THE SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC) OPERATOR'S MANUAL

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THE SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC) OPERATOR'S MANUAL

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CONTENTS

SECTION II

AN OVERVIEW OF OPERATING THE SMAC PROGRAM

The SMAC program user specifies values of input variables describing the vehicles, the accident scene, and some computation details.* The computer will return a printout giving position, heading, vector and angular velocity, as well as tire tracks, at regular time intervals throughout the collision sequence. If desired, a graphic display of the simulated collision will also be created by a plotting subroutine. If the user is trying to simulate an actual collision, he will note differences between the actual and simulated collision, and modify the input data to obtain a better match.**

To clarify the data input procedure, we shall divide input data into four categories: vehicle properties (length, width, mass, etc.). calculation constants, initial conditions, and control inputs. Where particular vehicles are being simulated, most properties for any given make and model of car car be found in a reference manual (see reference 1). Otherwise, typical values such as those provided in the attached Table I may be used. Usually, values for vehicle properties are not changed in the iteration process mentioned above.

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* We suggest using an input data form provided with the manual to record your decisions prior to transferring them on the computer (See Section III(D)).

** The art of modification is a subject in itself. One suggestion is to modify one variable at a time in order to attribute the total change from the last run to the present run to that sole modification. Understanding the theory of the SMAC program and understanding how a field investigator chooses a value for a variable will give you much insight into the modification phase of SMAC.

Calculation constants, such as the time interval used, the acceptable error in balancing collision forces, etc., are explained individually in this manual, and suggested values are given. Generally, changes in these variables will only have a secondary effect on accuracy of calculation, expense of run, or specific error messages discussed subsequently.

Often, the user will wish to simulate an accident in which only part of the information, say the final resting positions and tire tracks, is known. He will vary the input data, trying to obtain outputs corresponding to collision. The input variables of interest are the initial conditions (position, heading, velocity) and the control inputs (braking, accelerative traction, and steering). Once the skid marks and final positions match fairly well, the user will presumably have obtained a good approximation of the initial positions, headings and velocities of the cars, if the vehicle properties used are accurate.

SECTION III

INPUT FORMAT*

A. Discussion

The first two records (e.g. cards) of a data deck for input to the SMAC program (if a data file is used, one line = one record) are heading records: these are for user convenience and contain no calculation data. Information placed in these records is printed at the top of each page of output to identify the printout. While they may be left blank, these records must not be omitted.

Next come 14 numbered records giving calculation input data. (In certain cases discussed later there will be additional, unnumbered records following records 8 and 11. These are the torque and steering tables.) The numbered records 1 through 14 are formatted 9F8.0, I8. (A remote time-share terminal user has the capability to input the input records in a free format.) Calculation data appear in the 9 floating point fields. A decimal point must appear in each floating point number. The card identification number appears, right justified, in the final integer field. After record 14 a final record, blank except for the number 9999 in columns 77-80, completes the input data. A sample computer printout of the input card images of a run follows in Section III B.

*Section III is subdivided into four parts which should be studied together. Once SMAC format is absorbed, the user is ready to learn the definitions of the input variables (i.e., Section IV).

B. Sample Computer Printout Of Input Card Images

```
SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
                                        CASE-MO-100                    JAN. 1, 1974
   0.      2.      .05     .001    .01     .005    1.      2.      2.                1
   0.      8.      0.      0.      314.8   0.                                        2
   187.    0.      180.    0.      35.2    0.                                        3
   52.7    54.8    57.7    19762.5 7.5     0.      85.7    -100.   35.7              4
   60.5    63.     63.1    38032.8 10.6    0.      100.5   -119.6  39.6              5
-10250. -10250. -10195. -10195.                                                     6
-10250. -10250. -10195. -10195.                                                     7
   0.      1.2     .2      0.                                                        8
  -609.    -0.     -0.     -0.     -0.     -0.     -0.
  -609.    -0.     -0.     -0.     -0.     -0.     -0.
  -406.    -0.     -0.     -0.     -0.     -0.     -0.
  -406.    -0.     -0.     -0.     -0.     -0.     -0.
   0.      1.2     .2      0.                                                        9
  -861.    -861.   -861.   -861.   -861.   -861.   -861.
  -861.    -861.   -861.   -861.   -861.   -861.   -861.
  -574.    -574.   -574.   -574.   -574.   -574.   -574.
  -574.    -574.   -574.   -574.   -574.   -574.   -574.
   0.      .3      .1      1.                                                       10
   0.      .3      .1      1.                                                       11
   0.      70.     100.    70.     .7      .7      .0003                            12
   2.      .2      15.     5.      30.     50.     .55                              13
 .06423 3.5417-34.7381-5                                                           14
                                                                                 9999
```

C. Annotated User's Sheet

INPUT DATA FORM (SMAC)

Field Number	1	2	3	4	5	6	7	8	9	10	Comments
Value Range	1-3	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72	73-80	
2 lines of 80 characters for identifying a particular run. If a line is left blank, in keeping with format, it cannot be left out.										1	← In col. 80
										2	← In col. 80
										3	← In col. 80
										4	← In col. 80
										5	← In col. 80
										6	← In col. 80
										7	← In col. 80
										8	← In col. 80
7 fields that are 10 characters wide per line--a maximum of 201 fields										9	← In col. 80
7 fields that are 10 characters wide per line--a maximum of 201 fields										10	← In cols. 79,80
7 fields that are 10 characters wide per line--a maximum of 201 fields										11	← In cols. 79,80
7 fields that are 10 characters wide per line--a maximum of 201 fields										12	← In cols. 79,80
										13	← In cols. 79,80
										14	← In cols. 79,80
										9999	← In cols. 79-80

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DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

D. USER'S SHEET

1	2	3	4	5	6	7	8	9	10	COMMENTS
									1	
									2	
									3	
									4	
									5	
									6	
									7	
									8	
									9	
									10	
									11	
									12	
									13	
									14	

NOTE: When a point is determined for reading the cursor, depress any alphanumeric key to record the point.

To restore the drawing to its original size, use the FUL command.

```
>FUL
```

2. Termination of Viewing

END - END should be the response to the prompt. The user will then be prompted with an *.

*END - END should then be the response.

3. Termination

If no further viewing is to be done, respond to the # with BYE

```
BYE
```

The system will respond with an accounting summary for this session, and the user will be logged off the system.

VIII. Reference Manuals

The following DAC-II manuals may be used as references:

a) DAC-II HOST Manual
b) DAC-II Edit Reference Manual
c) DAC-II FASTDRAW/HOST Extended Features
d) DSS Users Manual.

The following MCAUTO manuals describe DSS:

a) DSS User's Manual
b) IPF User's Manual

IX. Assistance

If there are questions concerning this program, contact:

a) Mike Gedera (314) 232-6823

SECTION IV
DESCRIPTION OF INPUT VARIABLES*

A. Detailed Input Variable Description

Input data variables are listed below in the following manner:

(1) A pointer denotes the card and the field position within that card (e.g., the pointer 1:3 refers to card 1, field 3).

(2) The variable name as it occurs in the program (e.g., DTTRAJ).

(3) Where applicable, a symbol is used in analysis, usually a Greek letter with appropriate subscript.

(4) An explanation of the variable is given.

(5) Where called for, suggested values are given.

(Note 0 indicates zero, Ø indicates letter "oh").

1:1 TO — The time, in seconds, at which the program starts. TO is arbitrary, and is generally chosen to be 0.0 for convenience.

1:2 TF — The time, in seconds, at which the program ends. TF-TO=total duration of the run.

1:3 DTTRAJ — The program approximates a continous, non-linear path in time and space by breaking it into small increments, taken as linear, rather than by a true line integral. DTTRAJ is the time interval of integration before, and again after, vehicle contact. This will generally be the largest time interval used (on the order of .05 seconds, smaller where forces or speeds are usually high), since changes are gradual and continous during trajectory.

[With this, and with all intervals, a smaller value will yield greater accuracy, but will also increase computer time and expense. In general, the accuracy desired will be greater when the user wishes to match a set of empirical data than when seeking to simulate a situation for heuristic purposes.]

1:4 DTCØLL — This is the interval of integration, in seconds, during the collision, where large crash forces require a small time interval (on the order of .001) to obtain a good approximation.

*It is recommended that until becoming "adequate" in the utilization of SMAC that the user rely on the detailed input variable description of Section IV(A) rather than the brief input variable description of Section IV(B).

1:5	DTCØLT		This is the interval of integration in seconds for the first 100 time increments immediately after vehicle separation. DTCØLT will generally be smaller than DTTRAJ (e.g., .01) since higher speeds and spin are often involved at this stage.
1:6	DTPRNO		The printout time interval in seconds.
1:7 1:8	UVMIN) PSIDMN)		If the absolute value of the total vector velocity in inches/second is less than UVMIN for both vehicles, and the absolute value of the angular velocity in degrees/second is less than PSIDMN for both vehicles, the run terminates. If no minimum value cut-off is desired, these can be set to 0.0. (1 mph = 17.6 inches/second)
1:9	IVEHO		Number of simulated vehicles (1. or 2.) if IVEHO = 1., program ignores inputs on records 3, 5,7,9 & 11; however, these records must be included in keeping with format.
1:10			The numerals 01, 02, - - - -, 14 go in columns 79 and 80 (see Section III(C)). This item is omitted on subsequent record explanation.
2:1	XCP10	X'c10	The X' coordinate, in inches, of the center of gravity of of vehicle 1, (V1). The smaller vehicle should be entered as V1. Collision forces are calculated in a clockwise sweep of V1. The force calculations are less accurate in the vicinity of a narrow intrusion; therefore, accuracy is improved when V1 is the smaller vehicle. A fixed Cartesian coordinate system is used, with the positive X' axis shown pointing upward, and the positive Y' axis to the right. Angles are measured clockwise from the positive X' axis.
2:2	YCP10	Y'c10	The Y'-coordinate, in inches, of the center of mass of V1. (See also comments on XCP10).
2:3	PSI10	Ψ_{10}	The heading angle, in degrees of V1 measured clockwise from the positive X' axis.
2:4	PSI1DO	$\dot{\Psi}_{10}$	The angular velocity, in degrees/second of V1. Taken to be positive when rotation is clockwise.
2:5	U10	Ψ_{10}	The initial forward velocity of V1 in inches/second. The longitudinal component of the total vector velocity of V1.

2:6	V10		The initial sideway velocity of V1 in inches/second with right taken as positive.
3:1	XCP20	X'_{c20}	Same as Card 2; except for vehicle 2.
	YCP20	Y'_{c20}	
	PSI20	ψ_{20}	
	PSI2DD	$\dot{\psi}_{20}$	
	U20	u_{20}	
	V20	v_{20}	
4:1	A1	a_1	The distance in inches from the center of gravity of V1 to the midpoint between the front wheels (see Table I for typical values).
4:2	B1	b_1	The distance in inches from the center of gravity of V1 to the midpoint between the rear wheels, taken as positive (see Table I for typical values).
4:3	TR1	T_1	Average tread width in inches, i.e., distance between left and right tires, averaged over front and rear pairs (for typical values, see Table I).
4:4	FIZ1	I_{z1}	Yaw inertia, in lb-sec^2-inches, of V1. This is a measure of the torque needed to induce a given spin in V1, and depends both on the total mass of the vehicle and on how far this mass is, on the average, from the center of gravity. For typical values of mass and of k^2 ($I_{z1} = k^2 \times M$), see Table I.
4:5	FMASS1	M_1	The total mass of V1, measured in lb-sec^2/inch. If vehicle weight in lbs. is known, mass in lb-sec^2/inch can be found by dividing by 386.4 (for typical values see Table I).
4:6	PSIR10	ψ_{R1}	The rear axle steer angle in degrees; angular displacement from normal orientation, with clockwise displacement taken as positive (thus for undamaged rear axle = 0.0).

4:7 XF1 — Distance in inches from center of gravity of V1 to the front end of the car body. (For typical values, see Table I.)

4:8 XR1 — Distance in inches from center of gravity V1 to the rear end of the car body, taken as negative. (For typical values, see Table I.)

4:9 YS1 — Distance in inches from the center of gravity of V1 to the side of the car body; 1/2 total width. (For typical values, see Table I.)

5:1	A2	a_2
5:2	B2	b_2
5:3	TR2	T_2
5:4	FIZ2	I_{z2}
5:5	FMASS2	M
5:6	PSIRS0	ψ_{r2}
5:7	XF2	x_{F2}
5:8	XR2	x_{R2}
5:9	YS2	y_{S2}

Same as 4:1-9 except for vehicle 2.

6:1 CSTF1(1) c_{11} — Cornering stiffness for small angles, in lbs/radian, for right front tire of V1. When the tire is directed at an angle to the direction of motion, a steering force occurs in a direction perpendicular to the direction in which the tires are pointed. This force does not vary linearly with the tire slip angle, but relation is nearly linear for small slip angles. The nominal cornering stiffness is the normal force in pounds divided by the slip angle in radians for small angles. For larger angles the rate of increase of perpendicular force with increasing angle falls off as "saturation" is approached. The program handles this in a standard manner for all tires.

Typical values for cornering stiffness are -10200 lbs/radian. Cornering stiffnesses are input separately to allow the simulation of tire damage--a damaged tire which has lost its pressure will have a far lower cornering stiffness, perhaps 20 percent of that for an undamaged tire. Under-inflated tires will have somewhat lower cornering stiffnesses than the values given, but far greater than seriously damaged tires.

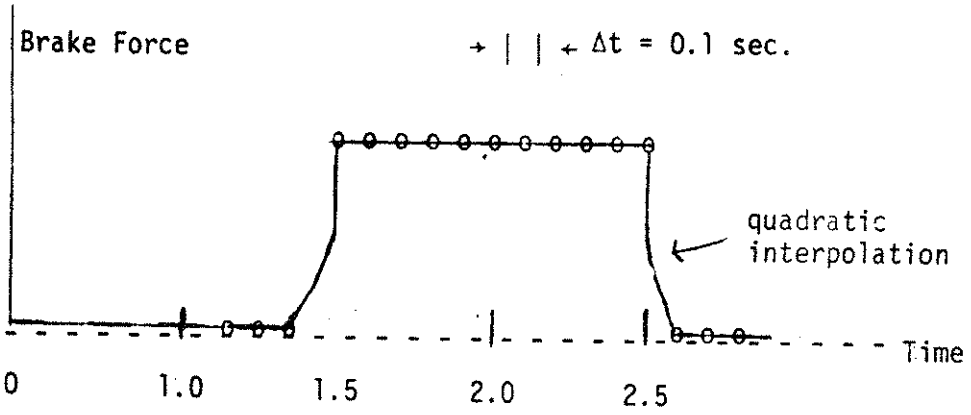
6:2	CSTF1(2)	C_{12}	Cornering stiffness, left front tire of V1, lbs/radian.
6:3	CSTF1(3)	C_{13}	Cornering stiffness, right rear tire of V1, lbs/radian.
6:4	CSTF1(4)	C_{14}	Cornering stiffness, left rear tire of V1, lbs/radian.
7:1	CSTF2(1)	C_{21}	Same as 6:1-4, except for V2.
7:2	CSTF2(2)	C_{22}	
7:3	CSTF2(3)	C_{23}	
7:4	CSTF2(4)	C_{24}	
8:1	TBTQ1		Initial time in seconds for V1's Torque (braking or accelerating) inputs. When applying torque to V1 after the run has begun (TBTQ1>TO), at least three zero inputs prior to time TBTQ1 should be inputed. This is done to accommodate quadratic interpolations which require two end points and one turning point (thus 3 points).
8:2	TETQ1		End time for torque inputs for V1 in seconds. If control inputs for torque end in the middle of a run (TETQ1<TF) input tables should end with three zero inputs to insure zero control inputs after TETQ1 (same reasoning as 8:1).
8:3	TINCQ1		Time increment for torque inputs, V1, in seconds. One value for torque is input each increment, so the size of TINCQ determines the fineness with which braking and traction can be described by the mathematical model.
8:4	NTBLQ1		If this variable is set equal to zero, the program reads the torque input tables and includes them in the calculations for the run. If any other value is entered the program ignores card #8 and there are no torque inputs for V1. For cards #8-11, when the final variable is set equal to 0.0, the card is followed by tables, each consisting of from 1 to 29 unnumbered cards, formatted (7F10.0). Each table represents the control inputs for a single wheel. Accelerative torque inputs are positive, braking inputs negative, both are in pounds. The number of entries per wheel is $\frac{\text{TETQ1} - \text{TBTQ1}}{\text{TINCQ1}} + 1$. Entries for each wheel begin on a new card.

8:4 (Continued)

If a friction decrement with speed is used (item 12:7), at high speeds, friction and thus maximum possible tire force will be reduced. Also, if both steering and traction inputs are included for a given tire, the vector sum of these inputs cannot exceed the maximum possible force for that tire. If too large a force is entered, the program will substitute the largest possible value (i.e., a value equal to the product of the weight on that tire multiplied by the coefficient of friction).

To illustrate the torque input process, an example is in order.

Example of Torque Input. It is desired to apply the brakes of the rear wheels of a 4,000-lb vehicle (V1) strong enough to lock those wheels during the interval from 1.5 to 2.5 seconds after the program starts. Brake forces are zero at other times. (Steering inputs would be handled in the same manner as this braking example.)



Card 8	1.2	2.8	0.1	0.					
Torque Table	0.	0.	0.	0.	0.	0.	0.	)	
								)	
	0.	0.	0.	0.	0.	0.	0.	)	RF
								)	Wheel
	0.	0.	0.					)	

(Plus 3 cards for LF wheel identical to

8:4 (Continued)

RR Wheel

```
(     0.      0.      0.  -2000.  -2000.  -2000.  -2000.
(
( -2000.  -2000.  -2000.  -2000.  -2000.  -2000.  -2000.
(
(     0.      0.      0.
```

(Plus 3 cards for LR wheel, identical to RR wheel)

Notice that the start and end times are three time increments before and after the brake pulse, respectively, to allow for insertion of three zero force inputs as discussed under 8:1 and 8:2.

Notice that the braking force input (-2000 lbs. on each rear wheel) exceeds the maximum friction force available at that wheel (approximately 1/4 of vehicle weight x friction coefficient). This is done to insure skidding. The program will combine this force vectorially with any steering forces present, and limit the resultant to the maximum friction force.

Tables for Card 8:

(1) Traction (+) or braking (-) inputs, right front wheel, V1, in pounds force.

(2) Same, left front wheel.

(3) Same, right rear wheel.

(4) Same, left rear wheel.

9:1 9:2 9:3 9:4 Tables (1-4)	TBTQ2 TETQ2 TINCQ2 NTBLQ2	Same as 8:1-4 and subsequent tables, except for V2.
10:1	TBPSF1	Starting time for steer inputs, in seconds, V1. (See 8:1; same format as torque inputs.)
10:2	TEPSF1	End time for steer inputs, in seconds, V1 (see 8:2).
10:3	TINCP1	Time increment for steer inputs, in seconds, V1 (see 8:3).
10:4	NTBLP1	If ≠0.0, program ignores card 10 and no steering inputs are used in calculations for V1.
		Steer tables are exactly like torque tables (see note on control inputs after card 8) except that values input represent tire angle, in degrees (left turn is negative, right is positive, straight ahead is 0.0 degrees). There are only 2 tables per vehicle since only front wheels are steered.
		Tables for Card 10:
		(1) Steer inputs, right front tire, V1, in degrees.
		(2) Steer inputs, left front tire, V1, in degrees.
11:1 11:2 11:3 11:4 Tables (1-2)	TBPSF2 TEPSF2 TINCP2 NTBLP2	Same as 10:1-4 and subsequent tables, but for V2.

12:1	XBP(1)	x'_{B1}	These coordinates, in inches, define two points, $B_1 = (x'_{B1}, y'_{B1})$ and $B_2 = (x'_{B2}, y_{B2})$ in the plane of the tire forces. These 2 points determine a boundary line, dividing the plane into two zones which may be assigned different coefficients of friction. This allows the user to simulate a vehicle running onto a dirt shoulder field, etc., or any such situation which demands two adjacent areas of different frictional properties. The zone on the side of the line which contains the origin is defined as zone 1, and the other zone 2.
12:2	YBP(1)	y'_{B1}	
12:3	XBP(2)	x'_{B2}	
12:4	YBP(2)	y'_{B2}	
12:5	XMU1	μ_1	The coefficient of friction in zone 1. The coefficient can be made to vary with speed (see 12:7); it is assumed independent of other factors within a zone. Use 0.7 for dry pavement, 0.3 for wet.
12:6	XMU2	μ_2	The coefficient of friction in zone 2 (see above).
12:7	CMU	c_μ	The coefficient of linear decrement of friction with tire speed in seconds/inch. In general, the effective tire-surface friction coefficient decreases with speed and c_μ simulates this decrease. The effective friction coefficient, used in all SMAC calculations, is computed as μ effective $= \mu_o - c_\mu \lvert v \rvert$ where μ_o is the nominal coeffficient of friction, and is the tire speed. Thus, if no decrement is desired as speed increases, is set to 0.0. The recommended value is .0003.
13:1	DELPSO	$\Delta\psi$	The interval between radial vectors in degrees. The SMAC program calculates all collision forces in a clockwise sweep about the center of gravity of V1. The sweep is broken into increments of size $\frac{1}{4}360\ \Delta\psi$ (DELPSO must be an integer). Too large a value of $\Delta\psi$ will cause inaccuracies, too small a value will exceed the program's capacity. The collision interface is handled in a table of up to 100 points. If more than 100 points are required to handle the damage area, the message "ISTOP = 9" appears on the printout. The suggested value is 2. degrees, which can be increased (e.g. to 3.) if the error message "ISTOP = 9" appears.
13:2	DELRØ0	$\Delta\rho$	The increment of change of the radius vector in inches. (See explanation after card 13.) A value of around .2 is recommended.

13:3	ALAMB	λ	The acceptable error in intervehicle pressure equilibrium, in pounds/inch. Choose λ greater than K_{V1} times $\Delta\rho$ and also greater than K_{V2} times $\Delta\rho$ (see explanation after card 13) e.g. for K_{V1} = 30., K_{V2} = 50., $\Delta\rho$ = .2, λ could be 12.
13:4	ZETAV	ζ_V	The minimum relative velocity for intervehicle friction, in inches/second. If, while in contact, the adjacent surfaces of the two vehicle move with respect to each other at a speed less than this, intervehicle friction is ignored. A value of around 5.0 inch/second is recommended.
13:5	AKV(1)	K_{V1}	Load-deflection characteristic, in pounds/inch^2, of V1 (see explanation after card 13). Values range from around 30. for subcompact cars to around 50. for full-sized.
13:6	AKV(2)	K_{V2}	Same as above, but for V2.
13:7	AMU	μ	This is the coefficient of friction between the two vehicles when they are in contact and the adjacent surfaces of V1 and V2 are moving with respect to each other (at a velocity greater than ζ_V). The force tangent to the interface opposing the relative motion = ζ times the force with which the surfaces press together. A value of about .55 is recommended.

Note on $\Delta\rho$, λ, K_{V1} and calculation of collision forces:

As the body of a car is crushed, it exerts a force proportional to that crush. The SMAC program assumes that at any point on the interface between two vehicles, the pressures exerted by the two surfaces must be essentially equal. Since the simulation is two-dimensional, units for pressure are in pounds/inch. Since the pressure is (assumed) proportional to the depth of crush, with the car body assumed to be homogeneous, the load-deflection characteristic K_V is in units of pressure/inch of crush = (pounds/inch)/inch = lbs/in.^{2}. Points displaced by crush forces are constrained to move along the radial line from the vehicle center of gravity to the initial position of the displaced point before damage occurred. The program simulates crush by adjusting each of the radii in increments of $\Delta\rho$ until the pressures exerted balance to within an allowed error of λ.

Since for solution stability there must always be a value of ρ tested for which the pressures balance to within λ, and the change in pressure per increment $\Delta\rho$ is $K_V\Delta\rho$, it is necessary that $\lambda > K_V\Delta\rho$ for both K_{V1} and K_{V2}.

The program, in seeking equilibrium, will increment ρ by $\Delta\rho$ up to 200 times. If this is insufficient, the message ISTOP = 7 will appear on the output, and execution will terminate. If the condition $\lambda > K_{V1}\Delta\rho$, $K_{V2}\Delta\rho$ was satisfied, then a larger value of $\Delta\rho$ is needed (e.g. to .3 inches) when adjusting $\Delta\rho$ or K_V, be sure to adjust λ also if necessary.

14:1	C0	C_0	Coefficients of assumed parabolic variation of coefficient restitution. The car body is to have some elasticity with the degree of restitution varying non-linearly with the degree of deformation. Recommended values are .06423, 3.5417×10^{-3}, and 4.7381×10^{-5}, respectively. (To fit in the field of 8 columns the latter two should be entered as 3.5417-3 and 4.7381-5, which are interpreted as scientific notation).
14:2	C1	C_1	
14:3	C2	C_2	
(15:10)			Two numerals 9999 appear in columns 77-80. Be sure all the numbered cards 1-14 have their number included, right justified, in the final integer field of each card.

B. Brief Input Variable Description

Card No.	Program Variable	Analysis Variable	Definition	Units
1	T0	-	Start time	Seconds
	TF	-	End time	Seconds
	DTTRAJ	-	Interval of integration at beginning and ending of run	Seconds
	DTCØLL	-	Interval of integration during collision contact	Seconds
	DTCØLT	-	Interval of integration for 100 time increments subsequent to separation	Seconds
	DTPRN0	-	Output time interval	Seconds
	UVMIN	-	Vector velocity test for stop	Inches/Sec
	PSIDMN	-	Angular velocity test for stop	Degrees/Sec
	IVEH0	-	Number of Simulated Vehicles (1.0 or 2.0)	-
2	XCP10	x'_{c10}	Vehicle 1, initial x'_c	Inches
	YCP10	y'_{c10}	Vehicle 1, initial y'_c	Inches
	PSI10	ψ_{10}	Vehicle 1, initial ψ	Degrees
	PSI1D0	$\dot{\psi}_{10}$	Vehicle 1, initial $\dot{\psi}$	Degrees/Sec
	U10	u_{10}	Vehicle 1, initial u	Inches/Sec
	V10	v_{10}	Vehicle 1, initial v	Inches/Sec
3	XCP20	x'_{c20}	Vehicle 2, initial x'_c	Inches
	YCP20	y'_{c20}	Vehicle 2, initial y'_c	Inches
	PSI20	ψ_{20}	Vehicle 2, initial ψ	Degrees
	PSI2D0	$\dot{\psi}_{20}$	Vehicle 2, initial $\dot{\psi}$	Degrees/Sec
	U20	u_{20}	Vehicle 2, initial u	Inches/Sec
	V20	v_{20}	Vehicle 2, initial v	

Card No.	Program Variable	Analysis Variable	Definition	Units
4	A1	a_1	Vehicle 1, CG to F. Wheel ℄ (+)	Inches
	B1	b_1	Vehicle 1, CG to R. Wheel ℄ (+)	Inches
	TR1	T_1	Vehicle 1, Average Tread	Inches
	FIZ1	I_{Z1}	Vehicle 1, Yaw Inertia	Lb-Sec^2-In
	FMASS1	M_1	Vehicle 1, Total Mass	Lb-Sec^2/In.
	PSIR10	ψ_{R1}	Vehicle 1, Rear Axle Angle (Damage)	Degrees
	XF1	X_{F1}	Vehicle 1, CG to Front (+)	Inches
	XR1	X_{R1}	Vehicle 1, CG to Rear (-)	Inches
	YS1	Y_{S1}	Vehicle 1, CG to Side (+)	Inches
5	A2	a_2	Vehicle 2, CG to F. Wheel ℄ (+)	Inches
	B2	b_2	Vehicle 2, CG to R. Wheel ℄ (+)	Inches
	TR2	T_2	Vehicle 2, Average Tread	Inches
	FIZ2	I_{Z2}	Vehicle 2, Yaw Inertia	Lb-Sec^2/In
	FMASS2	M_2	Vehicle 2, Total Mass	Lb-Sec^2/In
	PSIR20	ψ_{R2}	Vehicle 2, Rear Axle Angle (Damage)	Degrees
	XF2	X_{F2}	Vehicle 2, CG to Front (+)	Inches
	XR2	X_{R2}	Vehicle 2, CG to Rear (-)	Inches
	YS2	Y_{S2}	Vehicle 2, CG to Side (+)	Inches
6	CSTF1(1)	C_{11}	Vehicle 1, RF Tire Cornering Stiffness	Pounds/Radian
	CSTF1(2)	C_{12}	Vehicle 1, LF Tire Cornering Stiffness	Pounds/Radian
	CSTF1(3)	C_{13}	Vehicle 1, RR Tire Cornering Stiffness	Pounds/Radian
	CSTF1(4)	C_{14}	Vehicle 1, LR Tire Cornering Stiffness	Pounds/Radian

Card No.	Program Variable	Analysis Variable	Definition	Units
7	CSTF2(1)	C_{21}	Vehicle 2, RF Tire Cornering Stiffness	Pounds/Radi
	CSTF2(2)	C_{22}	Vehicle 2, LF Tire Cornering Stiffness	Pounds/Radi
	CSTF2(3)	C_{23}	Vehicle 2, RR Tire Cornering Stiffness	Pounds/Radi
	CSTF2(4)	C_{24}	Vehicle 2, LR Tire Cornering Stiffness	Pounds/Radi
8	TBTQ1	-	Initial time for torque inputs, Vehicle 1	Seconds
	TETQ1	-	Final time for torque inputs, Vehicle 1	Seconds
	TINCQ1	-	Time increment for torque inputs, Vehicle 1	Seconds
	NTBLQ1	-	If $\neq 0.0$, do not read table	-

(1) Table of Traction (+) or Braking (-) Force at RF Wheel, Vehicle 1 Card format 7F10.0, use three to two hundred and one values for each wheel. The number of entries for each wheel is computed as

$$\frac{\text{TETQ1} - \text{TBTQ1}}{\text{TINCQ1}} + 1.$$

Start the entries for each wheel on a new card. Seven entires per card.

(2) Table of Traction (+) or Braking (-) Force at LF Wheel, Vehicle 1

(3) Table of Traction (+) or Braking (-) Force at RR Wheel, Vehicle 1

(4) Table of Traction (+) or Braking (-) Force at LR Wheel, Vehicle 1

Card No.	Program Variable	Analysis Variable	Description	Units
9	TBTQ2	-	Initial time for torque inputs, Vehicle 2	Seconds
	TETQ2	-	Final time for torque inputs, Vehicle 2	Seconds
	TINCQ2	-	Time increment for torque inputs, Vehicle 2	Seconds
	NTBLQ2	-	If ≠ 0.0, do not read table	-
	(1) Table of Traction (+) or Braking (-) Force at RF Wheel, Vehicle 2			
	(2) Table of Traction (+) or Braking (-) Force at LF Wheel, Vehicle 2			See comments following card 8
	(3) Table of Traction (+) or Braking (-) Force at RR Wheel, Vehicle 2			
	(4) Table of Traction (+) or Braking (-) Force at LR Wheel, Vehicle 2			
10	TBPSF1	-	Initial time for steer inputs, Vehicle 1	Seconds
	TEPSF1	-	Final time for steer inputs, Vehicle 1	Seconds
	TINCP1	-	Time increments for steer inputs, Vehicle 1	Seconds
	NTBLP1	-	If ≠ 0.0, do not read table	-
	(1) Steer Table (degrees) for RF Wheel, Vehicle 1			
	(2) Steer Table (degrees) for LF Wheel, Vehicle 1			

(See comments following card 8)

Card No.	Program Variable	Analysis Variable	Description	Units
11	TBPSF2	-	Initial time for steer inputs, Vehicle 2	Seconds
	TEPSF2	-	Final time for steer inputs, Vehicle 2	Seconds
	TINCP2	-	Time increments for steer inputs, Vehicle 2	Seconds
	NTBLP2	-	If $\neq 0.0$, do not read table	-
	(1) Steer Table (degrees) for RF Wheel, Vehicle 2			
	(2) Steer Table (degrees) for LF Wheel, Vehicle 2			
	(See comments following card 8)			
12	XBP(1)	X'_{B1}	Points defining boundary between terrain zones	Inches
	YBP(1)	Y'_{B1}		Inches
	XBP(2)	X'_{B2}		Inches
	YBP(2)	Y'_{B2}		Inches
	XMU1	μ_1	Tire-Terrain Friction Coefficient at Zero Speed (Zone 1)	-
	XMU2	μ_2	Tire-Terrain Friction Coefficient at Zero Speed (Zone 2)	-
	CMU	C_μ	Coefficient of linear decrement of friction with tire speed	-
13	DELPS0	$\Delta\psi$	Interval between radial vectors	Degrees
	DELR$\emptyset$0	$\Delta\rho$	Increment of change in radius vector	Inches
	ALAMB	λ	Acceptable error in equilibrium	Lb/Inch
	ZETAV	ζ_V	Minimum relative velocity for friction	Inches/Sec
	AKV(1)	K_{V1}	Load-deflection characteristic, Vehicle 1	Lb/In^2
	AKV(2)	K_{V2}	Load-deflection characteristic, Vehicle 2	Lb/In^2
	AMU	μ	Intervehicle friction coefficient	-

Card No.	Program Variable	Analysis Variable	Description	Units
14	C0	C_0	Coefficients of assumed parabolic variation of coefficient of restitution with deflection	-
	C1	C_1		-
	C2	C_2		-

SECTION V

OUTPUT FORMAT

A. Discussion

The output of the SMAC program is largely self-explanatory, but to prevent any initial confusion it will be briefly discussed here. The output consists of printout and an optional graphic display.

The printout first gives a line-for-line transcription of the input record. This is followed by a table of input data in which the variable name and units, as well as the input value, are printed; thus when the user wants to find a particular variable it is not necessary to identify the specific input field. Directly under this table, control inputs (from torque and steering tables) are listed.

Next comes the main body of the printout. The first page, marked page 1 in the upper right hand corner, gives the following data for vehicle 1 in labeled columns:* Coordinate position of the center of mass, the heading angle, for forward and lateral velocities, the angular velocity, the acceleration in the forward and lateral directions, and the absolute magnitude of the total acceleration.

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* As always with the SMAC program, coordinates are in a Cartesian system with the positive x-axis at "North", positive y-axis at "East", and angles measured clockwise from the positive x-axis. For angular velocity, clockwise is positive, and for vector velocity forward and right are positive, backward and left negative. It should be noted that, although input are in inches, output are in feet.

Page 2 gives the velocity vector direction and tire tracks for vehicle 1. The velocity vector is the angle at which the car is moving with respect to its forward direction, measured clockwise from straight forward. Then the coordinate position of each tire is given for each time increment. The asterisk next to the coordinates denotes skidding tires.

Page 3 and 4 repeat this information for vehicle 2. The page after page 4, numbered page 1, begins again with vechicle 1 at the next time increment following vehicle 1's previous page 1. This 4-page pattern of vehicle 1's moving coordinate position and tire tracking (same for vehicle 2) repeats till the run ends.

At any time when the time increment changes, there is an announcement on the page prior to the first page including the new increment. The announcement includes values of the old and new increments, and the time of switchover. (For explanation of the roles of the respective Δt's, see items 1:3-5 in the preceding section.)

At the end of this main table, there are miscellaneous subroutine messages and then a damage summary. The first part of the summary is a table of displaced points--any point moved by crush forces is given in two forms, polar and cartesian. Specifically, for each vehicle ther is a table

of 4 columns. The first two give radius in inches and angle in degrees (measured clockwise from front center) of each displaced point with respect to the center of gravity of the vehicle. The other two columns give x and y coordinates of the displaced points in the vehicle-fixed coordinate system (origin at center of gravity, positive x-axis through front center, positive y-axis to right).

Below the table of displaced points for each vehicle is a concise discription of the damage, given in the following form for each vehicle: the beginning and end points of the damage area in polar coordinates, the angular coordinate of the midpoint of damage, the vehicle damage index (VDI), and ΔV. ΔV is the total change in velocity (the time integral of the absolute value of the acceleration) over the period where acceleration exceeds 1 g. given in mph.

In addition to the printout, the SMAC program can create a graphic display of the simulated accident showing the position at impact, final position, damage, and tire tracks. The display consists of a heading, which includes the first two cards of input, the plot of collision, and a table of data. The plot includes labeled X' and Y' axes with a scale given at the bottom. The position of each car at impact is shown with dotted lines, and the final position with solid lines. Where damage has occurred, the solid line shows the damaged outline, with the original outline

superimposed with dotted lines. Vehicles are labeled vehicle 1 and vehicle 2, and heading is given by a triangle inside each car outline, pointing in the forward direction. A small circle indicates the center of gravity. Tire tracks are also shown--solid lines where the tire is skidding, dotted lines where it is rolling.

The table appearing beneath the plot gives the following information for vehicles #1 and #2: coordinate position of the center of gravity, heading angle, forward and lateral velocity in mph and angular velocity at impact, coordinate position of center of gravity, heading angle and remarks on presence or absence of motion at end of run, and figures for vehicle damage index and ΔV (See Section V(C), page 36 for graphic display).

P((I,K),I= 1, 2),K=1), 4) STEER TABLES ALL ZERO FOR VEHICLE NO. 1

P((I,K),I= 3, 4),K=1), 4) STEER TABLES ALL ZERO FOR VEHICLE NO. 2

B. Sample Computer Printout (This output resulted from the input data shown in IIIB)

SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
CAL-CASE-MO-10U
JAN. 13,1974

INITIAL CONDITIONS

VEHICLE NO. 1			VEHICLE NO. 2		
XC10*	= 0.0	INCHES	XC20*	= 187.000	INCHES
YC10*	= 8.000	INCHES	YC20*	= 0.0	INCHES
PSI10	= 0.0	DEGREES	PSI20	= 180.000	DEGREES
PSI1D0	= 0.0	DEG/SEC	PSI2D0	= 0.0	DEG/SEC
U10	= 316.800	IN/SEC	U20	= 35.200	IN/SEC
V10	= 0.0	IN/SEC	V20	= 0.0	IN/SEC

CALCULATION CONSTANTS

DELPSI	= 2.000	DEGREES
DELRHO	= 0.200	INCHES
LAMBDA	= 15.000	LB/IN.PRESSURE ERROR
ZETAV	= 5.000	IN/SEC.MIN.FOR FRICT

DIMENSIONS AND INERTIAL PROPERTIES

A1	= 52.700	INCHES	A2	= 60.500	INCHES
B1	= 54.800	INCHES	B2	= 63.000	INCHES
TR1	= 57.700	INCHES	TR2	= 63.100	INCHES
I1	= 19763.	LB-SEC**2-IN	I2	= 38033.	LB-SEC**2-IN
M1	= 7.500	LB-SEC**2/IN	M2	= 10.600	LB-SEC**2/IN
PSIR10	= 0.0	DEGREES	PSIR20	= 0.0	DEGREES
XF1	= 85.700	INCHES	XF2	= 100.500	INCHES
XR1	=-100.000	INCHES	XR2	=-119.600	INCHES
YS1	= 35.700	INCHES	YS2	= 39.600	INCHES

DEFORMABLE LAYER

KV1	= 30.000	LB/(IN**2)
KV2	= 50.000	LB/(IN**2)
MU.FRICT	= 0.550	
C0	= 0.064	RESTITUTION
C1	= 0.35417E-02	VERSUS
C2	= 0.47381E-04	DEFLECTION

TIRE PROPERTIES

CORNERING STIFFNESS

C(1)	= -10250.	LB/RAD	C(5)	= -10250.	LB/RAD
C(2)	= -10250.	**	C(6)	= -10250.	**
C(3)	= -10195.	**	C(7)	= -10195.	**
C(4)	= -10195.	**	C(8)	= -10195.	**

TIRE-TERRAIN COEF AND TERRAIN ZONES

XR1*	= 0.0	IN.	YR1*	= 70.000	IN.
XR2*	= 100.000	IN.	YR2*	= 70.000	IN.
XMU1	= 0.700				
XMU2	= 0.700				
CMU	= 0.30000E-03				

PSIB RANGE TESTS
COLLISION CRITERIA

PSILIM1	= 70.000	DEGREES
PSILIM2	= 110.000	**
PSILIM3	= 250.000	**
PSILIM4	= 290.000	**

PSIBI FOR RHOBI TESTS
COLLISION CRITERIA

PSILIM5	= 10.000	DEGREES
PSILIM6	= 170.000	**
PSILIM7	= 190.000	**
PSILIM8	= 350.000	**

PROGRAM CONTPOL DATA

T0	= 0.0	SEC.,BEGIN
TF	= 2.000	** END
DTTRAJ	= 0.050	** INTEG. INTVL.TRAJ
DTCOLL	= 0.001	** INTEG.INTVL.COLL
DTCOLT	= 0.010	** INTEG.INTVL.CPOS
DTPRNT	= 0.005	** PRINT INTERVAL
UVMIN	= 1.000	IN/SEC STOPPING TEST
PSIDOT	= 2.000	DEG/SEC STOPPING TEST

NO.OF VEHICLES = 2.
FMOV'E = 0.(ZERO,FINAL DAMAGE TABLE TAPE
(NON-ZERO,DAMAGE HISTORY TAPE
(ALSO WRITTEN ON FORTRAN 2.
(TAPE IS ALWAYS FORTRAN 1)

P((I,K),I= 3, 4),K=1), 4) STEER TABLES ALL ZERO FOR VEHICLE NO. 1

0.0570	1.35	0.67	-0.05	18.30	0.11	-1.15	-8.08	0.17	8.09
0.0580	1.37	0.67	-0.05	18.10	0.12	-1.15			

SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)

CAL-CASE-MD-IDU

JAN. 13,1974

VEHICLE NO. 1

	C.G. POSITION		HEADING ANGLE	VELOCITIES		ANGULAR VELOCITY	ACCELERATION		
TIME	XC1*	YC1*	PSI1	FWD	LAT	PSI1DOT	AX1	AY1	ACC1
SEC.	FT	FT	DEG	FT/SEC	FT/SEC	DEG/SEC	G	G	G
0.0	0.0	0.67	0.0	26.40	0.0	0.0	-0.60	0.0	0.60
0.0100	0.26	0.67	0.0	26.21	0.0	0.0	-1.85	-0.02	1.85
0.0110	0.29	0.67	-0.00	26.15	-0.00	-0.03	-2.01	-0.02	2.01
0.0120	0.32	0.67	-0.00	26.08	0.00	-0.05	-2.16	-0.11	2.17
0.0130	0.34	0.67	-0.00	26.01	-0.00	-0.09	-2.31	-0.06	2.31
0.0140	0.37	0.67	-0.00	25.93	-0.00	-0.15	-2.40	-0.03	2.40
0.0150	0.39	0.67	-0.00	25.85	-0.00	-0.20	-2.54	-0.04	2.54
0.0160	0.42	0.67	-0.00	25.77	-0.00	-0.26	-2.73	-0.04	2.73
0.0170	0.44	0.67	-0.00	25.68	-0.00	-0.30	-2.92	-0.03	2.92
0.0180	0.47	0.67	-0.00	25.58	-0.01	-0.35	-3.02	-0.03	3.02
0.0190	0.50	0.67	-0.00	25.48	-0.00	-0.38	-3.27	-0.20	3.29
0.0200	0.52	0.67	-0.00	25.38	-0.01	-0.48	-3.41	-0.08	3.41
0.0210	0.55	0.67	-0.00	25.27	-0.01	-0.54	-3.52	-0.14	3.53
0.0220	0.57	0.67	-0.00	25.16	-0.01	-0.64	-3.70	-0.14	3.70
0.0230	0.60	0.67	-0.00	25.04	-0.01	-0.71	-3.82	-0.10	3.82
0.0240	0.62	0.67	-0.00	24.92	-0.01	-0.74	-3.92	-0.01	3.92
0.0250	0.65	0.67	-0.01	24.79	-0.01	-0.83	-4.04	0.09	4.05
0.0260	0.67	0.67	-0.01	24.66	-0.01	-0.93	-4.11	0.02	4.11
0.0270	0.70	0.67	-0.01	24.53	-0.01	-0.93	-4.17	-0.11	4.17
0.0280	0.72	0.67	-0.01	24.39	-0.00	-0.97	-4.28	0.04	4.28
0.0290	0.74	0.67	-0.01	24.25	-0.01	-1.08	-4.54	-0.06	4.54
0.0300	0.77	0.67	-0.01	24.10	-0.00	-1.12	-4.83	-0.06	4.83
0.0310	0.79	0.67	-0.01	23.94	-0.01	-1.25	-5.06	-0.02	5.06
0.0320	0.82	0.67	-0.01	23.78	0.00	-1.19	-5.17	0.09	5.17
0.0330	0.84	0.67	-0.01	23.61	0.00	-1.20	-5.18	-0.04	5.18
0.0340	0.86	0.67	-0.02	23.44	0.01	-1.14	-5.43	-0.08	5.43
0.0350	0.89	0.67	-0.02	23.27	0.01	-1.19	-5.51	0.06	5.52
0.0360	0.91	0.67	-0.02	23.09	0.02	-1.22	-5.66	0.01	5.66
0.0370	0.93	0.67	-0.02	22.91	0.01	-1.40	-5.68	-0.26	5.68
0.0380	0.96	0.67	-0.02	22.73	0.01	-1.62	-5.92	-0.08	5.92
0.0390	0.98	0.67	-0.02	22.54	0.01	-1.71	-6.00	-0.10	6.00
0.0400	1.00	0.67	-0.02	22.35	0.01	-1.86	-6.17	-0.22	6.17
0.0410	1.02	0.67	-0.03	22.15	0.01	-1.97	-6.23	0.16	6.23
0.0420	1.05	0.67	-0.03	21.96	0.01	-2.05	-6.36	0.34	6.37
0.0430	1.07	0.67	-0.03	21.75	0.02	-1.90	-6.45	0.47	6.47
0.0440	1.09	0.67	-0.03	21.55	0.03	-1.75	-6.57	0.33	6.58
0.0450	1.11	0.67	-0.03	21.34	0.04	-1.62	-6.68	-0.01	6.68
0.0460	1.13	0.67	-0.03	21.13	0.05	-1.60	-6.71	0.07	6.71
0.0470	1.15	0.67	-0.04	20.91	0.06	-1.61	-6.92	0.04	6.92
0.0480	1.17	0.67	-0.04	20.69	0.06	-1.65	-6.96	0.00	6.96
0.0490	1.19	0.67	-0.04	20.47	0.06	-1.64	-7.13	0.23	7.13
0.0500	1.21	0.67	-0.04	20.24	0.07	-1.61	-7.24	-0.21	7.24
0.0510	1.24	0.67	-0.04	20.01	0.08	-1.58	-7.49	0.16	7.49
0.0520	1.25	0.67	-0.04	19.78	0.09	-1.47	-7.54	0.22	7.54
0.0530	1.27	0.67	-0.05	19.54	0.09	-1.41	-7.58	0.26	7.59
0.0540	1.29	0.67	-0.05	19.30	0.10	-1.25	-7.75	0.23	7.75
0.0550	1.31	0.67	-0.05	19.05	0.11	-1.27	-7.80	-0.09	7.80
0.0560	1.33	0.67	-0.05	18.81	0.11	-1.33	-7.94	-0.07	7.94
							-8.00	0.19	8.00

SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
CAL-CASE-MO-100
JAN. 10,1974

VEHICLE NO. 1

TIME SEC	VELOCITY VECTOR ATAN(V1/U 1) DEG	TIRE TRACKS(FT) RF X1*	RF Y1*	LF X2*	LF Y2*	RR X3*	RR Y3*	LR X4*	LR Y4*
		(*ASTERISK INDICATES SKIDDING TIRE)							
0.0	0.0	4.4*	3.1*	4.4*	-1.7*	-4.6	3.1	-4.6	-1.7
0.010	0.0	4.7*	3.1*	4.7*	-1.7*	-4.3	3.1	-4.3	-1.7
0.011	359.999	4.7*	3.1*	4.7*	-1.7*	-4.3	3.1	-4.3	-1.7
0.012	0.000	4.7*	3.1*	4.7*	-1.7*	-4.3	3.1	-4.3	-1.7
0.013	359.999	4.7*	3.1*	4.7*	-1.7*	-4.2	3.1	-4.2	-1.7
0.014	359.996	4.8*	3.1*	4.8*	-1.7*	-4.2	3.1	-4.2	-1.7
0.015	359.993	4.8*	3.1*	4.8*	-1.7*	-4.2	3.1	-4.2	-1.7
0.016	359.991	4.8*	3.1*	4.8*	-1.7*	-4.1	3.1	-4.1	-1.7
0.017	359.990	4.8*	3.1*	4.8*	-1.7*	-4.1	3.1	-4.1	-1.7
0.018	359.989	4.9*	3.1*	4.9*	-1.7*	-4.1	3.1	-4.1	-1.7
0.019	359.990	4.9*	3.1*	4.9*	-1.7*	-4.1	3.1	-4.1	-1.7
0.020	359.989	4.9*	3.1*	4.9*	-1.7*	-4.0	3.1	-4.0	-1.7
0.021	359.984	4.9*	3.1*	4.9*	-1.7*	-4.0	3.1	-4.0	-1.7
0.022	359.980	5.0*	3.1*	5.0*	-1.7*	-4.0	3.1	-4.0	-1.7
0.023	359.980	5.0*	3.1*	5.0*	-1.7*	-4.0	3.1	-4.0	-1.7
0.024	359.983	5.0*	3.1*	5.0*	-1.7*	-3.9	3.1	-3.9	-1.7
0.025	359.981	5.0*	3.1*	5.0*	-1.7*	-3.9	3.1	-3.9	-1.7
0.026	359.978	5.1*	3.1*	5.1*	-1.7*	-3.9	3.1	-3.9	-1.7
0.027	359.985	5.1*	3.1*	5.1*	-1.7*	-3.9	3.1	-3.9	-1.7
0.028	359.989	5.1*	3.1*	5.1*	-1.7*	-3.8	3.1	-3.8	-1.7
0.029	359.984	5.1*	3.1*	5.1*	-1.7*	-3.8	3.1	-3.8	-1.7
0.030	359.989	5.2*	3.1*	5.2*	-1.7*	-3.8	3.1	-3.8	-1.7
0.031	359.983	5.2*	3.1*	5.2*	-1.7*	-3.8	3.1	-3.8	-1.7
0.032	0.001	5.2	3.1	5.2	-1.7	-3.7	3.1	-3.7	-1.7
0.033	0.010	5.2	3.1	5.2	-1.7	-3.7	3.1	-3.7	-1.7
0.034	0.028	5.3	3.1	5.3	-1.7	-3.7	3.1	-3.7	-1.7
0.035	0.033	5.3	3.1	5.3	-1.7	-3.7	3.1	-3.7	-1.7
0.036	0.041	5.3	3.1	5.3	-1.7	-3.7	3.1	-3.7	-1.7
0.037	0.032	5.3	3.1	5.3	-1.7	-3.6	3.1	-3.6	-1.7
0.038	0.018	5.3	3.1	5.3	-1.7	-3.6	3.1	-3.6	-1.7
0.039	0.020	5.4	3.1	5.4	-1.7	-3.6	3.1	-3.6	-1.7
0.040	0.015	5.4	3.1	5.4	-1.7	-3.6	3.1	-3.6	-1.7
0.041	0.015	5.4	3.1	5.4	-1.7	-3.5	3.1	-3.5	-1.7
0.042	0.020	5.4	3.1	5.4	-1.7	-3.5	3.1	-3.5	-1.7
0.043	0.052	5.5	3.1	5.5	-1.7	-3.5	3.1	-3.5	-1.7
0.044	0.088	5.5	3.1	5.5	-1.7	-3.5	3.1	-3.5	-1.7
0.045	0.120	5.5	3.1	5.5	-1.7	-3.5	3.1	-3.5	-1.7
0.046	0.138	5.5	3.1	5.5	-1.7	-3.4	3.1	-3.4	-1.7
0.047	0.152	5.5	3.1	5.5	-1.7	-3.4	3.1	-3.4	-1.7
0.048	0.162	5.6	3.1	5.6	-1.7	-3.4	3.1	-3.4	-1.7
0.049	0.179	5.6	3.1	5.6	-1.7	-3.4	3.1	-3.4	-1.7
0.050	0.201	5.6	3.1	5.6	-1.7	-3.4	3.1	-3.4	-1.7
0.051	0.220	5.6	3.1	5.6	-1.7	-3.3	3.1	-3.3	-1.7
0.052	0.248	5.6	3.1	5.6	-1.7	-3.3	3.1	-3.3	-1.7
0.053	0.270	5.7	3.1	5.7	-1.7	-3.3	3.1	-3.3	-1.7
0.054	0.297	5.7	3.1	5.7	-1.7	-3.3	3.1	-3.3	-1.7
0.055	0.318	5.7	3.1	5.7	-1.7	-3.3	3.1	-3.3	-1.7
0.056	0.332	5.7	3.1	5.7	-1.7	-3.2	3.1	-3.2	-1.7
				5.7	-1.7	-3.2	3.1	-3.2	-1.7

SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)

CAL-CASE-MO-IOU

JAN. 11,1974

VEHICLE NO. 2

	C.G. POSITION		HEADING ANGLE	VELOCITIES		ANGULAR VELOCITY	ACCELERATION		
TIME	XC2*	YC2*	PSI2	FWD	LAT	PSI2DOT	AX2	AY2	ACC2
SEC.	FT	FT	DEG	FT/SEC	FT/SEC	DEG/SEC	G	G	G
0.0	15.56	0.0	180.00	2.93	0.0	0.0	-0.63	0.0	0.63
0.0100	15.56	0.00	180.00	2.73	0.0	0.0	-1.53	-0.02	1.53
0.0110	15.85	0.00	180.00	2.68	-0.00	-0.04	-1.65	-0.02	1.65
0.0120	15.55	0.00	180.00	2.62	-0.00	-0.07	-1.75	-0.09	1.76
0.0130	15.55	0.00	180.00	2.57	-0.00	-0.11	-1.86	-0.06	1.86
0.0140	15.54	0.00	180.00	2.51	-0.00	-0.16	-1.93	-0.05	1.93
0.0150	15.54	0.00	180.00	2.44	-0.00	-0.22	-2.02	-0.06	2.02
0.0160	15.54	0.00	180.00	2.38	-0.01	-0.27	-2.16	-0.07	2.16
0.0170	15.54	0.00	180.00	2.30	-0.01	-0.32	-2.30	-0.06	2.30
0.0180	15.54	0.00	180.00	2.23	-0.01	-0.38	-2.37	-0.07	2.37
0.0190	15.53	0.00	180.00	2.15	-0.01	-0.41	-2.55	-0.19	2.56
0.0200	15.53	0.00	180.00	2.07	-0.01	-0.49	-2.65	-0.11	2.65
0.0210	15.53	0.00	180.00	1.98	-0.02	-0.53	-2.73	-0.16	2.74
0.0220	15.53	0.00	180.00	1.89	-0.02	-0.59	-2.86	-0.17	2.86
0.0230	15.52	0.00	180.00	1.80	-0.02	-0.63	-2.94	-0.14	2.95
0.0240	15.52	0.00	180.00	1.71	-0.02	-0.65	-3.02	-0.08	3.02
0.0250	15.52	0.00	179.99	1.61	-0.03	-0.69	-3.10	0.00	3.10
0.0260	15.52	0.00	179.99	1.51	-0.03	-0.74	-3.15	-0.05	3.15
0.0270	15.52	0.00	179.99	1.41	-0.03	-0.74	-3.20	-0.14	3.20
0.0280	15.52	0.00	179.99	1.31	-0.03	-0.74	-3.28	-0.04	3.28
0.0290	15.52	0.00	179.99	1.20	-0.04	-0.80	-3.46	-0.11	3.46
0.0300	15.51	0.00	179.99	1.09	-0.04	-0.80	-3.67	-0.11	3.67
0.0310	15.51	0.00	179.99	0.97	-0.04	-0.86	-3.82	-0.09	3.83
0.0320	15.51	0.00	179.99	0.84	-0.04	-0.79	-3.91	-0.03	3.91
0.0330	15.51	0.00	179.99	0.72	-0.04	-0.78	-3.92	-0.12	3.92
0.0340	15.51	0.00	179.99	0.59	-0.04	-0.71	-4.09	-0.14	4.10
0.0350	15.51	0.00	179.99	0.46	-0.04	-0.71	-4.16	-0.04	4.16
0.0360	15.51	0.00	179.99	0.33	-0.04	-0.68	-4.25	-0.06	4.25
0.0370	15.51	0.00	179.99	0.19	-0.04	-0.71	-4.23	-0.18	4.23
0.0380	15.51	0.00	179.98	0.06	-0.05	-0.68	-3.89	-0.03	3.89
0.0390	15.51	0.00	179.98	-0.06	-0.05	-0.53	-3.80	0.06	3.80
0.0400	15.51	0.00	179.98	-0.17	-0.04	-0.52	-3.42	-0.11	3.42
0.0410	15.51	0.00	179.98	-0.28	-0.04	-0.54	-3.44	0.12	3.44
0.0420	15.51	0.00	179.98	-0.39	-0.04	-0.57	-3.53	0.22	3.53
0.0430	15.51	0.00	179.98	-0.50	-0.03	-0.48	-3.59	0.31	3.60
0.0440	15.51	0.00	179.98	-0.62	-0.03	-0.39	-3.67	0.22	3.68
0.0450	15.51	0.00	179.98	-0.73	-0.02	-0.33	-3.75	-0.03	3.75
0.0460	15.51	0.00	179.98	-0.85	-0.02	-0.34	-3.78	0.01	3.78
0.0470	15.51	0.00	179.98	-0.97	-0.01	-0.38	-3.93	-0.03	3.93
0.0480	15.52	0.00	179.98	-1.10	-0.01	-0.43	-3.96	-0.06	3.96
0.0490	15.52	0.00	179.98	-1.22	-0.01	-0.46	-4.08	-0.04	4.08
0.0500	15.52	0.00	179.98	-1.35	-0.01	-0.46	-4.16	-0.21	4.17
0.0510	15.52	0.00	179.98	-1.48	-0.01	-0.49	-4.34	0.05	4.34
0.0520	15.52	0.00	179.98	-1.62	-0.01	-0.51	-4.38	0.10	4.38
0.0530	15.52	0.00	179.98	-1.76	-0.00	-0.54	-4.41	0.12	4.42
0.0540	15.52	0.00	179.98	-1.90	0.00	-0.50	-4.53	0.11	4.53
0.0550	15.53	0.00	179.98	-2.04	0.00	-0.58	-4.58	-0.12	4.59
0.0560	15.53	0.00	179.98	-2.18	0.00	-0.70	-4.68	-0.11	4.69
0.0570	15.53	0.00	179.98	-2.33	0.00	-0.70	-4.72	0.08	4.72
0.0580	15.53	0.00	179.97	-2.48	0.01	-0.72	-4.78	0.07	4.78

0.056	179.699	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.057	179.699	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.058	179.840	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6

SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
CAL-CAC-MI-100
JAN. 15,1974

VEHICLE NO. 2

TIME SEC	VELOCITY VECTOR ATAN(V2/U 2) DEG	TIRE TRACKS(FT) RF X1*	RF Y1*	LF X2*	LF Y2*	RR X3*	RR Y3*	LR X4*	LR Y4*
		(*ASTERISK INDICATES SKIDDING TIRE)							
0.0	0.0	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.010	0.0	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.011	359.994	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.012	359.993	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.013	359.973	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.014	359.939	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.015	359.899	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.016	359.849	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.017	359.809	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.018	359.743	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.019	359.706	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.020	359.596	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.021	359.516	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.022	359.389	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.023	359.283	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.024	359.196	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.025	359.027	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.026	358.849	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.027	358.754	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.028	358.603	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.029	358.297	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.030	358.046	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.031	357.546	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.032	357.352	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.033	356.846	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.034	356.350	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.035	355.130	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.036	353.055	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.037	347.031	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8*	2.6*
0.038	322.074	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8*	2.6*
0.039	216.552	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.040	193.540	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.041	188.427	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.042	186.073	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.043	183.879	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.044	182.400	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.045	181.476	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.046	181.072	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.047	180.858	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.048	180.772	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.049	180.631	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.050	180.465	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.051	180.357	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.052	180.197	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.053	180.106	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.054	179.917	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6
0.055	179.911	10.5*	-2.6*	10.5*	2.6*	20.8	-2.6	20.8	2.6

DONE IN OUT 2

SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
CAL-CRASH-MOD-100
JAN. 13,1974
DAMAGE SUMMARY (DISPLACED POINTS, * J POINT)

VEHICLE NO. 1
25 POINTS

RHOB1	PSIB1	X1	Y1
INCHES	DEG	INCHES	INCHES
73.769	0.0	73.7691	0.0
73.820	2.000	73.7747	2.5763
73.991	4.000	73.8011	5.1607
74.199	6.000	73.7929	7.7559
74.404	8.000	73.7689	10.3675
74.925	10.000	73.7868	13.0106
75.408	12.000	73.7598	15.6781
76.053	14.000	73.7938	18.3988
76.771	16.000	73.7973	21.1610
77.552	18.000	73.7562	23.9648
78.536	20.000	73.7996	26.8608
79.350	22.000	73.5718	29.7249
79.448	334.000	71.4071	-34.8277
80.773	336.000	73.7895	-32.8533
79.579	338.000	73.7839	-29.8107
78.517	340.000	73.7822	-26.8546
77.552	342.000	73.7563	-23.9650
76.772	344.000	73.7976	-21.1612
76.053	346.000	73.7937	-18.3989
75.408	348.000	73.7598	-15.6782
74.925	350.000	73.7871	-13.0107
74.404	352.000	73.7689	-10.3676
74.199	354.000	73.7927	-7.7560
73.991	356.000	73.8007	-5.1607
73.820	358.000	73.7749	-2.5764

VEHICLE NO. 2
20 POINTS

RHOB2	PSIB2	X2	Y2
INCHES	DEG	INCHES	INCHES
93.519	0.0	93.5195	0.0
93.580	2.000	93.5232	3.2659
93.668	4.000	93.4395	6.5339
93.983	6.000	93.4684	9.8239
94.413	8.000	93.4341	13.1397
94.879	10.000	93.4375	16.4755
95.577	12.000	93.4884	19.8716
96.310	14.000	93.4488	23.2994
97.172	16.000	93.4076	26.7842
100.541	338.000	93.2195	-37.5632
99.507	340.000	93.5062	-34.0336
98.321	342.000	93.5092	-30.3831
97.193	344.000	93.4277	-26.7901
96.309	346.000	93.4487	-23.2994
95.577	348.000	93.4884	-19.8717
94.879	350.000	93.4376	-16.4757
94.413	352.000	93.4942	-13.1399
93.984	354.000	93.4685	-9.8241
93.668	356.000	93.4394	-6.5340
93.580	358.000	93.5233	-3.2660

VEHICLE NO. 1
1 RANGES

BEGIN RHOB1	BEGIN PSIB1	END RHOB1	END PSIB1	MIDPOINT PSIM1	VEH.DAMAGE INDEX	VEL DELTA V
INCHES	DEG	INCHES	DEG	DEG		MPH
* 79.45	334.00	* 79.35	22.00	356.28	12FDEW2	18.28

VEHICLE NO. 2
1 RANGES

BEGIN RHOB2	BEGIN PSIB2	END RHOB2	END PSIB2	MIDPOINT PSIM2	VEH.DAMAGE INDEX	VEL DELTA
INCHES	DEG	INCHES	DEG	DEG		MPH
* 100.54	338.00	* 97.17	16.00	355.95	12FDEW1	10.9

pipe in OUT

VEHICLE NO. 1, ELAPSED T = 2.0000 SEC

VEHICLE NO. 2, ELAPSED T = 2.0000 SEC POR

done in MAIN

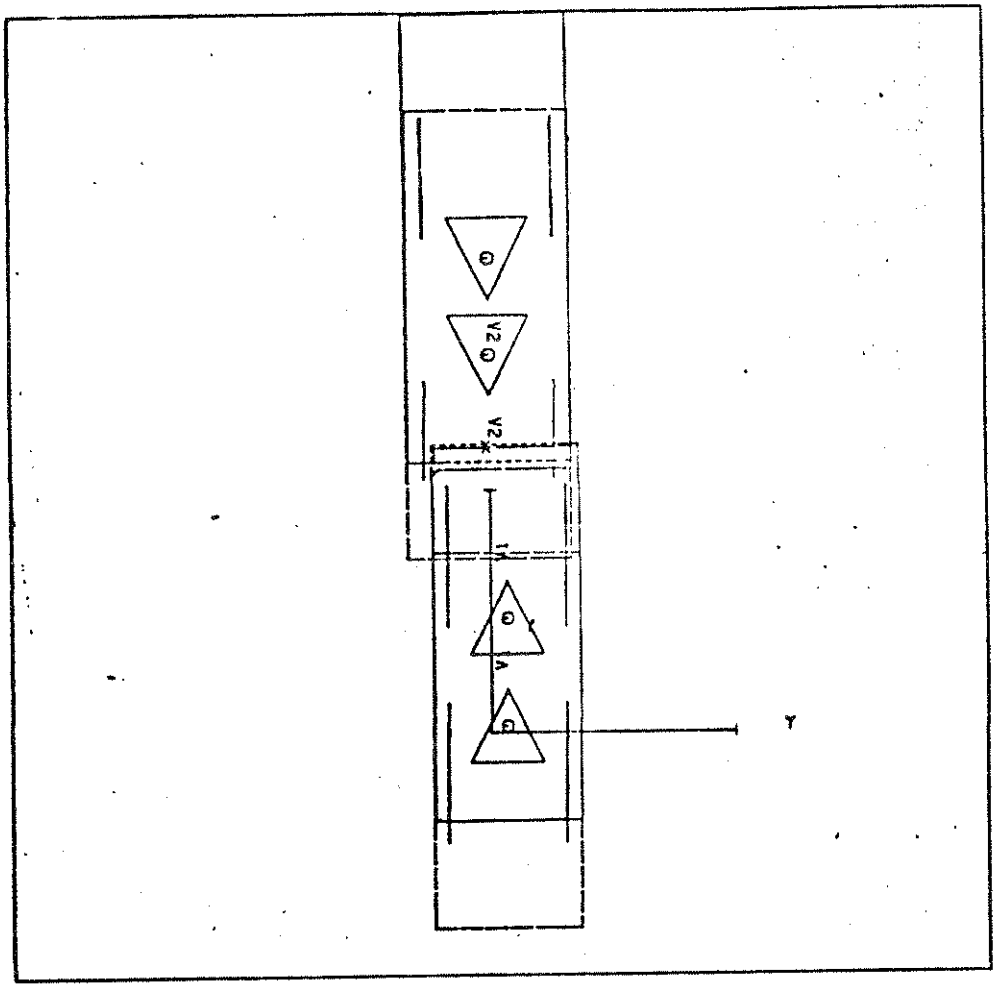
AT T= 1.2300 SEC.. VEHICLE 2 MOVING SLOWLY
SPEED = 0.64651E-01 FT/SEC, PSI2D= -0.37450E 00 DEG/SEC

C. Sample Graphic Display(Derived from the input data of IIIB)

GRAPHIC DISPLAY OF OUTPUTS OF ACCIDENT RECONSTRUCTION

COLLISION AND TRAJECTORY

CASE-MO-10U



AXIS INTERVALS ARE 10. FEET

RECONSTRUCTED POSITIONS AND VELOCITIES AT IMPACT							DISPLACED FINAL POSITIONS				VEHICLE DAMAGE INDICES	ΔV
	C.G. POSITION		HEADING				C.G. POSITION		HEADING	REMARKS		
	XC1	YC1	PSI1	FWD	LATERAL	ANGULAR	XC1F	YC1F	PSI1F			
	FT.	FT.	DEG.	MPH	MPH	DEG/SEC	FT.	FT.	DEG.			MPH
VEHICLE # 1	0.3	0.7	0.0	17.9	0.0	0.0	4.7	0.7	-0.2	IN MOTION AT 2.0 SEC AFTER INITIAL CONTACT	12FDEW2	18.5
VEHICLE # 2	15.8	0.0	180.0	7.9	0.0	0.0	19.5	-0.0	179.8	VEHICLE AT REST	12FDEW1	11.3

SECTION VI
SUGGESTED VALUES OF PARAMETERS

In the interest of simplicity, the presented preliminary evaluation of the SMAC computer program has made use of "typical" parameters other than weights for the different categories of vehicle size rather than actual parameters for the specific vehicles. Vehicles representative of four different size categories were selected to provide a basis for "typical" parameters. The following vehicles were included in the different categories.

1. Subcompact

   Volkswagen Beetle
   Toyota 1200
   Datsun 1200
   Vega
   Pinto
   Fiat 850

2. Compact

   Maverick
   Camero
   Dart
   Hornet

3. Intermediate

   Chevelle
   Torino
   Coronet
   Matador
   Skylark

4. Full Size

   Chevrolet
   Galaxie
   Polara
   Ambassador
   Monterey
   LeSabre
   New Yorker
   Fleetwood
   Continental

On the basis of available dimensional and shipping weight information, and with allowances made for both liquid weight and two passenger loading, the following "typical" parameters have been either directly derived or estimated from available measured values for similar vehicles.

TABLE 1

TYPICAL DIMENSIONAL AND INERTIAL PARAMETERS FOR 1971-72 AUTOMOBILES

Parameter	1 Subcompact	2 Compact	3 Intermediate	4 Full Size	Units
a	44.7	52.7	57.3	60.5	Inches
b	46.6	54.8	59.7	63.0	Inches
T	51.2	57.7	60.0	63.1	Inches
k^2	1963.	2635.	2998.	3588.	$Inches^2$
M	5.71	8.51	9.86	12.42	$Lb\text{-}Sec^2/in$
X_F	74.7	85.7	94.8	100.5	Inches
X_R	-83.5	-100.0	-110.8	-119.6	Inches
Y_S	31.1	35.7	38.4	39.6	Inches

TABLE 2

For the following vehicle parameters, representative values have been found but no refinement has yet been attempted for the different categories of vehicle size other than the load-deflection characteristic of the peripheral structure, K_V.

REPRESENTATIVE VALUES OF VEHICLE PARAMETERS

Parameter	Value	Units
$(CSTF)_{1,2}$	-10250.	Pounds/Radian
$(CSTF)_{3,4}$	-10195.	Pounds/Radian
C_μ	3×10^{-4}	Seconds/Inch
K_V	{ Full Size = 50 / Subcompact = 30 }	Pounds/Inch^2
C_0	0.06423	-
C_1	3.5417×10^{-3}	-
C_2	4.7381×10^{-5}	-
μ	0.550	-
$\Delta\Psi$	2.00	Degrees
$\Delta\rho$	0.20	Inches
λ	15.0	Lb/In
ζ_V	5.0	In/Sec

SECTION VII

REFERENCES

(1) Motor Vehicle Manufacture's Association (MVMA), "Accident Investigator's Manual", MVMA Detroit, Michigan. Useful for some vehicle properties.

(2) McHenry, R.R, "Development of a Computer Program to Aid the Investigation of Highway Accidents", Calspan Report No. VJ-2979-V-1, December 1971, HS 800 821. Explains theory and organization of program.

(3) McHenry, R.R., Segal, P.J., Lynch, J.P., Henderson, P.M., "Mathematical Reconstruction of Highway Accidents", Calspan Report No. ZM-5096-V-1, January 1973, HS 800 801. Gives Several case examples.

(4) McHenry, R.R., "Approximation of Impact Conditions via Computer Simulation", Proceeding International Accident Investigation Workshop, Brussels, Belgium, Pilot Study on Road Safety for the Committee on the Challenges of Modern Society, NATO, June, 1973, National Highway Traffic Safety Administrations, Washington, D.C. 20590. Provides a concise overview of SMAC.

(5) Jones, I.S., "Results of Selected Applications to Actual Highway Accidents of the SMAC Reconstruction Program" to be presented at Eighteenth Stapp Conference, Ann Arbor, Michigan, November, 1974. Shows how the operator can obtain a best fit to scene data.

(6) Jones, I.S., "The Application of the SMAC Accident Reconstruction Program to actual Highway Accidents". Proceedings of Eighteenth Conference of the American Association Automotive Medicine, Society of automotive Engineers, Inc., Toronto, Canada, 1974. Illustrates use of the START program to generate initial conditions for the SMAC program.

II. SMAC Job Submitted from a Remote Terminal

The following JCL may be used to execute the SMAC system from a remote batch terminal. The SMAC system executes in two steps. The first step accepts user input and produces output as described in the SMAC Operator's Manual. The second step produces an IPF which may be displayed or postprocessed by the user on the plotter of his choice.

```
//  Job cards - see MCAUTO OS Programmer's Guide for format
//*  DAC II routing cards and format cards                    (1)
// EXEC PGM=SMACIPF,REGION=180K
//STEPLIB DD DSN=DLS.GP12.DØT.SMAC,DISP=SHR
//FT01F001 DD DSN=&TEMP,UNIT=SYSDA,DISP=(,PASS),
//  DCB=(RECFM=VBS,LRECL=364,BLKSIZE=1832),SPACE=(1832,(100,10)
//FT02F001 DD DUMMY
//FT06F001 DD SYSØUT=A
//FT05F001 DD *
    SMAC input data
/*
// EXEC PGM=SMACPLØT,REGION=140K                            (2)
//STEPLIB DD DSN=DLS.GP12.DØT.SMAC,DISP=SHR
//FT01F001 DD DSN=&TEMP,UNIT=SYSDA,DISP=(ØLD,PASS)
//FT06F001 DD SYSØUT=A
//FT15F001 DD SYSØUT=A,DCB=(RECFM=FB,BLKSIZE=80)           (3)
//FT05F001 DD *
                                                           (4)
/*
```

Notes:

(1) DAC II routing cards and format cards needed only if file is to be displayed using FASTDRAW. (See following page for explanation of this situation.)

(2) JCL from this point produces the IPF which will be displayed or postprocessed.

(3) This DD statement will be used if the IPF is to be displayed using FASTDRAW.

If the IPF will be used as input to a MCAUTO postprocessor for the CalComp drum, CalComp flatbed, or Gould electrostatic plotter, define FT15F001 as follows:

```
//FT15F001 DD DSN=&IPF,UNIT=SYSDA,DISP=(,PASS),
// SPACE=(TRK,(5,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
```

(See MCAUTO IPF User's Manual for descriptions of various postprocessors available.)

If the IPF will be postprocessed at a user site to produce a plot, FT15F001 must be a punch file (SYSOUT=B).

(4) No data will be input by the user. Extra printout helpful in debugging program errors may be generated when this record is input.

1) The DAC II routing cards have the following format:

```
//*POSTP,UN=uuuuu,PW=ppppppp,PP=TOP.
//*TOP OUT=(SYSMSG=aaaaaaa,FT15F001=bbbbbbb)
```

The variables in these lines are defined as:

uuuuu - Valid CYBER user number

ppppppp - Valid CYBER password
(7 characters maximum)

aaaaaaa - Name of file where IBM messages will be stored
(7 characters maximum)

bbbbbbb - Name of file where the plot information will be stored
(7 characters maximum)

2) The format cards should be constructed as follows:

```
//*FORMAT PR,DDNAME=FT15F001,DEST=CDC1B,CONTROL=SINGLE
//*FORMAT PR,DDNAME=SYSMSG,DEST=CDC1B
//*FORMAT PR,DDNAME=SYSMSG,DEST=user terminal id
```

These format cards are necessary when routing output to the DAC II system.

III. Execution of SMAC Pre-Processor

The user of this system can execute the START program and/or generate the file for display by creating a job stream to execute SMAC on the IBM 370 system.

A. Log On Procedure

To connect the terminal to the DAC-II system, the user dials the phone number of a line of the appropriate speed (10 or 30 cps), listens for a beep, and types the return key once. The system responds:

```
MCAUTO - 11:39 DEC 14, '77
LOGON PLEASE:
PASSWORD
XXXXXXXXX
```

The user enters the account number and password. The form is:

```
LOGON PLEASE:  ACCOUNT NUMBER
PASSWORD
XXXXXXXXX (user password is entered on overtype for
           security.)
```

B. Initialization of SMAC System

```
#-SMACCOM.C0162
```

This line must be typed by the user. (# is a prompt and is not typed by the user.) This will load the system and give SMAC program control. The user will now be prompted with:

```
********** SMAC PRE-PROCESSOR **********
SELECT PROGRAM TO BE EXECUTED (START,SMAC)
```

The prompt character will be a ?.

The user will respond with either START or SMAC.

If SMAC is selected, the user will be issued a series of prompts which will enable him to prepare a SMAC input stream for batch processing on the IBM 370 (see Section III.D).

If START is selected, the user will be issued a series of prompts which will allow him to input basic accident data. The START program will then generate output consisting of:

Collision Conditions
Separation Conditions
Dimensions and Inertial Properties
SMAC input file.

The SMAC input file may be submitted for batch processing by the SMAC program on the IBM 370 if so desired. Multiple START cases are allowed, but only the last case may be submitted for SMAC processing.

C. START program

The user will be issued a series of prompts requesting that he input his accident data. All numerical data may be input with a free format. Data items must be separated by at least one comma or blank. A message

ERROR IN INPUT - RETYPE THIS LINE

will be printed whenever the system detects illegal characters in the numerical data. The user will then have to re-enter the line of data which contained the illegal data. Requested data items not input by the user will be set to zero. Refer to Section V (Sample Input and Output) for a listing of the prompts and the report generated by START after all data prompting has been completed.

After the report has been completed, the user will be prompted:

DO YOU WISH TO RUN ANOTHER START CASE
(YES OR NO)

If the response is YES, the user will be prompted:

SMAC DATA GENERATED BY START WILL BE LOST
DO YOU WISH TO PRINT THE SMAC DATA (YES OR NO)

If the response is NO, the user will again be prompted for his START input data.

If the response is YES, the system will print the SMAC data in the format required by the SMAC system before prompting for START data. The user may later input this data to the SMAC system using the SMAC pre-processor or punching the card deck himself.

If the user responds NO to the question

DO YOU WISH TO RUN ANOTHER START CASE

another prompt will appear:

IS SMAC DATA TO BE INPUT TO THE SMAC PROGRAM (YES OR NO)

If NO is the response, the user will be exited from the system and can then LOG OFF or do other processing as desired.

If YES is the response, the user will be prompted for additional information required to prepare the SMAC job stream as when he executes the SMAC command. The prompts will be as they are described in Section III.D, except that the user will not be prompted for data inputs as the data already exists (created by START).

D. SMAC Job Stream Creation

If the SMAC command was given as described in Section III.B or if a SMAC file has been created using START, the following prompts will be issued. The first prompt will be:

KEY IN NEW FILE NAME - SMAC FILE WILL BE BUILT
LS IT MAY BE CHANGED BY THE USER FOR FUTURE SUBMITTA

The prompt character will be a ?. The user will respond with a file name of up to 7 alphanumeric characters. This file will contain the JCL and data which will be transmitted to the IBM 370 for processing.

The user will next be prompted for information required for generating a JOB card for input to the IBM 370. He will be prompted with:

ENTER JOB CARD PARAMETERS
MCAUTO AC#, JOB ID

He will respond to the prompt with:

xxxxxxx,yyy

with xxxxxxx being the 7-digit accounting code assigned to the user for account billing and yyyy being a 4-character name chosen by the user. The user will then be prompted with:

CLIENT ID

and the response should be a blank or the extended accounting field mentioned in Section III.A. The user will then be prompted with:

PROGRAMMER ID

He will ordinarily respond with a blank.

However, if the output is to be routed to St. Louis in the event of a bug or some other difficulty on the system, the response will be:

GEDERA 6823 4811

This will guarantee that the output will be routed to the proper individual.

The user will then be prompted with:

KEY IN OUTPUT DESTINATION CODE
IF BLANK, OUTPUT WILL RETURN TO THE ORIGINATOR ONLY

Normal response is blank.

If a programmer ID response was not a blank, respond with MACC. To route the output to another terminal, respond with the proper terminal ID.

E. Data Input

There are three methods of inputting data to the system.

1. The user may load cards on the IBM 370 through a terminal creating a DSS file (see the MCAUTO DSS User's Manual).

2. The user may input his data directly into the terminal, using free form input. All data items must be input. If they are to be zero, type a zero. Data items may be separated by blanks or by commas.

3. The user may execute the START program.

If the third method has not been used, the user will be prompted with:

IS DATA TO BE INPUT FROM THIS TERMINAL
(YES OR NO)

If YES is the response, the user will then be prompted to key in his data in the manner described above in Data Input, Item 2.

NOTE: When entering table data (after lines 8, 9, 10 and 11) the user may type in all the data himself, or allow the computer to do it if all values following an entry are to be equal to that particular entry and constant from that point on. This can be done by typing an asterisk (*) after the desired table entry. This is a signal to the computer that indicates that the user wishes to propogate the value of the last numeric entry through the end of the table of the particular wheel the user is working on. An example of this is:

```
Card 10:     1.2    2.3    0.1    9.    (user input)

TYPE IN VEHICLE 1 WHEEL STEER TABLE (computer
                                      response)

12 VALUES PER FRONT TIRE ARE EXPECTED (7 per line)

Table:       0.     0.     0.    -20. *(user input)

Table:       0.     0.     0.    -20. *(user input)
```

The above user input would be interpreted by the computer to be:

```
Card 10:     1.2    2.3    0.1    0.

-2(  Table:  0.     0.     0.    -20.   -20.   -20.
            -20.   -20.   -20.   -20.   -20.

-20  Table:  0.     0.     0.    -20.   -20.   -20.
            -20.   -20.   -20.   -20.   -20.
```

If NO is the response, the user will be prompted:

KEY IN DSS USER ID AND FILE NAME

The response will be

DSSID, FILENAME

where DSSID is the name of the user's DSS account and FILENAME is the name of the file he is referencing. (See DSS User's Manual for further explanation of DSS.)

After SMAC data has been added to the job stream, the user will be prompted:

IS TIRE TRACK INFORMATION TO BE PRINTED (YES OR NO)

If the response is NO, the SMAC tire track information will not be printed. Otherwise, it will be printed.

F. Job Submission

The user will now be prompted as to whether he wishes to submit the job for processing.

DO YOU WISH TO SUBMIT THIS FILE TO RUN (YES OR NO)

If errors have been made when keying in data, the response will be NO. If the job is to be submitted, the response will be YES.

If the response is YES, the user will be prompted to:

KEY IN FILE NAME THAT WILL RECEIVE THE OUTPUT

The user will respond with a file name of up to 7 characters. It is this file which will be used for display on the Tektronix tube after the job has been run on the IBM 370. The system will generate IBM LINK JOB NAME IS = YYYYZZZZ.

If the response is NO, the user must change the file and submit it himself. Section III.H described this situation.

G. Job Status

After the job has been submitted to the IBM 370, the user may wish to inquire as to its status. This may be done by using the #INQ command.

#INQ YYYYZZZZ

where YYYYZZZZ is the Link ID generated previously.

The following responses are given:

1. WAITING TO BE TRANSMITTED.

2. TRANSMISSION TO DESTINATION COMPUTER IN PROGRESS.

3. JOB RECEIVED ON DESTINATION COMPUTER.

   An additional message describes the status of the job on the destination computer.

   ---RUNNING
   ---IN HOLD
   ---WAITING FOR DEVICES
   ---WAITING FOR OPERATOR RESPONSE
   ---WAITING FOR MAIN PROCESSOR
   ---WAITING FOR BREAKDOWN

4. JOB COMPLETED ON DESTINATION COMPUTER.

5. JOB RECEIVED ON CYBER SERVICE.

   If a DEF OUT file was requested, HOST also reports

   ---RESULTS IN FILE fid

   where "fid" is the file name supplied by the user to the prompt KEY IN FILE NAME THAT WILL RECEIVE THE OUTPUT.

6. NO JOBS FOUND.

   This message appears if there is no record of that ID on the given date. This may occur if the ID is incorrectly typed, if the date is not given for an ID submitted some previous day, or if the status information is no longer available.

The file may be displayed after it has been received on the Direct Access Computer.

H. Correcting Errors or Changing Input Data

If a file is to be corrected (JOB was not submitted) or if a file is to be changed (parameters are to be changed) and resubmitted, the following procedure should be used.

1. Saving Old File

If parameters are to be altered and the old file is not to be destroyed, the following should be executed:

```
#OLD OLDFILE
```

where OLDFILE is the name of the file which was previously transmitted to the IBM 370.

```
#REN NEWFILE
```

where NEWFILE is supplied by the user and is the name of the file to be edited and then submitted.

```
#SAV
```

2. Editing the File

```
#EDIT FILENAME
```

FILENAME is the name of the file to be submitted to the IBM 370. FILENAME was defined in Section E or Section H.1 using REN command.

Use the Edit Command (see DAC II Edit Manual) to correct or change records as you desire.

```
#DEF OUT=XXXX
```

where XXXX is the name of the file which will be used for display on the Tektronix.

```
#XMIT FILENAME
```

where FILENAME is the name of the file which you have edited.

The job will then be transmitted. The INQ command may be used as described above to check on the status of the job.

I. Job Termination - Logging Off

To log off the DAC II system, the user types

```
#BYE
```

The system responds with an accounting summary.

IV. Sample Input and Output

The sample code contained in this section illustrates the following:

1) Create SMAC data input from the terminal keyboard.
2) Create SMAC data input using DSS.
3) Use of EDIT, DEF OUT and XMIT to resubmit a SMAC job to the IBM 370.
4) Execution of the START program.

INPUT SMAC DATA USING THE DAC-II TIME SHARE SYSTEM
- SUBMIT JOB TO RUN ON THE 195 -

```
#-SMACCOM.C0162
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
?SMAC

 KEY IN FILE NAME-SMAC FILE WILL BE BUILT
 IT MAY BE CHANGED BY THE USER FOR FUTURE SMAC SUBMITTALS
?SMACIN
 ENTER JOB CARD PARAMETERS FOR STL
 MCAUTO AC#, JOB ID
:       ,SMACTEST
 CLIENT ID
:
 PROGRAMMER ID
:GEDERA 6823 4812

  KEY IN OUTPUT DESTINATION CODE
  IF BLANK, OUTPUT WILL RETURN TO ORIGINATOR ONLY

:MACC

  IS DATA TO BE INPUT FROM THIS TERMINAL?(YES OR NO)

:YES

  KEY IN TWO HEADING LINES

:SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
:CAL-CASE-71-55B

  TYPE IN FIRST EIGHT LINES OF DATA

:0.0 2.0 .025 .001 .01 .02 6.0 1.0 2.0
:330.77 337.54 -37. 0.0 247.596 0.0
:637. 227. 180. 0.0 440. 0.0
:57.3 59.7 60. 34200. 9.36 0.0 97.2 -109. 38.4
:53.4 55.6 57.7 25600. 7.98 0.0 93.4 -96.1 35.7
:-10250. -10250. -10195. -10195.
:-10250. -10250. -10195. -10195.
:0.0 2.0 1.0 0.0

  TYPE IN VEHICLE 1 WHEEL TORQUE TABLE
    3 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

:-1200. -1200. -1200.
:-1200. -1200. -1200.
:-1200. *
:-1200. *

  TYPE IN NINTH LINE OF DATA

:0.2 0.5 0.1 0.0
```

```
  TYPE IN VEHICLE 2 WHEEL TORQUE TABLE
    4 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

:0.0 0.0 0.0 0.0
:0.0 -1000. -1000. -1000.
:0.0 *
:0.0 -1000. *

  TYPE IN TENTH LINE OF DATA

:0.0 2.0 1.0 1.0

  TYPE IN ELEVENTH LINE OF DATA

:0.0 2.0 1.0 1.0

  TYPE IN LAST FOUR LINES OF DATA
  IF THE LAST DATA LINE IS NOT DESIRED,
  HIT RETURN WHEN THE FOURTH PROMPT SIGN APPEARS
:1.0 1.0 1.0 1.0 0.7 0.7 0.0 0.0
:2.0 0.2 15.0 5.0 50. 50. .55
:.06423 3.5417-3 4.7381-5
:

 IS TIRE TRACK INFORMATION TO BE PRINTED?(YES OR NO)

:YES

  DO YOU WISH TO SUBMIT THIS FILE TO RUN?(YES OR NO)

:YES

  KEY IN FILE NAME THAT WILL RECEIVE THE OUTPUT

:SMACOUT
 JOB SMAC0648 QUEUED FOR ST. LOUIS 370 SERVICE AT 09:19 JAN 16,'78
 IBM LINK JOB NAME IS = SMAC0648
    STOP
#
```

LIST OF FILE SMACINPT

```
#OLD SMACIN
#LNH
10//SMACTEST JOB (S,       ,'                    ','2000  0000',0000000,C),
20//            'GEDERA 6823 4812    ',MSGLEVEL=(0,0),
30//              LIM=(004.00,0004.00,005,000)
40//*FORMAT PR,DDNAME=SYSMSG
50//*FORMAT PR,DDNAME=FT06F001
60//*FORMAT PR,DDNAME=FT15F001,CONTROL=SINGLE
70//*FORMAT PR,DDNAME=SYSMSG,CONTROL=SINGLE,DEST=MACC
80//*FORMAT PR,DDNAME=FT06F001,DEST=MACC
90//    EXEC PGM=SMACIPF,REGION=180K
100//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
110//FT01F001 DD DSN=&TEMP,
120//        DCB=(RECFM=VBS,LRECL=364,BLKSIZE=1832),
130//        UNIT=SYSDA,DISP=(,PASS),SPACE=(1832,(100,10))
140//FT02F001 DD DUMMY
150//FT06F001 DD SYSOUT=A
160//SYSUDUMP DD SYSOUT=A
170//FT05F001 DD *
180SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
190CAL-CASE-71-55B
  1 200±0.0     2.0      .025     .001     .01      .02      6.0      1.0      2.0
  2 210±330.77  337.54   -37.     0.0      247.596  0.0
  3 220±637.    227.     180.     0.0      440.     0.0
  4 230±57.3    59.7     60.      34200.   9.36     0.0      97.2     -109.    38.4
  5 240±53.4    55.6     57.7     25600.   7.98     0.0      93.4     -96.1    35.7
  6 250-10250. -10250. -10195. -10195.
  7 260-10250. -10250. -10195. -10195.
  8 270±0.0     2.0      1.0      0.0
    280    -1200.    -1200.    -1200.
    290    -1200.    -1200.    -1200.
    300    -1200.    -1200.    -1200.
    310    -1200.    -1200.    -1200.
  9 320±0.2     0.5      0.1      0.0
    330       0.0       0.0       0.0       0.0
    340       0.0    -1000.    -1000.    -1000.
    350       0.0       0.0       0.0       0.0
    360       0.0    -1000.    -1000.    -1000.
 10 370±0.0     2.0      1.0      1.0
 11 380±0.0     2.0      1.0      1.0
 12 390±1.0     1.0      1.0      1.0      0.7      0.7      0.0      0.0
 13 400±2.0     0.2      15.0     5.0      50.      50.      .55
 14 410.06423  3.5417-34.7381-5
999 420    1.                                                                  9
430/*
440//    EXEC PGM=SMACPLOT,REGION=140K
450//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
460//FT01F001 DD DSN=&TEMP,UNIT=SYSDA,
470//        DISP=(OLD,DELETE)
480//FT06F001 DD SYSOUT=A
490//FT15F001 DD SYSOUT=A,DCB=(RECFM=FB,BLKSIZE=80)
500//SYSUDUMP DD SYSOUT=A
510//FT05F001 DD *
520       6.       6.    0    0       .1       0.       0.
530/*
#
```

195 SYSTEM OUTPUT OF SMAC JOB - JOB MAY HAVE BEEN SUBMITTED AS IN SECTION II OR SECTION III. THIS IS OUTPUT OF JOB USING FILE SMACINPT (LISTED IN THIS SECTION) AS INPUT TO THE 195.

```
 ISV40 JOB ORIGIN FROM GROUP=CDC1B    , DSP=CR , DEVICE=CDC1BRD1, 0C2
//SMAC0086 JOB (S,       ,'                    ',,'2000  0000',0000000,C),
//*ROUTE 00--DU01C50E
//             'GEDERA 6823 4812    ',MSGLEVEL=(0,0),
//               LIM=(004.00,0004.00,005,000)
//*POSTP,UN=C0162,HPW=4HIL508,PP=TOP,
//*TOP OUT=BBB
//*FORMAT PR,DDNAME=SYSMSG
//*FORMAT PR,DDNAME=FT06F001
//*FORMAT PR,DDNAME=FT15F001,CONTROL=SINGLE
//*FORMAT PR,DDNAME=SYSMSG,CONTROL=SINGLE,DEST=MACC
//*FORMAT PR,DDNAME=FT06F001,DEST=MACC
//     EXEC PGM=SMACIPF,REGION=180K
//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
//FT01F001 DD DSN=&TEMP,
//         DCB=(RECFM=VBS,LRECL=364,BLKSIZE=1832),
//         UNIT=SYSDA,DISP=(,PASS),SPACE=(1832,(100,10))
//FT02F001 DD DUMMY
//FT06F001 DD SYSOUT=A
//SYSUDUMP DD SYSOUT=A
//FT05F001 DD *
/*
//     EXEC PGM=SMACPLOT,REGION=140K
//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
//FT01F001 DD DSN=&TEMP,UNIT=SYSDA,
//         DISP=(OLD,DELETE)
//FT06F001 DD SYSOUT=A
//FT15F001 DD SYSOUT=A,DCB=(RECFM=FB,BLKSIZE=80)
//SYSUDUMP DD SYSOUT=A
//FT05F001 DD *
/*


 LOCATE':9575DLS.GP12.DOT.SMAC                                  '
 AL95750E001/DISKCE000E
 LOCATE':9575DLS.GP12.DOT.SMAC                                  '
 AL95750E001/DISKCE000E


AMDS01 SMAC0086 (9575) IN SETUP ON MAIN=SY3
 SMAC0086 IEF403I SMAC0086 STARTED    TIME=14.05.36
 SMAC0086 IEF234E D 506,ASP506
 SMAC0086 IEF234E D 507,ASP507
*SMAC0086*01 IECASP0 506 IS SMAC0086 A                    FT06F001
*SMAC0086*01 IECASP0 50C IS SMAC0086                      ASPI0001
 SMAC0086 IEC202E K 50C,019575,NL,SMAC0086,
 SMAC0086 MACRCDE  JOB SMAC0086 STEP            RC=0000
 SMAC0086 IEF234E D 506,ASP506
*SMAC0086*01 IECASP0 506 IS SMAC0086 A                    FT06F001
*SMAC0086*01 IECASP0 507 IS SMAC0086 A                    FT15F001
*SMAC0086*01 IECASP0 511 IS SMAC0086                      ASPI0002
 SMAC0086 IEC202E K 511,029575,NL,SMAC0086,
 SMAC0086 MACRCDE  JOB SMAC0086 STEP            RC=0000
 SMAC0086 IEF404I SMAC0086 ENDED       TIME=14.06.32
//SMAC0086 JOB (S957500000,                                        *
//         1560352,'C0162              ',,'2000  0000',0000000,C),  *
//             'GEDERA 6823 4812    ',MSGLEVEL=(0,0),               *
//               ROLL=(NO,NO)
**** LOAD MODULE RELOCATION FACTOR = 732AC8 *********
IEF142I - STEP WAS EXECUTED - COND CODE 0000
**** LOAD MODULE RELOCATION FACTOR = 73C828 *********
IEF142I - STEP WAS EXECUTED - COND CODE 0000
AMDS09 JOB 9575 (SMAC0086) IN BREAKDOWN
```

CREATE SMAC JOB USING
DAC-II-DSS COMBINATION;
DO NOT SUBMIT TO 195.

```
#-SMACCOM.C0162
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
:SMAC

 KEY IN FILE NAME-SMAC FILE WILL BE BUILT
 IT MAY BE CHANGED BY THE USER FOR FUTURE SMAC SUBMITTALS
:SMACIN1
 ENTER JOB CARD PARAMETERS FOR STL
 MCAUTO AC#, JOB ID
:       ,SMACTEST
 CLIENT ID
:
 PROGRAMMER ID
:GEDERA 6823 4812

  KEY IN OUTPUT DESTINATION CODE
  IF BLANK, OUTPUT WILL RETURN TO ORIGINATOR ONLY

:MACB

  IS DATA TO BE INPUT FROM THIS TERMINAL?(YES OR NO)

:NO

  KEY IN DSS USER ID AND FILE NAME

:DSSID,DSSFILE

  DO YOU WISH TO SUBMIT THIS FILE TO RUN?(YES OR NO)

:NO
    STOP
#
```

LIST OF FILE SMACINPT1

```
#OLD SMACIN1
#LNH
10//SMACTEST JOB (S,       ,'                    ','2000  0000',0000000,C),
20//            'GEDERA 6823 4812     ',MSGLEVEL=(0,0),
30//              LIM=(004.00,0004.00,005,000)
40//*FORMAT PR,DDNAME=SYSMSG
50//*FORMAT PR,DDNAME=FT06F001
60//*FORMAT PR,DDNAME=FT15F001,CONTROL=SINGLE
70//* ROUTE OUTPUT TO MIKE GEDERA *******
80//*FORMAT PR,DDNAME=SYSMSG,CONTROL=SINGLE,DEST=MACB
90//*FORMAT PR,DDNAME=FT06F001,DEST=MACB
100//     EXEC PGM=SMACIPF,REGION=180K
110//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
120//FT01F001 DD DSN=&TEMP,
130//        DCB=(RECFM=VBS,LRECL=364,BLKSIZE=1832),
140//        UNIT=SYSDA,DISP=(,PASS),SPACE=(1832,(100,10))
150//FT02F001 DD DUMMY
160//FT06F001 DD SYSOUT=A
170//SYSUDUMP DD SYSOUT=A
180//FT05F001 DD *
190/*DSS DSSID
200=INCLUDE DSSFILE
210/*
220//     EXEC PGM=SMACPLOT,REGION=140K
230//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
240//FT01F001 DD DSN=&TEMP,UNIT=SYSDA,
250//        DISP=(OLD,DELETE)
260//FT06F001 DD SYSOUT=A
270//FT15F001 DD SYSOUT=A,DCB=(RECFM=FB,BLKSIZE=80)
280//SYSUDUMP DD SYSOUT=A
290//FT05F001 DD *
300       6.       6.   0   0       .1       0.       0.
310/*
#
```

This example demonstrates how a user may edit an existing SMAC input file and then resubmit for processing. In this example, the file SMACINPT is changed so that the starting time is 1. and the integration interval is .0005. In addition, tire track prints are eliminated.

```
#OLD SMACIN
#REP 200 '0.0' '1. '
#REP 200 '.001 ' '.0005'
#REP 420 '1.' '  '
#SAV
#LNH
10//SMACTEST JOB (S,        ,'                    ','2000  0000',0000000,C),
20//            'GEDERA 6823 4812     ',MSGLEVEL=(0,0),
30//              LIM=(004.00,0004.00,005,000)
40//*FORMAT PR,DDNAME=SYSMSG
50//*FORMAT PR,DDNAME=FT06F001
60//*FORMAT PR,DDNAME=FT15F001,CONTROL=SINGLE
70//*FORMAT PR,DDNAME=SYSMSG,CONTROL=SINGLE,DEST=MACC
80//*FORMAT PR,DDNAME=FT06F001,DEST=MACC
90//    EXEC PGM=SMACIPF,REGION=180K
100//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
110//FT01F001 DD DSN=&TEMP,
120//        DCB=(RECFM=VBS,LRECL=364,BLKSIZE=1832),
130//        UNIT=SYSDA,DISP=(,PASS),SPACE=(1832,(100,10))
140//FT02F001 DD DUMMY
150//FT06F001 DD SYSOUT=A
160//SYSUDUMP DD SYSOUT=A
170//FT05F001 DD *
180SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
190CAL-CASE-71-55B
200±1.      2.0     .025    .0005   .01     .02     6.0     1.0     2.0
210±330.77  337.54  -37.    0.0     247.596 0.0
220±637.    227.    180.    0.0     440.    0.0
230±57.3    59.7    60.     34200.  9.36    0.0     97.2    -109.   38.4
240±53.4    55.6    57.7    25600.  7.98    0.0     93.4    -96.1   35.7
250-10250. -10250. -10195. -10195.
260-10250. -10250. -10195. -10195.
270±0.0     2.0     1.0     0.0
280    -1200.    -1200.    -1200.
290    -1200.    -1200.    -1200.
300    -1200.    -1200.    -1200.
310    -1200.    -1200.    -1200.
320±0.2     0.5     0.1     0.0
330       0.0       0.0       0.0       0.0
340       0.0    -1000.    -1000.    -1000.
350       0.0       0.0       0.0       0.0
360       0.0    -1000.    -1000.    -1000.
370±0.0     2.0     1.0     1.0
380±0.0     2.0     1.0     1.0
390±1.0     1.0     1.0     1.0     0.7     0.7     0.0     0.0
400±2.0     0.2     15.0    5.0     50.     50.     .55
410.06423  3.5417-34.7381-5
420
430/*
```

```
440//     EXEC PGM=SMACPLOT,REGION=140K
450//STEPLIB DD DSN=DLS.GP12.DOT.SMAC,DISP=SHR
460//FT01F001 DD DSN=&TEMP,UNIT=SYSDA,
470//        DISP=(OLD,DELETE)
480//FT06F001 DD SYSOUT=A
490//FT15F001 DD SYSOUT=A,DCB=(RECFM=FB,BLKSIZE=80)
500//SYSUDUMP DD SYSOUT=A
510//FT05F001 DD *
520       6.       6.    0    0        .1       0.       0.
530/*
#
```

EXECUTE THE START PROGRAM

```
#-SMACCOM.C0162
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
:START



 ************************************************************************
                          START PROGRAM  (VERSION 2)
 ************************************************************************
   ENTER REST POSITIONS AND HEADINGS FOR VEHICLE 1 AND VEHICLE 2
 FORM:  XCR1(FT.)  YCR1(FT.)  PSIR1(DEG) XCR2(FT) YCR2(FT) PSIR2(DEG)
:-8.7 4.3 -22. -.8 -2.1 164.
   ENTER IMPACT POSITIONS AND HEADINGS FOR VEHICLE 1 AND 2
 FORM: XSC1(FT) YSC1(FT) PSIS1(DEG) XCS2(FT) YCS2(FT) PSIS2(DEG)
:-8.4 1. 0. 8.4 -1. 180.
   DID ROTATIONAL (YAW) AND/OR LATERAL SKIDDING OF VEHICLE 1 STOP BEFORE
 REST POSITION WAS REACHED?  (ANSWER YES OR NO)
:NO
   DID ROTATIONAL (YAW) AND/OR LATERAL SKIDDING OF VEHICLE 2 STOP BEFORE
 REST POSITION WAS REACHED?  (ANSWER YES OR NO)
:NO
   ENTER VEHICLE 1 YAW ROTATION INDICATOR
 FORM:  IRT1  (0.=NO ROTATION,-1.=COUNTERCLOCKWISE,1.=CLOCKWISE)
:-1.
   DID VEHICLE 1 ROTATE MORE THAN 360 DEG. BETWEEN SEPARATION AND REST?
 (ANSWER YES OR NO)
:NO
   ENTER VEHICLE 2 YAW ROTATION INDICATOR
 FORM:  IRT2   (0.=NO ROTATION,-1.=COUNTERCLOCKWISE,1.=CLOCKWISE)
:-1.
   DID VEHICLE 2 ROTATE MORE THAN 360 DEGREES BETWEEN SEPARATION AND REST?
 (ANSWER YES OR NO)
:NO
   ENTER ROLLING RESISTANCES OF WHEELS OF VEHICLE 1
 (DAMAGE,BRAKES,ENGINE BRAKING,TIRES,0.00 TO 1.00, WHERE 1.00=LOCKED)
 FORM:   RF  LF  RR  LR
:0. 1. 0. 0.
   ENTER ROLLING RESISTANCES OF WHEELS OF VEHICLE 2
 (DAMAGE,BRAKES,ENGINE BRAKING,TIRES,0.00 TO 1.00, WHERE 1.00=LOCKED)
 FORM:   RF  LF  RR  LR
:0. 1. 0. 0.
   ENTER NOMINAL TIRE-GROUND FRICTION COEFFICIENT FORM:MU
:.5
   ENTER VEHICLE 1 TYPE
 (1.=SUBCOMPACT,2.=COMPACT,3.=INTERMEDIATE,4.=FULLSIZE)
:4.
   ENTER VEHICLE 2 TYPE
 (1.=SUBCOMPACT,2.=COMPACT,3.=INTERMEDIATE,4.=FULLSIZE)
:4.
```

```
   ARE THE ACTUAL WEIGHTS OF THE VEHICLES KNOWN?       (ANSWER YES OR NO)
:YES
   ENTER WEIGHTS OF VEHICLE 1 AND VEHICLE 2
 FORM:   WT1(LB.)   WT2(LB.)          (0. = TAKE DEFAULT VALUE)
:3080. 3950.
   ENTER A 7 CHARACTER VDI FOR VEHICLE 1
:12FYEW4
   ENTER A 7 CHARACTER VDI FOR VEHICLE 2
:12FYEW5
   ENTER A 72 CHARACTER RUN TITLE
:GEDERA START TEST
```

ACCIDENT RECONSTRUCTION - START RESULTS

GEDERA START TEST

COLLISION CONDITIONS

VEHICLE # 1			VEHICLE # 2		
XC10'	=	-8.400 FT.	XC20'	=	8.400 FT.
YC10	=	1.000 FT.	YC20'	=	-1.000 FT.
PSI10	=	0.000 DEGREES	PSI20	=	180.000 DEGREES
PSI1D0	=	0.000 DEG/SEC	PSI2D0	=	0.000 DEG/SEC
U10	=	27.300 MPH	U20	=	31.739 MPH
V10	=	0.000 MPH	V20	=	0.000 MPH

SEPARATION CONDITIONS

XCS1	=	-8.400 FT.	XCS2	=	8.400 FT.
YCS1	=	1.000 FT.	YCS2	=	-1.000 FT.
PSIS1	=	0.000 DEG	PSIS2	=	180.000 DEG
US1	=	-.455 MPH	US2	=	10.097 MPH
VS1	=	5.002 MPH	VS2	=	1.210 MPH
PSISD1	=	-47.716 DEG/SEC	PSISD2	=	-20.555 DEG/SEC

DIMENSIONS AND INERTIAL PROPERTIES

A1	=	60.500 INCHES	A2	=	60.500 INCHES
B1	=	63.000 INCHES	B2	=	63.000 INCHES
TR1	=	63.100 INCHES	TR2	=	63.100 INCHES
I1	=	28600.0 LB-SEC**2-IN	I2	=	36678.6 LB-SEC**2-IN
M1	=	7.971 LB-SEC**2/IN	M2	=	10.223 LB-SEC**2/IN
XF1	=	100.500 INCHES	XF2	=	100.500 INCHES
XR1	=	-119.600 INCHES	XR2	=	-119.600 INCHES
YS1	=	39.600 INCHES	YS2	=	39.600 INCHES

```
 DO YOU WISH TO RUN ANOTHER START CASE  -(YES OR NO)
:NO
 IS SMAC DATA TO BE INPUT TO THE SMAC PROGRAM(YES OR NO)
:NO
 SMAC DATA GENERATED BY START WILL BE LOST
DO YOU WISH TO PRINT THE SMAC DATA-(YES OR NO)
:NO
    STOP
#
```

V. Execution of the SMAC system on the Direct Access Computer (DAC)

The user of this system can execute any combination of the START program, the SMAC data generating program, the SMAC collision program, and the plotting program used to display the collision by initiating the MONITOR control program on the DAC-II system.

A. Log On Procedure

To connect the terminal to the DAC-II system, the user dials the phone number of a line of the appropriate speed (10 or 30 cps), listens for a beep, and types the return key once. The system responds:

```
MCAUTO - 10:15 OCT 15, '75
LOGON PLEASE:
PASSWORD
XXXXXXXXX (user password is entered on overtype
           for security.)
```

The user enters the account number and password. The form is:

```
LOGON PLEASE:  ACCOUNT NUMBER
PASSWORD
XXXXXXXXX
```

B. Initialization of SMAC system

```
#RNH MONLOM.C0162
```

This line must be typed by the user. (# is a prompt and is not typed by the user.) This will load the system and give MONITOR program control. The user will now be prompted with:

```
INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
(CHARACTER COMBINATION OF I, O, P, OR END)
```

The prompt character will be a ?.

The user must respond with a symbol code consisting of the letters 'I', 'O', 'P', or 'END'. The code 'END' is an indicator to the computer that the user is finished running the SMAC program and will terminate the MONITOR program. A definition of the symbol code is:

I = The START program or the SMAC data generating program is chosen to generate a SMAC input file.

IO = (a) The START program or the SMAC data generating program is chosen to generate a SMAC input fil

(b) The SMAC program is run using the input data file generated in step (2a) and produces a reduced printout on the users terminal, the full printout on a user specified file, and plot data on a user specified file.

IOP = (a) The START program or the SMAC data generating program is chosen to generate a SMAC input file.

(b) The SMAC program is run using the input data file generated in step (3a) and produces a reduced printout on a users terminal, the full printout on a user specified file, and plot data on a user specified file.

(c) The PLOT program is run using the plot data file generated in step (3b) and produces plotting output on a user specified file that can be input to the FASTDRAW system.

O = The SMAC program is run using an input data file supplied by the user and produces a reduced printout on the users terminal, the full printout on a user specified file, and plot data on a user specified file.

OP = (a) The SMAC program is run using an input data file supplied by the user and produces a reduced printout on the users terminal, the full printout on a user specified file, and plot data on a user specified file.

(b) The PLOT program is run using the plot data file generated in step (5a) and produces plotting output on a user specified file that can be input to the FASTDRAW system.

P = The PLOT program is run using a plot data file supplied by the user and produces plotting output on a user specified file that can be input to the FASTDRAW system.

END = Terminates the MONITOR program.

Control automatically reverts to the MONITOR program after processing is completed for options I through P and an additional symbolic input is expected for mult case runs.

C. SMAC Data Generating Program

When the user reply to the MONITOR program is 'I', 'IO' or 'IOP', the START-SMAC data generating program is initiated. The user will be prompted with:

```
**********SMAC PRE-PROCESSOR**********
SELECT PROGRAM TO BE EXECUTED (START,SMAC)
```

After the prompt, the user must respond with either START or SMAC.

If SMAC is selected, the user will be issued a series of prompts which will enable him to prepare a SMAC input data file for processing (see Section III). The user will also be prompted to supply a name for this data file. The data file will be saved in the users account until the user wishes to delete it.

The SMAC input data file may be submitted for processing at a later date to the SMAC program on the DAC-II System by choosing option 'O' or 'OP' on the MONITOR program and supplying the file name to the program.

D. START program

If START is selected, the user will be issued a series of prompts which will allow him to input basic accident data. The START program will then generate output consisting of:

Collision Conditions
Separation Conditions
Dimensions and Inertial Properties

The user will also be prompted to supply a name for the data file that START generates. This data file will be saved in the users account until the user wishes to delete it.

The START input data file may be submitted for processing at a later date to the SMAC program on the DAC-II system by choosing option 'O' or 'OP' on the MONITOR program and supplying the file name to the program.

All numerical data may be input with a free format to both the START and SMAC data generating programs. Data items must be separated by at least one blank. The message

ERROR IN INPUT - RETYPE THIS LINE

will be printed whenever the system detects illegal characters in the numerical data. The user must re-enter the line of data which contained the illegal data. Requested data items not input by the user will be set to zero. Refer to Section V (Sample Input and Output) for a listing of the prompts and the report generated by START after all data prompting has been completed.

Respond with DIS.

You will then be prompted:

TERMINAL CODE:

Respond with TEK if using a Tektronix tube.

B. If this file has been displayed previously, the following procedure should be used:

*USE DISPIPF

DISPIPF is the file built in using the BUI command (Section IV.A).

*DIS

The user will now be prompted TERMINAL CODE as in Section IV.A. The picture will then be generated rotated 90°. To re-orient the view, respond to the prompt character >.

REO 90

The view will now be generated in the proper orientation.

To add the annotation to the drawing, respond to the next > with

ANN

1. Windowing

Whenever a blow-up of a certain section of the drawing is desired, the user may use the WIN command

>WIN

The user is instructed to

ENTER TWO POINTS WITH CURSOR

Points are entered by reading the graphics cursor. Two points define the diagonal of a rectangular window. The image is redrawn showing only the parts of the previous image which were inside the window enlarged to occupy the whole screen.

E. SMAC Program

The SMAC program processes the input data file automatically passed to it from the START or SMAC data generating programs when utilizing MONITOR options 'O' and 'OP'. Once processing begins, the SMAC program prompts the user for a file name in which to store the complete SMAC output and a second file name in which to store the plot data that the SMAC program generates. The last two files that are prompted for will be saved in the users account until the user wishes to delete them.

The program also produces a modified output (selected variables of the complete output) that is directed to the users console. If the user wishes to interrogate the complete SMAC output file he may use the LIST command available on the DAC system or use the PRINT command on the HOST system (see Section VI) to route the desired file to a high speed printer in the users facility.

F. PLOT Program

The PLOT program processes the plot data file automatically passed to it form the SMAC program when utilizing MONITOR options 'IOP' and 'OP' or prompts the user for a plot data file name when utilizing MONITOR option 'P'. Once processing begins, the PLOT program prompts the user for a file name in which to store the plotting output that the PLOT program generates. This file will be saved in the users account for later display on the FASTDRAW system until the user wishes to delete it.

G. Data Input

There are two methods of entering data to the system.

1. The user may input his data directly into the terminal, using free form input via the SMAC data generating program. All data items must be input as per Enclosure I. If they are to be zero, type a zero. All data items must be separated by one or more blanks.

2. The user may execute the START program and, by inputting the proper responses in free field format to queries asked by the program on input data file is generated.

If method 1 is used, the user will be prompted to key in his data in the manner described above in Data Input, Item 1. After the SMAC data generating program has created the input data file the user will be prompted:

IS TIRE TRACK INFORMATION TO BE PRINTED
(YES OR NO)

If the response is NO, the SMAC tire track information will not be printed. Otherwise, it will be printed.

NOTE: When entering table data (after lines 8, 9, 10 and 11) the user may type in all the data himself, or allow the computer to do it if all value following an entry are to be equal to that particular entry and constant from that point on. This can be done by typing an asterisk (*) after the desired table entry. This is a signal to the computer that indicates that the user wishes to propogate the value of the last numeric entry through the end of the table of the particular wheel the user is working on. An example of this is:

Card 10: 1.2 2.3 0.1 0. (user input)

ons TYPE IN VEHICLE 1 WHEEL STEER TABLE (computer resp
12 VALUES PER FRONT TIRE ARE EXPECTED (7 per line)

Table: 0. 0. 0. -20. * (user input)

Table: 0. 0. 0. -20. * (user input)

The above user input would be interpreted by the computer to be:

Card 10: 1.2 2.3 0.1 0.

Table: 0. 0. 0. -20. -20. -20. -20.
-20. -20. -20. -20. -20.

Table: 0. 0. 0. -20. -20. -20. -20.
-20. -20. -20. -20. -20.

H. Correcting Errors or Changing Input Data

If a file is to be corrected or if a file is to be changed (parameters are to be changed) and resubmitted, the following procedure should be used.

1. Saving Old File

If parameters are to be altered and the old file is not to be destroyed, the following should be executed:

```
#OLD OLDFILE
```

where OLDFILE is the name of the file which was previously generated on the DAC-II system.

```
#REN NEWFILE
```

where NEWFILE is supplied by the user and is the name of the file to be edited and then submitted.

```
#SAV
```

2. Editing the File

```
#EDIT FILENAME
```

FILENAME is the name of the file to be processed on the DAC-II system. FILENAME was defined in Section E or Section H.1 using REN command.

Use the Edit Command (see DAC-II Edit Manual) to correct or change records as you desire.

I. Job Termination - Logging Off

To log off the DAC-II system the user types

```
#BYE
```

The system responds with an accounting summary.

VI. Sample Input and Output

The sample code contained in this section illustrates the following:

1) Create SMAC data input from the terminal using the SMAC data generator (option 'I').

2) Create SMAC data input from the terminal using the START program (option 'I').

3) Create SMAC data, input from the terminal using the SMAC data generator and run this data in the SMAC program (option 'IO').

4) Create SMAC data input from the terminal using the SMAC data generator, run this data in the SMAC program and create a plot file (option 'IOP').

5) Run the SMAC program with data created previously (option 'O').

6) Run the SMAC program with data created previously and create a plot file (option 'OP').

7) Create a plot file from plot data created previously (option 'P').

8) Input data created with the SMAC data generating program.

9) Input data created with the START program.

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

:I
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
:SMAC

 KEY IN FILE NAME-SMAC FILE WILL BE BUILT
 IT MAY BE CHANGED BY USER FOR FUTURE SMAC SUBMITTALS
 (7 CHAR. OR LESS)

:FILE2

  KEY IN TWO HEADING LINES

:SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
:CAL-CASE-71-55B

  TYPE IN FIRST EIGHT LINES OF DATA

:0.0 2.0 .025 .001 .01 .02 6.0 1.0 2.0
:330.77 337.54 -37. 0.0 247.596 0.0
:637. 227. 180. 0.0 440. 0.0
:57.3 59.7 60. 34200. 9.36 0.0 97.2 -109. 38.4
:53.4 55.6 57.7 25600. 7.98 0.0 93.4 -96.1 35.7
:-10250. -10250. -10195. -10195.
:-10250. -10250. -10195. -10195.
:0.0 2.0 1.0 0.0

  TYPE IN VEHICLE 1 WHEEL TORQUE TABLE
    3 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

:-1200. -1200. -1200.
:-1200. *
:-1200. *
:-1200. *

  TYPE IN NINTH LINE OF DATA

:0.2 0.5 0.1 0.0

  TYPE IN VEHICLE 2 WHEEL TORQUE TABLE
    4 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

:0. *
:0. -1000. *
:0. *
:0. -1000. *

  TYPE IN TENTH LINE OF DATA

:0.0 2.0 1.0 1.0
```

Create SMAC data input from the terminal using the SMAC data generator (option 'I').

```
  TYPE IN ELEVENTH LINE OF DATA

:0.0 2.0 1.0 1.0

  TYPE IN LAST FOUR LINES OF DATA
  IF THE LAST DATA LINE IS NOT DESIRED,
  HIT RETURN WHEN THE FOURTH PROMPT SIGN APPEARS
:1.0 1.0 1.0 1.0 0.7 0.7 0.0 0.0
:2.0 0.2 15. 5.0 50. 50. .55
:.06423 3.5417-3 4.7381-5
:

 IS TIRE TRACK INFORMATION TO BE PRINTED?(YES OR NO)

:NO

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

:END
    STOP

MRU=      6.923

#
```

Create SMAC data input from the terminal using the START program (option 'I').

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?I
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
?START



 ************************************************************************
                          START PROGRAM  (VERSION 2)
 ************************************************************************
   ENTER REST POSITIONS AND HEADINGS FOR VEHICLE 1 AND VEHICLE 2
 FORM:  XCR1(FT.)  YCR1(FT.)  PSIR1(DEG) XCR2(FT) YCR2(FT) PSIR2(DEG)
?-8.7 4.3 -22. -.8 -2.1 164.
   ENTER IMPACT POSITIONS AND HEADINGS FOR VEHICLE 1 AND 2
 FORM: XSC1(FT) YSC1(FT) PSIS1(DEG) XCS2(FT) YCS2(FT) PSIS2(DEG)
?-8.4 1. 0. 8.4 -1. 180.
   DID ROTATIONAL (YAW) AND/OR LATERAL SKIDDING OF VEHICLE 1 STOP BEFORE
 REST POSITION WAS REACHED?  (ANSWER YES OR NO)
?NO
   DID ROTATIONAL (YAW) AND/OR LATERAL SKIDDING OF VEHICLE 2 STOP BEFORE
 REST POSITION WAS REACHED?  (ANSWER YES OR NO)
?NO
   ENTER VEHICLE 1 YAW ROTATION INDICATOR
 FORM:  IRT1  (0.=NO ROTATION,-1.=COUNTERCLOCKWISE,1.=CLOCKWISE)
?-1.
   DID VEHICLE 1 ROTATE MORE THAN 360 DEG. BETWEEN SEPARATION AND REST?
 (ANSWER YES OR NO)
?NO
   ENTER VEHICLE 2 YAW ROTATION INDICATOR
 FORM:  IRT2   (0.=NO ROTATION,-1.=COUNTERCLOCKWISE,1.=CLOCKWISE)
?-1.
   DID VEHICLE 2 ROTATE MORE THAN 360 DEGREES BETWEEN SEPARATION AND REST?
 (ANSWER YES OR NO)
?NO
   ENTER ROLLING RESISTANCES OF WHEELS OF VEHICLE 1
 (DAMAGE,BRAKES,ENGINE BRAKING,TIRES,0.00 TO 1.00, WHERE 1.00=LOCKED)
 FORM:   RF  LF  RR  LR
?0. 1. 0. 0.
   ENTER ROLLING RESISTANCES OF WHEELS OF VEHICLE 2
 (DAMAGE,BRAKES,ENGINE BRAKING,TIRES,0.00 TO 1.00, WHERE 1.00=LOCKED)
 FORM:   RF  LF  RR  LR
?0. 1. 0. 0.
   ENTER NOMINAL TIRE-GROUND FRICTION COEFFICIENT FORM:MU
?.5
   ENTER VEHICLE 1 TYPE
 (1.=SUBCOMPACT,2.=COMPACT,3.=INTERMEDIATE,4.=FULLSIZE)
?4.
   ENTER VEHICLE 2 TYPE
 (1.=SUBCOMPACT,2.=COMPACT,3.=INTERMEDIATE,4.=FULLSIZE)
?4.
```

```
   ARE THE ACTUAL WEIGHTS OF THE VEHICLES KNOWN?       (ANSWER YES OR NO)
?YES
   ENTER WEIGHTS OF VEHICLE 1 AND VEHICLE 2
 FORM:   WT1(LB.)   WT2(LB.)          (0, = TAKE DEFAULT VALUE)
?3080. 3950.
   ENTER A 7 CHARACTER VDI FOR VEHICLE 1
?12FYEW4
   ENTER A 7 CHARACTER VDI FOR VEHICLE 2
?12FYEW5
   ENTER A 72 CHARACTER RUN TITLE
?GEDERA START TEST
```

ACCIDENT RECONSTRUCTION - START RESULTS

GEDERA START TEST

COLLISION CONDITIONS

VEHICLE # 1			VEHICLE # 2		
XC10'	=	-8.400 FT.	XC20'	=	8.400 FT.
YC10	=	1.000 FT.	YC20'	=	-1.000 FT.
PSI10	=	0.000 DEGREES	PSI20	=	180.000 DEGREES
PSI1D0	=	0.000 DEG/SEC	PSI2D0	=	0.000 DEG/SEC
U10	=	27.300 MPH	U20	=	31.739 MPH
V10	=	0.000 MPH	V20	=	0.000 MPH

SEPARATION CONDITIONS

XCS1	=	-8.400 FT.	XCS2	=	8.400 FT.
YCS1	=	1.000 FT.	YCS2	=	-1.000 FT.
PSIS1	=	0.000 DEG	PSIS2	=	180.000 DEG
US1	=	-.455 MPH	US2	=	10.097 MPH
VS1	=	5.002 MPH	VS2	=	1.210 MPH
PSISD1	=	-47.716 DEG/SEC	PSISD2	=	-20.555 DEG/SEC

DIMENSIONS AND INERTIAL PROPERTIES

A1	=	60.500 INCHES	A2	=	60.500 INCHES
B1	=	63.000 INCHES	B2	=	63.000 INCHES
TR1	=	63.100 INCHES	TR2	=	63.100 INCHES
I1	=	28600.0 LB-SEC**2-IN	I2	=	36678.6 LB-SEC**2-IN
M1	=	7.971 LB-SEC**2/IN	M2	=	10.223 LB-SEC**2/IN
XF1	=	100.500 INCHES	XF2	=	100.500 INCHES
XR1	=	-119.600 INCHES	XR2	=	-119.600 INCHES

```
 YS1      =  39.600 INCHES                YS2      =  39.600 INCHES
 DO YOU WISH TO PRINT THE SMAC DATA - (YES OR NO)
?YES
SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
GEDERA START TEST
     0.0      4.0     .025     .001      .01     .001      30.      5.0      2.0        1
 -100.80    12.00     0.00     0.00   480.49     0.00                                   2
  100.80   -12.00   180.00     0.00   558.60     0.00                                   3
   60.50    63.00    63.10 28600.0     7.97     0.0    100.50 -119.60    39.60        4
   60.50    63.00    63.10 36678.6    10.22     0.0    100.50 -119.60    39.60        5
 -11572. -11572. -11113. -11113.                                                       6
 -11572. -11572. -11113. -11113.                                                       7
    .125     .175      .01       0.0                                                   8
       0.0        0.0        0.0      -0.00      -0.00      -0.00
       0.0        0.0        0.0    -392.79    -392.79    -392.79
       0.0        0.0        0.0      -0.00      -0.00      -0.00
       0.0        0.0        0.0      -0.00      -0.00      -0.00
    .125     .175      .01       0.0                                                   9
       0.0        0.0        0.0      -0.00      -0.00      -0.00
       0.0        0.0        0.0    -503.74    -503.74    -503.74
       0.0        0.0        0.0      -0.00      -0.00      -0.00
       0.0        0.0        0.0      -0.00      -0.00      -0.00
     0.0      .30      .10      1.0                                                     10
     0.0      .30      .10      1.0                                                     11
  -2400.   2400.   2400.   2400.      .50      .50      0.0                           12
     2.0      .2     15.0      5.0    50.00    50.00     0.55                          13
 0.046061.7547-31.6711-5                                                               14
 DO YOU WISH TO SAVE THE SMAC DATA FILE - (YES OR NO)
?YES

 KEY IN FILE NAME-SMAC FILE WILL BE BUILT
 IT MAY BE CHANGED BY USER FOR FUTURE SMAC SUBMITTALS
 (7 CHAR. OR LESS)

?FILE3

 IS TIRE TRACK INFORMATION TO BE PRINTED?(YES OR NO)

?NO

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?END
    STOP

MRU=      7.442

#
```

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?IO
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
?SMAC

 KEY IN FILE NAME-SMAC FILE WILL BE BUILT
 IT MAY BE CHANGED BY USER FOR FUTURE SMAC SUBMITTALS
 (7 CHAR. OR LESS)

?FILE2

  KEY IN TWO HEADING LINES

?SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
?CAL-CASE-71-55B

  TYPE IN FIRST EIGHT LINES OF DATA

?0.0 2.0 .025 .001 .01 .02 6.0 1.0 2.0
?330.77 337.54 -37. 0.0 247.596 0.0
?637. 227. 180. 0.0 440. 0.0
?57.3 59.7 60. 34200. 9.36 0.0 97.2 -109. 38.4
?53.4 55.6 57.7 25600. 7.98 0.0 93.4 -96.1 35.7
?-10250. -10250. -10195. -10195.
?-10250. -10250. -10195. -10195.
?0.0 2.0 1.0 0.0

  TYPE IN VEHICLE 1 WHEEL TORQUE TABLE
    3 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

?-1200. *
?-1200. *
?-1200. *
?-1200. *

  TYPE IN NINTH LINE OF DATA

?0.2 0.5 0.1 0.0

  TYPE IN VEHICLE 2 WHEEL TORQUE TABLE
    4 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

?0.0 *
?0.0 -1000. *
?0.0 *
?0.0 -1000. *

  TYPE IN TENTH LINE OF DATA

?0.0 2.0 1.0 1.0
```

Create SMAC data, input from the terminal using the SMAC data generator, run this data in the SMAC program (option 'IO').

```
  TYPE IN ELEVENTH LINE OF DATA

?0.0 2.0 1.0 1.0

  TYPE IN LAST FOUR LINES OF DATA
  IF THE LAST DATA LINE IS NOT DESIRED,
  HIT RETURN WHEN THE FOURTH PROMPT SIGN APPEARS
?1.0 1.0 1.0 1.0 0.7 0.7 0.0 0.0
?2.0 0.2 15.0 5.0 50. 50. .55
?.06423 3.5417-3 4.7381-5
?

 IS TIRE TRACK INFORMATION TO BE PRINTED?(YES OR NO)

?NO

  INPUT FILE NAME THAT IS TO RECEIVE SMAC OUTPUT
  (7 CHAR. OR LESS)

?FILE4

  INPUT FILE NAME THAT IS TO RECEIVE PLOT FILE
  (7 CHAR. OR LESS)

?FILE5

 SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
 CAL-CASE-71-55B


                        INITIAL CONDITIONS
     VEHICLE NO. 1                              VEHICLE NO. 2
 XC10'     = 330.770 INCHES              XC20'     = 637.000 INCHES
 YC10'     = 337.540 INCHES              YC20'     = 227.000 INCHES
 PSI10     = -37.000 DEGREES             PSI20     = 180.000 DEGREES
 PSI1D0    =   0.000 DEG/SEC             PSI2D0    =   0.000 DEG/SEC
 U10       = 247.596 IN/SEC              U20       = 440.000 IN/SEC
 V10       =   0.000 IN/SEC              V20       =   0.000 IN/SEC

          CALCULATION CONSTANTS
 DELPSI    =   2.000 DEGREES
 DELRHO    =    .200 INCHES
 LAMBDA    =  15.000 LB/IN,PRESSURE ERROR
 ZETAV     =   5.000 IN/SEC,MIN.FOR FRICT

               DIMENSIONS AND INERTIAL PROPERTIES
 A1        =  57.300 INCHES              A2        =  53.400 INCHES
 B1        =  59.700 INCHES              B2        =  55.600 INCHES
 TR1       =  60.000 INCHES              TR2       =  57.700 INCHES
 I1        =  34200. LB-SEC**2-IN        I2        =  25600. LB-SEC**2-IN
 M1        =   9.360 LB-SEC**2/IN        M2        =   7.980 LB-SEC**2/IN
 PSIR10    =   0.000 DEGREES             PSIR20    =   0.000 DEGREES
 XF1       =  97.200 INCHES              XF2       =  93.400 INCHES
 XR1       =-109.000 INCHES              XR2       = -96.100 INCHES
```

```
YS1       =  38.400 INCHES                YS2       =  35.700 INCHES

         DEFORMABLE LAYER
KV1       =  50.000 LB/(IN**2)
KV2       =  50.000 LB/(IN**2)
MU,FRICT  =    .550
C0        =    .064 RESTITUTION
C1        =   .35417E-02   VERSUS
C2        =   .47381E-04 DEFLECTION

                          TIRE PROPERTIES
                       CORNERING STIFFNESS
C(1)      = -10250. LB/RAD                C(5)      = -10250. LB/RAD
C(2)      = -10250.  ''                   C(6)      = -10250.  ''
C(3)      = -10195.  ''                   C(7)      = -10195.  ''
C(4)      = -10195.  ''                   C(8)      = -10195.  ''

  TIRE-TERRAIN COEF AND TERRAIN ZONES
XB1' =   1.000 IN.      YB1' =   1.000 IN.
XB2' =   1.000 IN.      YB2' =   1.000 IN.
XMU1 =    .700
XMU2 =    .700
CMU  =  0.

            PROGRAM CONTROL DATA
T0        =   0.000 SEC.,BEGIN
TF        =   2.000  ''  END
DTTRAJ    =    .025  ''  INTEG. INTVL,TRAJ
DTCOLL    =    .001  ''  INTEG.INTVL,COLL
DTCOLT    =    .010  ''  INTEG.INTVL,CPOS
DTPRNT    =    .020  ''  PRINT INTERVAL
UVMIN     =   6.000 IN/SEC STOPPING TEST
PSIDOT    =   1.000DEG/SEC STOPPING TEST
NO.OF VEHICLES = 2.
 FMOVIE = -0.(ZERO,FINAL DAMAGE TABLE TAPE
              (NON-ZERO,DAMAGE HISTORY TAPE
              (ALSO WRITTEN ON FORTRAN 2.
                 (TAPE IS ALWAYS FORTRAN 1)

   VEHICLE NO. 1                VEHICLE NO. 2
      1 RANGES                     1 RANGES
VEH.DAMAGE    VEL            VEH.DAMAGE    VEL
  INDEX     DELTA V            INDEX     DELTA V
              MPH                            MPH
 12FDEW2      16.35          11LFEW2      18.59

 INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
 (CHARACTER COMBINATION OF I, O, P, OR END)

?END
    STOP

MRU=     81.967

#
```

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?IOP
 ********** SMAC PRE-PROCESSOR **********
   SELECT PROGRAM TO BE EXECUTED - (START,SMAC)
?SMAC

 KEY IN FILE NAME-SMAC FILE WILL BE BUILT
 IT MAY BE CHANGED BY USER FOR FUTURE SMAC SUBMITTALS
 (7 CHAR. OR LESS)

?FILE2

  KEY IN TWO HEADING LINES

?SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
?CAL-CASE-71-55B

  TYPE IN FIRST EIGHT LINES OF DATA

?0.0 2.0 .025 .001 .01 .02 6.0 1.0 2.0
?330.77 337.54 -37. 0.0 247.596 0.0
?637. 227. 180. 0.0 440. 0.0
?57.3 59.7 60. 34200. 9.36 0.0 97.2 -109. 38.4
?53.4 55.6 57.7 25600. 7.98 0.0 93.4 -96.1 35.7
?-10250. -10250. -10195. -10195.
?-10250. -10250. -10195. -10195.
?0.0 2.0 1.0 0.0

  TYPE IN VEHICLE 1 WHEEL TORQUE TABLE
    3 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

?-1200. *
?-1200. *
?-1200. *
?-1200. *

  TYPE IN NINTH LINE OF DATA

?0.2 0.5 0.1 0.0

  TYPE IN VEHICLE 2 WHEEL TORQUE TABLE
    4 VALUES PER TIRE ARE EXPECTED (7 PER LINE)

?0.0 *
?0.0 -1000. *
?0.0 *
?0.0 -1000. *

  TYPE IN TENTH LINE OF DATA

?0.0 2.0 1.0 1.0
```

Create SMAC data input from the terminal using the SMAC data generator run this data in the SMAC program and create a plot file (option 'IOP').

```
  TYPE IN ELEVENTH LINE OF DATA

?0.0 2.0 1.0 1.0

  TYPE IN LAST FOUR LINES OF DATA
  IF THE LAST DATA LINE IS NOT DESIRED,
  HIT RETURN WHEN THE FOURTH PROMPT SIGN APPEARS
?1.0 1.0 1.0 1.0 0.7 0.7 0.0 0.0
?2.0 0.2 15.0 5.0 50. 50. .55
?.06423 3.5417-3 4.7381-5
?

 IS TIRE TRACK INFORMATION TO BE PRINTED?(YES OR NO)

?NO

  INPUT FILE NAME THAT IS TO RECEIVE SMAC OUTPUT
  (7 CHAR. OR LESS)

?FILE4

  INPUT FILE NAME THAT IS TO RECEIVE PLOT FILE
  (7 CHAR. OR LESS)

?FILE5

 SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
 CAL-CASE-71-55B


                          INITIAL CONDITIONS
     VEHICLE NO. 1                                VEHICLE NO. 2
 XC10'     = 330.770 INCHES                 XC20'     = 637.000 INCHES
 YC10'     = 337.540 INCHES                 YC20'     = 227.000 INCHES
 PSI10     = -37.000 DEGREES                PSI20     = 180.000 DEGREES
 PSI1D0    =   0.000 DEG/SEC                PSI2D0    =   0.000 DEG/SEC
 U10       = 247.596 IN/SEC                 U20       = 440.000 IN/SEC
 V10       =   0.000 IN/SEC                 V20       =   0.000 IN/SEC

          CALCULATION CONSTANTS
 DELPSI    =   2.000 DEGREES
 DELRHO    =    .200 INCHES
 LAMBDA    =  15.000 LB/IN,PRESSURE ERROR
 ZETAV     =   5.000 IN/SEC,MIN.FOR FRICT

               DIMENSIONS AND INERTIAL PROPERTIES
 A1        =  57.300 INCHES                 A2        =  53.400 INCHES
 B1        =  59.700 INCHES                 B2        =  55.600 INCHES
 TR1       =  60.000 INCHES                 TR2       =  57.700 INCHES
 I1        =  34200. LB-SEC**2-IN           I2        =  25600. LB-SEC**2-IN
 M1        =   9.360 LB-SEC**2/IN           M2        =   7.980 LB-SEC**2/IN
 PSIR10    =   0.000 DEGREES                PSIR20    =   0.000 DEGREES
 XF1       =  97.200 INCHES                 XF2       =  93.400 INCHES
 XR1       =-109.000 INCHES                 XR2       = -96.100 INCHES
 YS1       =  38.400 INCHES                 YS2       =  35.700 INCHES
```

```
        DEFORMABLE LAYER
KV1       =  50.000 LB/(IN**2)
KV2       =  50.000 LB/(IN**2)
MU,FRICT =    .550
C0        =    .064 RESTITUTION
C1        =   .35417E-02   VERSUS
C2        =   .47381E-04 DEFLECTION

                          TIRE PROPERTIES
                        CORNERING STIFFNESS
C(1)      = -10250. LB/RAD                C(5)      = -10250. LB/RAD
C(2)      = -10250.  ''                   C(6)      = -10250.  ''
C(3)      = -10195.  ''                   C(7)      = -10195.  ''
C(4)      = -10195.  ''                   C(8)      = -10195.  ''

  TIRE-TERRAIN COEF AND TERRAIN ZONES
XB1' =   1.000 IN.     YB1' =   1.000 IN.
XB2' =   1.000 IN.     YB2' =   1.000 IN.
XMU1 =    .700
XMU2 =    .700
CMU  =  0.

            PROGRAM CONTROL DATA
T0        =   0.000 SEC.,BEGIN
TF        =   2.000  ''  END
DTTRAJ    =    .025  ''  INTEG. INTVL,TRAJ
DTCOLL    =    .001  ''  INTEG.INTVL,COLL
DTCOLT    =    .010  ''  INTEG.INTVL,CPOS
DTPRNT    =    .020  ''  PRINT INTERVAL
UVMIN     =   6.000 IN/SEC STOPPING TEST
PSIDOT    =   1.000DEG/SEC STOPPING TEST
NO.OF VEHICLES = 2.
 FMOVIE = -0.(ZERO,FINAL DAMAGE TABLE TAPE
              (NON-ZERO,DAMAGE HISTORY TAPE
              (ALSO WRITTEN ON FORTRAN 2.
                 (TAPE IS ALWAYS FORTRAN 1)

   VEHICLE NO. 1              VEHICLE NO. 2
      1 RANGES                   1 RANGES
VEH.DAMAGE   VEL           VEH.DAMAGE   VEL
  INDEX    DELTA V          INDEX    DELTA V
             MPH                        MPH
 12FDEW2     16.35         11LFEW2     18.59

  INPUT FILE NAME THAT IS TO RECEIVE PLOTTING OUTPUT
  (7 CHAR. OR LESS)

?FILE6

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?END
    STOP

MRU=     94.639

#
```

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?O

  INPUT NAME OF DATA FILE TO BE RUN
  (7 CHAR. OR LESS)

?FILE2

  INPUT FILE NAME THAT IS TO RECEIVE SMAC OUTPUT
  (7 CHAR. OR LESS)

?FILE4

  INPUT FILE NAME THAT IS TO RECEIVE PLOT FILE
  (7 CHAR. OR LESS)

?FILE5

 SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
 CAL-CASE-71-55B


                          INITIAL CONDITIONS
     VEHICLE NO. 1                              VEHICLE NO. 2
 XC10'     = 330.770 INCHES                 XC20'     = 637.000 INCHES
 YC10'     = 337.540 INCHES                 YC20'     = 227.000 INCHES
 PSI10     = -37.000 DEGREES                PSI20     = 180.000 DEGREES
 PSI1D0    =   0.000 DEG/SEC                PSI2D0    =   0.000 DEG/SEC
 U10       = 247.596 IN/SEC                 U20       = 440.000 IN/SEC
 V10       =   0.000 IN/SEC                 V20       =   0.000 IN/SEC

          CALCULATION CONSTANTS
 DELPSI    =   2.000 DEGREES
 DELRHO    =    .200 INCHES
 LAMBDA    =  15.000 LB/IN,PRESSURE ERROR
 ZETAV     =   5.000 IN/SEC,MIN.FOR FRICT

               DIMENSIONS AND INERTIAL PROPERTIES
 A1        =  57.300 INCHES                 A2        =  53.400 INCHES
 B1        =  59.700 INCHES                 B2        =  55.600 INCHES
 TR1       =  60.000 INCHES                 TR2       =  57.700 INCHES
 I1        =  34200. LB-SEC**2-IN           I2        =  25600. LB-SEC**2-IN
 M1        =   9.360 LB-SEC**2/IN           M2        =   7.980 LB-SEC**2/IN
 PSIR10    =   0.000 DEGREES                PSIR20    =   0.000 DEGREES
 XF1       =  97.200 INCHES                 XF2       =  93.400 INCHES
 XR1       =-109.000 INCHES                 XR2       = -96.100 INCHES
 YS1       =  38.400 INCHES                 YS2       =  35.700 INCHES

         DEFORMABLE LAYER
 KV1       =  50.000 LB/(IN**2)
 KV2       =  50.000 LB/(IN**2)
 MU,FRICT  =    .550
 C0        =    .064 RESTITUTION
 C1        =  .35417E-02   VERSUS
```

Run the SMAC program wi
data created previously
(option 'O').

```
C2        =    .47381E-04 DEFLECTION

                          TIRE PROPERTIES
                        CORNERING STIFFNESS
C(1)      = -10250. LB/RAD                C(5)      = -10250. LB/RAD
C(2)      = -10250.  ''                   C(6)      = -10250.  ''
C(3)      = -10195.  ''                   C(7)      = -10195.  ''
C(4)      = -10195.  ''                   C(8)      = -10195.  ''

  TIRE-TERRAIN COEF AND TERRAIN ZONES
XB1' =    1.000 IN.      YB1' =    1.000 IN.
XB2' =    1.000 IN.      YB2' =    1.000 IN.
XMU1 =     .700
XMU2 =     .700
CMU  =  0.

             PROGRAM CONTROL DATA
T0        =    0.000 SEC.,BEGIN
TF        =    2.000  ''  END
DTTRAJ    =     .025  ''  INTEG. INTVL,TRAJ
DTCOLL    =     .001  ''  INTEG.INTVL,COLL
DTCOLT    =     .010  ''  INTEG.INTVL,CPOS
DTPRNT    =     .020  ''  PRINT INTERVAL
UVMIN     =    6.000 IN/SEC STOPPING TEST
PSIDOT    =    1.000DEG/SEC STOPPING TEST
NO.OF VEHICLES = 2.
 FMOVIE = -0.(ZERO,FINAL DAMAGE TABLE TAPE
              (NON-ZERO,DAMAGE HISTORY TAPE
              (ALSO WRITTEN ON FORTRAN 2.
                 (TAPE IS ALWAYS FORTRAN 1)

   VEHICLE NO. 1              VEHICLE NO. 2
      1 RANGES                   1 RANGES
VEH.DAMAGE   VEL           VEH.DAMAGE   VEL
  INDEX    DELTA V          INDEX    DELTA V
             MPH                        MPH
 12FDEW2     16.35         11LFEW2     18.59

 INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
 (CHARACTER COMBINATION OF I, O, P, OR END)

?END
    STOP

MRU=     75.958

#
```

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?OP

  INPUT NAME OF DATA FILE TO BE RUN
  (7 CHAR. OR LESS)

?FILE2

  INPUT FILE NAME THAT IS TO RECEIVE SMAC OUTPUT
  (7 CHAR. OR LESS)

?FILE4

  INPUT FILE NAME THAT IS TO RECEIVE PLOT FILE
  (7 CHAR. OR LESS)

?FILE5

 SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
 CAL-CASE-71-55B


                          INITIAL CONDITIONS
     VEHICLE NO. 1                                VEHICLE NO. 2
 XC10'     = 330.770 INCHES                 XC20'     = 637.000 INCHES
 YC10'     = 337.540 INCHES                 YC20'     = 227.000 INCHES
 PSI10     = -37.000 DEGREES                PSI20     = 180.000 DEGREES
 PSI1D0    =   0.000 DEG/SEC                PSI2D0    =   0.000 DEG/SEC
 U10       = 247.596 IN/SEC                 U20       = 440.000 IN/SEC
 V10       =   0.000 IN/SEC                 V20       =   0.000 IN/SEC

          CALCULATION CONSTANTS
 DELPSI    =   2.000 DEGREES
 DELRHO    =    .200 INCHES
 LAMBDA    =  15.000 LB/IN,PRESSURE ERROR
 ZETAV     =   5.000 IN/SEC,MIN.FOR FRICT

               DIMENSIONS AND INERTIAL PROPERTIES
 A1        =  57.300 INCHES                 A2        =  53.400 INCHES
 B1        =  59.700 INCHES                 B2        =  55.600 INCHES
 TR1       =  60.000 INCHES                 TR2       =  57.700 INCHES
 I1        =  34200. LB-SEC**2-IN           I2        =  25600. LB-SEC**2-IN
 M1        =   9.360 LB-SEC**2/IN           M2        =   7.980 LB-SEC**2/IN
 PSIR10    =   0.000 DEGREES                PSIR20    =   0.000 DEGREES
 XF1       =  97.200 INCHES                 XF2       =  93.400 INCHES
 XR1       =-109.000 INCHES                 XR2       = -96.100 INCHES
 YS1       =  38.400 INCHES                 YS2       =  35.700 INCHES

         DEFORMABLE LAYER
 KV1       =  50.000 LB/(IN**2)
 KV2       =  50.000 LB/(IN**2)
 MU,FRICT  =    .550
 C0        =    .064 RESTITUTION
```

Run the SMAC program with data created previously and create a plot file (option 'OP').

```
C1        =    .35417E-02   VERSUS
C2        =    .47381E-04 DEFLECTION

                          TIRE PROPERTIES
                       CORNERING STIFFNESS
C(1)      = -10250. LB/RAD                C(5)      = -10250. LB/RAD
C(2)      = -10250.  ''                   C(6)      = -10250.  ''
C(3)      = -10195.  ''                   C(7)      = -10195.  ''
C(4)      = -10195.  ''                   C(8)      = -10195.  ''

  TIRE-TERRAIN COEF AND TERRAIN ZONES
XB1' =    1.000 IN.      YB1' =    1.000 IN.
XB2' =    1.000 IN.      YB2' =    1.000 IN.
XMU1 =     .700
XMU2 =     .700
CMU  =   0.

            PROGRAM CONTROL DATA
T0        =    0.000 SEC.,BEGIN
TF        =    2.000  ''  END
DTTRAJ    =     .025  ''  INTEG. INTVL,TRAJ
DTCOLL    =     .001  ''  INTEG.INTVL,COLL
DTCOLT    =     .010  ''  INTEG.INTVL,CPOS
DTPRNT    =     .020  ''  PRINT INTERVAL
UVMIN     =    6.000 IN/SEC STOPPING TEST
PSIDOT    =    1.000DEG/SEC STOPPING TEST
NO.OF VEHICLES = 2.
 FMOVIE = -0.(ZERO,FINAL DAMAGE TABLE TAPE
              (NON-ZERO,DAMAGE HISTORY TAPE
              (ALSO WRITTEN ON FORTRAN 2.
                 (TAPE IS ALWAYS FORTRAN 1)

   VEHICLE NO. 1              VEHICLE NO. 2
      1 RANGES                   1 RANGES
VEH.DAMAGE   VEL           VEH.DAMAGE   VEL
  INDEX    DELTA V          INDEX    DELTA V
             MPH                        MPH
 12FDEW2     16.35         11LFEW2     18.59

  INPUT FILE NAME THAT IS TO RECEIVE PLOTTING OUTPUT
  (7 CHAR. OR LESS)

?FILE6

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?END
    STOP

MRU=    89.401

#
```

```
#RNH MONLOM.C0162

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?P

  INPUT NAME OF FILE TO BE USED IN PLOTTING PGM.
  (7 CHAR. OR LESS)

?FILE5

  INPUT FILE NAME THAT IS TO RECEIVE PLOTTING OUTPUT
  (7 CHAR. OR LESS)

?FILE6

  INPUT SYMBOL OF SMAC OPTION YOU WISH TO RUN
  (CHARACTER COMBINATION OF I, O, P, OR END)

?END
    STOP

MRU=     15.089

#
```

Create a plot file from plot data created previously (option 'P').

```
#LNH FILE2
10SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
20CAL-CASE-71-55B
1   30±0.0      2.0       .025      .001      .01       .02       6.0       1.0       2.0
2   40±330.77   337.54    -37.      0.0       247.596   0.0
3   50±637.     227.      180.      0.0       440.      0.0
4   60±57.3     59.7      60.       34200.    9.36      0.0       97.2      -109.     38.4
5   70±53.4     55.6      57.7      25600.    7.98      0.0       93.4      -96.1     35.7
6
7   80-10250.  -10250.  -10195.  -10195.
    90-10250.  -10250.  -10195.  -10195.
8   100±0.0       2.0       1.0       0.0
    110      -1200.    -1200.    -1200.
    120      -1200.    -1200.    -1200.
    130      -1200.    -1200.    -1200.
    140      -1200.    -1200.    -1200.
9   150±0.2       0.5       0.1       0.0
    160          0.0         0.0         0.0         0.0
    170          0.0      -1000.      -1000.      -1000.
    180          0.0         0.0         0.0         0.0
    190          0.0      -1000.      -1000.      -1000.
10  200±0.0       2.0       1.0       1.0
11  210±0.0       2.0       1.0       1.0
12  220±1.0       1.0       1.0       1.0       0.7       0.7       0.0       0.0
13  230±2.0       0.2       15.0      5.0       50.       50.       .55
14
999 240.06423  3.5417-34.7381-5                                                    9
    250
    260
    #
```

Input data created with the SMAC data generating program.

```
#LNH FILE3
10SIMULATION MODEL OF AUTOMOBILE COLLISIONS (SMAC)
20GEDERA START TEST
30      0.0      4.0     .025     .001      .01     .001      30.      5.0      2.0
40 -100.80    12.00     0.00     0.00   480.49     0.00
50  100.80   -12.00   180.00     0.00   558.60     0.00
60   60.50    63.00    63.10 28600.0     7.97     0.0    100.50 -119.60    39.60
70   60.50    63.00    63.10 36678.6    10.22     0.0    100.50 -119.60    39.60
80 -11572. -11572. -11113. -11113.
90 -11572. -11572. -11113. -11113.
100     .125     .175      .01       0.0
110        0.0        0.0        0.0      -0.00      -0.00      -0.00
120        0.0        0.0        0.0   -392.79    -392.79    -392.79
130        0.0        0.0        0.0      -0.00      -0.00      -0.00
140        0.0        0.0        0.0      -0.00      -0.00      -0.00
150     .125     .175      .01       0.0
160        0.0        0.0        0.0      -0.00      -0.00      -0.00
170        0.0        0.0        0.0   -503.74    -503.74    -503.74
180        0.0        0.0        0.0      -0.00      -0.00      -0.00
190        0.0        0.0        0.0      -0.00      -0.00      -0.00
200      0.0      .30      .10      1.0
210      0.0      .30      .10      1.0
220   -2400.    2400.    2400.    2400.      .50      .50      0.0
230      2.0       .2     15.0      5.0    50.00    50.00     0.55
240 0.046061.7547-31.6711-5
250                                                                          9
260
#
```

Input data created with the START program.

VII. Displaying a Plot File Generated by the SMAC-PLOT Program on the IBM 370 or DAC-II System

Log on procedure is the same as that when preparing SMAC for submittal to either the IBM 370 or the DAC-II system. The user dials the phone number of a line of the appropriate speed (10 or 30 cps), listens for a beep, and types the return key once. The system responds:

```
MCAUTO - 11:29 DEC 14, '73
LOGON PLEASE:
PASSWORD
XXXXXXXXX
```

The user enters the account number and password, The form is:

```
LOGON PLEASE:  ACCOUNT NUMBER
PASSWORD
XXXXXXXXX
```

After logging on, enter via the keyboard:

```
#FAS
```

You will be prompted with * for each command as you are now under control of the FASTDRAW executive.

A. If the file has not been displayed previously, the following steps should be used.

```
*BUI DISPIPF FROM DEFOUTFIL
```

where DISPIPF is the name of a new file built by FASTDRAW for display purposes. DEFOUTFIL is the name of the file created in the earlier SMAC run on the IBM 370 or the DAC-II system.

On the IBM 370 run, this file was defined when the user responded to the prompt KEY IN FILE NAME THAT WILL RECEIVE THE OUTPUT. If the SMAC run had been submitted after correcting a file (Section H.2 of Generation of File for Display), this file was defined using DEF OUT=XXXX. If the job was submitted as described in Section II, this file was named in The DAC-II routing card.

On the DAC-II system run, this file was defined when the user responded to the prompt INPUT FILE NAME THAT IS TO RECEIVE PLOTTING OUTPUT (7 CHAR. OR LESS)

FASTDRAW will then prompt LANGUAGE:

Respond with PLOT.

An asterisk will appear (*).