BI(1,46),BJ(1,1))                                     TALK2340
      DATA BI/'FLOOR-X ',6*1H ,'SEAT BACK-X ',5*1H ,'ROOF-X  ',6*1H ,   TALK2350
     .'UPPER PANEL-X    ',4*1H ,'WINDSHIELD-X',5*1H ,'LOWER STEERING WHEETALK2360
     .L-X  ',2*1H ,'LOWER PANEL-X    ',4*1H ,'STEERING COLUMN-X    ',3*1H TALK2370
     .,'TOEBOARD-X  ',5*1H ,'FLOOR-Y ',6*1H ,'SEAT BACK-Y ',5*1H ,      TALK2380
     .'ROOF-Y  ',6*1H ,'UPPER PANEL-Y    ',4*1H ,'WINDSHIELD-Y',5*1H ,  TALK2390
     .'LOWER STEERING WHEEL-Y  ',2*1H ,'LOWER PANEL-Y    ',4*1H ,'STEERINTALK2400
     .G COLUMN-Y    ',3*1H ,'TOEBOARD-Y  ',5*1H ,'HIP CONTACT ARC RADIUS TALK2410
     . ', 2*1H ,'UPPER TORSO CONTACT ARC RADIUS  HEAD CONTACT ARC RADIUSTALK2420
     . ', 2*1H ,'ELBOW CONTACT ARC RADIUS',2*1H ,'HAND CONTACT ARC RADIUTALK2430
     .S ',2*1H ,'KNEE CONTACT ARC RADIUS ',2*1H ,'FOOT CONTACT ARC RADIUTALK2440
     .S ',2*1H ,  'TO HEAD CENTER OF CURVATURE      TO CHEST CENTER OF CUTALK2450
     .RVATURE',1H ,'LOWER TORSO LENGTH  ',3*1H ,'CENTER TORSO LENGTH ', TALK2460
     .3*1H ,'UPPER TORSO LENGTH  ',3*1H ,'CENTER TORSO TO UPPER ARM   ',TALK2470
     .1H ,'UPPER ARM LENGTH',4*1H ,'LOWER ARM LENGTH',4*1H ,'UPPER LEG LTALK2480
     .ENGTH',4*1H ,'LOWER LEG LENGTH',4*1H ,'FLOOR-LENGTH',5*1H ,'SEAT BTALK2490
```

TALK2 Main Program (page 1 of 6)

```
      .ACK-LENGTH',4*1H ,'ROOF-LENGTH ',5*1H ,'UPPER PANEL-LENGTH  ',3*1HTALK2500
      . ,'WINDSHIELD-LENGTH',3*1H ,'LOWER STEERING WHEEL LENGTH ',1H ,   TALK2510
      .'LOWER PANEL-LENGTH',3*1H ,'STEERING COLUMN-LENGTH',2*1H ,        TALK2520
      .'TOEBOARD-LENGTH ',4*1H ,'DISTANCE FROM HIP TO SEAT FRONT '/      TALK2530
       DATA BJ/'NUMBER OF BELT SEGMENTS ',2*1H ,'LOWER TORSO-C.G. TO LOWETALK2540
      .R JOINT CENTER TORSO-C.G. TO LOWER JOINTUPPER TORSO-C.G. TO LOWER TALK2550
      .JOINT HEAD-C.G. TO LOWER JOINT',2*1H ,'UPPER ARM-C.G. TO LOWER JOITALK2560
      .NT   LOWER ARM-C.G. TO LOWER JOINT   UPPER LEG-C.G. TO LOWER JOINTTALK2570
      .   LOWER LEG-C.G. TO LOWER JOINT   UPPER STEERING WHEEL-X  ',2*1H TALK2580
      .,'BACK OF FRONT SEAT-X',3*1H ,'UPPER STEERING WHEEL-Y  ',2*1H ,   TALK2590
      .'BACK OF FRONT SEAT-Y',3*1H ,'UPPER STEERING WHEEL-LENGTH     ',  TALK2600
      .'BACK OF FRONT SEAT-LENGTH   ',1H /                               TALK2610
       DO 9 I=1,82                                                       TALK2620
       DO 9 J=48,61                                                      TALK2630
    9  V(I,J)=0.                                                         TALK2640
       DO 8 I=1,61                                                       TALK2650
    8  LA(I)=-1                                                          TALK2660
       DO 25 I=1,3                                                       TALK2670
   25  IG(I)=0                                                           TALK2680
       DTR=.01745329                                                     TALK2690
       N=0                                                               TALK2700
       REWIND 9                                                          TALK2710
       READ(9)(DUM(I),I=1,6),(B(I),I=1,9),DUM(1),(B(I),I=10,18),DUM(1),  TALK2720
      .B(19),DUM(1),(B(I),I=20,44),(DUM(I),I=1,22),B(45),B(46),          TALK2730
      .(DUM(I),I=1,10),(B(I),I=47,54)                                    TALK2740
   18  N=N+1                                                             TALK2750
       IF(N.GT.82) GO TO 19                                              TALK2760
       READ(9,END=19)T(N),(V(N,I),I=1,33),AH(N),BH(N),CH(N),DH(N),ACH(N),TALK2770
      .BCH(N),CCH(N),DCH(N),JJ,(KI(I),KA(I),PP(I),I=1,JJ),(V(N,I),I=34,43TALK2780
      .),BL                                                              TALK2790
       IF(T(N).LT.0.) GO TO 19                                           TALK2800
       DO 20 I=41,43                                                     TALK2810
   20  V(N,I)=V(N,I)/DTR                                                 TALK2820
       IF(JJ)18,18,4                                                     TALK2830
    4  DO 7 J=1,JJ                                                       TALK2840
       KIJ=KI(J)                                                         TALK2850
       GO TO (61,61,62,63,64,64,64,66),KIJ                               TALK2860
   61  M=48                                                              TALK2870
       GO TO 67                                                          TALK2880
   62  M=48+KA(J)/2                                                      TALK2890
       GO TO 67                                                          TALK2900
   63  M=51+KA(J)                                                        TALK2910
       GO TO 67                                                          TALK2920
   64  M=58+(KIJ-5)/2                                                    TALK2930
       GO TO 67                                                          TALK2940
   66  M=60+(KA(J)-1)/8                                                  TALK2950
   67  LA(M)=KA(J)                                                       TALK2960
    7  V(N,M)=PP(J)                                                      TALK2970
       GO TO 18                                                          TALK2980
   19  WRITE(6,601)                                                      TALK2990
```

TALK2 Main Program (page 2 of 6)

```
601   FORMAT('OENTER 6 IF CONVERSATIONAL, 7 IF NOT')                    TALK3000
      READ(1,500)IWR                                                    TALK3010
      IF(IWR.EQ.6)IR=1                                                  TALK3020
      IF(IWR.EQ.7)IR=8                                                  TALK3030
      N=N-1                                                             TALK3040
1000  WRITE(IWR,602)                                                    TALK3050
602   FORMAT(1HO/1X/'OENTER DATA TYPE, 1 IF INITIAL, 2 IF GENERAL, 3 IF TALK3060
     .COMPLEX, 4 IF DONE')                                              TALK3070
      READ(IR,500,END=598)KIND                                          TALK3080
500   FORMAT(I10)                                                       TALK3090
      GO TO (1,2,3,999),KIND                                            TALK3100
1     WRITE(IWR,612)                                                    TALK3110
612   FORMAT('OENTER VARIABLE NUMBER - 0 IF DONE')                      TALK3120
39    WRITE(IWR,613)                                                    TALK3130
613   FORMAT(' (   )')                                                  TALK3140
      READ(IR,500)K                                                     TALK3150
      KC=K                                                              TALK3160
      IF(K.EQ.0) GO TO 1000                                             TALK3170
      IF((K.NE.4).AND.(K.NE.13).AND.(K.NE.39)) GO TO 40                 TALK3180
      IF(IG(3).GT.0) GO TO 41                                           TALK3190
      WRITE(IWR,607)                                                    TALK3200
      READ(IR,500)NPASGR                                                TALK3210
      IG(3)=1                                                           TALK3220
41    IF(NPASGR-2)42,40,42                                              TALK3230
42    IF(K-13) 44,45,46                                                 TALK3240
44    K=55                                                              TALK3250
      GO TO 43                                                          TALK3260
45    K=57                                                              TALK3270
      GO TO 43                                                          TALK3280
46    K=59                                                              TALK3290
43    IF(NPASGR.EQ.3)K=K+1                                              TALK3300
40    WRITE(6,614)B(KC),(BI(I,K),I=1,8)                                 TALK3310
614   FORMAT(1HO,F13.3,' = ',8A4)                                       TALK3320
      GO TO 39                                                          TALK3330
2     WRITE(IWR,603)                                                    TALK3340
603   FORMAT('OHOW MANY VARIABLES?')                                    TALK3350
      READ(IR,500)NUM                                                   TALK3360
      WRITE(IWR,604)                                                    TALK3370
604   FORMAT('OENTER VARIABLE NUMBERS'/1X,4('(    )'))                  TALK3380
      READ(IR,501)(IN(J),J=1,NUM)                                       TALK3390
501   FORMAT(4(1X,I3,1X))                                               TALK3400
50    WRITE(IWR,605)                                                    TALK3410
605   FORMAT('OENTER TIME INTERVAL'/1X,'FROM(',7X,')TO(',7X,')')        TALK3420
      READ(IR,502)TMIN,TMAX                                             TALK3430
502   FORMAT(5X,F7.0,4X,F7.0)                                           TALK3440
      DO 11 I=1,N                                                       TALK3450
      IF(TMIN.LE.T(I))GO TO 12                                          TALK3460
11    CONTINUE                                                          TALK3470
12    JI=I                                                              TALK3480
      DO 13 I=JI,N                                                      TALK3490
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      IF(TMAX.LT.T(I)) GO TO 14                                       TALK3500
   13 CONTINUE                                                        TALK3510
   14 JJ=I                                                            TALK3520
      DO 15 I=1,NUM                                                   TALK3530
      K=IN(I)                                                         TALK3540
      IF((K.LT.44).OR.(K.GT.47)) GO TO 24                             TALK3550
      IF(K.LT.46) GO TO 23                                            TALK3560
      IF(IG(2).EQ.1) GO TO 28                                         TALK3570
      WRITE(IWR,615)                                                  TALK3580
  615 FORMAT('OENTER VALUE OF "PCHEST"')                              TALK3590
      READ(IR,503) PCHEST                                             TALK3600
  503 FORMAT(F15.0)                                                   TALK3610
      IG(2)=1                                                         TALK3620
      DO 26 II=1,N                                                    TALK3630
      X=ACH(II)-PCHEST*BCH(II)                                        TALK3640
      Y=CCH(II)+PCHEST*DCH(II)                                        TALK3650
      V(II,46)=SQRT(X*X+Y*Y)                                          TALK3660
   26 V(II,47)=ATAN2(Y,X)/DTR                                         TALK3670
      GO TO 28                                                        TALK3680
   23 IF(IG(1).EQ.1) GO TO 28                                         TALK3690
      WRITE(IWR,606)                                                  TALK3700
  606 FORMAT('OENTER VALUE OF "PHEAD"')                               TALK3710
      READ(IR,503)PHEAD                                               TALK3720
      IG(1)=1                                                         TALK3730
      DO 27 II=1,N                                                    TALK3740
      X=AH(II)-PHEAD*BH(II)                                           TALK3750
      Y=CH(II)+PHEAD*DH(II)                                           TALK3760
      V(II,44)=SQRT(X*X+Y*Y)                                          TALK3770
   27 V(II,45)=ATAN2(Y,X)/DTR                                         TALK3780
   24 IF(K.LT.48) GO TO 28                                            TALK3790
      IF(LA(K).GT.0) GO TO 28                                         TALK3800
      WRITE(6,635)K                                                   TALK3810
  635 FORMAT(' CONTACT NUMBER ',I2,' NEVER OCCURRED'/)                TALK3820
      K=1                                                             TALK3830
   28 H(1,I)=V11(K)                                                   TALK3840
      H(2,I)=V12(K)                                                   TALK3850
      H(3,I)=V13(K)                                                   TALK3860
      H(4,I)=V14(K)                                                   TALK3870
      H(5,I)=V21(K)                                                   TALK3880
      H(6,I)=V22(K)                                                   TALK3890
      H(7,I)=V23(K)                                                   TALK3900
      IF(K.LT.48) GO TO 29                                            TALK3910
      K=LA(K)+47                                                      TALK3920
      IF(K-51)29,30,29                                                TALK3930
   30 IF(IG(3).EQ.1) GO TO 31                                         TALK3940
      WRITE(IWR,607)                                                  TALK3950
  607 FORMAT('OENTER OCCUPANT POSITION NUMBER')                       TALK3960
      READ(IR,500)NPASGR                                              TALK3970
      IG(3)=1                                                         TALK3980
   31 IF(NPASGR-2) 32,29,33                                           TALK3990
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32    K=57                                                        TALK4000
      GO TO 29                                                    TALK4010
33    K=58                                                        TALK4020
29    H(8,I)=V31(K)                                               TALK4030
      H(9,I)=V32(K)                                               TALK4040
      H(10,I)=V33(K)                                              TALK4050
15    H(11,I)=V34(K)                                              TALK4060
      WRITE(6,608)((H(K,L),K=1,4),L=1,NUM)                        TALK4070
608   FORMAT(/1X/7X,4(4A4))                                       TALK4080
      WRITE(6,609)((H(K,L),K=5,7),L=1,NUM)                        TALK4090
609   FORMAT(9X,4(3A4,4X))                                        TALK4100
      WRITE(6,610)((H(K,L),K=8,11),L=1,NUM)                       TALK411C
610   FORMAT('   TIME ',4(4A4)/)                                  TALK4120
      IF(KIND.EQ.3) GO TC 51                                      TALK4130
      DO 16 J=JI,JJ                                               TALK4140
      DO 17 I=1,NUM                                               TALK4150
      K=IN(I)                                                     TALK4160
17    OUT(I)=V(J,K)                                               TALK4170
16    WRITE(6,611) T(J),(OUT(I),I=1,NUM)                          TALK4180
611   FORMAT(1X,F5.3,4(F13.3,3X))                                 TALK4190
      GO TO 1000                                                  TALK4200
3     WRITE(IWR,630)                                              TALK4210
630   FORMAT('0ENTER DECISION VARIABLE')                          TALK4220
      READ(IR,500)IN(1)                                           TALK4230
      WRITE(IWR,631)                                              TALK4240
631   FORMAT('0ENTER COMPARISON VALUE')                           TALK4250
      READ(IR,503)CV                                              TALK4260
      WRITE(IWR,632)                                              TALK4270
632   FORMAT('0ENTER COMPARISON MODE - 1 IF GT, 2 IF LT')         TALK4280
      READ(IR,500)MO                                              TALK4290
      WRITE(IWR,603)                                              TALK4300
      READ(IR,500)NUM                                             TALK4310
      NUM=NUM+1                                                   TALK4320
      WRITE(IWR,633)                                              TALK4330
633   FORMAT('0ENTER VARIABLE NUMBERS'/1X,3('(    )'))            TALK4340
      READ(IR,501)(IN(I),I=2,NUM)                                 TALK4350
      GO TO 50                                                    TALK4360
51    KJ=IN(1)                                                    TALK4370
      IF(MO.EQ.1) GO TO 52                                        TALK4380
      DO 53 J=JI,JJ                                               TALK4390
      IF(V(J,KJ).LT.CV) GO TC 54                                  TALK4400
53    CONTINUE                                                    TALK4410
55    WRITE(6,634)                                                TALK4420
634   FORMAT('0THE REQUIRED CONDITION NEVER OCCURRED')            TALK4430
      GO TO 1000                                                  TALK4440
52    DO 56 J=JI,JJ                                               TALK4450
      IF(V(J,KJ).GT.CV) GO TO 54                                  TALK4460
56    CONTINUE                                                    TALK4470
      GO TO 55                                                    TALK4480
54    DO 57 I=1,NUM                                               TALK4490
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      K= IN(I)                                                          TALK4500
   57 OUT(I) =V(J,K)                                                    TALK4510
      WRITE(6,611)T(J),(OUT(I),I=1,NUM)                                 TALK4520
      GO TO 1000                                                        TALK4530
  998 IF(IWR.EQ.6) GO TO 999                                            TALK4540
      IWR=6                                                             TALK4550
      IR=5                                                              TALK4560
      GO TO 1000                                                        TALK4570
  999 STOP                                                              TALK4580
      END                                                               TALK4590
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TALK2 Main Program (page 6 of 6)

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      DIMENSION ELAMB(6),XSMALA(10),YSMALA(10),AR(8),EL(8),DA(10),      TALK4600
     .CPSIA(10),SPSIA(10),IGNORE(10),RHO(8),ZVEC(11),ZVECP(11),         TALK4610
     .PHI(3),BL(3),PN(3),TA(8)                                          TALK4620
      DIMENSION TT(8),TV(8),KI(8),KA(8),PP(8)                           TALK4630
      REWIND 9                                                          TALK4640
      READ(9)ELAMB,XSMALA,YSMALA,AR,RHOPFZ,RHOPTZ,EL,DA,CPSIA,          TALK4650
     1SPSIA,TUAMZ,ZZERC,NBELT,IGNORE,RHO                                TALK4660
    2 READ(9,END=1)TIME,TT,TV,TA,DISP,ZVECP(9),PLX,ZVEC(10),            TALK4670
     1ZVECP(10),PLY,ZVEC(11),ZVECP(11),PLC,AH,BH,CH,DH,ACH,BCH,CCH,     TALK4680
     2DCH,JJ,(KI(I),KA(I),PP(I),I=1,JJ),(PN(N),N=1,3),FSPRM,FS,         TALK4690
     3HEADX,HEADY,PHI,BL                                                TALK4700
      IF(TIME.LT.0.) GO TO 1                                            TALK4710
      GO TO 2                                                           TALK4720
    1 CALL SUMARY                                                       TALK4730
      STOP                                                              TALK4740
      END                                                               TALK4750
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