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FINAL REPORT

MODIFIED ARTICULATED VEHICLE SIMULATION

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16. Abstract

Prior to the work reported herein, a simplified interactive simulation (called the "TBS simulation") for predicting the braking and steering responses of commercial vehicles was developed at the Highway Safety Research Institute of The University of Michigan under sponsorship of the Motor Vehicle Manufacturers Association. The TBS simulation was based on a doctoral dissertation by Leucht entitled "Directional Dynamics of the Tractor-Semi-Trailer Vehicle," The University of Michigan, 1970.

This report gives the details of the optional addition of the Breeze jacknife restraint device to the TBS simulation.

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1.0 INTRODUCTION

This is a final report on a research task entitled "Modified Articulated Vehicle Simulation," conducted by the Highway Safety Research Institute of The University of Michigan. This study was supported by the National Highway Traffic Safety Administration of the U. S. Department of Transportation.

The goal of this research task was to add to an existing simulation the capability to simulate the Breeze jackknife restraint device. This report documents the addition as follows. First, an overview of the analytical problem is presented, followed by an explanation of the kinematics and some details of the new software. The kinematics section is closely linked to the software by relating equations in the text to line numbers in the computer program. Next, some sample computer runs introduce the input/output (I/O) of the modified simulation. A flow chart and a list of the modified program is given in the appendix.

2.0 AN OVERVIEW OF THE ANALYTICAL PROBLEM

It should be emphasized that prior to the work reported herein, a simplified, interactive simulation (called the "TBS Simulation") for predicting the braking and steering responses of commercial vehicles was developed at the Highway Safety Research Institute of The University of Michigan under the sponsorship of the Motor Vehicle Manufacturers Association [2]. The TBS simulation was based on a doctoral dissertation by Leucht entitled "Directional Dynamics of the Tractor-Semitrailer Vehicle," The University of Michigan, 1970 [1].

This report gives the details of the optional addition of the Breeze jackknife restraint device to the TBS simulation. It will be assumed throughout that the reader is conversant with References 1 and 2.

A schematic diagram of the Breeze device is presented in Figure 1. The "brake drum" at the lower right of the figure is mounted on the trailer. As the articulation angle increases, the cable must be played out. The jackknife restraint is applied as the air applied to the trailer brakes is also applied to the brake drum, retarding increased articulation.

One can follow through the equations of Leucht and show that tension in the cables of the Breeze device has the following effects:

1. An equal and opposite additional force at the hitch
2. Load transfer for both the tractor and trailer.

The cable tension and the force at the hitch, of course, form equal and opposite couples on the tractor and the trailer. The couples have components in the body roll, pitch, and yaw directions. The sense of the vertical, or yaw, component of the couples is to reduce the articulation angle.

The addition of the Breeze device to the software has been implemented in the following way.

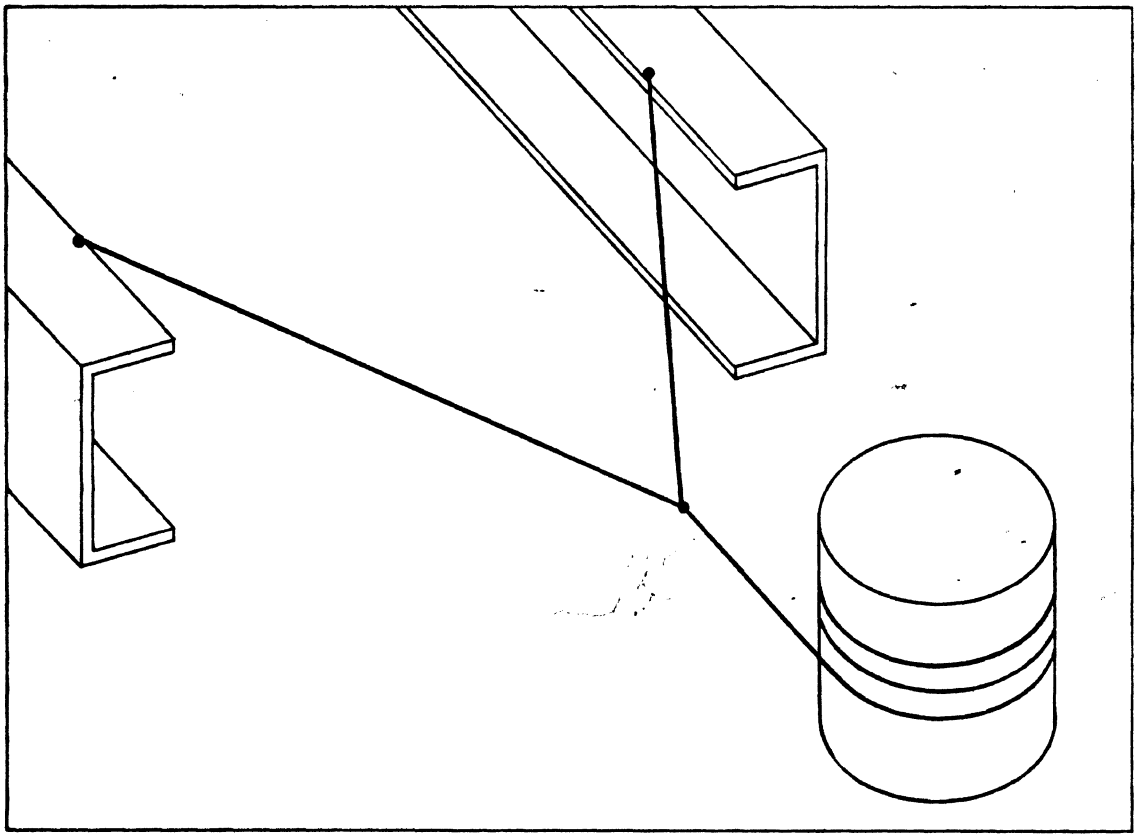


Figure 1. A schematic diagram of the Breeze device.

1. The tension in the cable is assumed to be a multiple of the desired* trailer brake force.

2. This tension is then used to compute the vertical component of the couple and the longitudinal and lateral load transfers of the tractor and the trailer.

3. The vertical component of the couple appears in the equations of motion.

The additional software has been designed for inclusion into the TBS simulation with minimal changes to the original program. This situation leads us to review the TBS simulation briefly before proceeding into the Breeze device.

2.1 The TBS Simulation

The equations of motion of the TBS articulated vehicle program are dynamically coupled in the following way:

$$(A_{(t)})\ddot{X} = F_{(t)} \tag{1}$$

where the four by four $A_{(t)}$ matrix and $F_{(t)}$ can be computed at any time, t. The acceleration vector $\ddot{X}$ is

$$\ddot{X} = \begin{bmatrix} \dot{u} \\ \dot{v} \\ \dot{r} \\ \ddot{\Gamma} \end{bmatrix} \tag{2}$$

where $\dot{u}$ is the longitudinal acceleration, $\dot{v}$ is the lateral acceleration, $\dot{r}$ is the rate of change of yaw rate, and $\ddot{\Gamma}$ is the second time derivative of the articulation angle. The interested reader can find the equations of motion in [1].

---

*Desired force does not equal the actual force if a trailer wheel locks.

The method of integration of equations of motion is relatively* straightforward. At time, t_o, the $A_{(to)}$ and $F_{(to)}$ are computed and Equation (1) is solved for the $\ddot{X}$, which are then integrated across Δt. The solutions to the integration facilitate the calculation of $A_{(to+\Delta t)}$ and $F_{(to+\Delta t)}$ for use in further integration.

The addition of the Breeze hitch to the formulation causes two changes in Equation (1), namely, the $\dot{r}$ and $\ddot{\Gamma}$ equations have a Breeze moment term appearing on the right-hand side. Thus we have, in the notation of the computer program,

$$\begin{aligned}
A_1\dot{u} + A_5\dot{v} + A_9\dot{r} + A_{13}\ddot{\Gamma} &= f1(t) \\
A_2\dot{u} + A_6\dot{v} + A_{10}\dot{r} + A_{14}\ddot{\Gamma} &= f2(t) \\
A_3\dot{u} + A_7\dot{v} + A_{11}\dot{r} + A_{15}\ddot{\Gamma} &= f3(t) + BT1 \cdot TBREEZE \\
A_4\dot{u} + A_8\dot{v} + A_{12}\dot{r} + A_{16}\ddot{\Gamma} &= f4(t) - BT1 \cdot TBREEZE
\end{aligned} \qquad (3)$$

where TBREEZE is the tension in the cable, and BT1 is a function of vehicle geometry.

(The A's are given in Fortran line numbers 635 through 715 and the right-hand sides are given in Fortran line numbers 2235 to 2310. See the listing in the appendix to this report.)

Equation (3) is operative as long as the system is "unlocked," that is, as long as the cable is not holding the articulation angle constant. In that case, TBREEZE is a straightforward multiple of the desired trailer brake force. If the cable does hold Γ fixed, however, then two conditions must follow:

1) $\ddot{\Gamma} = 0$

---

*One significant complication is the quasi-static load transfer, which makes $F_{(t)}$ a function of $\ddot{X}$, a situation which is handled by using "old" $\ddot{X}$ values to get the "new" $F_{(t)}$. We will ignore these matters here because they are not material to the present discussion.

2) TBREEZE, although limited by some maximum value, is unknown.

Since the "lock value" of the cable tension TBREEZE is limited but unknown, it's not obvious at the start of any Δt wide interval if the tension will be able to hold the articulation angle frozen. To check for lock, we first look for small $\dot{r}$. (Fortran line number 1455 will start the lock check any time $|\dot{r}|$ is less than .03 radians/sec.) If lock is a possibility, then the TBREEZE necessary to provide lock is found. If this is less than the maximum allowed by the Breeze mechanism, $\ddot{r}$ and $\dot{r}$ are set to zero. If the tension necessary for lockup is higher than the maximum allowed by the Breeze mechanism, then TBREEZE is reset to a multiple of the desired trailer brake force and Equation (3) is used. (This logic is handled at Fortran line number 2515.)

To solve for the TBREEZE value necessary for articulation lock,

$$A_{13} = 0 \tag{4a}$$

$$A_{14} = 0 \tag{4b}$$

$$A_{15} = -BT1 \tag{4c}$$

$$A_{16} = BT1 \tag{4d}$$

and the right-hand side of Equation (3) becomes

f1(t)

f2(t)

f3(t)

f4(t)

The solution of this modified form of Equation (3) now gives $\dot{u}$, $\dot{v}$, $\dot{r}$, and TBREEZE.

In the next section, the kinematics of the Breeze mechanism are presented, and the moment around the hitch is derived as a function of the cable tension TBREEZE for use in Equations (3) and (4).

3.0 THE KINEMATICS OF THE BREEZE JACKKNIFE RESTRAINT

The derivation of the equations of the Breeze jackknife restraint make use of the nomenclature shown in Figure 2.

From Figure 2, it is apparent that the articulation angle is related to the angle between the Breeze cable and the frame rails by the following relationship:

$$\text{when} \quad \phi = \frac{d}{e}\Gamma \quad |\phi| < \theta \tag{5}$$

(This corresponds to Fortran line number 1245.)

If $|\phi| > \theta$, the cables take on the configuration shown in Figure 3. In this case, the vector along the cable from the frame rail is given by

$$\bar{r} = d(-\sin\Gamma i - \cos\Gamma j) - B5i + A5j \tag{6}$$

The tangent of ϕ is the i component of $\bar{r}$ divided by the j component of $\bar{r}$, viz.:

$$\tan\phi = \frac{d\sin\Gamma + B5}{d\cos\Gamma - A5} \tag{7}$$

(This corresponds to Fortran line number 1290.)

We also need to compute the angle between the cable tension and the trailer. Figure 3 indicates that this angle is $\phi - \Gamma$.

Now we wish to compute the vertical (i.e., the z) component of the moment around the hitch produced by the tension in the cables with the aid of the free-body diagrams given in Figure 4. On noting that the vector moment is given by

$$\bar{M} = \bar{r} \times \bar{T} \ , \tag{8}$$

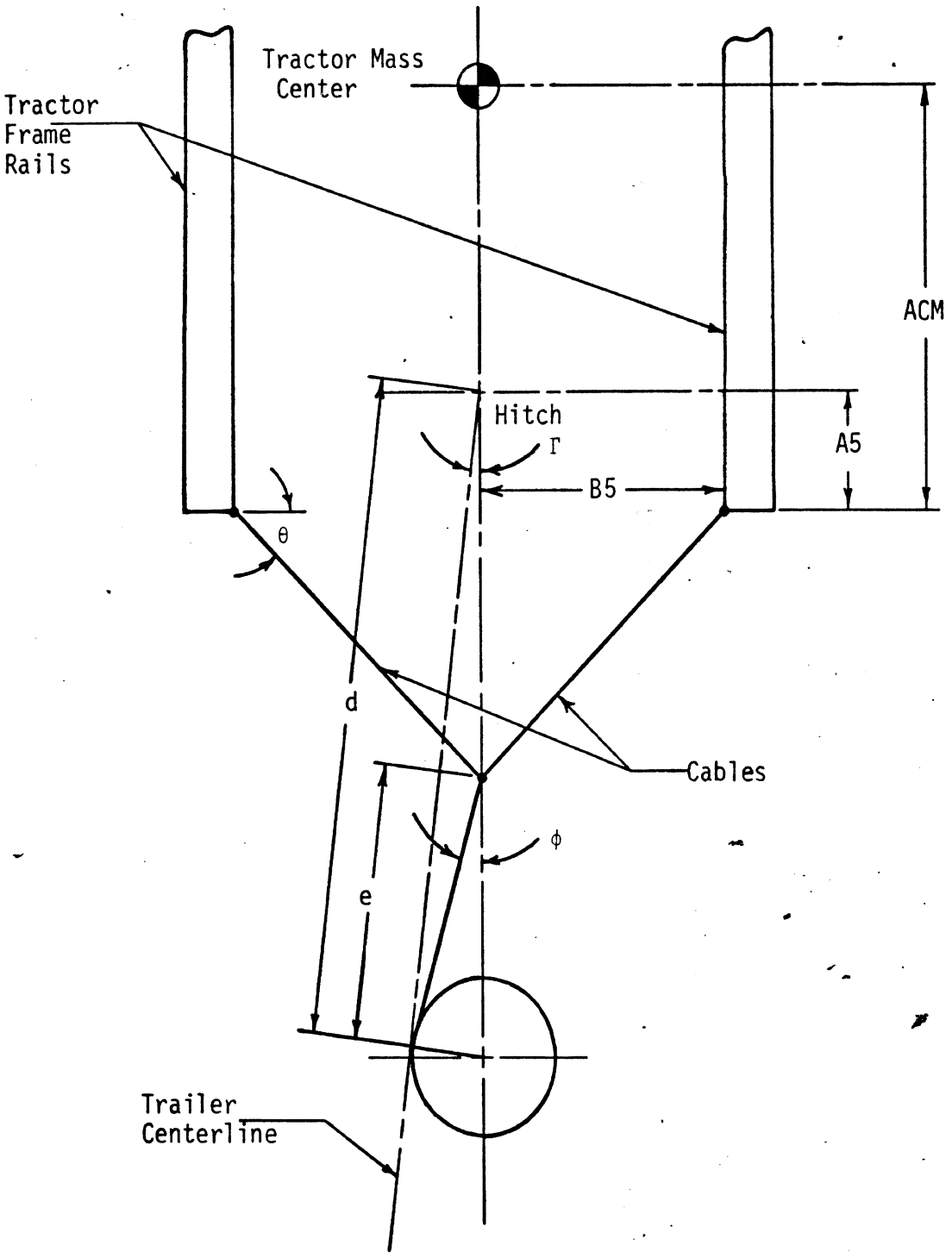


Figure 2. Schematic diagram, Breeze hitch.

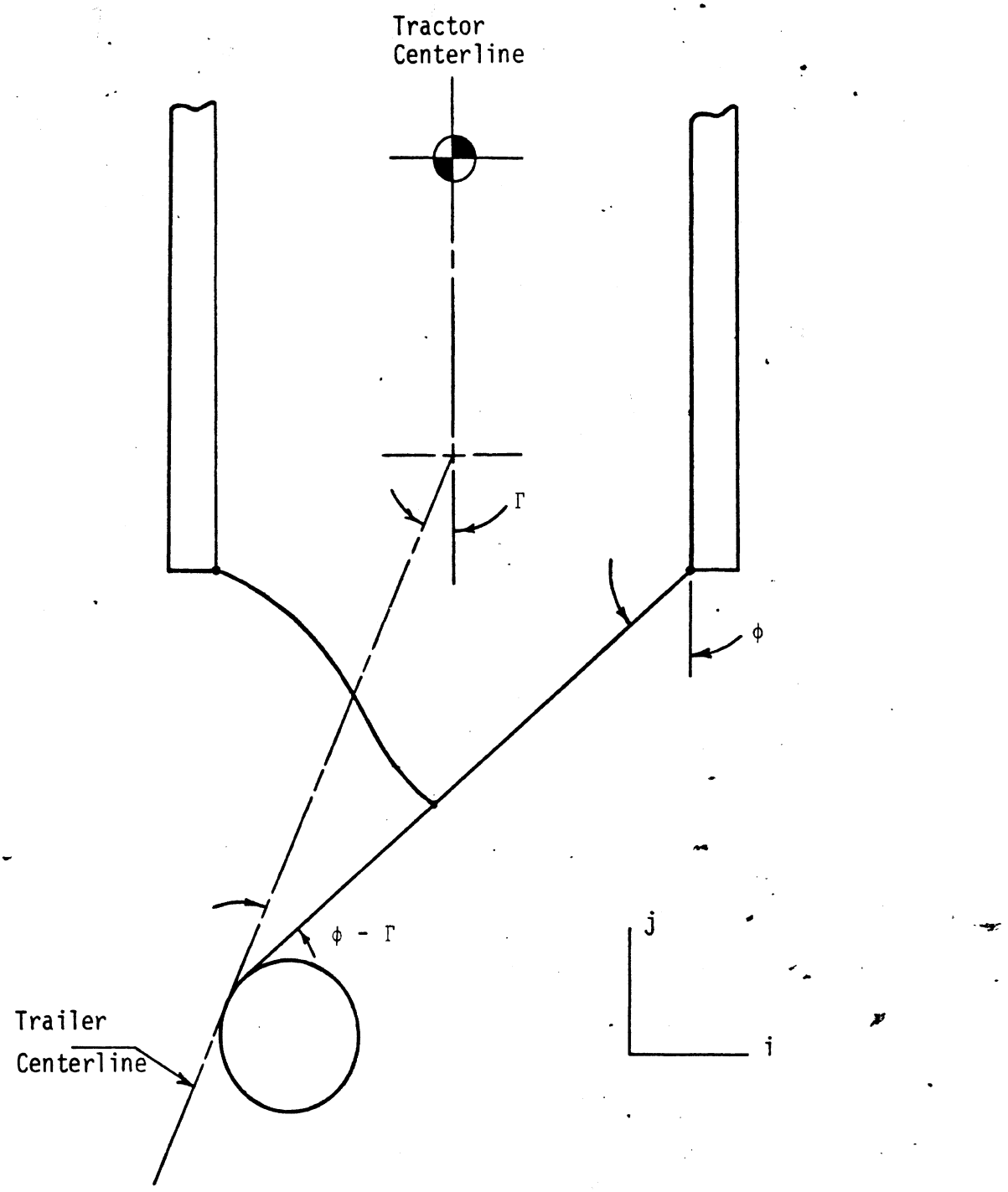


Figure 3. Cable configuration for $|\phi| > \theta$

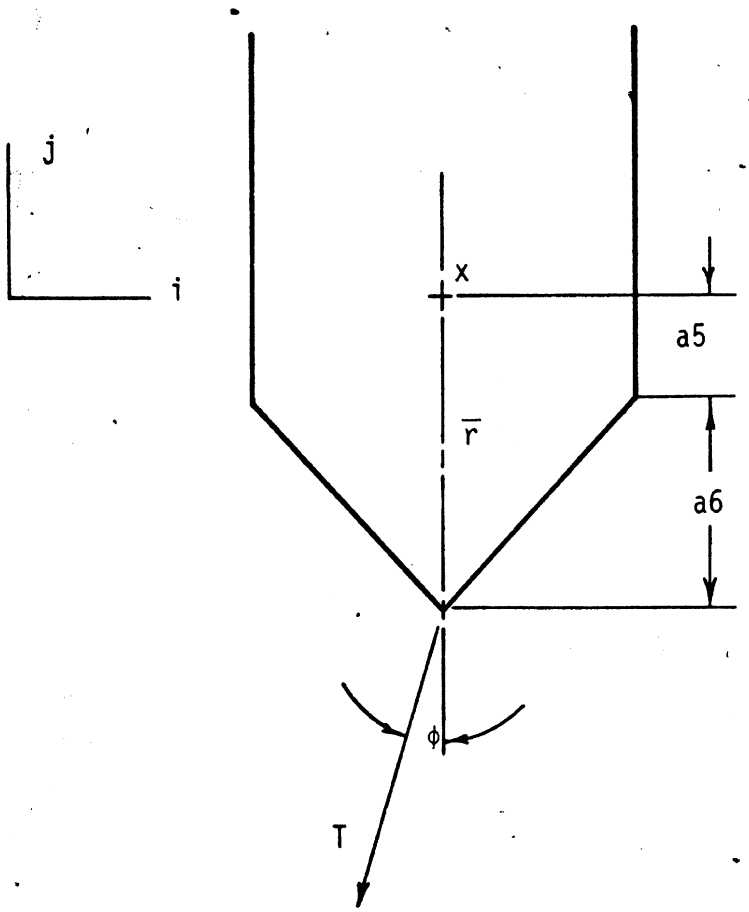


Figure 4a. Tractor free-body diagram, $|\phi| < \theta$

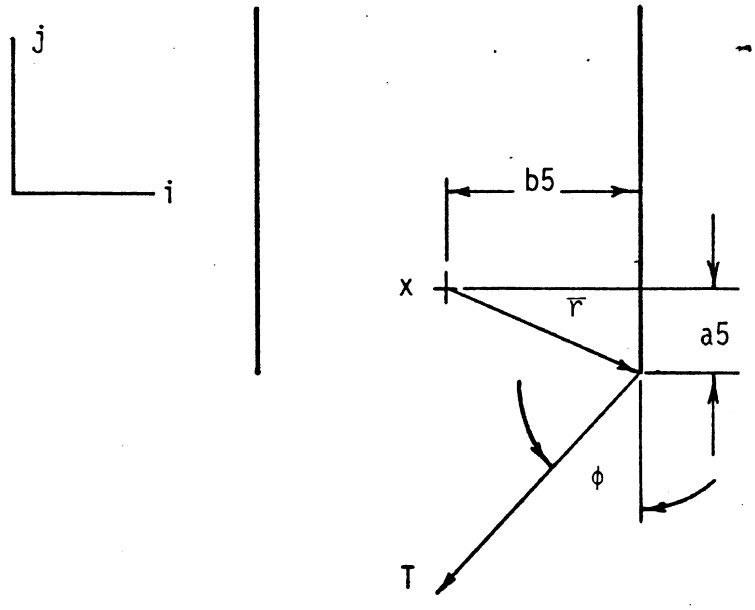


Figure 4b. Tractor free-body diagram, $|\phi| > \theta$

we find that for $|\phi| < \theta$ (see Figure 4a)

$$\bar{M} = [(A5 + A6) \sin \phi] \cdot TBREEZ \cdot k \qquad (9)$$

where k is the unit vector in the vertical direction. (The term in brackets is computed in Fortran line number 1425.)

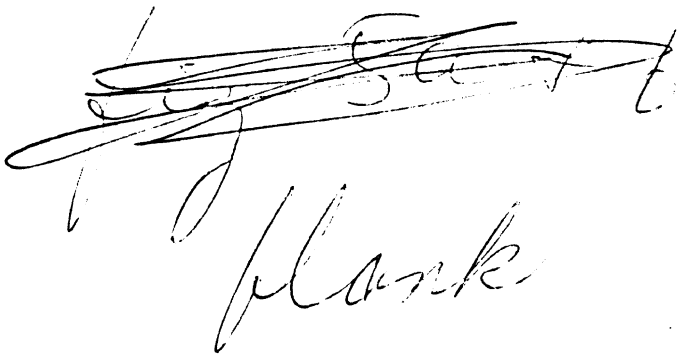
For $|\phi| > \theta$, Eq. (8) yields (see Figure 4b)

$$\bar{M} = \left[A5 \sin \phi + B5 \cos \phi \frac{\phi}{|\phi|}\right] TBREEZ \cdot k \qquad (10)$$

where the absolute value results from the necessity to flip sign on the B5 cos ϕ term for $\phi < 0$. Note for negative ϕ, the other frame rail attaches to the cable and the moment arm becomes -B5 cos ϕ. (The term in brackets is computed in Fortran line number 1335.)

Finally, we need certain pitch and roll moments to compute longitudinal and lateral load transfer. Noting that the cable is horizontal at height ZBREEZ, the tractor roll moment about any point in the ground plane due to the tension in the cable is -ZBREEZ · TBREEZ · sin ϕ. (This is computed in Fortran line number 1700.) The tractor pitch moment about any point in the ground plane is ZBREEZ · TBREEZ · cos ϕ. (This is computed in Fortran line number 1845.)

The equations of Reference 1 require that the trailer roll moment be calculated about the hitch, and pitch moments about the ground plane. The trailer roll moment about the hitch is -TBREEZ · sin (ϕ-Γ) · (ZO-ZBREEZ). (This is computed in Fortran line number 1755.) The trailer pitch moment about the ground plane is TZBREEZ · cos (ϕ-Γ) · ZBREEZ. (This is computed in Fortran line number 1835.)



4.0 SAMPLE RUNS

This section presents an echo of the input to the TBS program, followed by three sample runs. In each sample run, a step 2° steer angle is applied with the vehicle coasting at 45 mph on a high-μ surface. Then at .5 second, 500 pounds brake force is "demanded" at each front wheel, and 5000 pounds brake force is "demanded" at each of the tractor rear wheels and each of the trailer wheels.

Run 1 proceeds without antilock or Breeze restraint, and a jackknife results.

Run 2 proceeds with antilock operational on all tractor wheels, preventing the jackknife.

Run 3 proceeds using the Breeze device. Again, jackknife is prevented. Note that the input variables to run 3 use the nomenclature of this report. HITCHT is the gain of the Breeze device indicating that, for this run, the allowable cable tension is twice the desired trailer brake force for <u>one trailer wheel</u>.

```
YOU ARE ABOUT TO RUN THE HSRI SIMULATION PROGRAM FOR
A TRACTOR-TRAILER WITH BREEZE HITCH IN THE HORIZONTAL PLANE
PRINT PROGRAM EXPLANATIONS? (Y OR N): N
LIST INPUT PARAMETERS? Y
READ DATA FROM FILE? Y
ENTER INPUT DEVICE NUMBER IN I2 FORMAT: 07

*** BEGIN INPUT ***
41 ENTER ANTILOCK CODE FOR TRACTOR FRONT, TRACTOR REAR,
    AND TRAILER AXLES.
    0=NO ANTILOCK,  1=INDEPENDENT ANTILOCK,  FORMAT=3I1.
000
42 ENTER CODE FOR TANDEM AXLES TRACTOR REAR, DUAL TIRES
    TRACTOR REAR, TANDEM AXLES TRAILER, DUAL TIRES TRAILER
    0=NO,  1=YES,  FORMAT=4I1.
1100
```

INPUT PARAMETER TABLE

NO.	SYMBOL	DESCRIPTION	INITIAL VALUE
01	GVW1	WT. OF TRACTOR (LBS)	14970.00
02	GVW2	WT. OF TRAILER (LBS)	11160.00
03	IZZ	TRACTOR MOM. OF INERTIA (IN-LB-SEC**2)	241636.00
04	ITZZ	TRAILER MOM. OF INERTIA (IN-LB-SEC**2)	736983.00
05	AA	DIST. BETWEEN TRACTOR TANDEM AXLES (IN)	54.40
07	A1	DIST. FROM TRACTOR CG TO FRONT AXLE (IN)	63.90
08	A2	DIST. FROM TRACTOR CG TO REAR AXLE (IN)	78.10
09	A3	DIST. FROM TRAILER CG TO FIFTH WHL (IN)	261.20
10	A4	DIST. FROM TRAILER CG TO AXLE (IN)	104.80
11	BB	DIST. FROM TRACTOR REAR SUSPENSION TO FIFTH WHL (IN). FIFTH WHL LOCATED AFT OF SUSPENSION IS NEGATIVE.	0.0
12	TRA1	HALF LAT. DIST. BETWEEN CENTERS OF TIRE CONTACT ON TRACTOR FRONT AXLE (IN)	40.00
13	TRA2	HALF LAT. DIST. BETWEEN CENTERS OF TIRE CONTACT ON TRACTOR REAR AXLE/S (IN)	36.00
14	TRA3	HALF LAT. DIST. BETWEEN CENTERS OF TIRE CONTACT ON TRAILER AXLE/S (IN)	36.00
15	Z0	HEIGHT OF FIFTH WHL ABOVE GROUND (IN)	40.00
16	Z1	HEIGHT OF TRACTOR CG ABOVE GROUND (IN)	39.90
17	Z2	HEIGHT OF TRAILER CG ABOVE GROUND (IN)	55.50
18	MU5	FIFTH WHEEL FRICTION COEFFICIENT	0.05
19	RAD5	EQUIVALENT RADIUS OF FIFTH WHEEL (IN)	19.00
20	GAM1	PORTION OF TOTAL LAT. LOAD TRANSFER ON FRONT AXLE OF TRACTOR	0.15
21	GAM3	TRACTOR TANDEM AXLE LOAD X-FER COEF.	0.0
23	VEL	INITIAL VELOCITY: U-DIRECTION (MPH)	45.00
		(FPS)	66.00
24	TIMF	MAX. SIMULATION TIME FOR THIS RUN (SEC)	4.00
25	IQUIT	MAX. ARTICULATION ANGLE ALLOWED (DEG)	30.00
	CALF	CORNERING STIFFNESS OF TIRES (LBS/DEG)	
29		CALF(1)=	467.00
30		CALF(3)=	200.00
31		CALF(7)=	400.00
	MUP	PEAK TIRE-ROAD FRICTION COEFFICIENT	
32		MUP(1)=	0.95
	MUS	SLIDING TIRE-ROAD FRICTION COEF.	
35		MUS(1)=	0.90
	SP	SLIP CORRESPONDING TO PEAK MU	
38		SP(1)=	0.15

```
BRAKE FORCE TABLE
NUMBER OF LINES:   3

TIME                                DESIRED FORCES:
(SEC)     FSX(1)     FSX(2)     FSX(3)     FSX(4)     FSX(7)     FSX(8)

0.0         0.0        0.0        0.0        0.0        0.0        0.0
0.5000      0.0        0.0        0.0        0.0        0.0        0.0
0.6000    500.00     500.00    5000.00    5000.00    5000.00    5000.00


   STEER TABLE
NUMBER OF LINES:   2

TIME      STEER ANGLE
(SEC)       (DEG)

  0.0          0.0
  0.1000       2.00
CHANGE PARAMETERS? N
BREEZE HITCH?  N
CHANGE BRAKE FORCE TABLE? N
CHANGE STEER TABLE? N
ECHO STATIC LOADS? Y
    STATIC LOADS (LBS)
 TRACTOR FRONT AXLE:          8233.49
 TRACTOR LEADING TANDEM:      4966.02
         TRAILING TANDEM:     4966.02
 TRAILER AXLE:                7964.46

ENTER INITIAL ARTIC. ANGLE:  0.
WILL ARTIC. ANGLE BE VARIED?  Y
ANY DATA CHANGES NOW? N


    ♦♦♦ END OF INPUT ♦♦♦
```

```
WOULD YOU LIKE TO ENTER NEW SLIP POLL-OFF TABLE? N
DO YOU WANT A LIST OF OUTPUT VARIABLES? Y

♦♦♦ POSITION VARIABLES ♦♦♦

 1          XO-COORD
 2          YO-COORD
 3               PSI
 4             GAMMA

♦♦♦ VELOCITY VARIABLES ♦♦♦

 5               U-VEL
 6               V-VEL
 7              PSIDOT
 8          GAMMADOT

♦♦♦

 9          TURN RAD
10          SIDESLIP

♦♦♦ TIRE SLIP ANGLES ♦♦♦

11          ALFA 1+2
12          ALFA 3+4
13          ALFA 5+6
14          ALFA 7+8
15          ALFA9+10

♦♦♦ ACCELERATION VARIABLES ♦♦♦

16               U-DOT
17               V-DOT
18          PSI-DDOT
19          GAM-DDOT
20          LONG ACC
21          LAT. ACC

♦♦♦ TIRE-ROAD INTERFACE FORCES ♦♦♦
♦♦♦ BRAKE FORCES: FX(I), SIDE FORCES FY(I) ♦♦♦

22               FX(1)
23               FX(2)
24               FX(3)
25               FX(4)
26               FX(5)
27               FX(6)
28               FX(7)
29               FX(8)
30               FX(9)
31              FX(10)
32               FY(1)
33               FY(2)
34               FY(3)
35               FY(4)
36               FY(5)
37               FY(6)
38               FY(7)
39               FY(8)
40               FY(9)
41              FY(10)
```

```
 *** LOAD TRANSFERS, LONG. DFX(I),LAT. DFY(I) ***

42              DFX(1)
43              DFX(2)
44              DFX(3)
45              DFX(4)
46              DFX(5)
47              DFX(6)
48              DFX(7)
49              DFX(8)
50              DFX(9)
51             DFX(10)
52              DFY(1)
53              DFY(2)
54              DFY(3)
55              DFY(4)
56              DFY(5)
57              DFY(6)
58              DFY(7)
59              DFY(8)
60              DFY(9)
61             DFY(10)

*** INSTANTANEOUS LOAD FORCES ***

62              FZ(1)
63              FZ(2)
64              FZ(3)
65              FZ(4)
66              FZ(5)
67              FZ(6)
68              FZ(7)
69              FZ(8)
70              FZ(9)
71             FZ(10)

*** PROGRAMMED BRAKE FORCES ***

72              FSX(1)
73              FSX(2)
74              FSX(3)
75              FSX(4)
76              FSX(5)
77              FSX(6)
78              FSX(7)
79              FSX(8)
80              FSX(9)
81             FSX(10)

*** HITCH FORCES ***

82              XH
83              YH
84            IBREEZ
```

RUN #1

```
PRINT OUTPUT ON FILE? N
ENTER TOTAL NUMBER OF OUTPUT VARIABLES (01-06): 06

ENTER NUMBERS OF VARIABLES YOU WANT
SEPARATE NUMBERS BY COMMAS-(01,84)
04,08,19,20,21,84

ENTER TIME INCREMENT TO BE PRINTED OUT
.1

♦♦♦COMPUTATIONS ARE STOPPED♦♦
♦♦♦ TIME IS   2.81 SECONDS ♦♦♦
♦♦♦ARTIC. ANGLE IS -31.51 DEGREES ♦♦♦
```

TIME	GAMMA	GAMMADOT	GAM-DDOT	LONG ACC	LAT. ACC	TBREEZ
0.0	0.0	0.0	0.0	-0.0	0.0	0.0
0.10	-0.04	-1.20	-22.07	-0.07	3.29	0.0
0.22	-0.32	-3.29	-12.70	-0.07	3.35	0.0
0.32	-0.70	-4.20	-5.63	-0.07	3.93	0.0
0.42	-1.14	-4.47	-0.09	-0.07	4.64	0.0
0.50	-1.52	-4.33	3.07	-3.82	5.19	0.0
0.60	-1.97	-4.93	-7.70	-19.34	3.60	0.0
0.71	-2.56	-5.82	-7.85	-19.34	4.31	0.0
0.81	-3.19	-6.64	-8.73	-19.35	5.04	0.0
0.91	-3.90	-7.53	-7.56	-19.37	5.79	0.0
1.01	-4.69	-8.36	-10.78	-19.37	6.69	0.0
1.11	-5.58	-9.36	-4.89	-19.38	7.44	0.0
1.20	-6.45	-10.20	-10.66	-19.37	8.39	0.0
1.30	-7.52	-11.11	-9.34	-19.36	9.32	0.0
1.40	-8.68	-12.00	-8.76	-19.34	10.23	0.0
1.51	-10.05	-12.98	-8.81	-19.31	11.36	0.0
1.61	-11.39	-13.84	-7.55	-19.26	12.29	0.0
1.71	-12.82	-14.62	-8.19	-19.19	13.25	0.0
1.81	-14.32	-15.39	-6.21	-19.11	14.10	0.0
1.91	-15.89	-16.04	-7.01	-19.00	14.96	0.0
2.01	-17.53	-16.67	-4.64	-18.87	15.66	0.0
2.11	-19.22	-17.15	-5.12	-18.71	16.34	0.0
2.21	-20.96	-17.58	-2.84	-18.54	16.82	0.0
2.31	-22.73	-17.84	-2.46	-18.33	17.22	0.0
2.41	-24.52	-17.99	-0.29	-18.13	17.39	0.0
2.51	-26.32	-17.94	1.31	-17.92	17.39	0.0
2.61	-28.10	-17.68	4.00	-17.72	17.11	0.0
2.71	-29.85	-17.12	7.12	-17.55	16.56	0.0
2.81	-31.51	-16.20	11.12	-17.42	15.68	0.0

```
DO YOU WANT ANY MORE OUTPUT? N
STOP? N
```

RUN #2

```
CHANGE PARAMETERS? Y

ENTER PARAMETER NUMBER TO BE CHANGED (01-42)
41
41 ANTILOCK CODE (3I1): 110

ANTEFF          ANTILOCK EFFECTIVENESS COEFFICIENT (LAT.,LONG.)
26                                  FRONT AXLE: ANTEFF= 0.5,0.0
27          TRACTOR REAR AXLE (OR TANDEM AXLE): ANTEFF= 0.5,0.0
? 0
BREEZE HITCH? N
CHANGE BRAKE FORCE TABLE? N
CHANGE STEER TABLE? N
ECHO STATIC LOADS? N

ENTER INITIAL ARTIC. ANGLE:  0.
ANY DATA CHANGES NOW? N


    ••• END OF INPUT •••

PRINT OUTPUT ON FILE? N
ENTER TOTAL NUMBER OF OUTPUT VARIABLES (01-06): 06

ENTER NUMBERS OF VARIABLES YOU WANT
SEPARATE NUMBERS BY COMMAS-(01,34)
04,08,19,20,21,34

ENTER TIME INCREMENT TO BE PRINTED OUT
.1
```

TIME	GAMMA	GAMMADOT	GAM-DDOT	LONG ACC	LAT. ACC	TBREEZ
0.0	0.0	0.0	0.0	-0.0	0.0	0.0
0.10	-0.04	-1.20	-22.07	-0.07	3.29	0.0
0.22	-0.32	-3.29	-12.70	-0.07	3.35	0.0
0.32	-0.70	-4.20	-5.63	-0.07	3.93	0.0
0.42	-1.14	-4.47	-0.09	-0.07	4.64	0.0
0.50	-1.52	-4.33	3.07	-3.82	5.19	0.0
0.60	-1.94	-3.78	11.40	-19.30	4.64	0.0
0.70	-2.36	-3.55	12.39	-19.29	5.14	0.0
0.80	-2.45	-1.28	12.50	-19.30	5.41	0.0
0.90	-2.52	-0.07	11.88	-19.32	5.43	0.0
1.00	-2.47	1.03	9.49	-19.34	5.43	0.0
1.10	-2.32	1.92	9.43	-19.36	5.24	0.0
1.20	-2.03	2.73	4.57	-19.39	5.03	0.0
1.30	-1.79	3.23	3.53	-19.41	4.71	0.0
1.40	-1.43	3.32	0.99	-19.42	4.55	0.0
1.50	-1.03	4.04	1.31	-19.43	4.24	0.0
1.60	-0.62	4.16	0.54	-19.44	3.98	0.0
1.70	-0.21	4.18	-0.08	-19.44	3.75	0.0
1.80	0.21	4.14	-1.09	-19.43	3.56	0.0
1.90	0.62	4.02	-1.17	-19.42	3.36	0.0
2.00	1.02	3.88	-1.99	-19.40	3.19	0.0
2.10	1.39	3.68	-1.90	-19.38	3.00	0.0
2.20	1.75	3.47	-2.56	-19.36	2.82	0.0
2.30	2.09	3.22	-2.54	-19.33	2.62	0.0
2.40	2.39	2.95	-3.01	-19.31	2.42	0.0
2.50	2.67	2.65	-3.10	-19.28	2.20	0.0
2.60	2.92	2.33	-3.38	-19.25	1.98	0.0
2.70	3.14	1.99	-3.49	-19.23	1.75	0.0
2.80	3.32	1.64	-3.56	-19.20	1.51	0.0
2.90	3.47	1.30	-3.49	-19.18	1.27	0.0
3.00	3.58	0.96	-3.39	-19.17	1.03	0.0
3.10	3.66	0.63	-3.23	-19.16	0.80	0.0
3.20	3.71	0.33	-2.99	-19.15	0.58	0.0
3.30	3.73	0.05	-2.62	-19.15	0.37	0.0
3.40	3.72	-0.19	-2.14	-19.15	0.18	0.0
3.50	3.69	-0.37	-1.51	-19.16	0.01	0.0
3.60	3.65	-0.48	-0.73	-19.17	-0.13	0.0
3.70	3.60	-0.51	-0.16	-19.18	-0.19	0.0
3.80	3.54	-0.53	-0.16	-19.18	-0.19	0.0
3.90	3.49	-0.54	-0.16	-19.19	-0.19	0.0
3.94	3.47	-0.55	-0.17	-19.18	-0.19	0.0

```
DO YOU WANT ANY MORE OUTPUT? N

••• TRUCK HAS STOPPED IN  3.94 SECONDS •••
STOP? N
```

RUN #3

```
CHANGE PARAMETERS? Y

ENTER PARAMETER NUMBER TO BE CHANGED (01-42)
41
41 ANTILOCK CODE (3I1): 000
? 0
BREEZE HITCH?  Y
ENTER HITCHT,DD,E,THETA(DEG),A5,A6,B5,ACM,ZBREEZ
SEPERATED BY COMMA.
2.,7.,1.5,45.,3.,1.5,1.5,6.,3.333

 HITCHT  =     2.00000
 DD      =     7.00000   FT
 E       =     1.50000   FT
 THETA   =    45.00000   DEG
 A5      =     3.00000   FT
 A6      =     1.50000   FT
 B5      =     1.50000   FT
 ACM     =     6.00000   FT
 ZBREEZ  =     3.33300   FT
CHANGE BREEZE HITCH DATA?  N
CHANGE BRAKE FORCE TABLE? N
CHANGE STEER TABLE? N
ECHO STATIC LOADS? N

ENTER INITIAL ARTIC. ANGLE:  0.
ANY DATA CHANGES NOW? N


    *** END OF INPUT ***

PRINT OUTPUT ON FILE? N
ENTER TOTAL NUMBER OF OUTPUT VARIABLES (01-06): 06

ENTER NUMBERS OF VARIABLES YOU WANT
SEPARATE NUMBERS BY COMMAS-(01-24)
04,08,19,20,21,24

ENTER TIME INCREMENT TO BE PRINTED OUT
.1

      TIME      GAMMA   GAMMADOT   GAM-DDOT   LONG ACC   LAT. ACC     TBREEZ
      0.0         0.0        0.0        0.0       -0.0        0.0        0.0
      0.10       -0.04      -1.20     -22.07      -0.07       3.29       0.0
      0.22       -0.32      -3.29     -12.70      -0.07       3.35       0.0
      0.32       -0.70      -4.20      -5.63      -0.07       3.93       0.0
      0.42       -1.14      -4.47      -0.09      -0.07       4.64       0.0
      0.50       -1.52      -4.33       4.11      -3.88       5.19     499.35
      0.60       -1.93      -3.63      16.86     -19.30       3.70   10000.00
      0.71       -2.22      -1.73      13.59     -19.29       4.23   10000.00
      0.81       -2.31      -0.15      16.22     -19.30       4.50   10000.00
      0.90       -2.31       0.0        0.0      -19.35       4.47    4131.13
      1.01       -2.31       0.0        0.0      -19.38       4.61    4311.52
      1.11       -2.31       0.0        0.0      -19.38       4.77    4470.73
      1.21       -2.31       0.0        0.0      -19.39       4.95    4650.68
      1.31       -2.31       0.0        0.0      -19.40       5.14    4838.20
      1.41       -2.31       0.0        0.0      -19.41       5.34    5035.16
      1.51       -2.31       0.0        0.0      -19.42       5.53    5215.20
      1.61       -2.31       0.0        0.0      -19.42       5.70    5384.16
      1.71       -2.31       0.0        0.0      -19.43       5.86    5558.32
      1.81       -2.31       0.0        0.0      -19.42       5.99    5707.20
      1.91       -2.31       0.0        0.0      -19.42       6.08    5830.75
      2.01       -2.31       0.0        0.0      -19.41       6.13    5925.20
      2.11       -2.31       0.0        0.0      -19.39       6.14    5985.03
      2.21       -2.31       0.0        0.0      -19.37       6.09    6004.79
      2.31       -2.31       0.0        0.0      -19.35       5.99    5979.25
      2.41       -2.31       0.0        0.0      -19.32       5.82    5903.53
      2.51       -2.31       0.0        0.0      -19.29       5.59    5772.70
      2.61       -2.31       0.0        0.0      -19.25       5.30    5587.05
      2.71       -2.31       0.0        0.0      -19.22       4.94    5342.68
      2.81       -2.31       0.0        0.0      -19.18       4.52    5042.10
      2.91       -2.31       0.0        0.0      -19.15       4.04    4684.82
      3.01       -2.31       0.0        0.0      -19.12       3.53    4273.55
      3.11       -2.31       0.0        0.0      -19.09       2.99    3864.85
      3.21       -2.31       0.0        0.0      -19.08       2.44    3417.54
      3.31       -2.31       0.0        0.0      -19.07       1.90    2967.57
      3.41       -2.31       0.0        0.0      -19.07       1.40    2530.86
      3.51       -2.31       0.0        0.0      -19.08       0.95    2120.74
      3.61       -2.31       0.0        0.0      -19.11       0.56    1744.25
      3.71       -2.31       0.0        0.0      -19.11       0.42    1604.00
      3.81       -2.31       0.0        0.0      -19.11       0.42    1604.54
      3.91       -2.31       0.0        0.0      -19.11       0.42    1604.55
      3.93       -2.31       0.0        0.0      -19.11       0.42    1604.49
DO YOU WANT ANY MORE OUTPUT? N

*** TRUCK HAS STOPPED IN  3.93 SECONDS ***
STOP? Y
```

5.0 REFERENCES

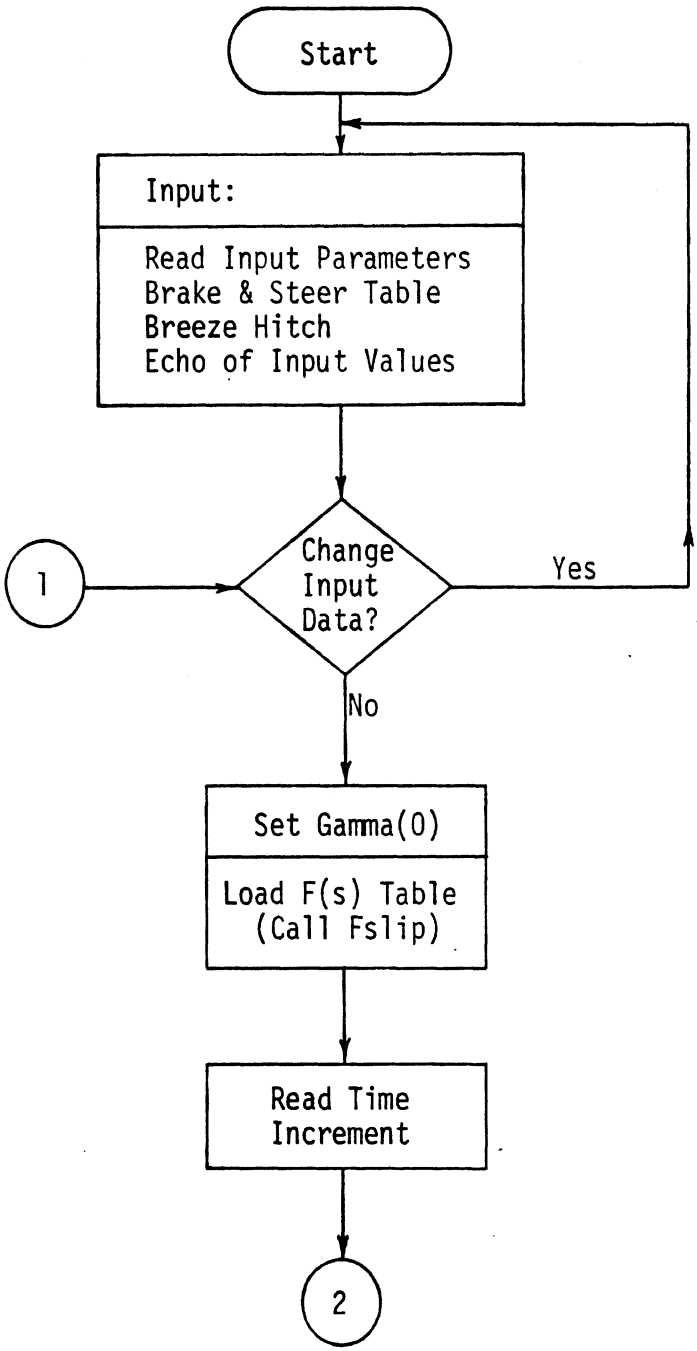
1. Leucht, P.M., Directional Dynamics of the Tractor-Semi-Trailer Vehicle, Ph.D. Thesis, University of Michigan, 1970.

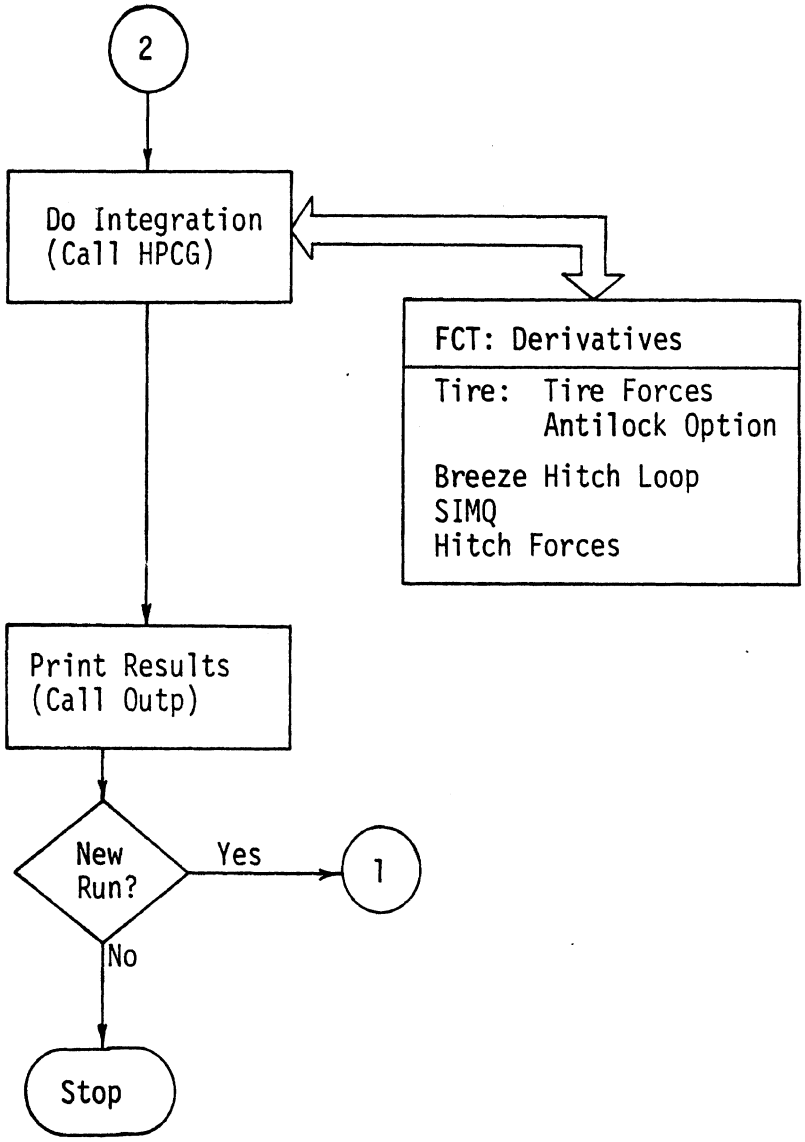
2. Moncarz, H.T., Bernard, J.E., and Fancher, P.S., A Simplified Interactive Simulation for Predicting the Braking and Steering Response of Commercial Vehicles, Highway Safety Research Institute, Univ. of Michigan, August 1975.

APPENDIX

This appendix presents a flow chart and a source listing for the TBS program. Note that the last two subroutines in the source list are HPCG and SIMQ, both IBM subroutines. HPCG performs the integration and SIMQ solves the four-by-four set of equations to uncouple the accelerations.

MACRO LOGIC FLOW




2
Do Integration
(Call HPCG)
FCT: Derivatives
Tire: Tire Forces
Antilock Option
Breeze Hitch Loop
SIMQ
Hitch Forces
Print Results
(Call Outp)
New
Run?
Yes
1
No
Stop

```
C  ************************************************************          BRZH0000
C       TRACTOR-TRAILOR BREEZE HITCH PROGRAM                             BRZH0005
C  ************************************************************          BRZH0010
C                                                                        BRZH0015
C                                                                        BRZH0020
C ** MAIN PROGRAM BEGINS HERE                                           BRZH0025
C                                                                        BRZH0030
C                                                                        BRZH0035
      EXTERNAL  HPCG,FCT,OUTP                                            BRZH0040
      REAL      MU,MUS,M1,M2,I1,I2,MUS,MUT(10),MUSLOP,IQUIT              BRZH0045
      DIMENSION Y(8),PRMT(5),DERY(8),AUX(16,8),CIA(10),FZ(10),FSX(10),   BRZH0050
     1          DFZ(10),DELFZ(10),FX(10),FY(10)                          BRZH0055
      COMMON    W1,W2,M1,M2,A,B,C,D,H,Z0,Z1,Z2,GAM1,GAM2,MUS,RADS,DELTA, BRZH0060
     1          T1,T2,T3,CIA,FSX,FZ,INIT,I1,I2,DERX(4),FRZ(10),ALPHA(10) BRZH0065
     2          ,WINX,FY,DFZ,DELFZ,TIME,FX,DKEY,VEL,AAA,AAT,KEY(4),      BRZH0070
     3          MU(10),ANTEFF(10,2),IDUMP,XDUMP,XDOFF,MUS(10),KEYANT(3), BRZH0075
     5          MUSLOP(10),BET(15,7),ITAB,IXON,ITABS,STEER(25,2),ISAV,   BRZH0080
     6          GAM3,GAM4,TRUCK,IQUIT                                    BRZH0085
      COMMON    /IO/IR,IW                                                BRZH0090
      DATA      YES /'Y'/                                                BRZH0095
C                                                                        BRZH0100
C  ** READY TO START - READ INPUT DATA                                   BRZH0105
C                                                                        BRZH0110
  300 CONTINUE                                                           BRZH0115
      IW=6                                                               BRZH0120
      IR=5                                                               BRZH0125
      TRUCK=2                                                            BRZH0130
      NDIM=1                                                             BRZH0135
      ISAV=1                                                             BRZH0140
      IXON=1                                                             BRZH0145
C INITIALIZE TANDEM AXLE FORCES                                          BRZH0150
  999 CONTINUE                                                           BRZH0155
      FX(5)=0.                                                           BRZH0160
      FX(6)=0.                                                           BRZH0165
      FX(9)=0.                                                           BRZH0170
      FX(10)=0.                                                          BRZH0175
      FY(6)=0.                                                           BRZH0180
      FY(5)=0.                                                           BRZH0185
      FY(9)=0.                                                           BRZH0190
      FY(10)=0.                                                          BRZH0195
      CALL INPUT(Y,DERY,PRMT,NDIM)                                       BRZH0200
      IF (TRUCK .EQ. 0.) GO TO 1005                                      BRZH0205
      WRITE(IW,131)                                                      BRZH0210
  131 FORMAT(///'0',T6,'*** END OF INPUT ***'/)                          BRZH0215
      DO 2001 I=1,4                                                      BRZH0220
 2001 DERX(I)=0.                                                         BRZH0225
      CALL HPCG(PRMT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX)                      BRZH0230
      IF (PRMT(5) .EQ. 4.) GO TO 75                                      BRZH0235
      IF (PRMT(5) .EQ. 5.) GO TO 200                                     BRZH0240
      IF (PRMT(5) .GT. 0) GO TO 71                                       BRZH0245
      IF (IHLF .GT. 10) GO TO 70                                         BRZH0250
   71 CONTINUE                                                           BRZH0255
      INIT = 0                                                           BRZH0260
      GO TO 999                                                          BRZH0265
   70 WRITE(IW,107) IHLF                                                 BRZH0270
  107 FORMAT('0','**** ERROR RETURN,CODE IS',I3,' ****')                 BRZH0275
      DKEY=2.                                                            BRZH0280
      CALL OUTP(X,Y,DERY,IHLF,NDIM,PRMT)                                 BRZH0285
      GO TO 999                                                          BRZH0290
   75 WRITE(IW,1007) XDOFF                                               BRZH0295
```

```
 1007 FORMAT('0','*** TRUCK HAS STOPPED IN',F6.2,' SECONDS ***')          BRZH0300
      GO TO 71                                                            BRZH0305
  200 WRITE(IW,201) IQUIT                                                 BRZH0310
  201 FORMAT('0','*** COMPUTATIONS ARE STOPPED ***'/' ',                  BRZH0315
     1 '***ARTICULATION ANGLE GREATER THAN',                              BRZH0320
     2 F6.2,' DEGREES ***'/)                                              BRZH0325
      GO TO 71                                                            BRZH0330
 1006 FORMAT(' ', '*** SEE YOU NEXT TRIP ***'                             BRZH0335
     1 / '*** KEEP ON TRUCKIN! ***')                                      BRZH0340
 1005 WRITE(IW,1008)                                                      BRZH0345
 1008 FORMAT(//'NEW DATA SET?')                                           BRZH0350
      READ(IR,100)ANS                                                     BRZH0355
  100 FORMAT(A1)                                                          BRZH0360
      IF(ANS.EQ.YES)GO TO 300                                             BRZH0365
      WRITE(IW,1006)                                                      BRZH0370
      END                                                                 BRZH0375
C                                                                         BRZH0380
C                                                                         BRZH0385
C  ********************************************************             BRZH0390
      SUBROUTINE FCT(X,Y,DERY)                                            BRZH0395
C  ********************************************************             BRZH0400
C                                                                         BRZH0405
C                                                                         BRZH0410
      DIMENSION Y(8),DERY(8),CIA(10),DELFZ(10),DFZ(10),FX(10),            BRZH0415
     1          FY(10),FZ(10),FSX(10),BB(4),AA(16)                        BRZH0420
      REAL      MU,MUS,M1,M2,LAM1,LAM2,LAM3,LAM4,I1,I2                    BRZH0425
      REAL      MUSLOP,IQUIT,MUS,MUT(10),MM                               BRZH0430
      COMMON    W1,W2,M1,M2,A,B,C,D,H,ZM,Z1,Z2,GAM1,GAM2,MUS,RADS,DELTA,  BRZH0435
     1          T1,T2,T3,CIA,FSX,FZ,INIT,I1,I2,DERX(4),FRZ(10),ALPHA(10)  BRZH0440
     2          ,WINX,FY,DFZ,DELFZ,TIME,FX,DKFY,VEL,AAA,AAT,KEY(4),       BRZH0445
     3          MU(10),ANTEFF(10,2),TDUMP,XDUMP,XDOFF,MUS(10),KEYANT(3),  BRZH0450
     5          MUSLOP(10),BFT(15,7),ITAB,IXON,ITABS,STEER(25,2),ISAV,    BRZH0455
     6          GAM3,GAM4,TRUCK,IQUIT                                     BRZH0460
      COMMON    /IO/IR,IW                                                 BRZH0465
      COMMON    /BREEZ/TBREEZ,YBREEZ,HITCHT,DD,E,THETA,A5,A6,B5,ACM       BRZH0470
      COMMON    /KBREZ/KBREEZ,ZBREEZ,KKEY                                 BRZH0475
      COMMON    /FCTOUT/XL,YL,IPLOT                                       BRZH0480
C                                                                         BRZH0485
C **  CALCULATE PARAMETERS FOR NEW DERY VALUES                            BRZH0490
C **  BEGIN WITH CALCULATION OF TIRE SLIP ANGLES                          BRZH0495
C                                                                         BRZH0500
    4 IF (INIT .EQ. 1) INIT=0                                             BRZH0505
C                                                                         BRZH0510
C  **  COMPUTE DELTA FROM STEER TABLE                                     BRZH0515
C                                                                         BRZH0520
      IF(X.GT.STEER(ITABS,1))GO TO 4004                                   BRZH0525
      DO 4002 I=ISAV,ITABS                                                BRZH0530
      IF(X.EQ.STEER(I,1))GO TO 4003                                       BRZH0535
      IF(X.GT.STEER(I,1))GO TO 4002                                       BRZH0540
      IM1=I-1                                                             BRZH0545
      DELTA=(STEER(I,2)-STEER(IM1,2))/(STEER(I,1)                         BRZH0550
     1 -STEER(IM1,1))*(X-STEER(IM1,1))+STEER(IM1,2)                       BRZH0555
      GO TO 4005                                                          BRZH0560
 4003 DELTA=STEER(I,2)                                                    BRZH0565
      GO TO 4005                                                          BRZH0570
 4002 CONTINUE                                                            BRZH0575
      GO TO 4005                                                          BRZH0580
 4004 DELTA=STEER(ITABS,2)                                                BRZH0585
      GO TO 4006                                                          BRZH0590
 4005 ISAV=I-2                                                            BRZH0595
```

```
      IF(ISAV.LT.1)ISAV=1                                                BRZH0600
 4006 CONTINUE                                                           BRZH0605
      DELTA=DELTA/57.295                                                 BRZH0610
C                                                                        BRZH0615
C  **  THE AA MATRIX IS STORED COLUMNWISE. AA(1)*DERY(1)+AA(5)*DERY(2)   BRZH0620
C  **  +AA(9)*DERY(3)+AA(13)*DERY(4)=B(1) IS THE FIRST OF FOUR EQUATIONS BRZH0625
C  **  SOLVED BY THE SIMQ ROUTINE                                         BRZH0630
C                                                                        BRZH0635
      AA(1) = M1 + M2                                                    BRZH0640
      AA(2) = 0.0                                                        BRZH0645
      AA(3) = 0.0                                                        BRZH0650
      AA(4)= C*M2*SIN(Y(7))                                              BRZH0655
      AA(5) = 0.0                                                        BRZH0660
      AA(6) = M1 + M2                                                    BRZH0665
      AA(7)= -H*M2                                                       BRZH0670
      AA(8) = -C*M2*COS(Y(7))                                            BRZH0675
      AA(9)= C*M2*SIN(Y(7))                                              BRZH0680
      AA(10)=-M2*(H + C*COS(Y(7)))                                       BRZH0685
      AA(11)= M2*(H*H + C*H*COS(Y(7))) +I1                               BRZH0690
      AA(12) = I2 +C*M2*(C+H*COS(Y(7)))                                  BRZH0695
      AA(13)= C*M2*SIN(Y(7))                                             BRZH0700
      AA(14)= -C*M2*COS(Y(7))                                            BRZH0705
      AA(15)= H*C*M2*COS(Y(7))                                           BRZH0710
      AA(16) = I2 + C*C*M2                                               BRZH0715
    5 IF (Y(2) .NE. 0) GO TO 7                                           BRZH0720
      DO 6 I=1,10                                                        BRZH0725
    6 ALPHA(I)=0.                                                        BRZH0730
      GO TO 1400                                                         BRZH0735
    7 ALPHA(1)=((Y(4)+(A*Y(6)))/Y(2))-DELTA                              BRZH0740
      ALPHA(2)=ALPHA(1)                                                  BRZH0745
      ALPHA(3)=(Y(4)-((B-AAA/2.)*Y(6)))/Y(2)                             BRZH0750
      ALPHA(4)=ALPHA(3)                                                  BRZH0755
      IF(KEY(1).LT.1)GO TO 1399                                          BRZH0760
      ALPHA(5)=(Y(4)-((H+AAA/2.)*Y(6)))/Y(2)                             BRZH0765
      ALPHA(6)=ALPHA(5)                                                  BRZH0770
 1399 ALPHA(7)=((Y(4)-(H*Y(6)))*COS(Y(7))-(C+(D-AAT/2.))*(Y(6)+Y(8))     BRZH0775
     1-Y(2)*SIN(Y(7)))/((Y(2)*COS(Y(7)))+(Y(4)-(H*Y(6))*SIN(Y(7))))      BRZH0780
      ALPHA(8)=ALPHA(7)                                                  BRZH0785
      IF(KEY(3).LT.1)GO TO 1400                                          BRZH0790
      ALPHA(9)=((Y(4)-(H*Y(6)))*COS(Y(7))-(C+(D+AAT/2.))*(Y(6)+Y(8))     BRZH0795
     1-Y(2)*SIN(Y(7)))/((Y(2)*COS(Y(7)))+(Y(4)-(H*Y(6))*SIN(Y(7))))      BRZH0800
      ALPHA(10)=ALPHA(9)                                                 BRZH0805
 1400 CONTINUE                                                           BRZH0810
C                                                                        BRZH0815
C  **  COMPUTATION OF LONGITUDINAL AND LATERAL FORCES ON TIRES            BRZH0820
C                                                                        BRZH0825
      IF(X.GT.BFT(ITAB,1))GO TO 8004                                     BRZH0830
      DO 8002 I=IXON,ITAB                                                BRZH0835
      IF(X.EQ.BFT(I,1))GO TO 8003                                        BRZH0840
      IF(X.GT.BFT(I,1))GO TO 8002                                        BRZH0845
      IM1=I-1                                                            BRZH0850
      DO 1701 J=1,6                                                      BRZH0855
      K=J+1                                                              BRZH0860
      FSX(J)=(BFT(I,K)-BFT(IM1,K))/(BFT(I,1)-BFT(IM1,1))                 BRZH0865
     1 *(X-BFT(IM1,1))+BFT(IM1,K)                                        BRZH0870
 1701 CONTINUE                                                           BRZH0875
      GO TO 8005                                                         BRZH0880
 8003 CONTINUE                                                           BRZH0885
      DO 1702 J=1,6                                                      BRZH0890
      K=J+1                                                              BRZH0895
```

```
      FSX(J)=BFT(I,K)                                                    BRZH0900
 1702 CONTINUE                                                           BRZH0905
      GO TO 8005                                                         BRZH0910
 8002 CONTINUE                                                           BRZH0915
      GO TO 8005                                                         BRZH0920
 8004 DO 1703 J=1,6                                                      BRZH0925
      K=J+1                                                              BRZH0930
      FSX(J)=BFT(ITAB,K)                                                 BRZH0935
 1703 CONTINUE                                                           BRZH0940
      GO TO 8006                                                         BRZH0945
 8005 IXON=I-2                                                           BRZH0950
      IF(IXON.LT.1)IXON=1                                                BRZH0955
 8006 CONTINUE                                                           BRZH0960
      FSX(7)=FSX(5)                                                      BRZH0965
      FSX(8)=FSX(6)                                                      BRZH0970
      FSX(9)=FSX(5)                                                      BRZH0975
      FSX(10)=FSX(6)                                                     BRZH0980
      FSX(5)=FSX(3)                                                      BRZH0985
      FSX(6)=FSX(4)                                                      BRZH0990
      IDUMP2=0                                                           BRZH0995
      DO 371 I=1,10                                                      BRZH1000
      IF(I.GT.4.AND.I.LT.7.AND.KEY(1).LT.1)GO TO 371                     BRZH1005
      IF(I.GT.8.AND.KEY(3).LT.1)GO TO 371                                BRZH1010
      IF(FSX(I).LT.0..AND.IPLOT.NE.IPLOT)WRITE(IW,809)I                  BRZH1015
      IF(FSX(I).LT.0.)IDUMP2=1                                           BRZH1020
  371 CONTINUE                                                           BRZH1025
  809 FORMAT(5X,'COMPUTATIONS ARE STOPPED BECAUSE FSX(',                 BRZH1030
     1 I2,') IS NEGATIVE.')                                              BRZH1035
C*******                                                                 BRZH1040
C**THE TIRE FORCES ARE NOW CALCULATED                                    BRZH1045
      CALL TIRE(Y)                                                       BRZH1050
C                                                                        BRZH1055
C **  CALCULATION OF FIFTH WHEEL TORQUE  DUE TO STEEL ON STEEL CONTACT   BRZH1060
C                                                                        BRZH1065
C                                                                        BRZH1070
   14 IF (ABS(Y(8)) .GT. .03) GO TO 22                                   BRZH1075
      T=Y(8)/.03*((2.*MUS*D*W2*RADS)/(3.*(C+D)))                         BRZH1080
      GO TO 26)                                                          BRZH1085
   22 T=(Y(8)/ABS(Y(8)))*((2.*MUS*D*W2*RADS)/(3.*(C+D)))                 BRZH1090
C                                                                        BRZH1095
C ***********************************************************          BRZH1100
C     FROM HERE TO LINE BRZH1555 IS THE INITIAL BREEZE LOOP              BRZH1105
C ***********************************************************          BRZH1110
C                                                                        BRZH1115
C **  KKEY=1 IMPLIES BREEZE HITCH                                        BRZH1120
C                                                                        BRZH1125
  260 IF ( KKEY .NE. 1 ) GO TO 26                                        BRZH1130
C                                                                        BRZH1135
C **  KBREEZ=0 :  BREEZE HITCH UNLOCKED                                  BRZH1140
C **  KBREEZ=1 :  BREEZE HITCH LOCKED                                    BRZH1145
C                                                                        BRZH1150
C                                                                        BRZH1155
C **  BREEZE HITCH LOOP                                                  BRZH1160
C                                                                        BRZH1165
C **  TENSION IN THE CABLES ONLY                                         BRZH1170
C                                                                        BRZH1175
      IF (( Y(8)*Y(7)) .GT. 0.) GO TO 231                                BRZH1180
C                                                                        BRZH1185
C ** THE NEXT STATEMENT PREVENTS PHANTOM UNLOCK DUE                      BRZH1190
C ** TO HPCG INSPIRED Y(8) PETERRATIONS.  THE ONLY                       BRZH1195
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C ** WAY TO UNLOCK A LOCKED HITCH IS TO GO THROUGH                    BRZH1200
C ** THE LOOP, FIND TBREEZ .LT. 0, AND START OVER.                   BRZH1205
C ** SEE STATEMENT 394.4                                             BRZH1210
      IF ( KBREEZ .EQ. 1 ) GO TO 231                                 BRZH1215
C                                                                    BRZH1220
      TBREEZ=0.                                                      BRZH1225
      GO TO 26                                                       BRZH1230
C                                                                    BRZH1235
C ** COMPUTE THE PULL ANGLE ASSUMING SMALL ANGLES                    BRZH1240
  231 PHI=DD/E*Y(7)                                                  BRZH1245
C                                                                    BRZH1250
C ** SET THE CABLE TENSION, ASSUME NO LOCK                           BRZH1255
      TBREEZ=HITCHT*FSX(7)                                           BRZH1260
C                                                                    BRZH1265
      IF (ABS(PHI) .LT. THETA) GO TO 60                              BRZH1270
C                                                                    BRZH1275
C **  HANG FROM THE FRAME RAIL                                       BRZH1280
C                                                                    BRZH1285
      PHI=ATAN((DD*SIN(Y(7))+B5)/(DD*COS(Y(7))-A5))                  BRZH1290
C                                                                    BRZH1295
      SINPHI=SIN(PHI)                                                BRZH1300
      COSPHI=COS(PHI)                                                BRZH1305
C                                                                    BRZH1310
C ** COMPUTE THE FORCE DIRECTIONS IN THE TRAILER SYSTEM              BRZH1315
      TSPHI=SIN(PHI-Y(7))                                            BRZH1320
      TCPHI=COS(PHI-Y(7))                                            BRZH1325
C                                                                    BRZH1330
      BT1=A5*SINPHI+B5*COSPHI*PHI/ABS(PHI)                           BRZH1335
C                                                                    BRZH1340
C **  BT1 IS THE COEFFICIENT OF THE CABLE TENSION                    BRZH1345
C     APPEARING IN RIGHT HAND SIDE OF THE RDOT EQUATION,             BRZH1350
C     -BT1 IS THE COEFFICIENT IN THE GAMMADDOT EQUATION              BRZH1355
C     BT1*TBREEZ TURNS OUT TO BE THE MOMENT AROUND THE HITCH         BRZH1360
C                                                                    BRZH1365
      GO TO 61                                                       BRZH1370
C                                                                    BRZH1375
   60 CONTINUE                                                       BRZH1380
C                                                                    BRZH1385
C **  HANG FROM THE EYE                                              BRZH1390
C                                                                    BRZH1395
      SINPHI=SIN(PHI)                                                BRZH1400
      COSPHI=COS(PHI)                                                BRZH1405
      TSPHI=SIN(PHI-Y(7))                                            BRZH1410
      TCPHI=COS(PHI-Y(7))                                            BRZH1415
C                                                                    BRZH1420
      BT1=(A5+A6)*SINPHI                                             BRZH1425
C                                                                    BRZH1430
   61 CONTINUE                                                       BRZH1435
C                                                                    BRZH1440
      IF ( KBREEZ .EQ. 1 ) GO TO 62                                  BRZH1445
C                                                                    BRZH1450
      IF (ABS(Y(8)) .GT. 0.03 .OR. (DERX(4)*Y(8)) .LT. 0 ) GO TO 26  BRZH1455
C                                                                    BRZH1460
C **  ASSUME BREEZE HITCH LOCKED                                     BRZH1465
C     TBREEZ NOW REPLACES GAMMADDOT AS AN UNKNOWN                    BRZH1470
C     IN THE 4*4 OF ACCELERATIONS                                    BRZH1475
C                                                                    BRZH1480
C     REMEMBER TBREEZ IN CASE HITCH IS NOT REALLY LOCKED             BRZH1485
   62 TBAR=TBREEZ                                                    BRZH1490
C                                                                    BRZH1495
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C      GET RID OF TBREEZ FOR RHS EQUATIONS                                    BRZH1500
       TBREEZ=0.                                                              BRZH1505
       XY8=Y(8)                                                               BRZH1510
       Y(8)=0.                                                                BRZH1515
       KBREEZ=1                                                               BRZH1520
C                                                                             BRZH1525
C **   SET-UP NEW (4,4) TO SOLVE FOR TBREEZ                                   BRZH1530
C                                                                             BRZH1535
       AA(13)=0.                                                              BRZH1540
       AA(14)=0.                                                              BRZH1545
       AA(15)=-BT1                                                            BRZH1550
       AA(16)=BT1                                                             BRZH1555
C                                                                             BRZH1560
C ** INITIAL BREEZE HITCH LOOP FINISHED                                       BRZH1565
C                                                                             BRZH1570
C                                                                             BRZH1575
C **   COMPUTATION OF INERTIA FORCES AT CENTER OF MASS FOR TRACTOR AND         BRZH1580
C **   TRAILER, ALL AXLES  IN BOTH X AND Y COORDINATES                        BRZH1585
C                                                                             BRZH1590
   26 LAM1=(-M2*(DERX(1)-(Y(4)*Y(6))+(H*(Y(6)**2)))*COS(Y(7)))-(M2*(DERXBRZH1595
     1(2)+(Y(2)*Y(6))-(H*DERX(3)))*SIN(Y(7)))-(C*M2*(Y(6)+Y(8))**2)      BRZH1600
      LAM2=(M2*(DERX(1)-(Y(4)*Y(6))+(H*(Y(6)**2)))*SIN(Y(7)))-(M2*(DERX(BRZH1605
     12)+(Y(2)*Y(6))-(H*DERX(3)))*COS(Y(7)))+(C*M2*(DERX(3)+DERX(4)))    BRZH1610
      LAM3=(-M2*(DERX(1)-(Y(4)*Y(6))+(H*(Y(6)**2))))-(C*M2*(DERX(3)+DERXBRZH1615
     1(4))*SIN(Y(7)))-(C*M2*((Y(6)+Y(8))**2)*COS(Y(7)))                  BRZH1620
      LAM4=(-M2*(DERX(2)+(Y(2)*Y(6))-(H*DERX(3))))-(C*M2*((Y(6)+Y(8))**2BRZH1625
     1)*SIN(Y(7)))+(C*M2*(DERX(3)+DERX(4))*COS(Y(7)))                    BRZH1630
C*******                                                                      BRZH1635
C                                                                             BRZH1640
  370 IF (DKEY .EQ. 1.) GO TO 15                                              BRZH1645
       DKEY=1.                                                                BRZH1650
C                                                                             BRZH1655
C **   CALCULATION OF LATERAL LOAD TRANSFERS  NOTE, THESE ADD TO ZERO         BRZH1660
C ** NOTE DERX ARE THE LAGGED ACCELERATION VALUES                             BRZH1665
C ** AND XBREEZ IS THE LAGGED CABLE TENSION                                   BRZH1670
C                                                                             BRZH1675
   37 FX7891=FX(7)+FX(8)+FX(9)+FX(10)                                         BRZH1680
      FY7891=FY(7)+FY(8)+FY(9)+FY(10)                                         BRZH1685
      YTEMP=(FX7891)*SIN(Y(7))+(FY7891)*COS(Y(7))+XBREEZ*SINPHI               BRZH1690
      YL=LAM4+YTEMP                                                           BRZH1695
      ZTS=ZBREEZ*XBREEZ*SINPHI                                                BRZH1700
      DELFZ(1)=(GAM1/(2.*T1))*((-Z0*YL)+Z1*M1*(DERX(2)+Y(2)*                  BRZH1705
     &Y(6))+ZTS)                                                              BRZH1710
      DELFZ(2)=-DELFZ(1)                                                      BRZH1715
      DELFZ(3)=(GAM2/(2.*T2))*((-Z0*YL)+Z1*M1*(DERX(2)+Y(2)*                  BRZH1720
     &Y(6))+ZTS)                                                              BRZH1725
      IF(KEY(1).LT.1)GO TO 3004                                               BRZH1730
      DELFZ(3)=DELFZ(3)/2.                                                    BRZH1735
      DELFZ(5)=DELFZ(3)                                                       BRZH1740
      DELFZ(6)=-DELFZ(3)                                                      BRZH1745
 3004 DELFZ(4)=-DELFZ(3)                                                      BRZH1750
      DELFZ(7)=(-(Z2-ZM)*LAM2+Z0*FY7891+(Z0-ZBREEZ)*XBREEZ*TSPHI)             BRZH1755
     &/(2.*T3)                                                                BRZH1760
      IF(KEY(3).LT.1)GO TO 3005                                               BRZH1765
      DELFZ(7)=DELFZ(7)/2.                                                    BRZH1770
      DELFZ(9)=DELFZ(7)                                                       BRZH1775
      DELFZ(10)=-DELFZ(7)                                                     BRZH1780
 3005 DELFZ(8)=-DELFZ(7)                                                      BRZH1785
C                                                                             BRZH1790
C **   COMPUTATION OF LONGITUDINAL LOAD TRANSFERS  NOTE, SUM IS ZERO          BRZH1795
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C  **  THESE EQUATIONS MAY VARY FROM SOURCE EQUATIONS,                    BRZH1800
C                                                                        BRZH1805
      XTEMP=(FX7891)*COS(Y(7))-(FY7891)*SIN(Y(7))+XBREEZ*COSPHI          BRZH1810
      XL=LAM3+XTEMP                                                      BRZH1815
C                                                                        BRZH1820
C ** DZ IS THE DYNAMIC LOAD TRANSFERRED ON TO  THE HITCH                 BRZH1825
      DZ=(Z2*LAM1-Z0*(XL*COS(Y(7))+YL*SIN(Y(7)))+XBREEZ                  BRZH1830
     &*ZBREEZ*TOPHI)/(C+D)                                               BRZH1835
      DFZ(1)=(1./(2.*(A+B)))*((B-H)*DZ-M1*(DERX(1)-Y(4)*Y(6))*Z1+XL*Z0   BRZH1840
     &-XBREEZ*ZBREEZ*COSPHI)                                             BRZH1845
      DFZ(2)=DFZ(1)                                                      BRZH1850
      DFZ(3)=DZ*(A+H)/(A+B)-DFZ(1)                                       BRZH1855
      IF(KEY(1).LT.1)GO TO 3002                                          BRZH1860
      DFZ(3)=DFZ(3)/2.                                                   BRZH1865
      DFZ(5)=DFZ(3)                                                      BRZH1870
      DFZ(6)=DFZ(3)                                                      BRZH1875
 3002 DFZ(4)=DFZ(3)                                                      BRZH1880
      IF(KEY(1).LT.1)GO TO 3006                                          BRZH1885
      DFZ(3)=DFZ(3)-GAM3*(FX(3)+FX(5))                                   BRZH1890
      DFZ(4)=DFZ(4)-GAM3*(FX(4)+FX(6))                                   BRZH1895
      DFZ(5)=DFZ(5)+GAM3*(FX(3)+FX(5))                                   BRZH1900
      DFZ(6)=DFZ(6)+GAM3*(FX(4)+FX(6))                                   BRZH1905
 3006 CONTINUE                                                           BRZH1910
      DFZ(7)=-DZ/2.                                                      BRZH1915
      IF(KEY(3).LT.1)GO TO 3003                                          BRZH1920
      DFZ(7)=DFZ(7)/2.                                                   BRZH1925
      DFZ(9)=DFZ(7)                                                      BRZH1930
      DFZ(10)=DFZ(7)                                                     BRZH1935
 3003 DFZ(8)=DFZ(7)                                                      BRZH1940
      IF(KEY(3).LT.1)GO TO 3008                                          BRZH1945
      DFZ(7)=DFZ(7)-GAM4*(FX(7)+FX(9))                                   BRZH1950
      DFZ(8)=DFZ(8)-GAM4*(FX(8)+FX(10))                                  BRZH1955
      DFZ(9)=DFZ(9)+GAM4*(FX(7)+FX(9))                                   BRZH1960
      DFZ(10)=DFZ(10)+GAM4*(FX(8)+FX(10))                                BRZH1965
 3008 CONTINUE                                                           BRZH1970
C                                                                        BRZH1975
C **  COMPUTATION OF INSTANTANEOUS LOADS                                 BRZH1980
C                                                                        BRZH1985
      IDUMP=0                                                            BRZH1990
      DO 30 I=1,10                                                       BRZH1995
      DUAL=0.0                                                           BRZH2000
      IF(I.GT.2.AND.I.LT.7.AND.KEY(2).GT.0)DUAL=1.0                      BRZH2005
      IF(I.GT.6.AND.KEY(4).GT.0)DUAL=1.0                                 BRZH2010
      FZ(I)=(FRZ(I)+DFZ(I)+DELFZ(I))/(1.+DUAL)                           BRZH2015
      IF(I.GT.4.AND.I.LT.7.AND.KEY(1).LT.1)GO TO 30                      BRZH2020
      IF(I.GT.8.AND.KEY(3).LT.1)GO TO 30                                 BRZH2025
      IF(FZ(I).LT.0..AND.IW.NE.IPLOT)WRITE(IW,810)I                      BRZH2030
      IF(FZ(I).LT.0.)IDUMP=1                                             BRZH2035
   30 CONTINUE                                                           BRZH2040
      IF(IDUMP2.EQ.1)IDUMP=1                                             BRZH2045
  810 FORMAT(5X,'COMPUTATIONS ARE STOPPED BECAUSE WHEEL ',I2,            BRZH2050
     1 ' LIFTS OFF GROUND.')                                             BRZH2055
C                                                                        BRZH2060
C  **  USING THE ABOVE CALCULATIONS, PROCEED TO EVALUATE NEW DERIVATIVE  BRZH2065
C  **  VALUES FOR Y AT TIME INTERVAL X                                   BRZH2070
C  **  DERY(1) IS THE SPEED IN THE INERTIAL AXIS,X DIRECTION...Y(2) IS   BRZH2075
C  **  THE SPEED IN THE BODY AXIS X DIRECTION,   DERY(3) IS THE SPEED    BRZH2080
C  **  IN THE INERTIAL AXIS,Y DIRECTION...Y(4) IS THE SPEED IN THE BODY  BRZH2085
C  **  AXIS Y DIRECTION,                                                 BRZH2090
C  **  Y(1)=XO          DERY(1)=XO-DOT                                   BRZH2095
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C   **  Y(2)=U              DERY(2)=U-DOT                                    BRZH2100
C   **  Y(3)=YA             DERY(3)=YA-DOT                                   BRZH2105
C   **  Y(4)=V              DERY(4)=V-DOT                                    BRZH2110
C   **  Y(5)=PSI            DERY(5)=PSIDOT                                   BRZH2115
C   **  Y(6)=PSIDOT         DERY(6)=PSI-DDOT                                 BRZH2120
C   **  Y(7)=GAMMA          DERY(7)=GAMMADOT                                 BRZH2125
C   **  Y(8)=GAMMADOT       DERY(8)=GAMMA-DDOT                               BRZH2130
C                                                                            BRZH2135
   15 CONTINUE                                                               BRZH2140
C                                                                            BRZH2145
C   **  THESE LAM VALUES HAVE DERX(I) REMOVED FROM ABOVE (STATEMENT 26)      BRZH2150
C   **  LAM VALUES.  THEY FORM PART OF THE BB VECTOR IN AA*X=BB EQUATION     BRZH2155
C   **  WHICH WILL BE SOLVED BY SIMQ                                         BRZH2160
C                                                                            BRZH2165
      LAM2 = M2*((-Y(4)*Y(6) + H*Y(6)**2)* SIN(Y(7)) - Y(2)*Y(6)*            BRZH2170
     1COS(Y(7)))                                                            BRZH2175
      LAM3 =-M2*((-Y(4)*Y(6) + H*Y(6)**2) + C*(Y(6) + Y(8))**2*              BRZH2180
     1COS(Y(7)))                                                            BRZH2185
      LAM4 = -M2*(Y(2)*Y(6) + C*(Y(6) + Y(8))**2*SIN(Y(7)))                  BRZH2190
C                                                                            BRZH2195
C   **  THE RHS VALUES ARE THE RIGHT HAND SIDE OF THE LEUCHT EQUATIONS       BRZH2200
C   **  AS SHOWN IN THE THESIS                                               BRZH2205
C                                                                            BRZH2210
   41 FX3456=FX(3)+FX(4)+FX(5)+FX(6)                                         BRZH2215
      FY3456=FY(3)+FY(4)+FY(5)+FY(6)                                         BRZH2220
      F35M46=FX(3)+FX(5)-FX(4)-FX(6)                                         BRZH2225
      F79M81=FX(7)+FX(9)-FX(8)-FX(10)                                        BRZH2230
      RHS1   =(Y(4)*Y(6))+(1/M1)*(LAM3+(FX(1)+FX(2))*COS(DELTA)              BRZH2235
     1 +(FX3456)+((FX7891)*COS(Y(7)))-((FY(1)+FY(2))*SIN(DELTA))             BRZH2240
     2 -((FY7891)*SIN(Y(7))))                                                BRZH2245
   42 RHS2   =-(Y(2)*Y(6))+(1/M1)*(LAM4+((FX(1)+FX(2))*SIN(DELTA))           BRZH2250
     1 +(FX7891)*SIN(Y(7))+(FY(1)+FY(2))*COS(DELTA)+(FY3456)+(FY7891)        BRZH2255
     2 *COS(Y(7)))                                                           BRZH2260
      RHS3   =(1/I1)*((-H*LAM4)+(A*(FX(1)+FX(2))*SIN(DELTA))                 BRZH2265
     4 +(T1*(FX(1)-FX(2)                                                     BRZH2270
     1)*COS(DELTA))+(T2*(F35M46))-(H*(FX7891)*SIN(Y(7)))+(A*(FY(1)+FY(2)     BRZH2275
     2)*COS(DELTA))-(T1*(FY(1)-FY(2))*SIN(DELTA))                            BRZH2280
     3 -((B-AAA/2.)*(FY(3)+FY(4))+(B+AAA/2.)*(FY(5)+FY(6)))                  BRZH2285
     4 -(H*(FY7891)*COS(Y(7)))+T+BT1*TBREEZ)                                 BRZH2290
      RHS4   =(1/I2)*(-C*LAM2+T3*(F79M81)                                    BRZH2295
     2 -((C+D-AAT/2.)*(FY(7)+FY(8))+(C+D+AAT/2.)*(FY(9)+FY(10)))-T           BRZH2300
     3 -BT1*TBREEZ)                                                          BRZH2305
C                                                                            BRZH2310
   43 BB(1)=RHS1*M1                                                          BRZH2315
      BB(2)=RHS2*M1                                                          BRZH2320
      BB(3)=RHS3*I1                                                          BRZH2325
      BB(4)=RHS4*I2                                                          BRZH2330
C                                                                            BRZH2335
C   **  SIMQ SOLVES THE AA*X=BB EQUATIONS FOR THE ACCELERATIONS              BRZH2340
C   **  SEE SUBROUTINE SIMQ FOR DETAILS.  NOTE SIMQ RETURNS THE SOLUTION     BRZH2345
C   **  IN THE BB VECTOR, AND THE AA MATRIX IS DESTROYED.                    BRZH2350
C                                                                            BRZH2355
  528 CALL SIMQ(AA,BB,4,KS)                                                  BRZH2360
C                                                                            BRZH2365
C   **  CALCULATE THE DERIVATIVES                                            BRZH2370
      DO 1 I = 1,4                                                           BRZH2375
1     DERY(2*I) = BB(I)                                                      BRZH2380
      DERY(5)=Y(6)                                                           BRZH2385
      DERY(7)=Y(8)                                                           BRZH2390
      DERY(1)=Y(2)*COS(Y(5))-Y(4)*SIN(Y(5))                                  BRZH2395
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      DERY(3)=Y(2)*SIN(Y(5))+Y(4)*COS(Y(5))                          BRZH2400
C                                                                    BRZH2405
C                                                                    BRZH2410
C ***************************************************************  BRZH2415
C     FROM HERE TO LINE BRZH2700 IS THE SECOND BREEZE LOOP           BRZH2420
C ***************************************************************  BRZH2425
C                                                                    BRZH2430
      IF ( KKEY .EQ. 0 ) GO TO 3                                     BRZH2435
C                                                                    BRZH2440
C **  BREEZE HITCH LOCK?????????                                     BRZH2445
C                                                                    BRZH2450
      IF (KBREEZ .EQ. 0) GO TO 3                                     BRZH2455
C                                                                    BRZH2460
C ** HERE WE CALCULATE DERIVATIVES AND TBREEZ IF HITCH IS LOCKED     BRZH2465
C                                                                    BRZH2470
C **  ASSUME BREEZE HITCH LOCK                                       BRZH2475
      DERY(8)=0.                                                     BRZH2480
      TBREEZ=BB(4)                                                   BRZH2485
C                                                                    BRZH2490
C ** HITCH SHOULD BE UNLOCKED IF GAMMA WANTS TO GET SMALLER          BRZH2495
      IF ( BB(4) .LT. 0. .AND. KBREEZ .EQ. 1 ) GO TO 87241           BRZH2500
C                                                                    BRZH2505
C ** CHECK FOR TENSION FOR BEYOND CAPACITY                           BRZH2510
      IF ((BB(4)) .LT. (TBAR+0.1) ) GO TO 3                          BRZH2515
C                                                                    BRZH2520
C **  BAD ASSUMPTION, NOT ENOUGH TO KEEP HITCH LOCKED                BRZH2525
      TBREEZ=TBAR                                                    BRZH2530
      GO TO 87242                                                    BRZH2535
C                                                                    BRZH2540
87241 TBREEZ=0.                                                      BRZH2545
C                                                                    BRZH2550
87242 KBREEZ=0                                                       BRZH2555
      Y(8)=XY8                                                       BRZH2560
C                                                                    BRZH2565
C                                                                    BRZH2570
C **  GO BACK TO ORIGINAL (4,4)                                      BRZH2575
      AA(1) = M1 + M2                                                BRZH2580
      AA(2) = 0.0                                                    BRZH2585
      AA(3) = 0.0                                                    BRZH2590
      AA(4)= C*M2*SIN(Y(7))                                          BRZH2595
      AA(5) = 0.0                                                    BRZH2600
      AA(6) = M1 + M2                                                BRZH2605
      AA(7)= -H*M2                                                   BRZH2610
      AA(8) = -C*M2*COS(Y(7))                                        BRZH2615
      AA(9)= C*M2*SIN(Y(7))                                          BRZH2620
      AA(10)=-M2*(H + C*COS(Y(7)))                                   BRZH2625
      AA(11)= M2*(H*H + C*H*COS(Y(7))) +I1                           BRZH2630
      AA(12) = I2 +C*M2*(C+H*COS(Y(7)))                              BRZH2635
      AA(13)= C*M2*SIN(Y(7))                                         BRZH2640
      AA(14)= -C*M2*COS(Y(7))                                        BRZH2645
      AA(15)= H*C*M2*COS(Y(7))                                       BRZH2650
      AA(16) = I2 + C*C*M2                                           BRZH2655
C                                                                    BRZH2660
C **  FIX UP RHS TO INCLUDE TBREEZ                                   BRZH2665
      RHS1=RHS1-TBREEZ*COSPHI/M1                                     BRZH2670
      RHS2=RHS2-TBREEZ*SINPHI/M1                                     BRZH2675
      RHS3=RHS3+BT1*TBREEZ/I1                                        BRZH2680
      RHS4=RHS4+BT2*TBREEZ/I2                                        BRZH2685
C                                                                    BRZH2690
C **  GO BACK TO SIMQ TO FIND GAMMADOT                               BRZH2695
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      GO TO 43                                                          BRZH2700
C                                                                       BRZH2705
C ** SECOND BREEZE HITCH LOOP FINISHED                                  BRZH2710
C                                                                       BRZH2715
C                                                                       BRZH2720
C **  THESE CALCULATIONS GIVE THE HITCH FORCES USING DERY RATHER THAN DEBRZH2725
C                                                                       BRZH2730
    3 LAM3=LAM3-M2*(DERY(2)+C*(DERY(6)+DERY(8))*SIN(Y(7)))              BRZH2735
      LAM4=LAM4-M2*(DERY(4)-M*DERY(6)-C*(DERY(6)+DERY(8))*COS(Y(7)))    BRZH2740
      XL=LAM3+XTEMP+TBREEZ*COSPHI                                       BRZH2745
      YL=LAM4+YTEMP+TBREEZ*SINPHI                                       BRZH2750
C                                                                       BRZH2755
C **  DERY ARRAY NOW CONTAINS ALL NEW VALUES AT TIME STEP X             BRZH2760
C **  SUBROUTINE FINISHED RETURN TO HPCG                                BRZH2765
525   CONTINUE                                                          BRZH2770
      RETURN                                                            BRZH2775
      END                                                               BRZH2780
C                                                                       BRZH2785
C                                                                       BRZH2790
C                                                                       BRZH2795
C                                                                       BRZH2800
C  ************************************************************         BRZH2805
      SUBROUTINE INPUT(Y,DERY,PRMT,NDIM)                                BRZH2810
C  ************************************************************         BRZH2815
      DIMENSION Y(8),PRMT(5),AUX(16,8),DERY(8),CIA(10),FZ(10),FSX(10),  BRZH2820
     1          DFZ(10),DELFZ(10),FX(10),FY(10),PAR(40),PAR2(3)         BRZH2825
      REAL MU,MUS,M1,M2,I1,I2,MUS,MUT(10),MUSLOP,IQUIT                  BRZH2830
      INTEGER COR(25)                                                   BRZH2835
      COMMON    W1,W2,M1,M2,A,B,C,D,H,Z0,Z1,Z2,GAM1,GAM2,MUS,RADS,DELTA,BRZH2840
     1          T1,T2,T3,CIA,FSX,FZ,INIT,I1,I2,DERX(4),FRZ(10),ALPHA(10)BRZH2845
     2          ,WINX,FY,DFZ,DELFZ,TIME,FX,OKEY,VEL,AAA,AAT,KEY(4),     BRZH2850
     3          MU(10),ANTEFF(10,2),IDUMP,XDUMP,XDOFF,MUS(10),KEYANT(3),BRZH2855
     5          MUSLOP(10),BET(15,7),ITAB,IXON,ITABS,STEER(25,2),ISAV,  BRZH2860
     6          GAM3,GAM4,TRUCK,IQUIT                                  BRZH2865
      COMMON    /IO/IR,IW                                               BRZH2870
      COMMON    /BREEZ/TBREEZ,XBREEZ,HITCHT,DD,E,THETA,A5,A6,B5,ACM     BRZH2875
      COMMON    /KBREZ/KBREEZ,ZBREEZ,KKEY                               BRZH2880
      DATA      YES/'Y'/                                                BRZH2885
      DATA      IFLAG,ONCE,MUSLIP/0,0,.3/                               BRZH2890
C                                                                       BRZH2895
C  **  READY TO START                                                   BRZH2900
C                                                                       BRZH2905
C                                                                       BRZH2910
      NF=0                                                              BRZH2915
      IE=0                                                              BRZH2920
      IREP=0                                                            BRZH2925
      IF (TRUCK .EQ. 1) IREP=1                                          BRZH2930
      IF (IREP .EQ. 1) GO TO 1                                          BRZH2935
      WRITE(IW,90)                                                      BRZH2940
   90 FORMAT('1','YOU ARE ABOUT TO RUN THE HSRI SIMULATION PROGRAM FOR'/BRZH2945
     1' ','A TRACTOR-TRAILER WITH BREEZE HITCH IN THE HORIZONTAL PLANE')BRZH2950
      IBREZ=0                                                           BRZH2955
11000 FORMAT('0PRINT PROGRAM EXPLANATIONS? (Y OR N):')                  BRZH2960
11002 WRITE(IW,11000)                                                   BRZH2965
11003 READ(IR,92) ANS                                                   BRZH2970
11004 ISHOW=0                                                           BRZH2975
11005 IF(ANS .EQ. YES) ISHOW=1                                          BRZH2980
11006 IF(ISHOW .EQ. 1) CALL EXPLAN(1,ISHOW)                             BRZH2985
      GO TO 2                                                           BRZH2990
    1 WRITE(IW,91)                                                      BRZH2995
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   91 FORMAT('$','STOP?')                                                BRZH3000
11013 IF(ISHOW .EQ. 1) CALL EXPLAN(7,ISHOW)                              BRZH3005
      READ(IR,92) ANS                                                    BRZH3010
   92 FORMAT(A1)                                                         BRZH3015
      IF (ANS .NE. YES) GO TO 2                                          BRZH3020
      TRUCK=0.0                                                          BRZH3025
      RETURN                                                             BRZH3030
    2 TRUCK=1.0                                                          BRZH3035
      ISAV=1                                                             BRZH3040
      IXON=1                                                             BRZH3045
    4 DKEY=0.                                                            BRZH3050
      IF (IHEP .EQ. 1) GO TO 200                                         BRZH3055
      WRITE(IW,400)                                                      BRZH3060
  400 FORMAT('$','LIST INPUT PARAMETERS?')                               BRZH3065
11007 IF(ISHOW .EQ. 1) CALL EXPLAN(2,ISHOW)                              BRZH3070
      READ(IR,92) ANS                                                    BRZH3075
      IF (ANS .EQ. YES) NF=1                                             BRZH3080
      WRITE(IW,98)                                                       BRZH3085
   98 FORMAT('$','READ DATA FROM FILE?')                                 BRZH3090
      READ(IR,92) ANS                                                    BRZH3095
      IF (ANS .NE. YES) GO TO 37                                         BRZH3100
      WRITE(IW,38)                                                       BRZH3105
   38 FORMAT('$','ENTER INPUT DEVICE NUMBER IN I2 FORMAT:')              BRZH3110
      READ(IR,39) IDATA                                                  BRZH3115
   39 FORMAT(I2)                                                         BRZH3120
      IE=1                                                               BRZH3125
      IDATA1=IR                                                          BRZH3130
      IR=IDATA                                                           BRZH3135
   37 WRITE(IW,99)                                                       BRZH3140
   99 FORMAT('0','*** BEGIN INPUT ***')                                  BRZH3145
      PAR(5)=0.                                                          BRZH3150
      PAR(6)=0.                                                          BRZH3155
      PAR(21)=0.                                                         BRZH3160
      PAR(22)=0.                                                         BRZH3165
      PAR(26)=0.                                                         BRZH3170
      PAR(27)=0.                                                         BRZH3175
      PAR(28)=0.                                                         BRZH3180
      PAR2(1)=0.                                                         BRZH3185
      PAR2(2)=0.                                                         BRZH3190
      PAR2(3)=0.                                                         BRZH3195
      IF ( NF .EQ. 1) GO TO 402                                          BRZH3200
      READ(IR,3002)(KEYANT(I),I=1,3)                                     BRZH3205
 3002 FORMAT(3I1)                                                        BRZH3210
      READ(IR,3001)(KEY(I),I=1,4)                                        BRZH3215
 3001 FORMAT(4I1)                                                        BRZH3220
      PAR(19)=10.                                                        BRZH3225
      DO 403 I=1,40                                                      BRZH3230
      IF(I .EQ. 19 .AND. PAR(18) .EQ. 0) GO TO 403                       BRZH3235
      IF(I.EQ.5.AND.KEY(1).LT.1)GO TO 403                                BRZH3240
      IF(I.EQ.6.AND.KEY(3).LT.1)GO TO 403                                BRZH3245
      IF(I.EQ.21.AND.KEY(1).LT.1)GO TO 403                               BRZH3250
      IF(I.EQ.22.AND.KEY(3).LT.1)GO TO 403                               BRZH3255
      IF(I.GT.25.AND.I.LT.29)GO TO 409                                   BRZH3260
      ANS=NO                                                             BRZH3265
      IF(I.EQ.32)READ(IR,92)ANS                                          BRZH3270
      IF(ANS.EQ.YES)MUSLIP=1                                             BRZH3275
      IF(MUSLIP.GT.0)GO TO 410                                           BRZH3280
      READ(IR,103) PAR(I)                                                BRZH3285
      GO TO 403                                                          BRZH3290
  410 READ(IR,103)PAR(32)                                                BRZH3295
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      READ(IR,103)PAR(35)                                                    BRZH3300
      READ(IR,103)PAR(38)                                                    BRZH3305
      GO TO 404                                                              BRZH3310
  409 J=I-25                                                                 BRZH3315
      IF(KEYANT(J).GT.0)READ(IR,140)PAR(I),PAR2(J)                           BRZH3320
  403 CONTINUE                                                               BRZH3325
      GO TO 404                                                              BRZH3330
  402 CONTINUE                                                               BRZH3335
      WRITE(IW,4001)                                                         BRZH3340
11008 IF(ISHOW .EQ. 1) CALL EXPLAN(3,ISHOW)                                  BRZH3345
      READ(IR,3002)(KEYANT(I),I=1,3)                                         BRZH3350
      IF(IE.EQ.1)WRITE(IW,5002)(KEYANT(I),I=1,3)                             BRZH3355
      WRITE(IW,4002)                                                         BRZH3360
      READ(IR,3001)(KEY(I),I=1,4)                                            BRZH3365
      IF(IE.EQ.1)WRITE(IW,5001)(KEY(I),I=1,4)                                BRZH3370
 4001 FORMAT(' 41 ENTER ANTILOCK CODE FOR TRACTOR FRONT, TRACTOR REAR,'/     BRZH3375
     1 '      AND TRAILER AXLES.'/                                          BRZH3380
     2 '      0=NO ANTILOCK,  1=INDEPENDENT ANTILOCK,  FORMAT=3I1.')        BRZH3385
 4002 FORMAT(' 42 ENTER CODE FOR TANDEM AXLES TRACTOR REAR, DUAL TIRES'/     BRZH3390
     1 '      TRACTOR REAR, TANDEM AXLES TRAILER, DUAL TIRES TRAILER'/      BRZH3395
     2 '      0=NO,  1=YES,  FORMAT=4I1.')                                  BRZH3400
 5001 FORMAT(1X,4I1)                                                        BRZH3405
 5002 FORMAT(1X,3I1)                                                        BRZH3410
      WRITE(IW,101)                                                         BRZH3415
      PAR(19)=10.                                                           BRZH3420
      LAPOU=0                                                               BRZH3425
      DO 70 I=1,40                                                          BRZH3430
      IF(I .EQ. 19 .AND. PAR(18) .EQ. 0.) GO TO 70                          BRZH3435
      IF(I.EQ.5.AND.KEY(1).LT.1)GO TO 70                                    BRZH3440
      IF(I.EQ.6.AND.KEY(3).LT.1)GO TO 70                                    BRZH3445
      IF(I.EQ.21.AND.KEY(1).LT.1)GO TO 70                                   BRZH3450
      IF(I.EQ.22.AND.KEY(3).LT.1)GO TO 70                                   BRZH3455
11009 IF(I .EQ. 29 .AND. ISHOW .EQ. 1) CALL EXPLAN(4,ISHOW)                 BRZH3460
      IF(I.NE.32)GO TO 7600                                                 BRZH3465
      IF(IE.EQ.2)WRITE(IW,9001)                                             BRZH3470
 9001 FORMAT('&DO ALL TIRES HAVE THE SAME MU-SLIP CURVE?')                  BRZH3475
      READ(IR,92)ANS                                                        BRZH3480
      IF(ANS.NE.YES)GO TO 7601                                              BRZH3485
      MUSLIP=1                                                              BRZH3490
      CALL WRITEX(32)                                                       BRZH3495
      READ(IR,103)PAR(32)                                                   BRZH3500
      IF(IE.EQ.1)WRITE(IW,104)PAR(32)                                       BRZH3505
      CALL WRITEX(35)                                                       BRZH3510
      READ(IR,103)PAR(35)                                                   BRZH3515
      IF(IE.EQ.1)WRITE(IW,104)PAR(35)                                       BRZH3520
      CALL WRITEX(38)                                                       BRZH3525
      READ(IR,103)PAR(38)                                                   BRZH3530
      IF(IE.EQ.1)WRITE(IW,104)PAR(38)                                       BRZH3535
      GO TO 404                                                             BRZH3540
 7600 CONTINUE                                                              BRZH3545
      J=I-25                                                                BRZH3550
      IF(I.LT.26.OR.I.GT.28)GO TO 7601                                      BRZH3555
      IF(KEYANT(J).LT.1)GO TO 70                                            BRZH3560
11029 IF(LAPOU .NE. 0) GO TO 11031                                          BRZH3565
11030 IF(ISHOW .EQ. 1) CALL EXPLAN(9,ISHOW)                                 BRZH3570
11031 LAPOU=1                                                               BRZH3575
 7601 CONTINUE                                                              BRZH3580
      CALL WRITEX(I)                                                        BRZH3585
      IF (IE .EQ. 1) GO TO 71                                               BRZH3590
      IF(I.GT.25.AND.I.LT.29)GO TO 7008                                     BRZH3595
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      READ(IR,103) PAR(I)                                              BRZH3600
      GO TO 7010                                                       BRZH3605
 7008 J=I-25                                                           BRZH3610
      READ(IR,140)PAR(I),PAR2(J)                                       BRZH3615
 7010 CONTINUE                                                         BRZH3620
      GO TO 72                                                         BRZH3625
   71 CONTINUE                                                         BRZH3630
      IF(I.GT.25.AND.I.LT.29)GO TO 7150                                BRZH3635
      READ(IR,103) PAR(I)                                              BRZH3640
      GO TO 7102                                                       BRZH3645
 7150 J=I-25                                                           BRZH3650
      READ(IR,140)PAR(I),PAR2(J)                                       BRZH3655
 7102 CONTINUE                                                         BRZH3660
      IF(I.GT.25.AND.I.LT.29)GO TO 7199                                BRZH3665
      WRITE(IW,104) PAR(I)                                             BRZH3670
      GO TO 72                                                         BRZH3675
 7199 WRITE(IW,105)PAR(I),PAR2(J)                                      BRZH3680
   72 CONTINUE                                                         BRZH3685
      IF (I .NE. 23) GO TO 70                                          BRZH3690
      VEL=PAR(23)*5280./3600.                                          BRZH3695
      WRITE(IW,126) VEL                                                BRZH3700
   70 CONTINUE                                                         BRZH3705
C                                                                      BRZH3710
C  ** BRAKE FORCE TABLE                                                BRZH3715
C                                                                      BRZH3720
  404 CONTINUE                                                         BRZH3725
      DO 1700 I=1,15                                                   BRZH3730
      DO 1700 J=1,7                                                    BRZH3735
 1700 BFT(I,J)=0.0                                                     BRZH3740
C                                                                      BRZH3745
C  **  READ IN TABLE                                                   BRZH3750
C                                                                      BRZH3755
      IF (NE .EQ. 1) GO TO 405                                         BRZH3760
      READ(IR,137) ITAB                                                BRZH3765
      DO 406 I=1,ITAB                                                  BRZH3770
      READ(IR,140) (BFT(I,J),J=1,7)                                    BRZH3775
  406 CONTINUE                                                         BRZH3780
      GO TO 11                                                         BRZH3785
  405 CONTINUE                                                         BRZH3790
11011 IF(ISHOW .EQ. 1) CALL EXPLAN(5,ISHOW)                            BRZH3795
      WRITE(IW,135)                                                    BRZH3800
      READ(IR,137) ITAB                                                BRZH3805
      IF(IE.EQ.1) WRITE(IW,136) ITAB                                   BRZH3810
      WRITE(IW,138)                                                    BRZH3815
      DO 62 I=1,ITAB                                                   BRZH3820
      READ (IR,140) (BFT(I,J),J=1,7)                                   BRZH3825
      IF(IE.EQ.1) WRITE(IW,139) (BFT(I,J),J=1,7)                       BRZH3830
   62 CONTINUE                                                         BRZH3835
      IF (IE .EQ. 1) GO TO 11                                          BRZH3840
      WRITE(IW,142)                                                    BRZH3845
  142 FORMAT('$','ECHO TABLE?')                                        BRZH3850
      READ(IR,92) ANS                                                  BRZH3855
      IF(ANS.NE.YES)GO TO 11                                           BRZH3860
      WRITE(IW,138)                                                    BRZH3865
      DO 12 I=1,ITAB                                                   BRZH3870
   12 WRITE(IW,139)(BFT(I,J),J=1,7)                                    BRZH3875
   11 CONTINUE                                                         BRZH3880
C                                                                      BRZH3885
C  **  STEER TABLE                                                     BRZH3890
C                                                                      BRZH3895
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      DO 1410 I=1,25                                                    BRZH3900
      DO 1410 J=1,2                                                     BRZH3905
 1410 STEER(I,J)=0.0                                                    BRZH3910
      IF(NF.EQ.1)GO TO 1405                                             BRZH3915
      READ(IR,137)ITABS                                                 BRZH3920
      DO 1406 I=1,ITABS                                                 BRZH3925
      READ(IR,1140)(STEER(I,J),J=1,2)                                   BRZH3930
 1406 CONTINUE                                                          BRZH3935
 1140 FORMAT(2F10.0)                                                    BRZH3940
      GO TO 200                                                         BRZH3945
 1405 CONTINUE                                                          BRZH3950
11012 IF(ISHOW .EQ. 1) CALL EXPLAN(6,ISHOW)                             BRZH3955
      WRITE(IW,1135)                                                    BRZH3960
 1135 FORMAT(///T10,'STEER TABLE'/'&      NUMBER OF LINES:  ')         BRZH3965
      READ(IR,137)ITABS                                                 BRZH3970
      IF(IE.EQ.1) WRITE(IW,136)ITABS                                    BRZH3975
      WRITE(IW,1138)                                                    BRZH3980
 1138 FORMAT('0',T4,'TIME',T13,'STEER ANGLE'/T4,'(SEC)',T16,'(DEG)'/)   BRZH3985
      DO 1062 I=1,ITABS                                                 BRZH3990
      READ(IR,1140)(STEER(I,J),J=1,2)                                   BRZH3995
      IF(IE.EQ.1) WRITE(IW,1039)(STEER(I,J),J=1,2)                      BRZH4000
 1062 CONTINUE                                                          BRZH4005
      IF(IE.EQ.1)GO TO 1011                                             BRZH4010
      WRITE(IW,142)                                                     BRZH4015
      READ(IR,92)ANS                                                    BRZH4020
      IF(ANS.NE.YES)GO TO 1011                                          BRZH4025
      WRITE(IW,1138)                                                    BRZH4030
      DO 1012 I=1,ITABS                                                 BRZH4035
 1012 WRITE(IW,1039)(STEER(I,J),J=1,2)                                  BRZH4040
 1039 FORMAT(' ',F10.4,F10.2)                                           BRZH4045
 1011 CONTINUE                                                          BRZH4050
C                                                                       BRZH4055
C  **  END OF INPUT                                                     BRZH4060
C                                                                       BRZH4065
  200 CONTINUE                                                          BRZH4070
      IF (IE .EQ. 1) IR=IDATA1                                          BRZH4075
      WRITE(IW,215)                                                     BRZH4080
  205 FORMAT('0','CHANGE PARAMETERS?')                                  BRZH4085
      READ(IR,92) ANS                                                   BRZH4090
      IF (ANS .EQ. YES) GO TO 300                                       BRZH4095
      GO TO 22131                                                       BRZH4100
  300 IE=0                                                              BRZH4105
      IREP=1                                                            BRZH4110
  207 FORMAT(24(I2,1X))                                                 BRZH4115
 2000 FORMAT('0','*** ERROR, OUT OF RANGE ***')                         BRZH4120
      WRITE(IW,208)                                                     BRZH4125
  208 FORMAT('0','ENTER PARAMETER NUMBER TO BE CHANGED',                BRZH4130
     1 ' (01-42)')                                                      BRZH4135
  210 READ(IR,207)ICOR                                                  BRZH4140
      IF(ICOR.LT.1)GO TO 22131                                          BRZH4145
      IF (ICOR .GT. 42) WRITE(IW,2000)                                  BRZH4150
      IF (ICOR .GT. 42) GO TO 211                                       BRZH4155
      K=ICOR                                                            BRZH4160
      IF(K.EQ.41)GO TO 151                                              BRZH4165
      IF(K.EQ.42)GO TO 152                                              BRZH4170
      CALL WRITEX(K)                                                    BRZH4175
      IF(K.GT.25.AND.K.LT.29)GO TO 150                                  BRZH4180
      READ (IR,123) PAR(K)                                              BRZH4185
      GO TO 9150                                                        BRZH4190
  150 J=K-25                                                            BRZH4195
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      READ(IR,140)PAR(K),PAR2(J)                                        BRZH4200
      KEYANT(J)=0                                                       BRZH4205
      IF(PAR(K).NE.0..OR.PAR2(J).NE.0.)KEYANT(J)=1                      BRZH4210
 9150 CONTINUE                                                          BRZH4215
      IF (K .NE. 23) GO TO 211                                          BRZH4220
      VEL=PAR(K)*5280./3600.                                            BRZH4225
      WRITE(IW,126) VEL                                                 BRZH4230
      GO TO 211                                                         BRZH4235
  151 WRITE(IW,1151)                                                    BRZH4240
 1151 FORMAT('&41 ANTILOCK CODE (3I1):')                                BRZH4245
      READ(IR,3002)(KEYANT(J),J=1,3)                                    BRZH4250
      DO 153 J=1,3                                                      BRZH4255
      JP25=25+J                                                         BRZH4260
      IF(KEYANT(J) .NE. 1) GO TO 154                                    BRZH4265
      CALL WRITEX(JP25)                                                 BRZH4270
      READ(IR,140) PAR(JP25),PAR2(J)                                    BRZH4275
      GO TO 153                                                         BRZH4280
  154 PAR(JP25)=0.                                                      BRZH4285
      PAR2(J)=0.                                                        BRZH4290
  153 CONTINUE                                                          BRZH4295
      GO TO 211                                                         BRZH4300
  152 WRITE(IW,1152)                                                    BRZH4305
 1152 FORMAT('&42 TANDEM AXLE/DUAL TIRE CODE (4I1):')                   BRZH4310
      READ(IR,3001)(KEY(J),J=1,4)                                       BRZH4315
      IF(KEY(1) .NE. 1) GO TO 2105                                      BRZH4320
      CALL WRITEX(5)                                                    BRZH4325
      READ(IR,103)PAR(5)                                                BRZH4330
      CALL WRITEX(21)                                                   BRZH4335
      READ(IR,103) PAR(21)                                              BRZH4340
 2105 CONTINUE                                                          BRZH4345
      IF(KEY(3) .NE. 1) GO TO 211                                       BRZH4350
      CALL WRITEX(6)                                                    BRZH4355
      READ(IR,103) PAR(6)                                               BRZH4360
      CALL WRITEX(22)                                                   BRZH4365
      READ(IR,103) PAR(22)                                              BRZH4370
  211 CONTINUE                                                          BRZH4375
      WRITE(IW,212)                                                     BRZH4380
  212 FORMAT('&?')                                                      BRZH4385
      GO TO 210                                                         BRZH4390
C                                                                       BRZH4395
C ** READ BREEZE HITCH PARAMETERS                                       BRZH4400
C                                                                       BRZH4405
22131 WRITE(IW,8893)                                                    BRZH4410
 8893 FORMAT('&BREEZE HITCH? ')                                         BRZH4415
      KKEY=0                                                            BRZH4420
      XBREEZ=0.                                                         BRZH4425
      KBREEZ=0                                                          BRZH4430
      READ(IR,92) ANS                                                   BRZH4435
      IF ( ANS .NE. YES) GO TO 88213                                    BRZH4440
      KKEY=1                                                            BRZH4445
C                                                                       BRZH4450
      IF ( IBREZ .EQ. 1 ) GO TO 8899                                    BRZH4455
      IBREZ=1                                                           BRZH4460
C                                                                       BRZH4465
 8898 WRITE(IR,8895)                                                    BRZH4470
 8895 FORMAT(' ENTER HITCHT,DD,E,THETA(DEG),A5,A6,B5,ACM,ZBREEZ',/,     BRZH4475
     &' SEPERATED BY COMMA.')                                           BRZH4480
      READ(IR,8896) HITCHT,DD,E,THETA,A5,A6,B5,ACM,ZBREEZ               BRZH4485
 8896 FORMAT(9F10.5)                                                    BRZH4490
C                                                                       BRZH4495
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C                                                                       BRZH4500
      WRITE(IW,8897) HITCHT,DD,E,THETA,A5,A6,B5,ACM,ZBREEZ              BRZH4505
 8897 FORMAT(/,T3,'HITCHT  = ',F10.5,/,T3,'DD       = ',F10.5,         BRZH4510
     13X,'FT',/,T3,'E        = ',F10.5,3X,'FT',/,T3,'THETA    = ',F10.5, BRZH4515
     22X,'DEG',/,T3,'A5       = ',F10.5,3X,'FT',/,T3,'A6       = ',F10.5, BRZH4520
     33X,'FT',/,T3,'B5       = ',F10.5,3X,'FT',/,T3,'ACM      = ',F10.5, BRZH4525
     43X,'FT',/,T3,'ZBREEZ  = ',F10.5,3X,'FT')                          BRZH4530
      THETA=THETA*3.14159/180.                                          BRZH4535
C                                                                       BRZH4540
 8899 WRITE(IW,89792)                                                   BRZH4545
89792 FORMAT('&CHANGE BREEZE HITCH DATA? ')                             BRZH4550
      READ(IR,92) ANS                                                   BRZH4555
      IF ( ANS .EQ. YES ) GO TO 8898                                    BRZH4560
      GO TO 213                                                         BRZH4565
C                                                                       BRZH4570
88213 IBREZ=0                                                           BRZH4575
      TBREEZ=0.                                                         BRZH4580
C                                                                       BRZH4585
C ** BREEZE HITCH INPUT FINISHED                                        BRZH4590
C                                                                       BRZH4595
C                                                                       BRZH4600
  213 WRITE(IW,214)                                                     BRZH4605
  214 FORMAT('&','CHANGE BRAKE FORCE TABLE?')                           BRZH4610
      READ(IR,92) ANS                                                   BRZH4615
      IF (ANS .EQ. YES) GO TO 301                                       BRZH4620
      GO TO 3000                                                        BRZH4625
  301 WRITE(IW,2150)                                                    BRZH4630
 2150 FORMAT('&','ADD NEW LINES?')                                      BRZH4635
      READ(IR,92) ANS                                                   BRZH4640
      IF (ANS .NE. YES) GO TO 2301                                      BRZH4645
      WRITE(IW,2151)                                                    BRZH4650
 2151 FORMAT('&','HOW MANY LINES ARE TO BE ADDED?')                     BRZH4655
      READ(IR,137) ITAB2                                                BRZH4660
      ITAB3=ITAB+ITAB2                                                  BRZH4665
      IF (ITAB3 .LT. 16) GO TO 2155                                     BRZH4670
      WRITE(IW,2154)                                                    BRZH4675
      GO TO 301                                                         BRZH4680
 2155 WRITE(IW,2152)                                                    BRZH4685
 2152 FORMAT('0','ENTER NEW LINES;')                                    BRZH4690
      DO 2153 I=1,ITAB2                                                 BRZH4695
 2153 READ(IR,140) (BFT(ITAB+I,J),J=1,7)                                BRZH4700
 2154 FORMAT('0','*** TABLE SIZE EXCEEDED ***'/' ','*** ENTER SMALLER NUBRZH4705
     1MBER ***')                                                        BRZH4710
      ITAB=ITAB+ITAB2                                                   BRZH4715
      WRITE(IW,138)                                                     BRZH4720
      WRITE(IW,139) ((BFT(I,J),J=1,7),I=1,ITAB)                         BRZH4725
      WRITE(IW,224)                                                     BRZH4730
      READ(IR,92) ANS                                                   BRZH4735
      IF (ANS.EQ. YES) GO TO 3000                                       BRZH4740
      GO TO 301                                                         BRZH4745
 2301 WRITE(IW,215)                                                     BRZH4750
  215 FORMAT('&','HOW MANY LINES ARE TO BE CHANGED?')                   BRZH4755
      READ(IR,216) LNS                                                  BRZH4760
      IF(LNS.LT.16)GO TO 2156                                           BRZH4765
      WRITE(IW,2154)                                                    BRZH4770
      GO TO 2301                                                        BRZH4775
 2156 CONTINUE                                                          BRZH4780
  216 FORMAT(I2)                                                        BRZH4785
      WRITE(IW,217)                                                     BRZH4790
  217 FORMAT('&','ENTER LINE NUMBERS TO BE CHANGED; ')                  BRZH4795
```

```
      READ(IR,207) (COR(I),I=1,LNS)                                     BRZH4800
      WRITE(IW,222)                                                     BRZH4805
  222 FORMAT('0','ENTER CORRECTIONS:')                                  BRZH4810
      DO 223 I=1,LNS                                                    BRZH4815
      READ(IR,140) (BFT(COR(I),J),J=1,7)                                BRZH4820
  223 CONTINUE                                                          BRZH4825
      WRITE(IW,138)                                                     BRZH4830
      WRITE(IW,139) ((BFT(I,J),J=1,7),I=1,ITAB)                         BRZH4835
      WRITE(IW,224)                                                     BRZH4840
  224 FORMAT('0','IS TABLE CORRECT NOW?')                               BRZH4845
      READ(IR,92) ANS                                                   BRZH4850
      IF (ANS .EQ. YES) GO TO 3000                                      BRZH4855
      GO TO 301                                                         BRZH4860
 3000 CONTINUE                                                          BRZH4865
C                                                                       BRZH4870
C  **  CHANGE STEER TABLE                                               BRZH4875
C                                                                       BRZH4880
 4213 WRITE(IW,4214)                                                    BRZH4885
 4214 FORMAT('0','CHANGE STEER TABLE?')                                 BRZH4890
      READ(IR,92)ANS                                                    BRZH4895
      IF(ANS.EQ.YES)GO TO 4301                                          BRZH4900
      GO TO 3999                                                        BRZH4905
 4301 WRITE(IW,2150)                                                    BRZH4910
      READ(IR,92)ANS                                                    BRZH4915
      IF(ANS.NE.YES)GO TO 6301                                          BRZH4920
      WRITE(IW,2151)                                                    BRZH4925
      READ(IR,137)ITAB2S                                                BRZH4930
      ITAB3S=ITABS+ITAB2S                                               BRZH4935
      IF(ITAB3S.LT.26)GO TO 4155                                        BRZH4940
      WRITE(IW,2154)                                                    BRZH4945
      GO TO 4301                                                        BRZH4950
 4155 WRITE(IW,2152)                                                    BRZH4955
      DO 4153 I=1,ITAB2S                                                BRZH4960
 4153 READ(IR,1140)(STEER(ITABS+I,J),J=1,2)                             BRZH4965
      ITABS=ITABS+ITAB2S                                                BRZH4970
      WRITE(IW,1138)                                                    BRZH4975
      WRITE(IW,1139)((STEER(I,J),J=1,2),I=1,ITABS)                      BRZH4980
      WRITE(IW,224)                                                     BRZH4985
      READ(IR,92)ANS                                                    BRZH4990
      IF(ANS.EQ.YES)GO TO 3999                                          BRZH4995
      GO TO 4301                                                        BRZH5000
 6301 WRITE(IW,215)                                                     BRZH5005
      READ(IR,216)LNS                                                   BRZH5010
      WRITE(IW,217)                                                     BRZH5015
      READ(IR,207)(COR(I),I=1,LNS)                                      BRZH5020
      WRITE(IW,222)                                                     BRZH5025
      DO 4223 I=1,LNS                                                   BRZH5030
      READ(IR,1140)(STEER(COR(I),J),J=1,2)                              BRZH5035
 4223 CONTINUE                                                          BRZH5040
      WRITE(IW,1138)                                                    BRZH5045
      WRITE(IW,1039)((STEER(I,J),J=1,2),I=1,ITABS)                      BRZH5050
      WRITE(IW,224)                                                     BRZH5055
      READ(IR,92)ANS                                                    BRZH5060
      IF(ANS.EQ.YES)GO TO 3999                                          BRZH5065
      GO TO 4301                                                        BRZH5070
 3999 CONTINUE                                                          BRZH5075
C  **  EQUIVALENCE STATEMENTS                                           BRZH5080
C                                                                       BRZH5085
      W1=PAR(1)                                                         BRZH5090
      W2=PAR(2)                                                         BRZH5095
```

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      A=PAR(7)/12.                                                      BRZH5100
      B=PAR(8)/12.                                                      BRZH5105
      C=PAR(9)/12.                                                      BRZH5110
      D=PAR(10)/12.                                                     BRZH5115
      BBB=PAR(11)/12.                                                   BRZH5120
      H=B-BBB                                                           BRZH5125
      Z0=PAR(15)/12.                                                    BRZH5130
      Z1=PAR(16)/12.                                                    BRZH5135
      Z2=PAR(17)/12.                                                    BRZH5140
      T1=PAR(12)/12.                                                    BRZH5145
      T2=PAR(13)/12.                                                    BRZH5150
      T3=PAR(14)/12.                                                    BRZH5155
      GAM1=PAR(20)                                                      BRZH5160
      GAM2=1.-GAM1                                                      BRZH5165
      GAM3=PAR(21)                                                      BRZH5170
      RADS=PAR(19)/12.                                                  BRZH5175
      GAM4=PAR(22)                                                      BRZH5180
      IF(MUSLIP.EQ.0)GO TO 4801                                         BRZH5185
      DO 4802 I=1,10                                                    BRZH5190
      MU(I)=PAR(32)                                                     BRZH5195
      MUS(I)=PAR(35)                                                    BRZH5200
4802  MUSLOP(I)=PAR(38)                                                 BRZH5205
      GO TO 4803                                                        BRZH5210
4801  CONTINUE                                                          BRZH5215
      MUS(1)=PAR(35)                                                    BRZH5220
      MUS(2)=MUS(1)                                                     BRZH5225
      MUS(3)=PAR(36)                                                    BRZH5230
      MUS(7)=PAR(37)                                                    BRZH5235
      MU(1)=PAR(32)                                                     BRZH5240
      MU(2)=MU(1)                                                       BRZH5245
      MU(3)=PAR(33)                                                     BRZH5250
      MU(7)=PAR(34)                                                     BRZH5255
      MUSLOP(1)=PAR(38)                                                 BRZH5260
      MUSLOP(2)=MUSLOP(1)                                               BRZH5265
      MUSLOP(3)=PAR(39)                                                 BRZH5270
      MUSLOP(7)=PAR(40)                                                 BRZH5275
4803  CONTINUE                                                          BRZH5280
      ANTEFF(1,1)=PAR(26)                                               BRZH5285
      ANTEFF(2,1)=ANTEFF(1,1)                                           BRZH5290
      ANTEFF(3,1)=PAR(27)                                               BRZH5295
      ANTEFF(7,1)=PAR(28)                                               BRZH5300
      ANTEFF(1,2)=PAR2(1)                                               BRZH5305
      ANTEFF(2,2)=ANTEFF(1,2)                                           BRZH5310
      ANTEFF(3,2)=PAR2(2)                                               BRZH5315
      ANTEFF(7,2)=PAR2(3)                                               BRZH5320
      MUS=PAR(18)                                                       BRZH5325
      I1=PAR(3)/12.                                                     BRZH5330
      I2=PAR(4)/12.                                                     BRZH5335
      VEL=PAR(23)*5280./3600.                                           BRZH5340
      TIME=PAR(24)+.01                                                  BRZH5345
      CIA(1)=PAR(29)*57.295                                             BRZH5350
      CIA(2)=CIA(1)                                                     BRZH5355
      CIA(3)=PAR(30)*57.295                                             BRZH5360
      CIA(7)=PAR(31)*57.295                                             BRZH5365
      DO 3308 I=1,3                                                     BRZH5370
      IF(MUSLIP.EQ.1)GO TO 4804                                         BRZH5375
      MUS(3+I)=MUS(3)                                                   BRZH5380
      MUS(7+I)=MUS(7)                                                   BRZH5385
      MU(3+I)=MU(3)                                                     BRZH5390
      MU(7+I)=MU(7)                                                     BRZH5395
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      MUSLOP(3+I)=MUSLOP(3)                                              BRZH5400
      MUSLOP(7+I)=MUSLOP(7)                                              BRZH5405
 4004 CONTINUE                                                           BRZH5410
      DO 3009 J=1,2                                                      BRZH5415
      ANTEFF(3+I,J)=ANTEFF(3,J)                                          BRZH5420
 3009 ANTEFF(7+I,J)=ANTEFF(7,J)                                          BRZH5425
      CIA(3+I)=CIA(3)                                                    BRZH5430
 3008 CIA(7+I)=CIA(7)                                                    BRZH5435
      AAA=PAR(5)/12.                                                     BRZH5440
      AAT=PAR(6)/12.                                                     BRZH5445
      IQUIT=PAR(25)                                                      BRZH5450
C                                                                        BRZH5455
C **  COMPUTE STATIC LOADS AND ECHO                                      BRZH5460
C                                                                        BRZH5465
   52 FBZ(1)=((B**1)/(2.*(A+B)))+((D*(B-H)**2)/(2.*(A+B)*(C+D)))         BRZH5470
      FBZ(2)=FBZ(1)                                                      BRZH5475
      FBZ(3)=((A**1)/(2.*(A+B)))+((D*(A+H)**2)/(2.*(A+B)*(C+D)))         BRZH5480
      IF(KEY(1).LT.1)GO TO 3010                                          BRZH5485
      FBZ(3)=FBZ(3)/2.                                                   BRZH5490
      FBZ(5)=FBZ(3)                                                      BRZH5495
      FBZ(6)=FBZ(3)                                                      BRZH5500
 3010 FBZ(4)=FBZ(3)                                                      BRZH5505
      FBZ(7)=(C**2)/(2.*(C+D))                                           BRZH5510
      IF(KEY(3).LT.1)GO TO 3011                                          BRZH5515
      FBZ(7)=FBZ(7)/2.                                                   BRZH5520
      FBZ(9)=FBZ(7)                                                      BRZH5525
      FBZ(10)=FBZ(7)                                                     BRZH5530
 3011 FBZ(8)=FBZ(7)                                                      BRZH5535
      DO 5 I=1,10                                                        BRZH5540
      DUAL=0.0                                                           BRZH5545
      IF(I.GT.2.AND.I.LT.7.AND.KEY(2).GT.0)DUAL=1.0                      BRZH5550
      IF(I.GT.6.AND.KEY(4).GT.0)DUAL=1.0                                 BRZH5555
    5 FZ(I)=FBZ(I)/(1.+DUAL)                                             BRZH5560
      WRITE(IW,129)                                                      BRZH5565
  129 FORMAT('ECHO STATIC LOADS?')                                       BRZH5570
      READ(IR,92)ANS                                                     BRZH5575
      IF(ANS.NE.YES)GO TO 59                                             BRZH5580
C                                                                        BRZH5585
C  **  ECHO LOADS                                                        BRZH5590
C                                                                        BRZH5595
      FBAX1=2.*FBZ(1)                                                    BRZH5600
      FBAX2=2.*FBZ(3)                                                    BRZH5605
      FBAX3=2.*FBZ(7)                                                    BRZH5610
      WRITE(IW,73)FBAX1                                                  BRZH5615
   73 FORMAT(' ',T6,'STATIC LOADS (LBS)'/2X,'TRACTOR FRONT AXLE:    ',   BRZH5620
     1 F12.2)                                                            BRZH5625
      IF(KEY(1) .EQ. 1) GO TO 74                                         BRZH5630
      WRITE(IW,75)FBAX2                                                  BRZH5635
   75 FORMAT(2X,'TRACTOR REAR AXLE:     ',F12.2)                       BRZH5640
      GO TO 77                                                           BRZH5645
   74 WRITE(IW,76) FBAX2,FBAX2                                           BRZH5650
   76 FORMAT(2X,'TRACTOR LEADING TANDEM:',F12.2/9X,                      BRZH5655
     1 'TRAILING TANDEM:',F12.2)                                         BRZH5660
   77 CONTINUE                                                           BRZH5665
      IF(KEY(3) .EQ. 1) GO TO 78                                         BRZH5670
      WRITE(IW,79)FBAX3                                                  BRZH5675
   79 FORMAT(2X,'TRAILER AXLE:',10X,F12.2)                               BRZH5680
      GO TO 80                                                           BRZH5685
   78 WRITE(IW,81)FBAX3,FBAX3                                            BRZH5690
   81 FORMAT(2X,'TRAILER LEADING TANDEM:',F12.2/9X,                      BRZH5695
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     1 'TRAILING TANDEM:',F12.2)                                          BRZH5700
   80 CONTINUE                                                            BRZH5705
   59 CONTINUE                                                            BRZH5710
C                                                                         BRZH5715
C  **  INITIALIZATIONS                                                   BRZH5720
C                                                                         BRZH5725
      M1=W1/32.17                                                         BRZH5730
      M2=W2/32.17                                                         BRZH5735
      INIT=1                                                              BRZH5740
      WINX=0.0                                                            BRZH5745
      DELTA=DELTA*(2.*3.14159)/360.                                       BRZH5750
      NDIM=8                                                              BRZH5755
      PRMT(1)=0.0                                                         BRZH5760
      PRMT(2)=TIME                                                        BRZH5765
      PRMT(3)=.02                                                         BRZH5770
      PRMT(4)=.01                                                         BRZH5775
      DO 60 I=1,8                                                         BRZH5780
      Y(I)=0.                                                             BRZH5785
      DERY(I)=0.                                                          BRZH5790
   60 CONTINUE                                                            BRZH5795
      DO 61 I=2,8,2                                                       BRZH5800
   61 DERY(I)=.25                                                         BRZH5805
      Y(2)=VEL                                                            BRZH5810
      IF(IFLAG.EQ.1)GO TO 611                                             BRZH5815
      WRITE(IW,9002)                                                      BRZH5820
 9002 FORMAT(/'&ENTER INITIAL ARTIC. ANGLE: ')                            BRZH5825
      READ(IR,103)Y(7)                                                    BRZH5830
      Y(7)=Y(7)/57.295                                                    BRZH5835
      IF(Y(7).EQ.0..AND.ONCE.EQ.0.)GO TO 612                              BRZH5840
      ONCE=1.                                                             BRZH5845
      GO TO 611                                                           BRZH5850
  612 WRITE(IW,9003)                                                      BRZH5855
 9003 FORMAT('&WILL ARTIC. ANGLE BE VARIED? ')                            BRZH5860
      IF(ISHOW.EQ.1) CALL EXPLAN(8,ISHOW)                                 BRZH5865
      READ(IR,92)ANS                                                      BRZH5870
      IF(ANS.NE.YES)IFLAG=1                                               BRZH5875
      ONCE=1.                                                             BRZH5880
  611 CONTINUE                                                            BRZH5885
      WRITE(IW,9004)                                                      BRZH5890
      READ(IR,92)ANS                                                      BRZH5895
      IF(ANS.EQ.YES)GO TO 200                                             BRZH5900
C                                                                         BRZH5905
  101 FORMAT('0','INPUT PARAMETER TABLE'//'0','NO.',T6,'SYMBOL',T18,'DESCBRZH5910
     1RIPTION',T59,'INITIAL VALUE'//)                                     BRZH5915
  103 FORMAT(F14.2)                                                       BRZH5920
  104 FORMAT('+',1X,F12.2)                                                BRZH5925
  105 FORMAT('+',1X,2F6.2)                                                BRZH5930
  126 FORMAT(' ',T48,'(FPS)',4X,F14.2)                                    BRZH5935
  135 FORMAT('0',T7,'BRAKE FORCE TABLE'//'&     NUMBER OF LINES:  ')      BRZH5940
  136 FORMAT(I2)                                                          BRZH5945
  137 FORMAT(I2)                                                          BRZH5950
  138 FORMAT('0',T7,'TIME',T35,'DESIRED FORCES:'/T7,'(SEC)',T16,   'FSX(BRZH5955
     11)',T26,'FSX(2)',T36,'FSX(3)',T46,'FSX(4)',T56,'FSX(7)',T66,'FSX(8BRZH5960
     1)'/)                                                                BRZH5965
  139 FORMAT(' ',F14.4,6F10.2)                                            BRZH5970
  140 FORMAT(7F10.0)                                                      BRZH5975
  141 FORMAT('+',F10.4,6F10.2)                                            BRZH5980
 9004 FORMAT('&ANY DATA CHANGES NOW?')                                    BRZH5985
      XDUMP=0.0                                                           BRZH5990
      XDOFF=0.0                                                           BRZH5995
```

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      RETURN                                                            BRZH6000
      END                                                               BRZH6005
C                                                                       BRZH6010
C                                                                       BRZH6015
C  ****************************************************************     BRZH6020
      SUBROUTINE WRITEX(I)                                              BRZH6025
C  ****************************************************************     BRZH6030
C                                                                       BRZH6035
C                                                                       BRZH6040
      COMMON /IO/IR,IW                                                  BRZH6045
C                                                                       BRZH6050
C                                                                       BRZH6055
C **  FORMATS                                                           BRZH6060
C                                                                       BRZH6065
  101 FORMAT('&01  GVW1        WT. OF TRACTOR (LBS)',19X)               BRZH6070
  102 FORMAT('&02  GVW2        WT. OF TRAILER (LBS)',19X)               BRZH6075
  103 FORMAT('&03  IZZ         TRACTOR MOM. OF INERTIA (IN-LB-SEC**2) ')BRZH6080
  104 FORMAT('&04  ITZZ        TRAILER MOM. OF INERTIA (IN-LB-SEC**2) ')BRZH6085
  105 FORMAT('&05  AA          DIST. BETWEEN TRACTOR TANDEM AXLES (IN)')BRZH6090
  106 FORMAT('&06  AAT         DIST. BETWEEN TRAILER TANDEM AXLES (IN)')BRZH6095
  107 FORMAT('&07  A1          DIST. FROM TRACTOR CG TO FRONT AXLE(IN)')BRZH6100
  108 FORMAT('&08  A2          DIST. FROM TRACTOR CG TO REAR AXLE(IN) ')BRZH6105
  109 FORMAT('&09  A3          DIST. FROM TRAILER CG TO FIFTH WHL (IN)')BRZH6110
  110 FORMAT('&10  A4          DIST. FROM TRAILER CG TO AXLE (IN)     ')BRZH6115
  111 FORMAT(' 11  BB          DIST. FROM TRACTOR REAR SUSPENSION TO'/  BRZH6120
     1 19X,'FIFTH WHL (IN).  FIFTH WHL LOCATED '/                       BRZH6125
     2 '&',18X,'AFT OF SUSPENSION IS NEGATIVE.      ')                 BRZH6130
  112 FORMAT(' 12  TRA1        HALF LAT. DIST. BETWEEN CENTERS OF TIRE'/BRZH6135
     1'&                  CONTACT ON TRACTOR FRONT AXLE (IN)    ')      BRZH6140
  113 FORMAT(' 13  TRA2        HALF LAT. DIST. BETWEEN CENTERS OF TIRE'/BRZH6145
     1'&                  CONTACT ON TRACTOR REAR AXLE/S (IN)   ')      BRZH6150
  114 FORMAT(' 14  TRA3        HALF LAT. DIST. BETWEEN CENTERS OF TIRE'/BRZH6155
     1'&                  CONTACT ON TRAILER AXLE/S (IN)        ')      BRZH6160
  115 FORMAT('&15  Z0          HEIGHT OF FIFTH WHL ABOVE GROUND (IN)  ')BRZH6165
  116 FORMAT('&16  Z1          HEIGHT OF TRACTOR CG ABOVE GROUND(IN)  ')BRZH6170
  117 FORMAT('&17  Z2          HEIGHT OF TRAILER CG ABOVE GROUND (IN) ')BRZH6175
  118 FORMAT('&18  MU5         FIFTH WHEEL FRICTION COEFFICIENT       ')BRZH6180
  119 FORMAT('&19  RAD5        EQUIVALENT RADIUS OF FIFTH WHEEL (IN)  ')BRZH6185
  120 FORMAT(' 20  GAM1        PORTION OF TOTAL LAT. LOAD TRANSFER'/'&  BRZH6190
     1          ON FRONT AXLE OF TRACTOR                 ')           BRZH6195
  121 FORMAT('&21  GAM3        TRACTOR TANDEM AXLE LOAD X-FER COEF.   ')BRZH6200
  123 FORMAT('&23  VEL         INITIAL VELOCITY: U-DIRECTION (MPH)    ')BRZH6205
  122 FORMAT('&22  GAM0        TRAILER TANDEM AXLE LOAD X-FER COEF.   ')BRZH6210
  124 FORMAT('&24  TIMF        MAX. SIMULATION TIME FOR THIS RUN (SEC)')BRZH6215
  125 FORMAT('&25  IQUIT       MAX. ARTICULATION ANGLE ALLOWED   (DEG)')BRZH6220
  126 FORMAT(/' ANTEFF          ANTILOCK EFFECTIVENESS COEFFICIENT',    BRZH6225
     1 ' (LAT.,LONG.)'/                                                 BRZH6230
     2'&26                              FRONT AXLE: ANTEFF=')           BRZH6235
  127 FORMAT('&27          TRACTOR REAR AXLE (OR TANDEM AXLES): ANTEFF=')BRZH6240
  128 FORMAT('&28              TRAILER AXLE (OR TANDEM AXLES): ANTEFF=')BRZH6245
  129 FORMAT('   CALF          CORNERING STIFFNESS OF TIRES (LBS/DEG)'/'BRZH6250
     1&29                                        CALF(1)=')            BRZH6255
  130 FORMAT('&30                                          CALF(3)=')BRZH6260
  131 FORMAT('&31                                          CALF(7)=')BRZH6265
  132 FORMAT('    MUP           PEAK TIRE-ROAD FRICTION COEFFICIENT'/    BRZH6270
     1 '&32',46X,'MUP(1)=')                                             BRZH6275
  133 FORMAT('&33                                           MUP(3)=')BRZH6280
  134 FORMAT('&34                                           MUP(7)=')BRZH6285
  135 FORMAT('    MUS           SLIDING TIRE-ROAD FRICTION COEF.      '/  BRZH6290
     1       '&35                                          MUS(1)=')BRZH6295
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136 FORMAT('&36                                                    MUS(3)=')BRZH6300
137 FORMAT('&37                                                    MUS(7)=')BRZH6305
138 FORMAT('      SP          SLIP CORRESPONDING TO PEAK MU'/                BRZH6310
   1       '&38                                                  SP(1)=')BRZH6315
139 FORMAT('&39                                                  SP(3)=')BRZH6320
140 FORMAT('&40                                                  SP(7)=')BRZH6325
    GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23BRZH6330
   1,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40),I          BRZH6335
  1 WRITE(IW,101)                                                   BRZH6340
    RETURN                                                          BRZH6345
  2 WRITE(IW,102)                                                   BRZH6350
    RETURN                                                          BRZH6355
  3 WRITE(IW,103)                                                   BRZH6360
    RETURN                                                          BRZH6365
  4 WRITE(IW,104)                                                   BRZH6370
    RETURN                                                          BRZH6375
  5 WRITE(IW,105)                                                   BRZH6380
    RETURN                                                          BRZH6385
  6 WRITE(IW,106)                                                   BRZH6390
    RETURN                                                          BRZH6395
  7 WRITE(IW,107)                                                   BRZH6400
    RETURN                                                          BRZH6405
  8 WRITE(IW,108)                                                   BRZH6410
    RETURN                                                          BRZH6415
  9 WRITE(IW,109)                                                   BRZH6420
    RETURN                                                          BRZH6425
 10 WRITE(IW,110)                                                   BRZH6430
    RETURN                                                          BRZH6435
 11 WRITE(IW,111)                                                   BRZH6440
    RETURN                                                          BRZH6445
 12 WRITE(IW,112)                                                   BRZH6450
    RETURN                                                          BRZH6455
 13 WRITE(IW,113)                                                   BRZH6460
    RETURN                                                          BRZH6465
 14 WRITE(IW,114)                                                   BRZH6470
    RETURN                                                          BRZH6475
 15 WRITE(IW,115)                                                   BRZH6480
    RETURN                                                          BRZH6485
 16 WRITE(IW,116)                                                   BRZH6490
    RETURN                                                          BRZH6495
 17 WRITE(IW,117)                                                   BRZH6500
    RETURN                                                          BRZH6505
 18 WRITE(IW,118)                                                   BRZH6510
    RETURN                                                          BRZH6515
 19 WRITE(IW,119)                                                   BRZH6520
    RETURN                                                          BRZH6525
 20 WRITE(IW,120)                                                   BRZH6530
    RETURN                                                          BRZH6535
 21 WRITE(IW,121)                                                   BRZH6540
    RETURN                                                          BRZH6545
 22 WRITE(IW,122)                                                   BRZH6550
    RETURN                                                          BRZH6555
 23 WRITE(IW,123)                                                   BRZH6560
    RETURN                                                          BRZH6565
 24 WRITE(IW,124)                                                   BRZH6570
    RETURN                                                          BRZH6575
 25 WRITE(IW,125)                                                   BRZH6580
    RETURN                                                          BRZH6585
 26 WRITE(IW,126)                                                   BRZH6590
    RETURN                                                          BRZH6595
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   27 WRITE(IW,127)                                                     BRZH6600
      RETURN                                                            BRZH6605
   28 WRITE(IW,128)                                                     BRZH6610
      RETURN                                                            BRZH6615
   29 WRITE(IW,129)                                                     BRZH6620
      RETURN                                                            BRZH6625
   30 WRITE(IW,130)                                                     BRZH6630
      RETURN                                                            BRZH6635
   31 WRITE(IW,131)                                                     BRZH6640
      RETURN                                                            BRZH6645
   32 WRITE(IW,132)                                                     BRZH6650
      RETURN                                                            BRZH6655
   33 WRITE(IW,133)                                                     BRZH6660
      RETURN                                                            BRZH6665
   34 WRITE(IW,134)                                                     BRZH6670
      RETURN                                                            BRZH6675
   35 WRITE(IW,135)                                                     BRZH6680
      RETURN                                                            BRZH6685
   36 WRITE(IW,136)                                                     BRZH6690
      RETURN                                                            BRZH6695
   37 WRITE(IW,137)                                                     BRZH6700
      RETURN                                                            BRZH6705
   38 WRITE(IW,138)                                                     BRZH6710
      RETURN                                                            BRZH6715
   39 WRITE(IW,139)                                                     BRZH6720
      RETURN                                                            BRZH6725
   40 WRITE(IW,140)                                                     BRZH6730
      RETURN                                                            BRZH6735
      END                                                               BRZH6740
C                                                                       BRZH6745
C                                                                       BRZH6750
C  ******************************************************               BRZH6755
      SUBROUTINE OUTP(X,Y,DERY,IHLF,NDIM,PRMT)                          BRZH6760
C  ******************************************************               BRZH6765
C                                                                       BRZH6770
C                                                                       BRZH6775
      DIMENSION PRINT(250,85)                                           BRZH6780
      DIMENSION Y(8),PRMT(5),DERY(8),AUX(16,8),CIA(10),FZ(10),FSX(10),  BRZH6785
     1          DFZ(10),DELFZ(10),FX(10),FY(10)                        BRZH6790
      REAL MU,MU5,M1,M2,I1,I2,MUS,MUT(10),MUSLOP,IQUIT                  BRZH6795
      COMMON    W1,W2,M1,M2,A,B,C,D,H,Z0,Z1,Z2,GAM1,GAM2,MUS,RADS,DELTA,BRZH6800
     1          T1,T2,T3,CIA,FSX,FZ,TNIT,I1,I2,DERX(4),FBZ(10),ALPHA(10)BRZH6805
     2          ,WINX,FY,DFZ,DELFZ,TIME,FX,DKEY,VEL,AAA,AAT,KEY(4),     BRZH6810
     3          MU(10),ANTEFF(10,2),IDUMP,XDUMP,XDOFF,MUS(10),KEYANT(3),BRZH6815
     5          MUSLOP(10),BET(15,7),ITAB,IXON,ITABS,STEER(25,2),ISAV,  BRZH6820
     6          GAM3,GAM4,TRUCK,IQUIT                                  BRZH6825
      COMMON    /IO/IR,IW                                               BRZH6830
      COMMON    /BREEZ/TBREEZ,XBREEZ,HITCHT,DD,E,THETA,A5,A6,B5,ACM     BRZH6835
      COMMON    /KBREZ/KBREEZ,ZBREEZ,KKEY                               BRZH6840
      COMMON    /FCTOUT/XL,YL,IPLOT                                     BRZH6845
      DATA      YES,IFIRST/'Y',0/                                       BRZH6850
      DIMENSION NCOL(7)                                                 BRZH6855
      REAL*8    TITLE(85)                                               BRZH6860
      DATA TITLE/'    TIME','X0-COORD','Y0-COORD','     PSI','   GAMMA',BRZH6865
     1'   U-VEL','   V-VEL','  PSIDOT','GAMMADOT','TURN RAD','SIDESLIP',BRZH6870
     2'ALFA 1+2','ALFA 3+4','ALFA 5+6','ALFA 7+8','ALFA9+10',           BRZH6875
     3'   U-DOT','   V-DOT','PSI-DOOT',                                BRZH6880
     4'GAM-DOOT','LONG ACC','LAT. ACC','   FX(1)','   FX(2)','   FX(3)',BRZH6885
     5'   FX(4)','   FX(5)','   FX(6)','   FX(7)','   FX(8)','   FX(9)',BRZH6890
     6'  FX(10)','   FY(1)','   FY(2)','   FY(3)','   FY(4)','   FY(5)',BRZH6895
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     7*   FY(6)',*   FY(7)',*   FY(8)',*   FY(9)',*  FY(10)',*  DFX(1)',BRZH6900
     8*  DFX(2)',*  DFX(3)',*  DFX(4)',*  DFX(5)',*  DFX(6)',*  DFX(7)',BRZH6905
     9*  DFX(8)',*  DFX(9)',* DFX(10)',*  DFY(1)',*  DFY(2)',*  DFY(3)',BRZH6910
     A*  DFY(4)',*  DFY(5)',*  DFY(6)',*  DFY(7)',*  DFY(8)',*  DFY(9)',BRZH6915
     A* DFY(10)',*   FZ(1)',*   FZ(2)',*   FZ(3)',*   FZ(4)',*   FZ(5)',BRZH6920
     B*   FZ(6)',*   FZ(7)',*   FZ(8)',*   FZ(9)',*  FZ(10)',*  FSX(1)',BRZH6925
     C*  FSX(2)',*  FSX(3)',*  FSX(4)',*  FSX(5)',*  FSX(6)',*  FSX(7)',BRZH6930
     D*  FSX(8)',*  FSX(9)',* FSX(10)',*   XH    ',*   YH    ',* TBREEZ */BRZH6935
C                                                                       BRZH6940
C  **  READY TO START                                                   BRZH6945
C  **  INITIAL CALL TO OUTP                                             BRZH6950
C                                                                       BRZH6955
      DKEY=0                                                            BRZH6960
      IF (INIT .NE. 0) GO TO 7                                          BRZH6965
      INIT=INIT+8                                                       BRZH6970
      LINE=0                                                            BRZH6975
      PAGE=3.                                                           BRZH6980
      INW=0                                                             BRZH6985
      IF(IFIRST.GT.0)GO TO 500                                          BRZH6990
C                                                                       BRZH6995
C  **  DETERMINE WHICH VARIABLES TO BE PRINTED OUT                      BRZH7000
      WRITE(IW,125)                                                     BRZH7005
      IFIRST=1                                                          BRZH7010
  125 FORMAT('&','DO YOU WANT A LIST OF OUTPUT VARIABLES?')             BRZH7015
      READ(IR,101) ANS                                                  BRZH7020
      IF (ANS .NE. YES) GO TO 500                                       BRZH7025
      DO 471 I=1,84                                                     BRZH7030
      IF (I .EQ.1) WRITE(IW,472)                                        BRZH7035
  472 FORMAT('0','*** POSITION VARIABLES ***'/)                         BRZH7040
      IF (I .EQ. 5) WRITE(IW,473)                                       BRZH7045
  473 FORMAT('0','*** VELOCITY VARIABLES ***'/)                         BRZH7050
      IF (I .EQ. 9) WRITE(IW,474)                                       BRZH7055
  474 FORMAT('0','***'/)                                                BRZH7060
      IF (I .EQ. 11) WRITE(IW,475)                                      BRZH7065
  475 FORMAT('0','*** TIRE SLIP ANGLES ***'/)                           BRZH7070
      IF ( I .EQ. 16) WRITE(IW,476)                                     BRZH7075
  476 FORMAT('0','*** ACCELERATION VARIABLES ***'/)                     BRZH7080
      IF (I .EQ. 22) WRITE(IW,477)                                      BRZH7085
  477 FORMAT('0','*** TIRE-ROAD INTERFACE FORCES ***'/' ','*** BRAKE FORBRZH7090
     1CES: FX(I), SIDE FORCES FY(I) ***'/)                              BRZH7095
      IF (I .EQ. 42) WRITE(IW,478)                                      BRZH7100
  478 FORMAT('0',' *** LOAD TRANSFERS, LONG, DFX(I),LAT, DFY(I) ***'/)  BRZH7105
      IF (I .EQ. 62) WRITE(IW,479)                                      BRZH7110
  479 FORMAT('0','*** INSTANTANEOUS LOAD FORCES ***'/)                  BRZH7115
      IF ( I .EQ. 72) WRITE(IW,480)                                     BRZH7120
  480 FORMAT('0','*** PROGRAMMED BRAKE FORCES ***'/)                    BRZH7125
      IF(I .EQ. 82)WRITE(IW,481)                                        BRZH7130
  481 FORMAT('0','*** HITCH FORCES ***'/)                               BRZH7135
      WRITE(IW,126) I,TITLE(I+1)                                        BRZH7140
  126 FORMAT(' ',I2,10X,A8)                                             BRZH7145
  471 CONTINUE                                                          BRZH7150
  500 CONTINUE                                                          BRZH7155
C TO USE NSRT PLOTTING FACILITY, REMOVE C FROM NEXT 8 CARDS AND         BRZH7160
C DELETE IPLOT=100.                                                     BRZH7165
C     WRITE(IW,600)                                                     BRZH7170
C 600 FORMAT('&','PLOT (Y OR N)?')                                      BRZH7175
C     READ(IR,101)ANS                                                   BRZH7180
C     IF(ANS.NE.YES)GO TO 470                                           BRZH7185
C     WRITE(IW,103)                                                     BRZH7190
C     READ(IR,104)IPLOT                                                 BRZH7195
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C       INW=IPLOT                                                       BRZH7200
C       GO TO 102                                                       BRZH7205
        IPLOT=100                                                       BRZH7210
  470 WRITE(IW,100)                                                     BRZH7215
  100 FORMAT('0','PRINT OUTPUT ON FILE?')                               BRZH7220
      READ(IR,101) ANS                                                  BRZH7225
  101 FORMAT(A1)                                                        BRZH7230
      IF (ANS .NE. YES) GO TO 102                                       BRZH7235
      WRITE(IW,103)                                                     BRZH7240
  103 FORMAT('0','ENTER OUTPUT DEVICE NUMBER IN I2 FORMAT:')            BRZH7245
      READ(IR,104) INW                                                  BRZH7250
  104 FORMAT(I2)                                                        BRZH7255
  102 WRITE(IW,105)                                                     BRZH7260
  105 FORMAT('0','ENTER TOTAL NUMBER OF OUTPUT VARIABLES',              BRZH7265
     1 ' (01-06):')                                                     BRZH7270
      READ(IR,104) ICOL                                                 BRZH7275
      WRITE(IW,106)                                                     BRZH7280
  106 FORMAT('0','ENTER NUMBERS OF VARIABLES YOU WANT'/' ',             BRZH7285
     1 'SEPARATE NUMBERS BY COMMAS-(01,84)')                            BRZH7290
      READ(IR,107) (NCOL(I),I=1,ICOL)                                  BRZH7295
  107 FORMAT(24(I2,1X))                                                 BRZH7300
      DO 502 I=1,ICOL                                                   BRZH7305
  502 NCOL(I)=NCOL(I)+1                                                 BRZH7310
C                                                                       BRZH7315
C  **  NCOL HAS NUMBERS OF VARIABLES TO BE OUTPUT                       BRZH7320
C  **  SAVE FOR LATER USE                                              BRZH7325
C  **  READ IN TIME INCREMENT                                          BRZH7330
C                                                                       BRZH7335
      WRITE(IW,108)                                                     BRZH7340
  108 FORMAT('0','ENTER TIME INCREMENT TO BE PRINTED OUT')              BRZH7345
      READ(IR,109) WINX2                                                BRZH7350
  109 FORMAT(F6.4)                                                      BRZH7355
      WINX2=WINX2/.01                                                   BRZH7360
      IF (ICOL .LT. 7) GO TO 7                                          BRZH7365
  200 CONTINUE                                                          BRZH7370
      WRITE(IW,901)                                                     BRZH7375
  901 FORMAT('ERROR: NUMBER OF VARIABLES TOO HIGH')                     BRZH7380
      GO TO 102                                                         BRZH7385
C                                                                       BRZH7390
C  **  PRINT ARRAY DIMENSIONED                                         BRZH7395
C                                                                       BRZH7400
C  **  CONTINUE WITH FINAL CALCULATIONS                                BRZH7405
C                                                                       BRZH7410
    7 IF (INW .EQ. 0) GO TO 201                                         BRZH7415
      INW1=IW                                                           BRZH7420
      IW=INW                                                            BRZH7425
  201 ACY=DERY(4)+Y(2)*Y(6)                                             BRZH7430
      ACX=DERY(2)-Y(4)*Y(6)                                             BRZH7435
      DO 700 I=1,4                                                      BRZH7440
      K=2*I                                                             BRZH7445
  700 DERX(I)=DERY(K)                                                   BRZH7450
C                                                                       BRZH7455
      XAREEZ=TAREEZ                                                     BRZH7460
C                                                                       BRZH7465
      IF(IDUMP.EQ.1)PRMT(5)=6.                                          BRZH7470
      IF (Y(2) .GT. 0.) GO TO 19                                        BRZH7475
      PRMT(5)=4.                                                        BRZH7480
      XDOFF=X                                                           BRZH7485
      GO TO 1                                                           BRZH7490
C                                                                       BRZH7495
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C  **  SIDE SLIP + TURN RAD.                                                  BRZH7500
C                                                                            BRZH7505
   19 CONTINUE                                                               BRZH7510
C                                                                            BRZH7515
C                                                                            BRZH7520
      DENOM=(Y(2)*(DERY(4)+Y(2)*Y(6)))-(Y(4)*(DERY(2)-Y(4)*Y(6)))            BRZH7525
      IF (DENOM .EQ. 0) GO TO 22                                             BRZH7530
      RADIUS=((Y(2)*Y(2))+(Y(4)*Y(4)))**(1.5)/DENOM                          BRZH7535
      GO TO 23                                                               BRZH7540
   22 RADIUS=0.                                                              BRZH7545
   23 IF (Y(2) .EQ. 0.) GO TO 27                                             BRZH7550
      IF (ABS(Y(4)/Y(2)) .GT. .2) GO TO 220                                  BRZH7555
      SSLIP=Y(4)/Y(2)                                                        BRZH7560
      GO TO 29                                                               BRZH7565
  220 SSLIP = ATAN(Y(4)/Y(2))                                                BRZH7570
      GO TO 29                                                               BRZH7575
   27 SSLIP=3.14159/2.                                                       BRZH7580
   29 CONTINUE                                                               BRZH7585
      SSLIP =SSLIP*57.295                                                    BRZH7590
C                                                                            BRZH7595
C  **  CONTINUE?                                                             BRZH7600
C                                                                            BRZH7605
      IF (X .GE. TIMF) GO TO 1                                               BRZH7610
      IF (X .GE. (WINX*0.01)) GO TO 1                                        BRZH7615
      IF(IDUMP.EQ.1)GO TO 1                                                  BRZH7620
      IF (INW .NE. 0) IW=INW1                                                BRZH7625
      RETURN                                                                 BRZH7630
    1 WINX=WINX+WINX2                                                        BRZH7635
      LINE=LINE+1                                                            BRZH7640
C                                                                            BRZH7645
C  **  CONVERT RADIANS TO DEGREES                                            BRZH7650
C                                                                            BRZH7655
      PHI=Y(5)*57.295                                                        BRZH7660
      PSI=Y(7)*57.295                                                        BRZH7665
      PHID=Y(6)*57.295                                                       BRZH7670
      PSID=Y(8)*57.295                                                       BRZH7675
      DO 1714 I=1,13                                                         BRZH7680
      IF(I.GT.4.AND.I.LT.7.AND.KEY(1).LT.1)GO TO 1714                        BRZH7685
      IF(I.GT.8.AND.KEY(3).LT.1)GO TO 1714                                   BRZH7690
      ALPHA(I)=ALPHA(I)*57.295                                               BRZH7695
 1714 CONTINUE                                                               BRZH7700
      IF (Y(2) .LT. 0.00) Y(2)=0.                                            BRZH7705
C                                                                            BRZH7710
C  **  BEGIN OUTPUT SET UP                                                   BRZH7715
C  **  ICOL HAS NUMBER OF OUTPUT VARIABLES TO BE PRINTED                     BRZH7720
C  **  NCOL HAS NUMBER OF VARIABLES                                          BRZH7725
C  **  PRINT IS 2 DIMENSIONAL ARRAY, K*ICOL                                  BRZH7730
C  **  WHERE K IS NUMBER OF LINES,DETERMINED BE LENGTH OF RUN.               BRZH7735
C                                                                            BRZH7740
      PRINT(LINE,1)=X                                                        BRZH7745
      PRINT(LINE,2)=Y(1)                                                     BRZH7750
      PRINT(LINE,3)=Y(3)                                                     BRZH7755
      PRINT(LINE,4)=PHI                                                      BRZH7760
      PRINT(LINE,5)=PSI                                                      BRZH7765
      PRINT(LINE,6)=Y(2)                                                     BRZH7770
      PRINT(LINE,7)=Y(4)                                                     BRZH7775
      PRINT(LINE,8)=PHID                                                     BRZH7780
      PRINT(LINE,9)=PSID                                                     BRZH7785
      PRINT(LINE,10)=RADIUS                                                  BRZH7790
      PRINT(LINE,11)=SSLIP                                                   BRZH7795
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      PRINT(LINE,12)=ALPHA(1)                                                  BRZH7800
      PRINT(LINE,13)=ALPHA(3)                                                  BRZH7805
      PRINT(LINE,14)=ALPHA(5)                                                  BRZH7810
      PRINT(LINE,15)=ALPHA(7)                                                  BRZH7815
      PRINT(LINE,16)=ALPHA(9)                                                  BRZH7820
      PRINT(LINE,17)=DERY(2)                                                   BRZH7825
      PRINT(LINE,18)=DERY(4)                                                   BRZH7830
      PRINT(LINE,19)=DERY(6)*57.295                                            BRZH7835
      PRINT(LINE,20)=DERY(8)*57.295                                            BRZH7840
      PRINT(LINE,21)=ACX                                                       BRZH7845
      PRINT(LINE,22)=ACY                                                       BRZH7850
      DO 50 I=1,10                                                             BRZH7855
      DUAL=0.0                                                                 BRZH7860
      IF(I.GT.2.AND.I.LT.7.AND.KEY(2).GT.0)DUAL=1.0                            BRZH7865
      IF(I.GT.6.AND.KEY(4).GT.0)DUAL=1.0                                       BRZH7870
      PRINT(LINE,22+I)=FX(I)                                                   BRZH7875
      PRINT(LINE,32+I)=FY(I)                                                   BRZH7880
      PRINT(LINE,42+I)=DFZ(I)                                                  BRZH7885
      PRINT(LINE,52+I)=DELFZ(I)                                                BRZH7890
      PRINT(LINE,62+I)=FZ(I)*(DUAL+1.)                                         BRZH7895
      PRINT(LINE,72+I)=FSX(I)                                                  BRZH7900
   50 CONTINUE                                                                 BRZH7905
      PRINT(LINE,83)=XL                                                        BRZH7910
      PRINT(LINE,84)=YL                                                        BRZH7915
      PRINT(LINE,85)=TBREEZ                                                    BRZH7920
C                                                                              BRZH7925
C  **  OUTPUT ARRAY NOW SET UP                                                 BRZH7930
C                                                                              BRZH7935
C  **  GET READY TO PRINT                                                      BRZH7940
C                                                                              BRZH7945
      LIN=2                                                                    BRZH7950
      KIN=7                                                                    BRZH7955
      SUBPG=PAGE                                                               BRZH7960
      IF (ABS(PSI) .LT. IQUIT) GO TO 453                                       BRZH7965
      IF(INW.EQ.IPLOT)GO TO 2000                                               BRZH7970
      WRITE(IW,454) X,PSI                                                      BRZH7975
  454 FORMAT('0','***COMPUTATIONS ARE STOPPED**'/' ','*** TIME IS ',F6.2BRZH7980
     1,' SECONDS ***'/' ','***ARTIC. ANGLE IS ',F6.2,' DEGREES ***')       BRZH7985
      GO TO 300                                                                BRZH7990
  453 CONTINUE                                                                 BRZH7995
      IF (Y(2) .LE. 0.0) GO TO 300                                             BRZH8000
      IF ((X+.02) .GE. TIME) GO TO 300                                         BRZH8005
      IF(IDUMP.EQ.1)GO TO 300                                                  BRZH8010
      IF (INW .NE. 0) IW=INW1                                                  BRZH8015
      RETURN                                                                   BRZH8020
  300 CONTINUE                                                                 BRZH8025
      IF(INW.EQ.IPLOT)GO TO 2000                                               BRZH8030
      WRITE(IW,401) TITLE(1),(TITLE(NCOL(J)),J=1,ICOL)                         BRZH8035
 2000 CONTINUE                                                                 BRZH8040
      IF(INW.NE.IPLOT)GO TO 2009                                               BRZH8045
      WRITE(IW,2002)                                                           BRZH8050
 2002 FORMAT(3X,'-1.00')                                                       BRZH8055
      WRITE(INW1,2011)                                                         BRZH8060
 2011 FORMAT('&MULTIPLE PLOT 2=8? ')                                           BRZH8065
      READ(IR,101)ANS                                                          BRZH8070
      IF(ANS.EQ.YES)GO TO 2009                                                 BRZH8075
      WRITE(IW,104)ICOL                                                        BRZH8080
      WRITE(IW,107)(NCOL(I),I=1,ICOL)                                          BRZH8085
 2009 CONTINUE                                                                 BRZH8090
      DO 257 K=1,LINE                                                          BRZH8095
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      GO TO (251,252,253,254,255,256),ICOL                              BRZH8100
  251 WRITE(IW,403) PRINT(K,1),(PRINT(K,NCOL(J)),J=1,ICOL)              BRZH8105
      GO TO 257                                                         BRZH8110
  252 WRITE(IW,404) PRINT(K,1),(PRINT(K,NCOL(J)),J=1,ICOL)              BRZH8115
      GO TO 257                                                         BRZH8120
  253 WRITE(IW,405) PRINT(K,1),(PRINT(K,NCOL(J)),J=1,ICOL)              BRZH8125
      GO TO 257                                                         BRZH8130
  254 WRITE(IW,406) PRINT(K,1),(PRINT(K,NCOL(J)),J=1,ICOL)              BRZH8135
      GO TO 257                                                         BRZH8140
  255 WRITE(IW,407) PRINT(K,1),(PRINT(K,NCOL(J)),J=1,ICOL)              BRZH8145
      GO TO 257                                                         BRZH8150
  256 WRITE(IW,408) PRINT(K,1),(PRINT(K,NCOL(J)),J=1,ICOL)              BRZH8155
  257 CONTINUE                                                          BRZH8160
      IF(INW.NE.0)IW=INW1                                               BRZH8165
      WRITE(IW,450)                                                     BRZH8170
  450 FORMAT('0','DO YOU WANT ANY MORE OUTPUT?')                        BRZH8175
      READ(IR,101) ANS                                                  BRZH8180
      IF (ANS .NE. YES) GO TO 301                                       BRZH8185
      WRITE(IW,105)                                                     BRZH8190
      READ(IR,104) ICOL                                                 BRZH8195
      WRITE(IW,106)                                                     BRZH8200
      READ(IR,107) (NCOL(I),I=1,ICOL)                                  BRZH8205
      DO 503 I=1,ICOL                                                   BRZH8210
  503 NCOL(I)=NCOL(I)+1                                                 BRZH8215
      IF(INW.NE.0)IW=INW                                                BRZH8220
      GO TO 300                                                         BRZH8225
  301 CONTINUE                                                          BRZH8230
      PRMT(5)=1.                                                        BRZH8235
      IF (Y(2) .LE. 0.0) PRMT(5)=4.                                     BRZH8240
      IF(IDUMP.EQ.1)PRMT(5)=6.                                          BRZH8245
      IF (INW .NE. 0) IW=INW1                                           BRZH8250
      RETURN                                                            BRZH8255
C                                                                       BRZH8260
C  **  FORMATS                                                          BRZH8265
C                                                                       BRZH8270
  401 FORMAT('1',7(2X,A8))                                              BRZH8275
  402 FORMAT(F10.2)                                                     BRZH8280
  403 FORMAT(2F10.2)                                                    BRZH8285
  404 FORMAT(3F10.2)                                                    BRZH8290
  405 FORMAT(4F10.2)                                                    BRZH8295
  406 FORMAT(5F10.2)                                                    BRZH8300
  407 FORMAT(6F10.2)                                                    BRZH8305
  408 FORMAT(7F10.2)                                                    BRZH8310
      END                                                               BRZH8315
C                                                                       BRZH8320
C                                                                       BRZH8325
C  ***********************************************************          BRZH8330
      SUBROUTINE TIRE(Y)                                                BRZH8335
C  ***********************************************************          BRZH8340
C                                                                       BRZH8345
C                                                                       BRZH8350
      DIMENSION Y(8),PRMT(5),DERY(8),AUX(16,8),CIA(10),FZ(10),FSX(10),  BRZH8355
     1          DFZ(10),DELFZ(10),FX(10),FY(10)                         BRZH8360
      REAL MU,MUS,M1,M2,I1,I2,MUS,MUT(10),MUSLOP,MUX,MUMOD(10),IQUIT    BRZH8365
      COMMON    W1,W2,M1,M2,A,B,C,D,H,ZA,Z1,Z2,GAM1,GAM2,MUS,RADS,DELTA,BRZH8370
     1          T1,T2,T3,CIA,FSX,FZ,INIT,I1,I2,DERX(4),FBZ(10),ALPHA(10)BRZH8375
     2.         ,WINX,FY,DFZ,DELFZ,TIME,FX,DKEY,VEL,AAA,AAT,KEY(4),     BRZH8380
     3          MU(10),ANTEFF(10,2),IDUMP,XDUMP,XDOFF,MUS(10),KEYANT(3),BRZH8385
     5          MUSLOP(10),BFT(15,7),ITAB,IXON,ITABS,STEER(25,2),ISAV,  BRZH8390
     6          GAM3,GAM4,TRUCK,IQUIT                                   BRZH8395
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      COMMON    /IO/IR,IW                                                  BRZH8400
C                                                                          BRZH8405
C                                                                          BRZH8410
C                                                                          BRZH8415
      IAX=1                                                                BRZH8420
      IF(Y(2) .LT. 5.0) RETURN                                             BRZH8425
      DO 500 K=1,5                                                         BRZH8430
C TANDEM AXLES                                                             BRZH8435
      IF(K.EQ.3.AND.KEY(1).LT.1)GO TO 500                                  BRZH8440
      IF(K.EQ.5.AND.KEY(3).LT.1)GO TO 500                                  BRZH8445
      II1=2*K-1                                                            BRZH8450
      II2=2*K                                                              BRZH8455
C DUAL TIRES                                                               BRZH8460
      DUAL=0.0                                                             BRZH8465
      IF(K.GT.1.AND.K.LT.4.AND.KEY(2).GT.0)DUAL=1.0                        BRZH8470
      IF(K.GT.3.AND.KEY(4).GT.0)DUAL=1.0                                   BRZH8475
C WHEELS 1 AND 2 ARE IN GROUP 1; 3-6 ARE IN GROUP 2; 7-10 ARE              BRZH8480
C IN GROUP 3.                                                              BRZH8485
      IF(K.GT.1)IAX=2                                                      BRZH8490
      IF(K.GT.3)IAX=3                                                      BRZH8495
C                                                                          BRZH8500
C  ANTILOCK OPTIONS                                                        BRZH8505
C                                                                          BRZH8510
   14 CONTINUE                                                             BRZH8515
      II=2                                                                 BRZH8520
      DO 141 I=II1,II2                                                     BRZH8525
      GO TO 201                                                            BRZH8530
  141 CONTINUE                                                             BRZH8535
      GO TO 500                                                            BRZH8540
C                                                                          BRZH8545
C TIRE FORCES                                                              BRZH8550
C                                                                          BRZH8555
  201 CONTINUE                                                             BRZH8560
C FOR 2 TIRES IF DUAL                                                      BRZH8565
      FX(I)=-FSX(I)                                                        BRZH8570
      ALFBAR=CIA(I)*ALPHA(I)/(MU(I)*FZ(I))                                 BRZH8575
      IF(ABS(ALFBAR).GE.3.)GO TO 205                                       BRZH8580
      FY(I)=-MU(I)*FZ(I)*(ALFBAR-(ALFBAR*ABS(ALFBAR))/3.                   BRZH8585
     1 +(ALFBAR**3)/27.)*(1.+DUAL)                                         BRZH8590
      GO TO 206                                                            BRZH8595
  205 SGN=1.0                                                              BRZH8600
      IF(ALFBAR.LT.0.)SGN=-1.0                                             BRZH8605
      FY(I)=-MU(I)*FZ(I)*(1.+DUAL)*SGN                                     BRZH8610
  206 CONTINUE                                                             BRZH8615
      MUMOD(I)=MU(I)*(1.0-1.72*ABS(ALPHA(I)))                              BRZH8620
      IF(MUMOD(I).LT.MUS(I)*COS(ALPHA(I)))MUMOD(I)=MUS(I)*COS(ALPHA(I))    BRZH8625
      IF(ABS(FX(I)).GE.MUMOD(I)*FZ(I)*(1.+DUAL))GO TO 202                  BRZH8630
      MUX=-(FX(I)/(1.+DUAL))/FZ(I)                                         BRZH8635
      S=(MUX/MU(I))*MUSLOP(I)                                              BRZH8640
      FY(I)=FY(I)*FSLIP(S)                                                 BRZH8645
      GO TO 141                                                            BRZH8650
  202 CONTINUE                                                             BRZH8655
      IGOTO=KEYANT(IAX)+1                                                  BRZH8660
      GO TO (203,204,204,204,204),IGOTO                                    BRZH8665
  203 CONTINUE                                                             BRZH8670
      FX(I)=-MUS(I)*FZ(I)*COS(ALPHA(I))*(1.+DUAL)                          BRZH8675
      FY(I)=-MUS(I)*FZ(I)*SIN(ALPHA(I))*(1.+DUAL)                          BRZH8680
      GO TO 141                                                            BRZH8685
  204 CONTINUE                                                             BRZH8690
      DELTA1=FY(I)+MUS(I)*FZ(I)*SIN(ALPHA(I))*(1.+DUAL)                    BRZH8695
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      FY(I)=-MUS(I)*FZ(I)*SIN(ALPHA(I))*(1.+DUAL)+ANTEFF(I,1)*DELTA1     BRZH8700
      DELTA2=(MUS(I)*COS(ALPHA(I))-MU(I))*FZ(I)                          BRZH8705
      FX(I)=(-MUS(I)*FZ(I)*COS(ALPHA(I))+ANTEFF(I,2)*DELTA2)*(1.+DUAL)   BRZH8710
      GO TO 141                                                          BRZH8715
  500 CONTINUE                                                           BRZH8720
      RETURN                                                             BRZH8725
      END                                                                BRZH8730
C                                                                        BRZH8735
C                                                                        BRZH8740
C  ***********************************************************           BRZH8745
      FUNCTION FSLIP(S)                                                  BRZH8750
C  ***********************************************************           BRZH8755
C                                                                        BRZH8760
C                                                                        BRZH8765
      DIMENSION F(6),FDIFF(6),SLIP(6)                                    BRZH8770
      COMMON    /IO/ IR,IW                                               BRZH8775
      DATA      YES /'Y'/                                                BRZH8780
      DATA      SLIP /0.,.05,.10,.15,.20,.25/                            BRZH8785
      DATA      F /1.0,.88,.64,.46,.33,.26/                              BRZH8790
      DATA      INITIA /0/                                               BRZH8795
C                                                                        BRZH8800
C                                                                        BRZH8805
      IF(INITIA.GT.0)GO TO 10                                            BRZH8810
      WRITE(IW,900)                                                      BRZH8815
  900 FORMAT('$WOULD YOU LIKE TO ENTER NEW SLIP ROLL-OFF TABLE?')        BRZH8820
      READ(IR,800) ANS                                                   BRZH8825
  800 FORMAT(A1)                                                         BRZH8830
      IF(ANS.NE.YES)GO TO 1                                              BRZH8835
      WRITE(IW,901)                                                      BRZH8840
  901 FORMAT('ENTER F(S) FOR SLIPS OF 0.0,.05,.10,.15,.20,.25'/          BRZH8845
     1 'SEPARATE 6 NUMBERS BY COMMAS.')                                  BRZH8850
      READ(IR,801)(F(I),I=1,6)                                           BRZH8855
  801 FORMAT(6F10.0)                                                     BRZH8860
    1 CONTINUE                                                           BRZH8865
      SDIFF=.05                                                          BRZH8870
      FDIFF(1)=0.                                                        BRZH8875
      DO 5 I=1,5                                                         BRZH8880
      J=I+1                                                              BRZH8885
    5 FDIFF(J)=F(J)-F(I)                                                 BRZH8890
      INITIA=1                                                           BRZH8895
   10 CONTINUE                                                           BRZH8900
      DO 20 I=1,10                                                       BRZH8905
      IF(S.EQ.SLIP(I))GO TO 30                                           BRZH8910
      IF(S.LT.SLIP(I))GO TO 25                                           BRZH8915
   20 CONTINUE                                                           BRZH8920
   25 IM1=I-1                                                            BRZH8925
      FSLIP=F(IM1)+(S-SLIP(IM1))*FDIFF(I)/SDIFF                          BRZH8930
      RETURN                                                             BRZH8935
   30 FSLIP=F(I)                                                         BRZH8940
      RETURN                                                             BRZH8945
      END                                                                BRZH8950
C                                                                        BRZH8955
C                                                                        BRZH8960
C  ***********************************************************           BRZH8965
      SUBROUTINE EXPLAN(NUMBER,ISHOW)                                    BRZH8970
C  ***********************************************************           BRZH8975
C                                                                        BRZH8980
C                                                                        BRZH8985
      COMMON /IO/ IR,IW                                                  BRZH8990
      DATA   YES /'Y'/                                                   BRZH8995
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C                                                                       BRZH9000
C                                                                       BRZH9005
      GO TO (1,12,13,14,15,16,17,18,19),NUMBER                          BRZH9010
    1 WRITE(IW,1000)                                                    BRZH9015
      RETURN                                                            BRZH9020
 1000 FORMAT('     SINCE THE "EXPLANATION OPTION" HAS BEEN REQUESTED,'/  BRZH9025
     1 ' SUPPLEMENTARY INFORMATION IS PRINTED THE FIRST TIME THROUGH'/   BRZH9030
     2 ' THE EXECUTION OF THE PROGRAM TO AID THE USER IN UNDERSTAND-'/   BRZH9035
     3 ' ING THE PROGRAM.'/                                             BRZH9040
     5 '     IN RESPONDING TO ANY QUESTION FOLLOWING, A YES-RESPONSE'/  BRZH9045
     6 ' WILL BE ASSUMED IF THE FIRST LETTER OF THE RESPONSE IS "Y."'/   BRZH9050
     7 ' ANY OTHER RESPONSE WILL BE ASSUMED NO.'/)                      BRZH9055
   12 WRITE(IW,12000)                                                   BRZH9060
12000 FORMAT(/' BY ENTERING "Y", THE VALUE ENTERED FOR EACH PAR-'/      BRZH9065
     1 ' AMETER IS PRECEDED BY ITS IDENTIFYING PARAMETER NUMBER, ITS'/  BRZH9070
     2 ' ABBREVIATION, AND ITS VERBAL DESCRIPTION,'/                    BRZH9075
     3 '&ENTER RESPONSE:'/)                                             BRZH9080
      RETURN                                                            BRZH9085
   13 WRITE(IW,13000)                                                   BRZH9090
13000 FORMAT(' IDENTICAL ANTILOCK SYSTEMS ARE ASSUMED FOR TANDEM'/      BRZH9095
     1 '&AXLES.  ENTER ANTILOCK CODE:')                                 BRZH9100
      RETURN                                                            BRZH9105
   14 WRITE(IW,14000)                                                   BRZH9110
      WRITE(IW,14500)                                                   BRZH9115
14000 FORMAT(/'     TIRE PARAMETERS AND I.D. NUMBERS:'/                 BRZH9120
     + ' NUMBERS IN PARENTHESES ASSOCIATED WITH TIRE PROPER-'/           BRZH9125
     1 ' TIES CALF, MUP, MUS, AND SP REFER TO A PARTICULAR TIRE.'/      BRZH9130
     2 ' THE TIRES ARE NUMBERED AS FOLLOWS:'/                           BRZH9135
     3 ' 1 AND 2:  TRACTOR LEFT FRONT AND RIGHT FRONT,RESPECTIVELY.'/   BRZH9140
     4 ' 3 AND 4:  TRACTOR LEFT REAR AND RIGHT REAR, RESPECTIVELY.'/    BRZH9145
     5 ' IF THE TRACTOR HAS TANDEM AXLES, 3 AND 4 ARE THE LEFT AND'/    BRZH9150
     6 ' RIGHT TIRES, RESPECTIVELY, ON THE LEADING TANDEM.'/            BRZH9155
     7 ' 5 AND 6:  TRACTOR LEFT TRAILING TANDEM AND RIGHT TRAILING'/    BRZH9160
     8 ' TANDEM, RESPECTIVELY.  5 AND 6 ARE IGNORED IF SINGLE AXLE'/    BRZH9165
     D ' ON TRACTOR REAR.'/                                             BRZH9170
     9 ' 7 AND 8:  TRAILER LEFT AND RIGHT, RESPECTIVELY.  IF THE '/     BRZH9175
     A ' TRAILER HAS TANDEM AXLES, 7 AND 8 ARE THE LEFT AND RIGHT'/     BRZH9180
     B ' TIRES, RESPECTIVELY, ON THE LEADING TANDEM.')                  BRZH9185
14500 FORMAT(                                                           BRZH9190
     1 ' 9 AND 10: TRAILER LEFT TRAILING TANDEM AND RIGHT TRAILING'/    BRZH9195
     2 ' TANDEM, RESPECTIVELY.  9 AND 10 ARE IGNORED IF SINGLE AXLE'/   BRZH9200
     3 ' ON TRAILER.'//                                                 BRZH9205
     9 ' VALUES ARE ENTERED PER TIRE, EVEN IF DUALS ARE INDICATED.'/    BRZH9210
     A ' TIRES 1 AND 2 ARE ASSUMED EQUIVALENT; TIRES 3, 4, 5, AND'/     BRZH9215
     B ' 6 ARE ASSUMED EQUIVALENT; AND TIRES 7, 8, 9, AND 10 ARE '/     BRZH9220
     E ' ASSUMED EQUIVALENT.  IF SINGLE MU-SLIP CURVE IS OPTED,'/       BRZH9225
     C ' TIRES 1 TO 10 HAVE THE SAME MU-SLIP CURVE.  IN THIS '/         BRZH9230
     D ' CASE VALUES FOR TIRE 1, ONLY, ARE ENTERED.'/)                  BRZH9235
      RETURN                                                            BRZH9240
   15 WRITE(IW,15000)                                                   BRZH9245
15000 FORMAT(/'     BRAKE FORCE TABLE:'/                                BRZH9250
     + ' AT LEAST ONE LINE MUST BE ENTERED.  THE INITIAL TIME'/         BRZH9255
     1 ' MUST BE AT TIME T=0.  BRAKES ARE NUMBERED IN THE SAME '/       BRZH9260
     2 ' MANNER AS ARE TIRES.  BRAKES 3 AND 5 ARE EQUIVALENT AS ARE'/   BRZH9265
     3 ' 4 AND 6 (THOUGH BRAKES 5 AND 6 ARE IGNORED IF THE TRACTOR'/    BRZH9270
     4 ' HAS A SINGLE REAR AXLE).  THEREFORE, TABULAR DATA IS'/         BRZH9275
     5 ' NOT ENTERED FOR BRAKES 5 AND 6.  THE SAME IS TRUE FOR THE'/    BRZH9280
     6 ' TRAILER BRAKES.  TABULAR DATA IS ENTERED FOR BRAKES 7 AND'/    BRZH9285
     7 ' 8 ONLY.  BRAKES 9 AND 10 ARE ASSUMED IDENTICAL TO BRAKES'/     BRZH9290
     8 ' 7 AND 8, RESPECTIVELY, OR IGNORED IF THE TRAILER HAS A '/      BRZH9295
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     9 ' SINGLE AXLE,  LINE 1 FOR A STEP BRAKE INPUT WITHOUT SIDE'/      BRZH9300
     A ' TO SIDE IMBALANCE MAY BE: 0.,0.,0.,1000.,1000.,1500.,1500.')    BRZH9305
       RETURN                                                            BRZH9310
    16 WRITE(IW,16000)                                                   BRZH9315
16000 FORMAT(/'     STEER TABLE:'/                                       BRZH9320
     + ' AT LEAST ONE LINE MUST BE ENTERED, AND THE FIRST LINE'/         BRZH9325
     1 ' MUST BE AT TIME T=0.  EACH LINE CONTAINS THE TIME FOLLOWED'/    BRZH9330
     2 ' BY THE AVERAGE STEER ANGLE (IN DEGREES) OF THE TRACTOR'/        BRZH9335
     3 ' FRONT WHEELS.')                                                 BRZH9340
       RETURN                                                            BRZH9345
    17 WRITE(IW,17000)                                                   BRZH9350
17000 FORMAT(/' IF YOU ANSWER "Y" TO THIS QUESTION,  YOU MAY ENTER A'/   BRZH9355
     1 ' WHOLE NEW DATA SET OR ELSE TERMINATE THE PROGRAM,  ANY '/       BRZH9360
     2 ' OTHER RESPONSE WILL ALLOW YOU TO CHANGE ANY OF THE INPUT'/      BRZH9365
     3 ' DATA WITHOUT ENTERING A WHOLE NEW DATA SET.'/                   BRZH9370
     4 '&ENTER RESPONSE:')                                               BRZH9375
       ISHOW=0                                                           BRZH9380
       RETURN                                                            BRZH9385
    18 WRITE(IW,18000)                                                   BRZH9390
18000 FORMAT(/' A "Y"-RESPONSE WILL ALLOW YOU TO ENTER AN INITIAL '/     BRZH9395
     1 ' ARTIC. ANGLE WHEN YOU CHANGE PARAMETERS.  OTHERWISE, THE'/      BRZH9400
     2 ' INITIAL ARTIC. ANGLE WILL BE ASSUMED 0.'/'&ENTER RESPONSE:')    BRZH9405
       RETURN                                                            BRZH9410
    19 WRITE(IW,19000)                                                   BRZH9415
19000 FORMAT(/'     ANTILOCK EFFECTIVENESS:'/                            BRZH9420
     + ' TWO COEFFICIENTS ARE ENTERED HERE--THE LATERAL COEF-'/          BRZH9425
     1 'FICIENT, FOLLOWED BY THE LONGITUDINAL COEFFICIENT.')             BRZH9430
       RETURN                                                            BRZH9435
       END                                                               BRZH9440
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C                                                                       HPCG  10
C                                                                       HPCG  20
C     ...................................................................HPCG  30
C                                                                       HPCG  40
C        SUBROUTINE HPCG                                                HPCG  50
C                                                                       HPCG  60
C        PURPOSE                                                        HPCG  70
C           TO SOLVE A SYSTEM OF FIRST ORDER ORDINARY GENERAL           HPCG  80
C           DIFFERENTIAL EQUATIONS WITH GIVEN INITIAL VALUES.           HPCG  90
C                                                                       HPCG 100
C        USAGE                                                          HPCG 110
C           CALL HPCG (PRMT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX)              HPCG 120
C           PARAMETERS FCT AND OUTP REQUIRE AN EXTERNAL STATEMENT.      HPCG 130
C                                                                       HPCG 140
C        DESCRIPTION OF PARAMETERS                                      HPCG 150
C           PRMT    - AN INPUT AND OUTPUT VECTOR WITH DIMENSION GREATER HPCG 160
C                     OR EQUAL TO 5, WHICH SPECIFIES THE PARAMETERS OF  HPCG 170
C                     THE INTERVAL AND OF ACCURACY AND WHICH SERVES FOR HPCG 180
C                     COMMUNICATION BETWEEN OUTPUT SUBROUTINE (FURNISHED HPCG 190
C                     BY THE USER) AND SUBROUTINE HPCG, EXCEPT PRMT(5)  HPCG 200
C                     THE COMPONENTS ARE NOT DESTROYED BY SUBROUTINE    HPCG 210
C                     HPCG AND THEY ARE                                 HPCG 220
C           PRMT(1)- LOWER BOUND OF THE INTERVAL (INPUT).               HPCG 230
C           PRMT(2)- UPPER BOUND OF THE INTERVAL (INPUT).               HPCG 240
C           PRMT(3)- INITIAL INCREMENT OF THE INDEPENDENT VARIABLE      HPCG 250
C                    (INPUT).                                           HPCG 260
C           PRMT(4)- UPPER ERROR BOUND (INPUT). IF ABSOLUTE ERROR IS    HPCG 270
C                    GREATER THAN PRMT(4), INCREMENT GETS HALVED.       HPCG 280
C                    IF INCREMENT IS LESS THAN PRMT(3) AND ABSOLUTE     HPCG 290
C                    ERROR LESS THAN PRMT(4)/50, INCREMENT GETS DOUBLED.HPCG 300
C                    THE USER MAY CHANGE PRMT(4) BY MEANS OF HIS        HPCG 310
C                    OUTPUT SUBROUTINE.                                 HPCG 320
C           PRMT(5)- NO INPUT PARAMETER. SUBROUTINE HPCG INITIALIZES    HPCG 330
C                    PRMT(5)=0. IF THE USER WANTS TO TERMINATE          HPCG 340
C                    SUBROUTINE HPCG AT ANY OUTPUT POINT, HE HAS TO     HPCG 350
C                    CHANGE PRMT(5) TO NON-ZERO BY MEANS OF SUBROUTINE  HPCG 360
C                    OUTP. FURTHER COMPONENTS OF VECTOR PRMT ARE        HPCG 370
C                    FEASIBLE IF ITS DIMENSION IS DEFINED GREATER       HPCG 380
C                    THAN 5. HOWEVER SUBROUTINE HPCG DOES NOT REQUIRE   HPCG 390
C                    AND CHANGE THEM. NEVERTHELESS THEY MAY BE USEFUL   HPCG 400
C                    FOR HANDING RESULT VALUES TO THE MAIN PROGRAM      HPCG 410
C                    (CALLING HPCG) WHICH ARE OBTAINED BY SPECIAL       HPCG 420
C                    MANIPULATIONS WITH OUTPUT DATA IN SUBROUTINE OUTP. HPCG 430
C           Y       - INPUT VECTOR OF INITIAL VALUES.  (DESTROYED)      HPCG 440
C                     LATERON Y IS THE RESULTING VECTOR OF DEPENDENT    HPCG 450
C                     VARIABLES COMPUTED AT INTERMEDIATE POINTS X.      HPCG 460
C           DERY    - INPUT VECTOR OF ERROR WEIGHTS.  (DESTROYED)       HPCG 470
C                     THE SUM OF ITS COMPONENTS MUST BE EQUAL TO 1.     HPCG 480
C                     LATERON DERY IS THE VECTOR OF DERIVATIVES, WHICH  HPCG 490
C                     BELONG TO FUNCTION VALUES Y AT A POINT X.         HPCG 500
C           NDIM    - AN INPUT VALUE, WHICH SPECIFIES THE NUMBER OF     HPCG 510
C                     EQUATIONS IN THE SYSTEM.                          HPCG 520
C           IHLF    - AN OUTPUT VALUE, WHICH SPECIFIES THE NUMBER OF    HPCG 530
C                     BISECTIONS OF THE INITIAL INCREMENT. IF IHLF GETS  HPCG 540
C                     GREATER THAN 10, SUBROUTINE HPCG RETURNS WITH     HPCG 550
C                     ERROR MESSAGE IHLF=11 INTO MAIN PROGRAM.          HPCG 560
C                     ERROR MESSAGE IHLF=12 OR IHLF=13 APPEARS IN CASE  HPCG 570
C                     PRMT(3)=0 OR IN CASE SIGN(PRMT(3)).NE.SIGN(PRMT(2)-HPCG 580
C                     PRMT(1)) RESPECTIVELY.                            HPCG 590
C           FCT     - THE NAME OF AN EXTERNAL SUBROUTINE USED. IT       HPCG 600
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C                COMPUTES THE RIGHT HAND SIDES DERY OF THE SYSTEM   HPCG 610
C                TO GIVEN VALUES OF X AND Y. ITS PARAMETER LIST     HPCG 620
C                MUST BE X,Y,DERY. THE SUBROUTINE SHOULD NOT        HPCG 630
C                DESTROY X AND Y.                                   HPCG 640
C           OUTP - THE NAME OF AN EXTERNAL OUTPUT SUBROUTINE USED,  HPCG 650
C                ITS PARAMETER LIST MUST BE X,Y,DERY,IHLF,NDIM,PRMT,HPCG 660
C                NONE OF THESE PARAMETERS (EXCEPT, IF NECESSARY,    HPCG 670
C                PRMT(4),PRMT(5),...) SHOULD BE CHANGED BY          HPCG 680
C                SUBROUTINE OUTP. IF PRMT(5) IS CHANGED TO NON-ZERO,HPCG 690
C                SUBROUTINE HPCG IS TERMINATED.                     HPCG 700
C           AUX  - AN AUXILIARY STORAGE ARRAY WITH 16 ROWS AND NDIM HPCG 710
C                COLUMNS.                                           HPCG 720
C                                                                   HPCG 730
C       REMARKS                                                     HPCG 740
C          THE PROCEDURE TERMINATES AND RETURNS TO CALLING PROGRAM, IF HPCG 750
C          (1) MORE THAN 10 BISECTIONS OF THE INITIAL INCREMENT ARE HPCG 760
C              NECESSARY TO GET SATISFACTORY ACCURACY (ERROR MESSAGE HPCG 770
C              IHLF=11),                                            HPCG 780
C          (2) INITIAL INCREMENT IS EQUAL TO 0 OR HAS WRONG SIGN    HPCG 790
C              (ERROR MESSAGES IHLF=12 OR IHLF=13),                 HPCG 800
C          (3) THE WHOLE INTEGRATION INTERVAL IS WORKED THROUGH,    HPCG 810
C          (4) SUBROUTINE OUTP HAS CHANGED PRMT(5) TO NON-ZERO,     HPCG 820
C                                                                   HPCG 830
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED               HPCG 840
C          THE EXTERNAL SUBROUTINES FCT(X,Y,DERY) AND               HPCG 850
C          OUTP(X,Y,DERY,IHLF,NDIM,PRMT) MUST BE FURNISHED BY THE USER,HPCG 860
C                                                                   HPCG 870
C       METHOD                                                      HPCG 880
C          EVALUATION IS DONE BY MEANS OF HAMMINGS MODIFIED PREDICTOR-HPCG 890
C          CORRECTOR METHOD. IT IS A FOURTH ORDER METHOD, USING 4   HPCG 900
C          PRECEEDING POINTS FOR COMPUTATION OF A NEW VECTOR Y OF THE HPCG 910
C          DEPENDENT VARIABLES.                                     HPCG 920
C          FOURTH ORDER RUNGE-KUTTA METHOD SUGGESTED BY RALSTON IS  HPCG 930
C          USED FOR ADJUSTMENT OF THE INITIAL INCREMENT AND FOR     HPCG 940
C          COMPUTATION OF STARTING VALUES.                          HPCG 950
C          SUBROUTINE HPCG AUTOMATICALLY ADJUSTS THE INCREMENT DURING HPCG 960
C          THE WHOLE COMPUTATION BY HALVING OR DOUBLING.            HPCG 970
C          TO GET FULL FLEXIBILITY IN OUTPUT, AN OUTPUT SUBROUTINE  HPCG 980
C          MUST BE CODED BY THE USER.                               HPCG 990
C          FOR REFERENCE, SEE                                       HPCG1000
C          (1)  RALSTON/WILF, MATHEMATICAL METHODS FOR DIGITAL      HPCG1010
C               COMPUTERS, WILEY, NEW YORK/LONDON, 1960, PP.95-109. HPCG1020
C          (2)  RALSTON, RUNGE-KUTTA METHODS WITH MINIMUM ERROR BOUNDS,HPCG1030
C               MTAC, VOL.16, ISS.80 (1962), PP.431-437.            HPCG1040
C                                                                   HPCG1050
C     ..............................................................HPCG1060
C                                                                   HPCG1070
      SUBROUTINE HPCG(PRMT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX)           HPCG1080
C                                                                   HPCG1090
C                                                                   HPCG1100
      DIMENSION PRMT(1),Y(1),DERY(1),AUX(16,1)                      HPCG1110
      N=1                                                           HPCG1120
      IHLF=0                                                        HPCG1130
      X=PRMT(1)                                                     HPCG1140
      H=PRMT(3)                                                     HPCG1150
      PRMT(5)=0.                                                    HPCG1160
      DO 1 I=1,NDIM                                                 HPCG1170
      AUX(16,I)=0.                                                  HPCG1180
      AUX(15,I)=DERY(I)                                             HPCG1190
    1 AUX(1,I)=Y(I)                                                 HPCG1200
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      IF(H*(PRMT(2)-X))3,2,4                                          HPCG1210
C                                                                     HPCG1220
C     ERROR RETURNS                                                   HPCG1230
    2 IHLF=12                                                         HPCG1240
      GOTO 4                                                          HPCG1250
    3 IHLF=13                                                         HPCG1260
C                                                                     HPCG1270
C     COMPUTATION OF DERY FOR STARTING VALUES                         HPCG1280
    4 CALL FCT(X,Y,DERY)                                              HPCG1290
C                                                                     HPCG1300
C     RECORDING OF STARTING VALUES                                    HPCG1310
      CALL OUTP(X,Y,DERY,IHLF,NDIM,PRMT)                              HPCG1320
      IF(PRMT(5))6,5,6                                                HPCG1330
    5 IF(IHLF)7,7,6                                                   HPCG1340
    6 RETURN                                                          HPCG1350
    7 DO 8 I=1,NDIM                                                   HPCG1360
    8 AUX(8,I)=DERY(I)                                                HPCG1370
C                                                                     HPCG1380
C     COMPUTATION OF AUX(2,I)                                         HPCG1390
      ISW=1                                                           HPCG1400
      GOTO 100                                                        HPCG1410
C                                                                     HPCG1420
    9 X=X+H                                                           HPCG1430
      DO 10 I=1,NDIM                                                  HPCG1440
   10 AUX(2,I)=Y(I)                                                   HPCG1450
C                                                                     HPCG1460
C     INCREMENT H IS TESTED BY MEANS OF BISECTION                     HPCG1470
   11 IHLF=IHLF+1                                                     HPCG1480
      X=X-H                                                           HPCG1490
      DO 12 I=1,NDIM                                                  HPCG1500
   12 AUX(4,I)=AUX(2,I)                                               HPCG1510
      H=.5*H                                                          HPCG1520
      N=1                                                             HPCG1530
      ISW=2                                                           HPCG1540
      GOTO 100                                                        HPCG1550
C                                                                     HPCG1560
   13 X=X+H                                                           HPCG1570
      CALL FCT(X,Y,DERY)                                              HPCG1580
      N=2                                                             HPCG1590
      DO 14 I=1,NDIM                                                  HPCG1600
      AUX(2,I)=Y(I)                                                   HPCG1610
   14 AUX(9,I)=DERY(I)                                                HPCG1620
      ISW=3                                                           HPCG1630
      GOTO 100                                                        HPCG1640
C                                                                     HPCG1650
C     COMPUTATION OF TEST VALUE DELT                                  HPCG1660
   15 DELT=0.                                                         HPCG1670
      DO 16 I=1,NDIM                                                  HPCG1680
   16 DELT=DELT+AUX(15,I)*ABS(Y(I)-AUX(4,I))                          HPCG1690
      DELT=.0666667*DELT                                              HPCG1700
      IF(DELT-PRMT(4))19,19,17                                        HPCG1710
   17 IF(IHLF-10)11,18,18                                             HPCG1720
C                                                                     HPCG1730
C     NO SATISFACTORY ACCURACY AFTER 10 BISECTIONS. ERROR MESSAGE.    HPCG1740
   18 IHLF=11                                                         HPCG1750
      X=X+H                                                           HPCG1760
      GOTO 4                                                          HPCG1770
C                                                                     HPCG1780
C     THERE IS SATISFACTORY ACCURACY AFTER LESS THAN 11 BISECTIONS.    HPCG1790
   19 X=X+H                                                           HPCG1800
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      CALL FCT(X,Y,DERY)                                                HPCG1810
      DO 20 I=1,NDIM                                                    HPCG1820
      AUX(3,I)=Y(I)                                                     HPCG1830
   20 AUX(10,I)=DERY(I)                                                 HPCG1840
      N=3                                                               HPCG1850
      ISW=4                                                             HPCG1860
      GOTO 100                                                          HPCG1870
C                                                                       HPCG1880
   21 N=1                                                               HPCG1890
      X=X+H                                                             HPCG1900
      CALL FCT(X,Y,DERY)                                                HPCG1910
      X=PRMT(1)                                                         HPCG1920
      DO 22 I=1,NDIM                                                    HPCG1930
      AUX(11,I)=DERY(I)                                                 HPCG1940
   22Y(I)=AUX(1,I)+H*(.375*AUX(8,I)+.7916667*AUX(9,I)                   HPCG1950
     1-.2083333*AUX(10,I)+.0416667*DERY(I))                             HPCG1960
   23 X=X+H                                                             HPCG1970
      N=N+1                                                             HPCG1980
      CALL FCT(X,Y,DERY)                                                HPCG1990
      CALL OUTP(X,Y,DERY,IHLF,NDIM,PRMT)                                HPCG2000
      IF(PRMT(5))6,24,6                                                 HPCG2010
   24 IF(N-4)25,200,200                                                 HPCG2020
   25 DO 26 I=1,NDIM                                                    HPCG2030
      AUX(N,I)=Y(I)                                                     HPCG2040
   26 AUX(N+7,I)=DERY(I)                                                HPCG2050
      IF(N-3)27,29,200                                                  HPCG2060
C                                                                       HPCG2070
   27 DO 28 I=1,NDIM                                                    HPCG2080
      DELT=AUX(9,I)+AUX(9,I)                                            HPCG2090
      DELT=DELT+DELT                                                    HPCG2100
   28 Y(I)=AUX(1,I)+.3333333*H*(AUX(8,I)+DELT+AUX(10,I))                HPCG2110
      GOTO 23                                                           HPCG2120
C                                                                       HPCG2130
   29 DO 30 I=1,NDIM                                                    HPCG2140
      DELT=AUX(9,I)+AUX(10,I)                                           HPCG2150
      DELT=DELT+DELT+DELT                                               HPCG2160
   30 Y(I)=AUX(1,I)+.375*H*(AUX(8,I)+DELT+AUX(11,I))                    HPCG2170
      GOTO 23                                                           HPCG2180
C                                                                       HPCG2190
C     THE FOLLOWING PART OF SUBROUTINE HPCG COMPUTES BY MEANS OF        HPCG2200
C     RUNGE-KUTTA METHOD STARTING VALUES FOR THE NOT SELF-STARTING      HPCG2210
C     PREDICTOR-CORRECTOR METHOD.                                       HPCG2220
  100 DO 101 I=1,NDIM                                                   HPCG2230
      Z=H*AUX(N+7,I)                                                    HPCG2240
      AUX(5,I)=Z                                                        HPCG2250
  101 Y(I)=AUX(N,I)+.4*Z                                                HPCG2260
C     Z IS AN AUXILIARY STORAGE LOCATION                                HPCG2270
C                                                                       HPCG2280
      Z=X+.4*H                                                          HPCG2290
      CALL FCT(Z,Y,DERY)                                                HPCG2300
      DO 102 I=1,NDIM                                                   HPCG2310
      Z=H*DERY(I)                                                       HPCG2320
      AUX(6,I)=Z                                                        HPCG2330
  102 Y(I)=AUX(N,I)+.2969776*AUX(5,I)+.1587596*Z                        HPCG2340
C                                                                       HPCG2350
      Z=X+.4557372*H                                                    HPCG2360
      CALL FCT(Z,Y,DERY)                                                HPCG2370
      DO 103 I=1,NDIM                                                   HPCG2380
      Z=H*DERY(I)                                                       HPCG2390
      AUX(7,I)=Z                                                        HPCG2400
```

```
  103 Y(I)=AUX(N,I)+.2181004*AUX(5,I)-3.050965*AUX(6,I)+3.832865*Z       HPCG2410
C                                                                       HPCG2420
      Z=X+H                                                             HPCG2430
      CALL FCT(Z,Y,DERY)                                                HPCG2440
      DO 104 I=1,NDIM                                                   HPCG2450
  104 Y(I)=AUX(N,I)+.1747603*AUX(5,I)-.5514807*AUX(6,I)                 HPCG2460
     1+1.205536*AUX(7,I)+.1711848*H*DERY(I)                             HPCG2470
      GOTO(9,13,15,21),ISW                                              HPCG2480
C                                                                       HPCG2490
C     POSSIBLE BREAK-POINT FOR LINKAGE                                  HPCG2500
C                                                                       HPCG2510
C     STARTING VALUES ARE COMPUTED.                                     HPCG2520
C     NOW START HAMMINGS MODIFIED PREDICTOR-CORRECTOR METHOD.           HPCG2530
  200 ISTEP=0
      ICT=3
  201 IF(N-8)204,202,204                                                HPCG2550
C                                                                       HPCG2560
C     N=8 CAUSES THE ROWS OF AUX TO CHANGE THEIR STORAGE LOCATIONS      HPCG2570
  202 DO 203 N=2,7                                                      HPCG2580
      DO 203 I=1,NDIM                                                   HPCG2590
      AUX(N-1,I)=AUX(N,I)                                               HPCG2600
  203 AUX(N+6,I)=AUX(N+7,I)                                             HPCG2610
      N=7                                                               HPCG2620
C                                                                       HPCG2630
C     N LESS THAN 8 CAUSES N+1 TO GET N                                 HPCG2640
  204 N=N+1                                                             HPCG2650
C                                                                       HPCG2660
C     COMPUTATION OF NEXT VECTOR Y                                      HPCG2670
      DO 205 I=1,NDIM                                                   HPCG2680
      AUX(N-1,I)=Y(I)                                                   HPCG2690
  205 AUX(N+6,I)=DERY(I)                                                HPCG2700
      X=X+H                                                             HPCG2710
  206 ISTEP=ISTEP+1                                                     HPCG2720
      ICT=ICT+1
      DO 207 I=1,NDIM                                                   HPCG2730
     0DELT=AUX(N-4,I)+1.333333*H*(AUX(N+6,I)+AUX(N+6,I)-AUX(N+5,I)+     HPCG2740
     1AUX(N+4,I)+AUX(N+4,I))                                            HPCG2750
      Y(I)=DELT-.9256198*AUX(16,I)                                      HPCG2760
  207 AUX(16,I)=DELT                                                    HPCG2770
C     PREDICTOR IS NOW GENERATED IN ROW 16 OF AUX, MODIFIED PREDICTOR   HPCG2780
C     IS GENERATED IN Y, DELT MEANS AN AUXILIARY STORAGE.               HPCG2790
C                                                                       HPCG2800
      CALL FCT(X,Y,DERY)                                                HPCG2810
C     DERIVATIVE OF MODIFIED PREDICTOR IS GENERATED IN DERY             HPCG2820
C                                                                       HPCG2830
      DO 208 I=1,NDIM                                                   HPCG2840
     0DELT=.125*(9.*AUX(N-1,I)-AUX(N-3,I)+3.*H*(DERY(I)+AUX(N+6,I)+     HPCG2850
     1AUX(N+6,I)-AUX(N+5,I)))                                           HPCG2860
      AUX(16,I)=AUX(16,I)-DELT                                          HPCG2870
  208 Y(I)=DELT+.9743017*AUX(16,I)                                      HPCG2880
C                                                                       HPCG2890
C     TEST WHETHER H MUST BE HALVED OR DOUBLED                          HPCG2900
      DELT=0.                                                           HPCG2910
      DO 209 I=1,NDIM                                                   HPCG2920
  209 DELT=DELT+AUX(15,I)*ABS(AUX(16,I))                                HPCG2930
      IF(DELT-PRMT(4))210,222,222                                       HPCG2940
C                                                                       HPCG2950
C     H MUST NOT BE HALVED, THAT MEANS Y(I) ARE GOOD.                   HPCG2960
  210 CALL FCT(X,Y,DERY)                                                HPCG2970
      CALL OUTP(X,Y,DERY,IHLF,NDIM,PRMT)                                HPCG2980
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      IF(PRMT(5))212,211,212                                          HPCG2990
  211 IF(IHLF-11)213,212,212                                          HPCG3000
  212 RETURN                                                          HPCG3010
  213 IF(H*(X-PRMT(2)))214,212,212                                    HPCG3020
  214 IF(ABS(X-PRMT(2))-.1*ABS(H))212,215,215                         HPCG3030
  215 IF(DELT-.02*PRMT(4))216,216,201                                 HPCG3040
C                                                                     HPCG3050
C                                                                     HPCG3060
C     H COULD BE DOUBLED IF ALL NECESSARY PRECEEDING VALUES ARE       HPCG3070
C     AVAILABLE                                                       HPCG3080
  216 IF(IHLF)201,201,218
  218 IF(ISTEP-3)201,219,219
  219 IMOD=ICT/2
      IF(ICT-IMOD-IMOD)201,220,201
  220 H=H+H                                                           HPCG3140
      ICT=IMOD
      IHLF=IHLF-1                                                     HPCG3150
      ISTEP=0                                                         HPCG3160
      DO 221 I=1,NDIM                                                 HPCG3170
      AUX(N-1,I)=AUX(N-2,I)                                           HPCG3180
      AUX(N-2,I)=AUX(N-4,I)                                           HPCG3190
      AUX(N-3,I)=AUX(N-6,I)                                           HPCG3200
      AUX(N+6,I)=AUX(N+5,I)                                           HPCG3210
      AUX(N+5,I)=AUX(N+3,I)                                           HPCG3220
      AUX(N+4,I)=AUX(N+1,I)                                           HPCG3230
      DELT=AUX(N+6,I)+AUX(N+5,I)                                      HPCG3240
      DELT=DELT+DELT+DELT                                             HPCG3250
  221 AUX(16,I)=8.962963*(Y(I)-AUX(N-3,I))-3.361111*H*(DERY(I)+DELT   HPCG3260
     1+AUX(N+4,I))                                                    HPCG3270
      GOTO 201                                                        HPCG3280
C                                                                     HPCG3290
C                                                                     HPCG3300
C     H MUST BE HALVED                                                HPCG3310
  222 IHLF=IHLF+1                                                     HPCG3320
      ICT=ICT+ICT
      IF(IHLF-10)223,223,210                                          HPCG3330
  223 H=.5*H                                                          HPCG3340
      ISTEP=4                                                         HPCG3350
      DO 224 I=1,NDIM                                                 HPCG3360
     0Y(I)=.00390625*(80.*AUX(N-1,I)+135.*AUX(N-2,I)+40.*AUX(N-3,I)+  HPCG3370
     1AUX(N-4,I))-.1171875*(AUX(N+6,I)-6.*AUX(N+5,I)-AUX(N+4,I))*H    HPCG3380
     0AUX(N-4,I)=.00390625*(12.*AUX(N-1,I)+135.*AUX(N-2,I)+           HPCG3390
     1108.*AUX(N-3,I)+AUX(N-4,I))-.0234375*(AUX(N+6,I)+18.*AUX(N+5,I)-HPCG3400
     29.*AUX(N+4,I))*H                                                HPCG3410
      AUX(N-3,I)=AUX(N-2,I)                                           HPCG3420
  224 AUX(N+4,I)=AUX(N+5,I)                                           HPCG3430
      X=X-H                                                           HPCG3440
      DELT=X-(H+H)                                                    HPCG3450
      CALL FCT(DELT,Y,DERY)                                           HPCG3460
      DO 225 I=1,NDIM                                                 HPCG3470
      AUX(N-2,I)=Y(I)                                                 HPCG3480
      AUX(N+5,I)=DERY(I)                                              HPCG3490
  225 Y(I)=AUX(N-4,I)                                                 HPCG3500
      DELT=DELT-(H+H)                                                 HPCG3510
      CALL FCT(DELT,Y,DERY)                                           HPCG3520
      DO 226 I=1,NDIM                                                 HPCG3530
      DELT=AUX(N+5,I)+AUX(N+4,I)                                      HPCG3540
      DELT=DELT+DELT+DELT                                             HPCG3550
     0AUX(16,I)=8.962963*(AUX(N-1,I)-Y(I))-3.361111*H*(AUX(N+6,I)+DELT HPCG3560
     1+DERY(I))                                                       HPCG3570
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226 AUX(N+3,I)=DERY(I)                                          HPCG3580
    GOTO 246                                                    HPCG3590
    END                                                         HPCG3600
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C DECK  SIMQ                                                            SIMQ  10
C                                                                       SIMQ  20
C     ...................................................................SIMQ  30
C                                                                       SIMQ  40
C       SUBROUTINE SIMQ                                                 SIMQ  50
C                                                                       SIMQ  60
C       PURPOSE                                                         SIMQ  70
C          OBTAIN SOLUTION OF A SET OF SIMULTANEOUS LINEAR EQUATIONS,   SIMQ  80
C          AX=B                                                         SIMQ  90
C                                                                       SIMQ 100
C       USAGE                                                           SIMQ 110
C          CALL SIMQ(A,B,N,KS)                                          SIMQ 120
C                                                                       SIMQ 130
C       DESCRIPTION OF PARAMETERS                                       SIMQ 140
C          A - MATRIX OF COEFFICIENTS STORED COLUMNWISE.  THESE ARE     SIMQ 150
C              DESTROYED IN THE COMPUTATION.  THE SIZE OF MATRIX A IS   SIMQ 160
C              N BY N.                                                  SIMQ 170
C          B - VECTOR OF ORIGINAL CONSTANTS (LENGTH N). THESE ARE       SIMQ 180
C              REPLACED BY FINAL SOLUTION VALUES, VECTOR X.             SIMQ 190
C          N - NUMBER OF EQUATIONS AND VARIABLES. N MUST BE .GT. ONE.   SIMQ 200
C          KS - OUTPUT DIGIT                                            SIMQ 210
C               0 FOR A NORMAL SOLUTION                                 SIMQ 220
C               1 FOR A SINGULAR SET OF EQUATIONS                       SIMQ 230
C                                                                       SIMQ 240
C       REMARKS                                                         SIMQ 250
C          MATRIX A MUST BE GENERAL.                                    SIMQ 260
C          IF MATRIX IS SINGULAR , SOLUTION VALUES ARE MEANINGLESS,     SIMQ 270
C          AN ALTERNATIVE SOLUTION MAY BE OBTAINED BY USING MATRIX      SIMQ 280
C          INVERSION (MINV) AND MATRIX PRODUCT (GMPRD).                 SIMQ 290
C                                                                       SIMQ 300
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                   SIMQ 310
C          NONE                                                         SIMQ 320
C                                                                       SIMQ 330
C       METHOD                                                          SIMQ 340
C          METHOD OF SOLUTION IS BY ELIMINATION USING LARGEST PIVOTAL   SIMQ 350
C          DIVISOR. EACH STAGE OF ELIMINATION CONSISTS OF INTERCHANGING SIMQ 360
C          ROWS WHEN NECESSARY TO AVOID DIVISION BY ZERO OR SMALL       SIMQ 370
C          ELEMENTS.                                                    SIMQ 380
C          THE FORWARD SOLUTION TO OBTAIN VARIABLE N IS DONE IN         SIMQ 390
C          N STAGES. THE BACK SOLUTION FOR THE OTHER VARIABLES IS       SIMQ 400
C          CALCULATED BY SUCCESSIVE SUBSTITUTIONS. FINAL SOLUTION       SIMQ 410
C          VALUES ARE DEVELOPED IN VECTOR B, WITH VARIABLE 1 IN B(1),   SIMQ 420
C          VARIABLE 2 IN B(2),.....,  VARIABLE N IN B(N).               SIMQ 430
C          IF NO PIVOT CAN BE FOUND EXCEEDING A TOLERANCE OF 0.0,       SIMQ 440
C          THE MATRIX IS CONSIDERED SINGULAR AND KS IS SET TO 1. THIS   SIMQ 450
C          TOLERANCE CAN BE MODIFIED BY REPLACING THE FIRST STATEMENT.  SIMQ 460
C                                                                       SIMQ 470
C     ...................................................................SIMQ 480
C                                                                       SIMQ 490
      SUBROUTINE SIMQ(A,B,N,KS)                                         SIMQ 500
      DIMENSION A(1),B(1)                                               SIMQ 510
C                                                                       SIMQ 520
C        FORWARD SOLUTION                                               SIMQ 530
C                                                                       SIMQ 540
      TOL=0.0                                                           SIMQ 550
      KS=0                                                              SIMQ 560
      JJ=-N                                                             SIMQ 570
      DO 65 J=1,N                                                       SIMQ 580
      JY=J+1
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      JJ=JJ+N+1                                                        SIMQ 590
      BIGA=0                                                           SIMQ 600
      IT=JJ-J                                                          SIMQ 610
      DO 30 I=J,N                                                      SIMQ 620
C                                                                      SIMQ 630
C        SEARCH FOR MAXIMUM COEFFICIENT IN COLUMN                      SIMQ 640
C                                                                      SIMQ 650
      IJ=IT+I                                                          SIMQ 660
      IF(ABS(BIGA)-ABS(A(IJ))) 20,30,30                                SIMQ 670
   20 BIGA=A(IJ)                                                       SIMQ 680
      IMAX=I                                                           SIMQ 690
   30 CONTINUE                                                         SIMQ 700
C                                                                      SIMQ 710
C        TEST FOR PIVOT LESS THAN TOLERANCE (SINGULAR MATRIX)          SIMQ 720
C                                                                      SIMQ 730
      IF(ABS(BIGA)-TOL) 35,35,40                                       SIMQ 740
   35 KS=1                                                             SIMQ 750
      RETURN                                                           SIMQ 760
C                                                                      SIMQ 770
C        INTERCHANGE ROWS IF NECESSARY                                 SIMQ 780
C                                                                      SIMQ 790
   40 I1=J+N*(J-2)                                                     SIMQ 800
      IT=IMAX-J                                                        SIMQ 810
      DO 50 K=J,N                                                      SIMQ 820
      I1=I1+N                                                          SIMQ 830
      I2=I1+IT                                                         SIMQ 840
      SAVE=A(I1)                                                       SIMQ 850
      A(I1)=A(I2)                                                      SIMQ 860
      A(I2)=SAVE                                                       SIMQ 870
C                                                                      SIMQ 880
C        DIVIDE EQUATION BY LEADING COEFFICIENT                        SIMQ 890
C                                                                      SIMQ 900
   50 A(I1)=A(I1)/BIGA                                                 SIMQ 910
      SAVE=B(IMAX)                                                     SIMQ 920
      B(IMAX)=B(J)                                                     SIMQ 930
      B(J)=SAVE/BIGA                                                   SIMQ 940
C                                                                      SIMQ 950
C        ELIMINATE NEXT VARIABLE                                       SIMQ 960
C                                                                      SIMQ 970
      IF(J-N) 55,70,55                                                 SIMQ 980
   55 IQS=N*(J-1)                                                      SIMQ 990
      DO 65 IX=JY,N                                                    SIMQ1000
      IXJ=IQS+IX                                                       SIMQ1010
      IT=J-IX                                                          SIMQ1020
      DO 60 JX=JY,N                                                    SIMQ1030
      IXJX=N*(JX-1)+IX                                                 SIMQ1040
      JJX=IXJX+IT                                                      SIMQ1050
   60 A(IXJX)=A(IXJX)-(A(IXJ)*A(JJX))                                  SIMQ1060
   65 B(IX)=B(IX)-(B(J)*A(IXJ))                                        SIMQ1070
C                                                                      SIMQ1080
C        BACK SOLUTION                                                 SIMQ1090
C                                                                      SIMQ1100
   70 NY=N-1                                                           SIMQ1110
      IT=N*N                                                           SIMQ1120
      DO 80 J=1,NY                                                     SIMQ1130
      IA=IT-J                                                          SIMQ1140
      IB=N-J                                                           SIMQ1150
      IC=N                                                             SIMQ1160
      DO 80 K=1,J                                                      SIMQ1170
      B(IB)=B(IB)-A(IA)*B(IC)                                          SIMQ1180
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      IA=IA-N                                                   SIMQ1190
   80 IC=IC-1                                                   SIMQ1200
      RETURN                                                    SIMQ1210
      END                                                       SIMQ1220
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