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Users' Manual for Linear Freight Car Forced Lateral Response Analysis Computer Program

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Interim Report

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03 - Rail Vehicles &
Components

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16. Abstract

This manual documents a FORTRAN IV computer program that solves for the forced lateral sinusoidal and random response of a linear, 9 degree-of freedom freight car. The vehicle model represents the lateral dynamics of typical North American freight cars equipped with three piece trucks. Responses to both roadbed center-line alignment and cross level irregularities are computed.

The response is calculated using frequency domain techniques. The steady state sinusoidal transfer functions are computed, response power spectral densities obtained and R.M.S. values found by integration of the power spectra. Plots of selected output power spectra are prepared.

The manual briefly describes the vehicle and roadbed model and the solution technique. The program description, a sample run and a complete program listing are included.

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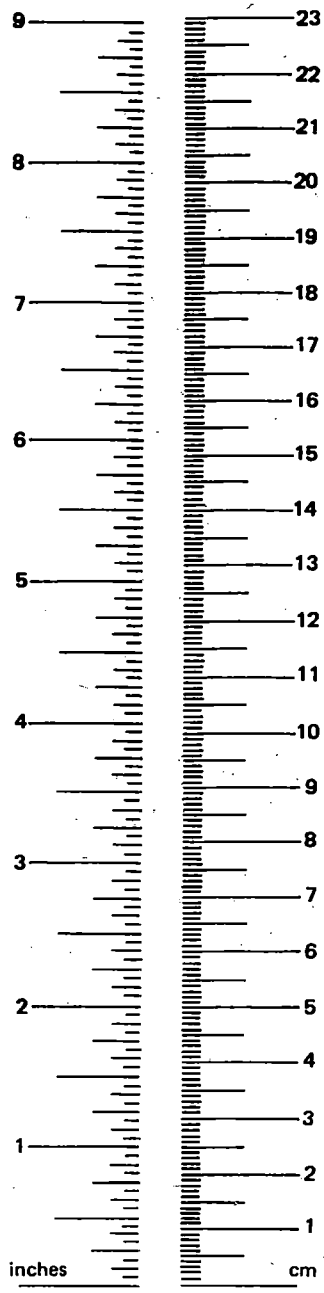
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

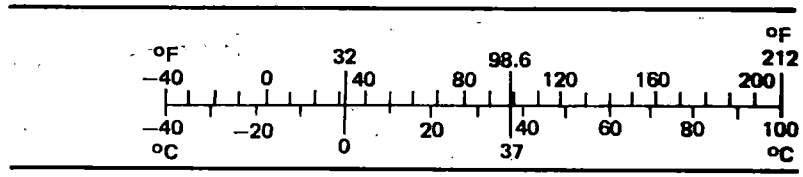
Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286, Units of Weight and Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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Chapter 1

INTRODUCTION

This Users' Manual documents the FR9DOF computer program that computes the forced response of a rail freight car to roadbed alignment and crosslevel disturbances. Both the sinusoidal and random response to roadbed disturbances are computed using linear system analysis techniques. The 9 degree-of-freedom vehicle model incorporated in the program is appropriate for the response of rail freight cars with 3-piece trucks of the type widely used in North America. Due to the assumptions inherent in this model and analysis, this program is not appropriate for studying the behavior of vehicles with very flexible bodies or for the vehicle response when hunting. The reader is referred to [1] for a more detailed description of the models and their uses.

This computer program was developed as a part of the ''Freight Car Dynamics'' research project conducted by Clemson University and Arizona State University in cooperation with the Association of American Railroads. The Freight Car Dynamics project was sponsored by the Federal Railroad Administration under contract DOT-OS-40018, with the broad objective of developing the background and mathematical tools that designers and operators of rail vehicles need to quantitatively understand present freight car dynamic problems. The total research effort was directed at the problems of rail vehicle curving behavior and freight car hunting as well as the problem of response to track irregularities. The overall project effort is described in [2].

This computer program is a companion to the 9 degree-of-freedom eigenvalue/eigenvector computer program described in [3]. Identical input formats for the vehicle parameters are used for the two programs, although the program control cards must, of necessity, differ. As the response computed by this program is only valid when the linear equations of vehicle motion have stable solutions, it is always advisable to establish the region of stable operation before using this forced response analysis.

The vehicle and roadbed model incorporated in the program is described in the following chapter along with the solution approach. Chapter 3 contains a description of the program including the input and output variables. A sample problem with input data, output listing and accompanying plots is contained in Chapter 4. The entire program listing may be found in the Appendix.

Chapter 2

MODELING AND ANALYSIS

INTRODUCTION

This analysis of the forced lateral response of a rail freight car utilizes a linear, 9 degree of freedom model of the freight car. Provision for sinusoidal and random disturbances in the rail alignment and crosslevel are made. Although the model is described in detail elsewhere [1], its major features are reviewed below.

The sinusoidal and random response are solved in the frequency domain. The mathematical techniques utilized are briefly reviewed at the close of this chapter.

FREIGHT CAR MODEL

Degrees of Freedom

The 9 degree of freedom model for the lateral dynamics of railway freight cars consists of a rigid car body on two, conventional three-piece trucks. A representative example of a three-piece truck is shown in Figure 1.

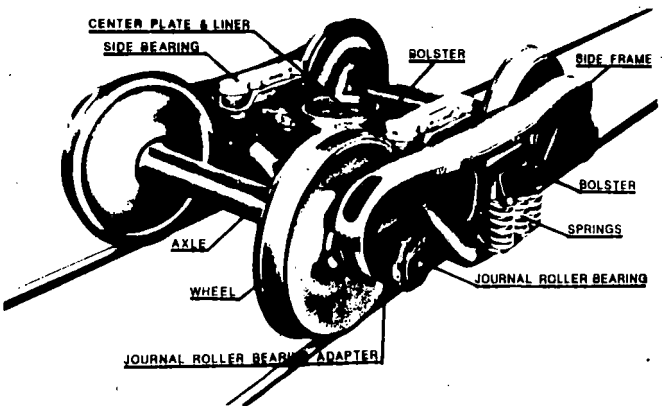


Figure 1. Three Piece Freight Truck

As shown in Figure 1, the sideframes rest on bearing adapters which, in turn, rest directly on the axle bearings. The kinematic assumption is made in this model that the sideframe-wheelset connections permit only relative rotational motion. Consequently, the wheelsets and the sideframes are forced to remain parallel. Thus, the truck and wheelset assembly may move laterally, rotate in yaw with respect to the car body, and may distort from a rectangular to a parallelogram planform. These three permissible motions, or degrees of freedom, (lateral, yaw, and warp) are shown in Figure 2 for each truck.

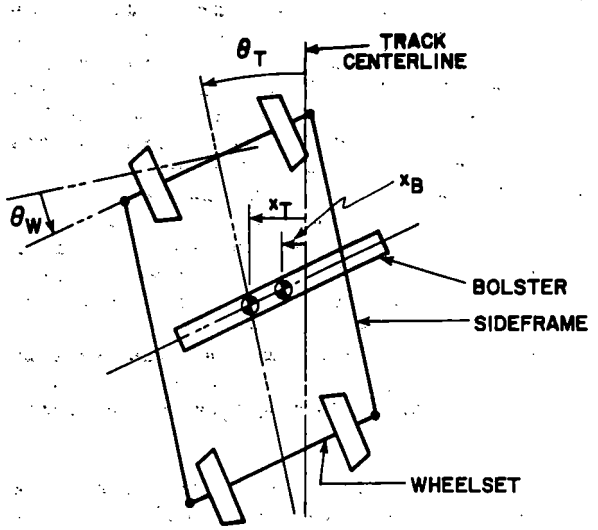


Figure 2. Freight Truck Schematic

The car body is assumed to be rigid and to have the three degrees of freedom represented by lateral, yawing, and rolling motions. Each end of the car body rests on the center plate of its respective truck bolster. It is assumed that the bolster/sideframe connection (see Figure 3) permits relative lateral and vertical motions as well as relative roll and yaw rotations. However, longitudinal clearances are sufficiently tight that it is assumed that there are no relative longitudinal motions. Thus, the truck bolster remains parallel to the wheelsets (in plan) during dynamic motions. No relative rocking or separation is considered between car body and truck bolster. The truck bolster moves laterally and in roll with the car body and yaws with the truck.

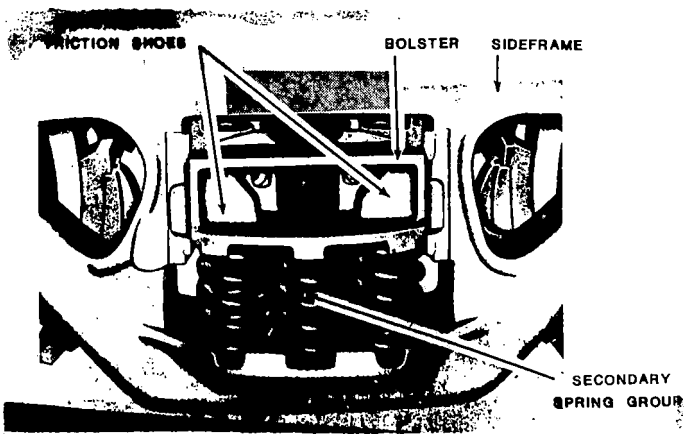


Figure 3. Suspension Configuration

Although there are other motions that may occur in the vehicle such as sideframe rocking, relative roll, vertical, and lateral motions between car body and truck bolster, flexible car body modes, etc., the 9 degree of freedom model described above is the simplest credible model for the lateral dynamic response of conventional North American freight cars. If the particular car body of interest is very flexible, appropriate degrees of freedom corresponding to these motions may be added. If large amplitude phenomena such as rock and roll are to be investigated, degrees of freedom should be added to allow for the possibility of relative roll and vertical motions of the car body and truck bolster. The adequacy of the 9 degrees of freedom model is obviously dependent on the particular problem being investigated.

The degrees of freedom for this model are summarized in Table 1 and shown in Figure 4.

Wheel-Rail Geometry

The transverse profiles of the wheels and rails enter the equations of motion through the wheel-rail geometry constraint characteristics [1,4]. These constraint functions are: (a) one half the normalized difference in rolling radii, $(r_L-r_R)/(2a)$; (b) one half the difference in contact angles, $(\delta_L-\delta_R)/2$; (c) the wheelset roll angle, ϕ, and (d) the average contact angle, $(\delta_L+\delta_R)/2$. In general, these constraint characteristics are nonlinear functions of the lateral displacement of the wheelset with respect to the track centerline, x_w-x_a. As long as flange contact does not occur, the dependence of these functions on the wheelset yaw angle is very small and may be considered negligible. A sketch of a typical normalized rolling radii difference is shown in Figure 5.

Table 1. Nine Degree of Freedom Model

x_{TF}, x_{TR}*	Lateral displacement of geometric center of truck frame at height of axle centerline; positive to left facing forward, measured from the track centerline.
θ_{TF}, θ_{TR}	Yaw angle of the truck centerline with respect to the track centerline; positive counterclockwise when viewed from above.
θ_{WF}, θ_{WR}	Warp angle of the truck frame; measured from the normal to the truck centerline to the axle centerline, positive counterclockwise when viewed from above.
x_C	Lateral displacement of the car body center of gravity from the track centerline; positive to the left facing forward.
θ_C	Yaw angle of the car body centerline with respect to the track centerline; positive counterclockwise when viewed from above.
ϕ_C	Roll angle of the car body with respect to the vertical; positive clockwise when viewed from the rear.

*Subscript F refers to front truck, R to rear.

Radii Difference

For wheel and rail profiles that are mirror images of each other on the left and right, the functions $(r_L-r_R)/(2a)$, $(\delta_L-\delta_R)/2$, and ϕ are odd functions of x_w-x_a while $(\delta_L+\delta_R)/2$ is an even function of x_w-x_a.

If we consider that the constraint functions are linearized, they may be expressed as:

$$(r_L-r_R)/(2a) = (\lambda/a)(x_w-x_a) \quad (1)$$

$$(\delta_L-\delta_R)/2 = (\Delta/a)(x_w-x_a) \quad (2)$$

$$\phi = (\Gamma/a)(x_w-x_a) \quad (3)$$

$$(\delta_L+\delta_R)/2 = \delta_o \quad (4)$$

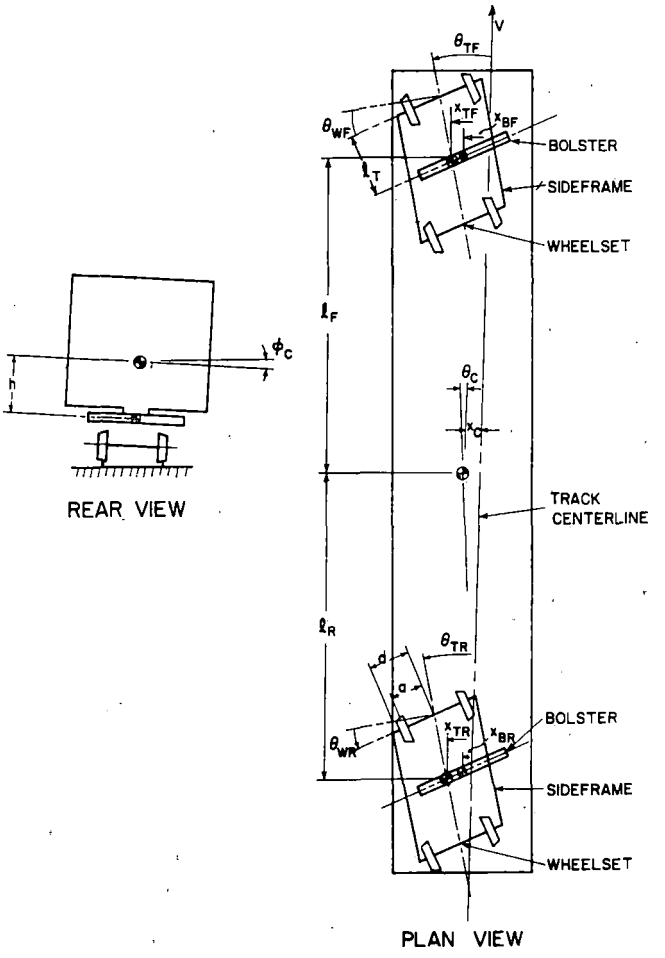


Figure 4. Freight Car Schematic

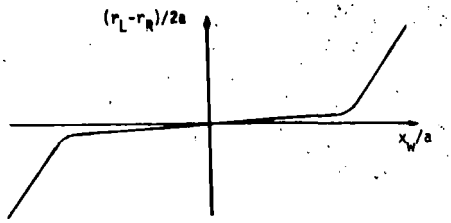


Figure 5. Typical Form for Normalized Rolling Radii Difference

Where: X_w - wheelset lateral displacement
a - semi-rail gauge

Some method of linearization must be used to obtain the coefficients λ, Δ, Γ, and δ_0 from the actual nonlinear constraint functions. The describing function method [5] has been successfully used in many cases. Other approaches such as Taylor series expansion about $x_w = 0$, or least squares fit of a straight line over some region centered at $x_w = 0$ have also been used. The resulting equivalent linear coefficients, λ, Δ, Γ, and δ_0 are used directly in the computer programs described in this manual. The nonlinear wheel-rail geometric constraint functions may be calculated for any wheel and rail profiles using the WHRAIL or WHRAILA computer programs [6]. Estimates for the linear coefficients defined above are calculated by the describing function technique in the WHRAILA computer program.

Creep Forces

The creep forces and moments arise from the shear stresses acting between the wheels and rails. The role these forces play in the dynamics of rail vehicles is discussed in [7]. The way in which they enter the equations of motion is presented in [1]. Kalker has developed theories for calculating these forces and moments [8].

The creep forces and moments depend on the elastic properties of the wheel and rail, the normal load across the wheel-rail contact zone, and the relative linear and angular velocities between wheel and rail at the contact zone. When these relative linear and angular velocities are normalized by the forward speed of the wheel they are called linear and spin creepages, respectively. The lateral and longitudinal components of the vector creep force and the creep moment about the normal to the contact zone depend nonlinearly on the creepages. For ''large'' values of creepage, gross slip may occur between wheel and rail and the vector creep force is limited by the level of adhesion. In such cases, Kalker's nonlinear theory may be used to calculate the creep forces and moments using computer codes such as those given in [9, 10].

For small creepages, Kalker's linear theory [8] provides the following relationships between the creep forces and creepages:

$$\underline{F}_L = \{[f_{11L}(-\dot{\underline{r}}_L \cdot \underline{e}_{1L}) + f_{12L}(-\underline{\omega}_L \cdot \underline{e}_{2L})]\underline{e}_{1L} + f_{33L}(\dot{\underline{r}}_L \cdot \underline{e}_{3L})\underline{e}_{3L}\}/V \quad (5)$$

$$\underline{M}_L = \{[f_{12L}(\dot{\underline{r}}_L \cdot \underline{e}_{1L}) + f_{22L}(-\underline{\omega}_L \cdot \underline{e}_{2L})]/V \quad (6)$$

$$\underline{F}_R = \{[f_{11R}(-\dot{\underline{r}}_R \cdot \underline{e}_{1R}) + f_{12R}(-\underline{\omega}_R \cdot \underline{e}_{2R})]\underline{e}_{1R} + f_{33R}(-\dot{\underline{r}}_R \cdot \underline{e}_{3R})\underline{e}_{3R}\}/V \quad (7)$$

$$\underline{M}_R = \{[f_{12R}(\dot{\underline{r}}_R \cdot \underline{e}_{1R}) + f_{22R}(-\underline{\omega}_R \cdot \underline{e}_{2R})]\underline{e}_{2R}\}/V \quad (8)$$

The $\underline{e}_{1L}$, $\underline{e}_{2L}$, $\underline{e}_{3L}$ and $\underline{e}_{1R}$, $\underline{e}_{2R}$, $\underline{e}_{2R}$ systems of unit vectors are defined for the left and right wheels. The $\underline{e}_1$ and $\underline{e}_3$ vectors are in the plane of contact and are directed laterally and longitudinally, respectively. The $\underline{e}_2$ vector is along the inward normal to the contact plane. $\underline{F}_L$ and $\underline{M}_L$ are the vector creep force and moment of the rail acting on the left wheel while $\underline{F}_R$ and $\underline{M}_R$ act on the right wheel. $\dot{\underline{r}}_L$ and $\dot{\underline{r}}_R$ are the velocities of the left and right wheels relative to their respective rails at the contact points. If the rails are assumed to be rigid, these are the wheel contact point velocities. If the rails are flexible or if the wheelset is on a roller rig, $\dot{\underline{r}}_L$ and $\dot{\underline{r}}_R$ depend on the velocities of the rails or rollers as well. Similarly, $\underline{\omega}_L$ and $\underline{\omega}_R$ are the angular velocities of the left and right wheels relative to their respective rails. If the wheelset and rails are assumed to be rigid, then $\underline{\omega}_L = \underline{\omega}_R$ where $\underline{\omega}$ is the angular velocity of the wheelset. V is the forward speed of the wheelset. The parameters f_{11}, f_{12}, f_{22}, and f_{33} are the lateral, lateral-spin, spin, and longitudinal linear creep coefficients, respectively. The subscripts L and R refer to the left and right wheels, respectively. When these expressions are linearized and when (a) identical profiles are used on the left and right wheels, (b) the rail profile is the same for left and right rails, and (c) the loading is symmetrical about the vehicle centerline, then the creep coefficients for the left and right wheels are identical. Almost without exception, the yaw moments due to lateral spin and pure spin ($\underline{M}_L$ and $\underline{M}_R$) are much smaller than the contribution to the yaw moment of the longitudinal creep forces. Consequently, in formulating the linear equations of motion, this contribution may be neglected if desired. However, the lateral force due to spin creep, $f_{12}(-\underline{\omega} \cdot \underline{e}_2)/V$ is generally not negligible although it is small if the contact angle between wheel and rail is small.

The linear creep coefficients may be calculated using the program based on Kalker's linear theory described in [11]. The values depend on the elastic properties of the wheel and rail, the radii of curvature of the surfaces at the contact zone, and the wheel load. For new, 33 inch diameter, AAR 1/20 wheels on rails with a 10 inch crown radius, these coefficients are:

$$f_{11} = 3552.\ (P)^{2/3}\ \text{lb/wheel} \qquad (9)$$

$$f_{12} = 1.1447\ (P)\ \text{ft lb/wheel} \qquad (10)$$

$$f_{22} = 4.1006 \times 10^{-4}\ (P)^{4/3}\ \text{lb ft}^2\text{/wheel} \qquad (11)$$

$$f_{33} = 3839.\ (P)^{2/3}\ \text{lb/wheel} \qquad (12)$$

where P is the load carried by one wheel, i.e., one-half the axle load. Because of the wide variations of the actual values prevailing in the field (due to surface contamination, work-hardening of the wheels and rails, changing rail head radii of curvature along the track, etc.), it is recommended that several values in the range of 30 to 100% of the Kalker values be used in dynamic analyses. The sensitivity of the lateral dynamic response to changes in creep coefficients is highly configuration-dependent. No general statement can be made regarding this, and the safest procedure is to check this sensitivity for the configuration under study.

Suspension

The 9 degree of freedom model is intended to represent a conventional North American freight car with three piece trucks. This model does not have a distinct primary suspension. The suspension elements are considered to be parallel combinations of linear springs and viscous dampers. These are: (a) The warp suspension element (one per truck) opposes warping deformation of the truck frame. Contributions to this lumped element are made by the resistances to relative yaw at the interfaces between the wheelsets and sideframes and the sideframes and bolster. (b) The yaw suspension element (one per truck) opposes relative yaw between the car body and truck bolster at the centerplate. (c) The lateral suspension elements (two per truck) oppose relative lateral motions between the truck sideframes and the truck bolster. (d) The vertical suspension elements (two per truck) oppose relative roll between the car body and truck bolster.

The actual suspension of a three piece freight truck is highly nonlinear due to the presence of Coulomb friction, clearances and stops. One of the major difficulties facing the user of this program is the determination of equivalent linear values for these nonlinearities. Certain elements may be treated by linearization about the equilibrium position. However, Coulomb friction can only be treated by a quasi-linearization process such as the sinusoidal or random input describing function. This procedure for rail vehicle applications is described in [5].

Roadbed Inputs

The response of the freight car to roadbed disturbances is of interest in evaluating such matters as the riding quality, the vibration environment at any point on the vehicle, or the wheel-rail force levels. This computer program provides for the lateral alignment, u_a, and crosslevel disturbances, u_ϕ, shown in Figure 6.

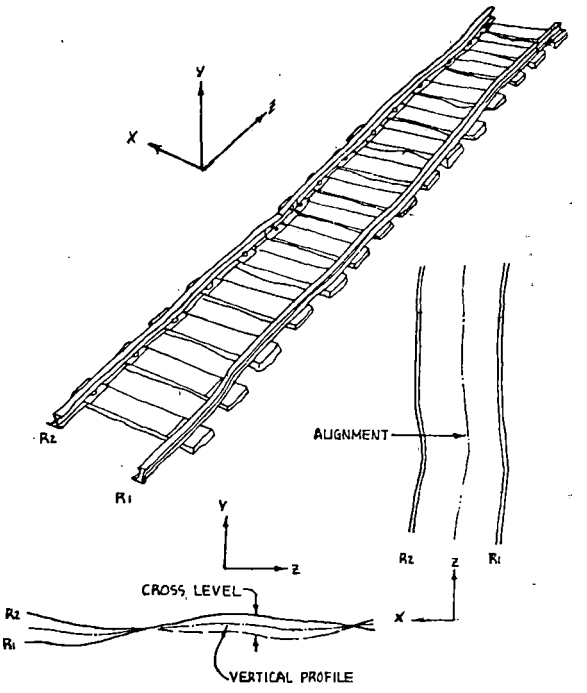


Figure 6. Roadbed Irregularities

The alignment disturbances enter the equations of motion through the wheel-rail geometry terms. Variation in alignment along the track leads to changes in the rolling radii difference and contact angle difference that, in turn, elicit a dynamic response from the vehicle. As a result, the alignment input terms appear in the creep force and gyroscopic force expressions.

The most dominant influence of the alignment variations on the vehicle motions is through the rolling radii difference and contact angle difference mechanisms. However, the time rate of change of lateral alignment will also give rise to a small wheelset roll velocity that in turn generates a lateral creep force and a gyroscopic force. The alignment time rate of change driving these effects should be interpreted as

$$\dot{u}_a = du_a/dt = (du_a/dz)(dz/dt)$$

$$= V(du_a/dz) \qquad (13)$$

Crosslevel disturbances were defined, in the analysis accompanying this program, as the rotation of the rail plane about a longitudinal axis relative to a fixed, level reference. The motions of the vehicle components, wheelsets,

sideframes, etc. were also referenced to the fixed level reference. As a result of these definitions, crosslevel disturbances appear in the vertical suspension forces between bolster and sideframe, and in the creep force and gravitational force expressions at the wheel-rail contact. The contributions to the latter are due to the relative lateral displacement that arises when the roadbed and wheelset rotate together without lateral wheelset movement, as well as to the relative lateral velocity at the wheel-rail contact that must accompany such movement. Both crosslevel displacement and its rate of change with time appear in the equations. The crosslevel rate of change with time, $\dot{\underline{u}}_\phi$, should be interpreted here, as follows,

$$du_\phi/dt = (du_\phi/dz)(dz/dt) = (du_\phi/dz)V \quad (14)$$

This lateral freight car response analysis provides for sinusoidal and random irregularities in the roadbed centerline alignment and/or the roadbed crosslevel. Because the model is linear, only the transfer function amplitudes between the input and the response variables are provided in the sinusoidal input analysis. A sum of the response to lateral alignment and crosslevel irregularities is not computed in the program.

The random characteristics of the centerline alignment and crosslevel disturbances are represented by spatial power spectral densities (PSD's) of the form

$$S_a(\Omega) = A_a/[\Omega^2(1+\Omega^2/\Omega_c^2)]$$

$$[ft^2/(rad/ft)] \quad (15)$$

$$S_a(\Omega) = A_\phi\Omega_c^2/[(\Omega^2+\Omega_c^2)(\Omega^2+\Omega_s^2)]$$

$$[rad^2/(rad/ft)] \quad (16)$$

where: Ω – spatial frequency, rad/ft
A_a – alignment constant
A_ϕ – crosslevel constant
Ω_c – long wavelength rolloff frequency
Ω_s – short wavelength rolloff frequency

These single sided PSD expressions have been developed to represent the characteristics of existing roadbed [12].

ANALYSIS METHOD

The linear equations of motion for the forced response of the freight car to roadbed disturbances may be expressed in the following matrix form,

$$M\underline{\ddot{x}} + C\underline{\dot{x}} + K\underline{x} = B_{A_1}\underline{u}_a + B_{A_2}\dot{\underline{u}}_a + B_{\phi_1}\underline{u}_\phi + B_{\phi_2}\dot{\underline{u}}_\phi \quad (17)$$

where: $\underline{x}$ – displacement vector
M,C,K – mass, dumping, and stiffness matrices
$\underline{u}_a$ – alignment input vector (one component/wheelset)
$\underline{u}_\phi$ – crosslevel input vector
B_{A_1}, B_{A_2} – alignment input matrices
B_{ϕ_1}, B_{ϕ_2} – crosslevel input matrices

If we take the LaPlace transform of this equation, and recognize that we can obtain the transfer functions for the steady state response to a harmonic disturbance by letting $s = j\omega$, then we obtain the following complex matrix equation,

$$[(K-\omega^2M)+j\omega C]\underline{X} = [B_{A_1}+j\omega B_{A_2}]\underline{U}_A + [B_{\phi_1}+j\omega B_{\phi_2}]\underline{U}_\phi \quad (18)$$

A solution for the response $\underline{X}$ to either an alignment or a crosslevel input is computed in this program by inverting the matrix,

$$[(K-\omega^2M)+j\omega C]$$

at each frequency of interest, and multiplying with the appropriate matrix on the right hand side of eq. (18), i.e. for alignment input:

$$\underline{X} = [(K-\omega^2M)+j\omega C]^{-1}\,[B_{A_1}+j\omega B_{A_2}]\underline{U}_A \quad (19)$$

and for crosslevel input

$$\underline{X} = [(K-\omega^2M)+j\omega C]^{-1}\,[B_{\phi_1}+j\omega B_{\phi_2}]\underline{U}_\phi \quad (20)$$

The input vectors $\underline{u}_a$ and $\underline{u}_\phi$ consist of the values of these quantities at each wheelset. These variables are related by a time delay. We assume the vehicle is travelling at constant speed such that if

$$U_{a_1} = A_x\cos\,\omega\,t \quad (21)$$

then the input at subsequent wheelsets is given by,

$$U_{a_i} = A_x\cos\,(t-l_i/V) \quad (22)$$

where

l_i – distance from ith wheelset to leading wheelset.

These time delay terms may be expressed in terms of an in-phase and out of phase term,

$$U_{xi} = [A_x\cos(\omega l_i/V)]\cos\,\omega t + [A_x\sin(\omega l_i/V)]\sin\,\omega t \quad (23)$$

or, employing complex variable notation in terms of a real and imaginary component,

$$U_{xi} = A_x\cos(\omega l_i/V) + j\,A_x\sin(\omega l_i/V) \quad (24)$$

The complex notation is used in the program, and the input vector, $\underline{U}_x$ or $\underline{U}_{c\phi}$, is reduced to the product of a time delay vector and a scalar defining the amplitude of the sinusoidal input. In a transfer function computation the scalar is taken as unity, and the input vector becomes,

$$\underline{U}_\phi = \underline{U} = \begin{bmatrix} 1 \\ \cos(\omega l_2/V)+j\sin(\omega l_2/V) \\ \cos(\omega l_3/V)+j\sin(\omega l_3/V) \\ \cos(\omega l_4/V)+j\sin(\omega l_4/V) \end{bmatrix} \quad (25)$$

The transfer functions are computed using the above matrices as follows:

$$\underline{T}_{Rx} = [(K-\omega^2 M)+j\omega C]^{-1}[B_{x_1}+j\omega B_{x_2}] \begin{bmatrix} 1 \\ \cos(\omega l_2/\sigma)+j\sin(\omega l_2/\sigma) \\ \cos(\omega l_3/V)+j\sin(\omega l_3/V) \\ \cos(\omega l_4/V)+j\sin(\omega l_4/\sigma) \end{bmatrix} \quad (26)$$

$$\underline{T}_{R\phi} = [(K-\omega^2 M)+j\omega C]^{-1}[B_{\phi_1}+j\omega B_{\phi_2}] \begin{bmatrix} 1 \\ \cos(\omega l_2/\sigma)+j\sin(\omega l_2/\sigma) \\ \cos(\omega l_3/V)+j\sin(\omega l_3/V) \\ \cos(\omega l_4/\sigma)+j\sin(\omega l_4/\sigma) \end{bmatrix} \quad (27)$$

In the computer program, certain additional quantities such as the wheel-rail contact forces, the suspension displacements, and component accelerations are also computed. These quantities are linear combinations of the component displacements and velocities, and may be computed directly from the transfer functions given in the equations above.

The power spectral densities (PSD's) of the displacements, velocities, and related quantities are computed as follows,

$$S_{xi}(f) = T_{Ri}^{*}\, T_{Ri}\, S_R(f) \quad (28)$$

where:

S_{xi} - PSD for i^{th} element of $\underline{x}$
S_R - PSD for input (alignment or crosslevel)
$T_{R_i}^{*}$ - complex conjugate of T_{Ri}

Note that the input PSD must be appropriately transformed from the spatial domain to the time domain.

The root mean square (RMS) values for the response variables are obtained by integrating the PSD's over the frequency range specified as input. Although the mean square value is the integral of the PSD over all frequencies from 0 to ∞, we find for the response predicted by this 9 DOF model that the error introduced by integration over a finite band width, roughly 0.1-20.0 Hz is small. The integration is handled numerically using the trapezoid rule.

Chapter 3

PROGRAM DESCRIPTION

INTRODUCTION

The FR9DOF computer program consists of a main program and ten subroutines. The program is writtten in FORTRAN IV. Input data is handled in the main program in a format compatible with the 9 DOF eigenvalue program described in [3]. The main program calls subroutines SETUP, VEL and FREQ to compute various portions of the mass, damping, stiffness and roadbed input matrices. Subroutines DCMINV, DMULT and DDIV called from the main program invert the complex system matrix. The transfer functions, PSD's and RMS values are computed, and calls to PLOTA, PLOTB, PLOTC and PLOTD made to plot the PSD's.

Input to the program includes specification of the velocities at which the vehicle response is to be computed, the frequency range and frequency increment to be used in the computations.

The program prints the input data, the transfer functions, the PSD's and the RMS values for all the degrees of freedom as well as the centerplate contact position, the centerplate vertical force, and the net lateral wheel-rail contact force/wheelset at each wheelset. The transfer functions and PSD's are computed at frequency intervals evenly spaced on a logarithmic scale.

Plots are generated for the PSD's of the vehicle displacements. Transfer function magnitudes TRA and TRAI and PSD's are found by appropriate matrix multiplications.

MAIN PROGRAM AND SUBROUTINES

Listings for the main program and all subroutines may be found in the appendix. Each is briefly described below.

MAIN PROGRAM--FR9DOF

The main program handles all input and output, calls subroutines to set up the system matrices, calls the matrix inversion subroutine, computes the transfer function magnitudes and PSD's, integrates the PSD's to obtain RMS values, and calls plot routines to display the results.

The program flows as follows: After reading and echoing the input data, subroutine SETUP is called to initialize the velocity and frequency independent terms of the mass (M), damping (C), stiffness (K) and roadbed input (FCLR, FCLF, FAR, FAI) matrices. An outer loop computes the response at the velocities specified in the input data. A call to subroutine VEL at the head of this loop initializes the velocity dependent terms of the system matrices.

The transfer functions and PSD's are computed at each frequency in an inner loop. Subroutine FREQ is called early in this loop to compute the frequency dependent coefficients in the system matrices. The matrix inversion at each frequency is carried out by subroutine DCMINV.

At the bottom of the outer (velocity) loop the mean square values are computed by simple Euler integration of the PSD values, and the transfer functions, PSD's and RMS values are printed. Subroutine PLOTA is called to plot the results before returning for a new velocity value.

DCMINV (AR, AI, N, DR, DI, L, M)

Inverts a complex matrix using double precision computation. The matrix is supplied in arrays DR and DI and the inverse returned in the same arrays. N specifies the order of the matrix, and DR and DI return the real and imaginary portions of the determinant of the matrix. L and M are working arrays of dimension N used by the subroutine.

This subroutine calls DDIV and DMULT.

DDIV (AR, AI, BR, BI, CR, CI)

Performs double precision division of two complex numbers. AR and AI contain the dividend, BR and BI the divisor and CR and CI the resulting quotient.

DMULT (AR, AI, BR, BI, CR, CI)

Performs double precision multiplcation of two complex numbers. The pairs (AR, AI) and (BR, BI) contain the multiplicands, and (CR, CI) the resulting product.

FREQ (FAI, FCLI, V, W)

This subroutine computes those terms of the input matrices that involve the frequency of the crosslevel or alignment input. These terms account for the time delay between the roadbed input at different wheelsets. The frequency and velocity, W and V are input to the subroutine and all the non-zero terms of the FCLI and FAI matrices are returned.

PLOTA (LABEL)

This subroutine sets up the axes for the PSD plots and writes a label to identify the run. The label is passed to the subroutine through the array LABEL. Subroutine PLOTC is called to draw the horizontal (frequency) axis and write the label.

PLOTB (FR, TPSD, TIPSD, FPSD, FIPSD, N, KI, V, S)

This subroutine draws the plots of the PSD's on the graphs prepared by PLOTA. The frequencies are supplied in array FR, the displacement PSD's in TPSD and T1PSD, and the force PSD's in FPSD and F1PSD. The number of points in each plot is N.

PLOTC (LABEL)

This subroutine draws the horizontal frequency axis for each plot and writes an identifying label at the top of each plot. The label is supplied in the array LABEL.

PLOTD (K1, S1, S2, IVEL)

This subroutine writes an identifying symbol and the speed associated with that symbol. This allows plots at different speeds to be plotted on the same axes.

SETUP (M, C, K, FAR, FCLR)

This subroutine computes the constant terms in the mass (M), damping (C), stiffness (K), alignment input (FAR) and crosslevel input (FCLR) matrices. The values for the computation are passed through labeled COMMON.

VEL (M, C, K, V)

The velocity dependent terms of the mass, damping and stiffness matrices are computed in this subroutine. Data for the computations are supplied from the main program and SETUP via COMMON blocks.

PROGRAM INPUT

The input parameters, listed in the order they are read, are given in Table 2.

Table 2. Program Input Parameters

Program Control Specifications		
IVO	Initial Velocity	ft/sec
IVF	Final Velocity	ft/sec
IDV	Velocity Increment	ft/sec
FSTART	Lowest Frequency	Hz
FSTEP	Number of frequency values per cycle	
FSTOP	Highest Frequency	Hz
LABEL	Identifying label for the plots	
Track Properties		
AX	Centerline Alignment PSD Coefficient	ft^2-rad/ft
APHI	Crosslevel PSD Coefficient	
OMGC	PSD Rolloff Frequency	rad/ft
OMGC	Crosslevel Cutoff Frequency	rad/ft
Vehicle Specifications		
XMW	Mass of wheelset	slugs
XIW1	Mass moment of inertia of wheelset axle centerline	slugs ft^2
XIW2	Centroidal mass moment of inertia of wheelset in yaw	slugs ft^2
XMB	Centroidal mass of bolster	slugs

Table 2. Program Input Parameters (cont.)

XIB2	Centroidal mass moment of inertia of bolster in yaw	slugs ft²
XIB3	Centroidal mass moment of inertia of bolster in roll	slugs ft²
XMS	Mass of sideframe	slugs
XIS2	Centroidal mass moment of inertia of sideframe in yaw	slugs ft²
XMC	Centroidal mass of car body	slugs
XIC2	Centroidal mass moment of inertia of carbody in yaw	slugs ft²
XIC3	Centroidal mass moment of inertia carbody in roll	slugs ft²
XIC23	Cross product of inertia of carbody	slugs ft²
TL	Semi truck wheelbase	ft
D	One half distance between sideframes	ft
RO	Wheel rolling radius at equilibrium	ft
A	One half track gauge	ft
HCG	Vertical distance between bolster and carbody CG	ft
GAM1	Roll coefficient for Axle 1	
GAM2	Roll coefficient for Axle 2	
GAM3	Roll coefficient for Axle 3	
GAM4	Roll coefficient for Axle 4	
BDEL 1	Contact angle coefficient for axle 1	
BDEL 2	Contact angle coefficient for axle 2	
BDEL 3	Contact angle coefficient for axle 3	
BDEL 4	Contact angle coefficient for axle 4	
DELO1	Initial wheel/rail contact angle for axle 1	
DELO2	Initial wheel/rail contact angle for axle 2	
DELO3	Initial wheel/rail contact angle for axle 3	
DELO4	Initial wheel/rail contact angle for axle 4	
ALAM11	Conicity for axle 1	
ALAM12	Conicity for axle 2	
ALAM13	Conicity for axle 3	

Table 2. Program Input Parameters (cont.)

ALAM14	Conicity for axle 4	
XKYF, XKYR	Vertical stiffness, sideframe to bolster, front and rear	lb/ft
XKXF, XKXR	Lateral stiffness, sideframe to bolster, front and rear	lb/ft
XKTWF, XKTWR	Truck warping stiffness, front and rear	lb-ft/rad
XKTCPF, XKTCPR	Centerplate stiffness, front and rear	lb-ft/rad
DYF, DYR	Vertical sideframe to bolster damping	lb-ft-sec/ft
DXF, DXR	Lateral sideframe to bolster damping	lb-ft-sec/rad
DTWF, DTWR	Truck warping damping, front and rear	lb-ft-sec/rad
DTCPF, DTCPR	Center plate damping, front and rear	lb-ft-sec/rad
CLF, CLF	Distance of carbody CG to truck, front and rear	ft
F11	Linear lateral creep coefficient	lb/wheel
F12	Linear lateral spin creep coefficient	lb-ft/wheel
F22	Linear spin creep coefficient	lb-ft²/wheel
F33	Linear longitudinal creep coefficient	lb/wheel

Input Formats

The input format for this program is listed below. The system parameters must be input into the program in the arrangement shown. The input on each card is format free, which means that the input parameters can be punched anywhere in the columns 1-72, separated by blanks or commas.

Card #	Input Parameter
1	IVO, IVF, IDV
2	FSTART, FSTEP, FSTOP
3	AX, APHI, OMGC, OMGS
4	LABEL
5	XMW, XIW1, XIW2
6	XMB, XIB2, XIB3
7	XMS, XIS2
8	XMC, XIC2, XIC3, XIC23
9	TL, D, RO, A
10	HCG, CLF, CLR
11	GAM1, GAM2, GAM3, GAM4
12	BDEL1, BDEL2, BDEL3, BDEL4
13	DELO1, DELO2, DELO3, DELO4
14	ALAM11, ALAM12, ALAM13, ALAM14
15	F11, F12, F22, F33
16	DYF, DXF, XKYF, XKXF
17	DYR, DXR, XKYR, XKXR
18	DTCPF, DTWF, XKTCPF, XKTWF
19	DTCPR, DTWR, XKTCPR, XKTWR

PROGRAM OUTPUT

The program prints out, in order of appearance, the following:

1. Vehicle Parameters
2. Track Parameters
3. Vehicle Speed
4. Mass, Damping and Stiffness Parameters
5. Component Displacement PSD's for Centerline Alignment Input
6. Displacement and Alignment R.M.S. Values
7. Component Displacement PSD's for Crosslevel Input
8. Displacement and Crosslevel R.M.S. Values
9. Lateral Wheel-Rail and Centerplate Lateral Force for Alignment Input
10. Lateral R.M.S. Forces for Alignment Input
11. Lateral Wheel-Rail and Centerplate Force for Crosslevel Input
12. Lateral R.M.S. Forces for Crosslevel Input

In addition, the program prepares CALCOMP PSD plots for the leading truck lateral and warp displacements, the car body lateral and roll displacements, and the lateral wheel-rail contact forces at the leading axle of each truck. These plots are prepared for both alignment and crosslevel inputs.

Most of the output is self explanatory, as seen in the sample run presented in the next section. However, the displacement PSD's are only identified by number. These numbers refer to positions in the following state vector:

PSD(1), RMS(1)	Front truck lateral
PSD(2), RMS(2)	Front truck yaw
PSD(3), RMS(3)	Front truck warp
PSD(4), RMS(4)	Rear truck lateral
PSD(5), RMS(5)	Rear truck yaw
PSD(6), RMS(6)	Rear truck warp
PSD(7), RMS(7)	Car Body lateral
PSD(8), RMS(8)	Car Body yaw
PSD(9), RMS(9)	Car Body roll
SPD(10), RMS(10)	Track input

Chapter 4

SAMPLE PROBLEM

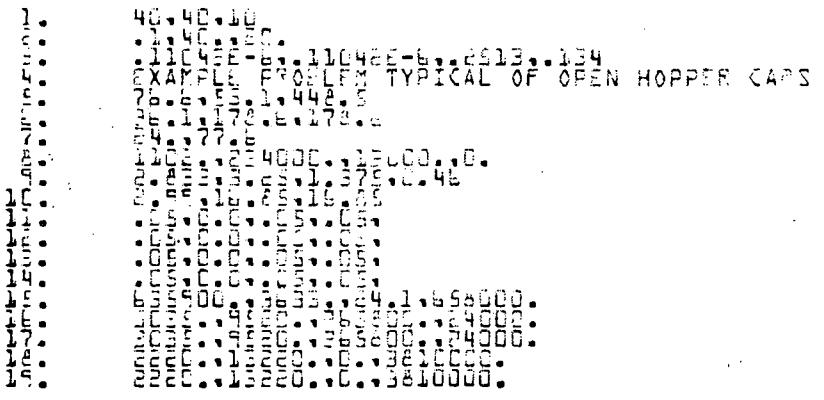
INTRODUCTION

The usage of the FR9DOF program is illustrated with a sample problem that utilizes the vehicle data described in the companion users' manual for the 9 degree of freedom eigenvalue program [3]. The vehicle data is representative of an open hopper car, where quasi-linearization has been used to obtain equivalent linear values for most of the suspension characteristics. Output solutions are obtained for the 0.10 to 20.0 Hz frequency range, and at a speed of 40 ft/sec.

In the following sections, a sample input data file, the sample output, and the plots generated by the program are illustrated.

SAMPLE INPUT DATA FILE

INPUT DATA PUNCTREAM FOR SAMPLE PROBLEM



SAMPLE OUTPUT LISTING

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS 00004

MASS PROPERTIES

XMC	(MASS OF THE CAR BODY)	= 0.1102E+04 SLUGS
XMB	(MASS OF THE BOLSTER)	= 0.3610E+02 SLUGS
XMS	(MASS OF THE SIDEFRAME)	= 0.2400E+02 SLUGS
XMW	(MASS OF THE WHEELSET)	= 0.7660E+02 SLUGS

XIC2	(MOMENT OF INERTIA OF THE CAR BODY IN YAW)	= 0.2340E+06 SLUG-FT**2
XIC3	(MOMENT OF INERTIA OF THE CAR BODY IN ROLL)	= 0.1300E+05 SLUG-FT**2
XIC23	(CROSS PRODUCT OF INERTIA FOR CAR BODY)	= 0.0 SLUG-FT**2
XIB2	(MOMENT OF INERTIA OF THE BOLSTER IN YAW)	= 0.1786E+03 SLUG-FT**2
XIB3	(MOMENT OF INERTIA OF THE BOLSTER IN ROLL)	= 0.1786E+03 SLUG-FT**2
XIS2	(MOMENT OF INERTIA OF THE SIDEFRAME IN YAW)	= 0.7760E+02 SLUG-FT**2
XIW1	(MOMENT OF INERTIA OF THE WHEELSET ABOUT AXLE)	= 0.5310E+02 SLUG-FT**2
XIW2	(MOMENT OF INERTIA OF THE WHEELSET IN YAW)	= 0.4485E+03 SLUG-FT**2

STIFFNESS PROPERTIES

XKXF	(LATERAL STIFFNESS, SIDEFRAME TO BOLSTER -FRONT-)	= 0.2400E+05 LB/FT
XKXR	(LATERAL STIFFNESS, SIDEFRAME TO BOLSTER -REAR-)	= 0.2400E+05 LB/FT
XKYF	(VERTICAL STIFFNESS,SIDEFRAME TO BOLSTER -FRONT-)	= 0.2658E+06 LB/FT
XKYR	(VERTICAL STIFFNESS, SIDEFRAME TO BOLSTER -REAR-)	= 0.2658E+06 LB/FT
XKTCPF	(CENTERPLATE STIFFNESS -FRONT-)	= 0.0 FT-LB/RAD
XKTCPR	(CENTERPLATE STIFFNESS -REAR-)	= 0.0 FT-LB/RAD
XKTWF	(TRUCK WARPING STIFFNESS -FRONT-)	= 0.3810E+07 FT-LB/RAD
XKTWR	(TRUCK WARPING STIFFNESS -REAR-)	= 0.3810E+07 FT-LB/RAD

DAMPING PROPERTIES

DTWF	(WARPING DAMPING-FRONT-)	= 0.1322E+05 LB-SEC/FT
DTWR	(WARPING DAMPING -REAR-)	= 0.1322E+05 LB-SEC/FT
DXF	(LATERAL SIDEFRAME TO BOLSTER DAMPING -FRONT-)	= 0.9520E+04 LB-SEC/FT
DXR	(LATERAL SIDEFRAME TO BOLSTER DAMPING -REAR-)	= 0.9520E+04 LB-SEC/FT
DYF	(VERTICAL SIDEFRAME TO BOLSTER DAMPING -FRONT-)	= 0.3035E+04 LB-SEC/FT
DYR	(VERTICAL SIDEFRAME TO BOLSTER DAMPING -REAR-)	= 0.3035E+04 LB-SEC/FT
DTCPF	(CENTERPLATE DAMPING -FRONT-)	= 0.2220E+04 LB-SEC/FT
DTCPR	(CENTERPLATE DAMPING -REAR-)	= 0.2220E+04 LB-SEC/FT

DIMENSIONS

A	(SEMI-DISTANCE BETWEEN WHEEL CONTACT POINTS)	= 0.2460E+01 FT
D	(SEMI-SPACING OF SIDEFRAME CENTER OF GRAVITIES)	= 0.3250E+01 FT
HCG	(VERTICAL DISTANCE BETWEEN TRUCK CG AND BODY CG)	= 0.2990E+01 FT
TL	(SEMI TRUCK WHEELBASE)	= 0.2833E+01 FT
CLF	(DISTANCE FROM BODY CG TO FRONT TRUCK)	= 0.1685E+02 FT
CLR	(DISTANCE FROM BODY CG TO REAR TRUCK)	= 0.1685E+02 FT
RO	(WHEEL ROLLING RADIUS)	= 0.1375E+01 FT

WHEEL CHARACTERISTICS

GAM1	(ROLL COEFFICIENT, AXLE 1)	= 0.5000E-01
GAM2	(ROLL COEFFICIENT, AXLE 2)	= 0.5000E-01
GAM3	(ROLL COEFFICIENT, AXLE 3)	= 0.5000E-01
GAM4	(ROLL COEFFICIENT, AXLE 4)	= 0.5000E-01
BDEL1	(CONTACT ANGLE COEFFICIENT,AXLE 1)	= 0.0
BDEL2	(CONTACT ANGLE COEFFICIENT,AXLE 2)	= 0.0
BDEL3	(CONTACT ANGLE COEFFICIENT,AXLE 3)	= 0.0
BDEL4	(CONTACT ANGLE COEFFICIENT,AXLE 4)	= 0.0
DEL01	(INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 1)	= 0.5000E-01
DEL02	(INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 2)	= 0.5000E-01
DEL01	(INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 3)	= 0.5000E-01
DEL04	(INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 4)	= 0.5000E-01
ALAM11	(CONICITY, AXLE 1)	= 0.5000E-01
ALAM12	(CONICITY, AXLE 2)	= 0.5000E-01
ALAM13	(CONICITY, AXLE 3)	= 0.5000E-01
ALAM14	(CONICITY, AXLE 4)	= 0.5000E-01

CREEP COEFFICIENTS

F11	(LATERAL CREEP COEFFICIENT)	= 0.6359E+06 LB
F12	(LATERAL/SPIN CREEP COEFFICIENT)	= 0.3633E+04 LB-FT
F22	(SPIN CREEP COEFFICIENT)	= 0.2410E+02 LB-FT**2
F33	(LONGITUDINAL CREEP COEFFICIENT)	= 0.6580E+06 LB

TRACK PROPERTIES

AX	(CENTERLINE ALIGNMENT PSD COEFFICIENT)	= 0.1104E-06 FT**2-RAD/FT
APHI	(CROSS LEVEL PSD COEFFICIENT)	= 0.1104E-06 FT**2-RAD/FT
OMGC	(PSD ROLL OFF FREQUENCY)	= 0.2513E+00 RAD/FT
OMGS	(CROSS LEVEL PSD CONSTANT)	= 0.1340E+00 RAD/FT

VELOCITY= 40.00FT/SEC

K-MATRIX

0.485E+05	-.254E+07	-.254E+07	0.0	0.0	0.0	-.480E+05	-.809E+06	-.144E+06
0.235E+06	0.156E+05	0.114E+05	0.0	0.0	0.0	0.0	0.0	0.0
0.235E+06	0.114E+05	0.382E+07	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.485E+05	-.254E+07	-.254E+07	-.480E+05	0.809E+06	-.144E+06
0.0	0.0	0.0	0.235E+06	0.156E+05	0.114E+05	0.0	0.0	0.0
0.0	0.0	0.0	0.235E+06	0.114E+05	0.382E+07	0.0	0.0	0.0
-.480E+05	0.0	0.0	-.480E+05	0.0	0.0	0.960E+05	0.0	0.287E+06
-.809E+06	0.0	0.0	0.809E+06	0.0	0.0	0.0	0.273E+08	0.0
-.258E+06	0.0	0.0	-.258E+06	0.0	0.0	0.287E+06	0.0	0.120E+08

C-MATRIX

0.826E+05	0.301E+03	0.301E+03	0.0	0.0	0.0	-.190E+05	-.321E+06	-.569E+05
-.311E+03	0.925E+06	0.400E+06	0.0	0.0	0.0	0.0	-.222E+04	0.0
-.311E+03	0.400E+06	0.414E+06	0.0	0.0	0.0	0.0	-.222E+04	0.0
0.0	0.0	0.0	0.826E+05	0.301E+03	0.301E+03	-.190E+05	0.321E+06	-.569E+05
0.0	0.0	0.0	-.311E+03	0.925E+06	0.400E+06	0.0	-.222E+04	0.0
0.0	0.0	0.0	-.311E+03	0.400E+06	0.414E+06	0.0	-.222E+04	0.0
-.190E+05	0.0	0.0	-.190E+05	0.0	0.0	0.381E+05	0.0	0.114E+06
-.321E+06	-.222E+04	-.222E+04	0.321E+06	-.222E+04	-.222E+04	0.0	0.108E+08	0.0
-.582E+05	0.0	0.0	-.582E+05	0.0	0.0	0.114E+06	0.0	0.469E+06

M-MATRIX

0.201E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.297E+04	0.158E+04	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.158E+04	0.158E+04	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.201E+03	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.297E+04	0.158E+04	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.158E+04	0.158E+04	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.117E+04	0.0	0.216E+03
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.254E+06	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.140E+05

*****PSD VALUES FOR ALIGNMENT INPUTS*****

FREQUENCY	PSD(1)	PSD(2)	PSD(3)	PSD(4)	PSD(5)	PSD(6)	PSD(7)	PSD(8)	PSD(9)
0.10000	.7648E-04	.1770E-07	.2252E-09	.7648E-04	.1772E-07	.2255E-09	.7156E-04	.1856E-07	.4358E-10
0.10593	.6877E-04	.1784E-07	.2426E-09	.6878E-04	.1787E-07	.2429E-09	.6383E-04	.1869E-07	.4717E-10
0.11220	.6192E-04	.1801E-07	.2628E-09	.6192E-04	.1804E-07	.2631E-09	.5694E-04	.1883E-07	.5123E-10
0.11885	.5581E-04	.1820E-07	.2860E-09	.5582E-04	.1823E-07	.2865E-09	.5079E-04	.1899E-07	.5580E-10
0.12589	.5039E-04	.1841E-07	.3129E-09	.5039E-04	.1845E-07	.3135E-09	.4532E-04	.1918E-07	.6095E-10
0.13335	.4556E-04	.1866E-07	.3440E-09	.4557E-04	.1871E-07	.3448E-09	.4044E-04	.1940E-07	.6675E-10
0.14125	.4128E-04	.1894E-07	.3801E-09	.4129E-04	.1900E-07	.3810E-09	.3609E-04	.1964E-07	.7326E-10
0.14962	.3748E-04	.1927E-07	.4220E-09	.3749E-04	.1933E-07	.4232E-09	.3221E-04	.1992E-07	.8058E-10
0.15849	.3411E-04	.1965E-07	.4707E-09	.3412E-04	.1972E-07	.4722E-09	.2876E-04	.2024E-07	.8881E-10
0.16788	.3113E-04	.2008E-07	.5277E-09	.3115E-04	.2017E-07	.5297E-09	.2568E-04	.2061E-07	.9805E-10
0.17783	.2851E-04	.2059E-07	.5947E-09	.2852E-04	.2069E-07	.5972E-09	.2294E-04	.2104E-07	.1084E-09
0.18836	.2620E-04	.2119E-07	.6739E-09	.2622E-04	.2130E-07	.6770E-09	.2050E-04	.2154E-07	.1201E-09
0.19953	.2418E-04	.2189E-07	.7680E-09	.2420E-04	.2202E-07	.7720E-09	.1832E-04	.2213E-07	.1332E-09
0.21135	.2243E-04	.2273E-07	.8807E-09	.2246E-04	.2287E-07	.8859E-09	.1639E-04	.2282E-07	.1480E-09
0.22387	.2093E-04	.2372E-07	.1017E-08	.2096E-04	.2389E-07	.1024E-08	.1467E-04	.2364E-07	.1646E-09
0.23714	.1966E-04	.2492E-07	.1183E-08	.1970E-04	.2512E-07	.1192E-08	.1314E-04	.2462E-07	.1834E-09
0.25119	.1862E-04	.2639E-07	.1389E-08	.1866E-04	.2662E-07	.1401E-08	.1178E-04	.2580E-07	.2046E-09
0.26607	.1780E-04	.2819E-07	.1647E-08	.1785E-04	.2847E-07	.1662E-08	.1057E-04	.2724E-07	.2288E-09

0.28184	.1722E-04	.3045E-07	.1976E-08	.1727E-04	.3079E-07	.1997E-08	.9506E-05	.2903E-07	.2564E-09
0.29854	.1688E-04	.3334E-07	.2404E-08	.1694E-04	.3374E-07	.2432E-08	.8568E-05	.3129E-07	.2881E-09
0.31623	.1683E-04	.3711E-07	.2975E-08	.1691E-04	.3760E-07	.3013E-08	.7747E-05	.3421E-07	.3250E-09
0.33496	.1714E-04	.4215E-07	.3760E-08	.1724E-04	.4277E-07	.3813E-08	.7037E-05	.3805E-07	.3684E-09
0.35481	.1792E-04	.4913E-07	.4877E-08	.1804E-04	.4991E-07	.4952E-08	.6431E-05	.4330E-07	.4205E-09
0.37584	.1938E-04	.5920E-07	.6541E-08	.1953E-04	.6022E-07	.6650E-08	.5929E-05	.5074E-07	.4845E-09
0.39811	.2190E-04	.7449E-07	.9161E-08	.2210E-04	.7585E-07	.9324E-08	.5535E-05	.6180E-07	.5656E-09
0.42169	.2621E-04	.9921E-07	.1358E-07	.2646E-04	.1010E-06	.1382E-07	.5253E-05	.7923E-07	.6718E-09
0.44668	.3374E-04	.1420E-06	.2164E-07	.3400E-04	.1443E-06	.2197E-07	.5075E-05	.1084E-06	.8133E-09
0.47315	.4672E-04	.2185E-06	.3705E-07	.4671E-04	.2200E-06	.3730E-07	.4873E-05	.1578E-06	.9799E-09
0.50118	.6306E-04	.3274E-06	.6176E-07	.6165E-04	.3221E-06	.6074E-07	.3971E-05	.2207E-06	.1004E-08
0.53088	.5797E-04	.3339E-06	.7004E-07	.5535E-04	.3202E-06	.6715E-07	.1627E-05	.2086E-06	.5207E-09
0.56234	.3057E-04	.1952E-06	.4551E-07	.2948E-04	.1887E-06	.4397E-07	.1902E-06	.1134E-06	.7865E-10
0.59566	.1355E-04	.9578E-07	.2480E-07	.1332E-04	.9413E-07	.2437E-07	.1722E-08	.5117E-07	.5544E-12
0.63095	.6285E-05	.4917E-07	.1413E-07	.6265E-05	.4887E-07	.1404E-07	.6501E-07	.2371E-07	.3861E-10
0.66834	.3148E-05	.2722E-07	.8668E-08	.3167E-05	.2724E-07	.8674E-08	.1207E-06	.1160E-07	.9244E-10
0.70794	.1681E-05	.1605E-07	.5658E-08	.1702E-05	.1612E-07	.5684E-08	.1431E-06	.5895E-08	.1398E-09
0.74989	.9424E-06	.9922E-08	.3868E-08	.9586E-06	.9987E-08	.3894E-08	.1418E-06	.3051E-08	.1764E-09
0.79432	.5481E-06	.6357E-08	.2735E-08	.5589E-06	.6403E-08	.2756E-08	.1273E-06	.1577E-08	.2022E-09
0.84139	.3277E-06	.4181E-08	.1982E-08	.3345E-06	.4211E-08	.1997E-08	.1070E-06	.7979E-09	.2176E-09
0.89125	.2001E-06	.2805E-08	.1461E-08	.2040E-06	.2822E-08	.1471E-08	.8523E-07	.3861E-09	.2231E-09
0.94406	.1241E-06	.1909E-08	.1090E-08	.1262E-06	.1918E-08	.1096E-08	.6477E-07	.1730E-09	.2193E-09
0.99999	.7785E-07	.1313E-08	.8197E-09	.7883E-07	.1317E-08	.8227E-09	.4696E-07	.6804E-10	.2071E-09
1.02919	.6186E-07	.1092E-08	.7118E-09	.6248E-07	.1095E-08	.7138E-09	.3926E-07	.3941E-10	.1983E-09
1.05925	.4923E-07	.9094E-09	.6184E-09	.4960E-07	.9111E-09	.6197E-09	.3240E-07	.2097E-10	.1878E-09
1.09018	.3922E-07	.7583E-09	.5374E-09	.3942E-07	.7593E-09	.5381E-09	.2636E-07	.9765E-11	.1758E-09
1.12201	.3127E-07	.6329E-09	.4668E-09	.3136E-07	.6334E-09	.4672E-09	.2114E-07	.3564E-11	.1627E-09
1.15477	.2494E-07	.5286E-09	.4053E-09	.2496E-07	.5288E-09	.4054E-09	.1668E-07	.7164E-12	.1486E-09
1.18849	.1989E-07	.4417E-09	.3515E-09	.1988E-07	.4417E-09	.3515E-09	.1293E-07	.4073E-15	.1339E-09
1.22320	.1585E-07	.3691E-09	.3044E-09	.1584E-07	.3691E-09	.3044E-09	.9826E-08	.5309E-12	.1187E-09
1.25891	.1263E-07	.3085E-09	.2633E-09	.1262E-07	.3085E-09	.2633E-09	.7308E-08	.1680E-11	.1035E-09
1.29567	.1004E-07	.2577E-09	.2272E-09	.1005E-07	.2578E-09	.2273E-09	.5304E-08	.3017E-11	.8849E-10
1.33351	.7975E-08	.2153E-09	.1956E-09	.7998E-08	.2155E-09	.1958E-09	.3743E-08	.4265E-11	.7396E-10
1.37245	.6320E-08	.1798E-09	.1680E-09	.6359E-08	.1800E-09	.1683E-09	.2557E-08	.5258E-11	.6023E-10
1.41252	.4998E-08	.1500E-09	.1439E-09	.5049E-08	.1503E-09	.1442E-09	.1681E-08	.5918E-11	.4753E-10
1.45377	.3942E-08	.1252E-09	.1228E-09	.4000E-08	.1254E-09	.1232E-09	.1055E-08	.6227E-11	.3611E-10
1.49622	.3101E-08	.1043E-09	.1044E-09	.3161E-08	.1046E-09	.1048E-09	.6254E-09	.6209E-11	.2614E-10
1.53991	.2434E-08	.8690E-10	.8847E-10	.2489E-08	.8718E-10	.8885E-10	.3444E-09	.5914E-11	.1775E-10
1.58487	.1905E-08	.7234E-10	.7462E-10	.1953E-08	.7258E-10	.7494E-10	.1714E-09	.5408E-11	.1104E-10
1.63115	.1487E-08	.6018E-10	.6262E-10	.1524E-08	.6037E-10	.6288E-10	.7349E-10	.4760E-11	.5990E-11
1.67878	.1159E-08	.5003E-10	.5228E-10	.1184E-08	.5016E-10	.5246E-10	.2440E-10	.4037E-11	.2561E-11
1.72780	.9023E-09	.4157E-10	.4339E-10	.9143E-09	.4164E-10	.4348E-10	.4517E-11	.3298E-11	.6261E-12
1.77826	.7017E-09	.3452E-10	.3577E-10	.7021E-09	.3454E-10	.3578E-10	.2668E-14	.2592E-11	.9790E-15
1.83018	.5455E-09	.2865E-10	.2928E-10	.5363E-09	.2863E-10	.2921E-10	.1890E-11	.1954E-11	.4474E-12
1.88362	.4239E-09	.2377E-10	.2376E-10	.4079E-09	.2372E-10	.2364E-10	.5069E-11	.1407E-11	.1687E-11
1.93863	.3294E-09	.1972E-10	.1910E-10	.3093E-09	.1965E-10	.1894E-10	.7234E-11	.9611E-12	.3417E-11
1.99523	.2556E-09	.1636E-10	.1518E-10	.2344E-09	.1629E-10	.1502E-10	.7896E-11	.6168E-12	.5331E-11
2.05350	.1978E-09	.1357E-10	.1192E-10	.1780E-09	.1350E-10	.1176E-10	.7523E-11	.3662E-12	.7143E-11
2.11346	.1522E-09	.1126E-10	.9211E-11	.1356E-09	.1120E-10	.9079E-11	.6869E-11	.1961E-12	.8605E-11
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2.23869	.8759E-10	.7763E-11	.5190E-11	.7976E-10	.7741E-11	.5130E-11	.6737E-11	.3241E-13	.9823E-11
2.30406	.6491E-10	.6457E-11	.3750E-11	.6131E-10	.6448E-11	.3723E-11	.7329E-11	.6614E-14	.9454E-11
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2.58520	.1507E-10	.3160E-11	.6374E-12	.1860E-10	.3163E-11	.6566E-12	.6025E-11	.1267E-13	.3783E-11
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2.81834	.3913E-11	.1924E-11	.2944E-13	.5180E-11	.1923E-11	.3199E-13	.9208E-12	.1194E-13	.4180E-12
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2.98534	.1927E-11	.1420E-11	.2402E-13	.1833E-11	.1421E-11	.2392E-13	.8526E-14	.6136E-14	.3646E-14
3.07251	.1511E-11	.1230E-11	.8355E-13	.1129E-11	.1233E-11	.8405E-13	.1976E-12	.3785E-14	.8478E-13
3.16223	.1206E-11	.1072E-11	.1668E-12	.7614E-12	.1075E-11	.1678E-12	.3831E-12	.2102E-14	.1762E-12
3.25457	.9225E-12	.9377E-12	.2640E-12	.5638E-12	.9406E-12	.2651E-12	.3660E-12	.1025E-14	.1973E-12
3.34960	.6479E-12	.8235E-12	.3676E-12	.4383E-12	.8252E-12	.3684E-12	.1920E-12	.4061E-15	.1420E-12
3.44741	.4134E-12	.7253E-12	.4712E-12	.3392E-12	.7258E-12	.4719E-12	.7683E-13	.9959E-16	.6077E-13
3.54808	.2552E-12	.6399E-12	.5698E-12	.2514E-12	.6399E-12	.5700E-12	.1949E-12	.1343E-17	.1295E-13
3.65168	.1856E-12	.5649E-12	.6590E-12	.1754E-12	.5651E-12	.6577E-12	.5023E-12	.4182E-16	.2079E-13
3.75831	.1825E-12	.4985E-12	.7349E-12	.1202E-12	.4994E-12	.7313E-12	.7530E-12	.1634E-15	.5663E-13
3.86806	.2024E-12	.4394E-12	.7952E-12	.9697E-13	.4407E-12	.7893E-12	.7125E-12	.3056E-15	.7265E-13

3.98101	.2051E-12	.3866E-12	.8383E-12	.1082E-12	.3877E-12	.8323E-12	.3856E-12	.4100E-15	.4702E-13
4.09725	.1740E-12	.3393E-12	.8647E-12	.1377E-12	.3397E-12	.8610E-12	.5249E-13	.4366E-15	.7244E-14
4.21690	.1194E-12	.2968E-12	.8756E-12	.1548E-12	.2964E-12	.8785E-12	.6921E-13	.3790E-15	.1049E-13
4.34003	.6517E-13	.2584E-12	.8734E-12	.1344E-12	.2576E-12	.8820E-12	.5869E-12	.2643E-15	.9641E-13
4.46676	.2899E-13	.2235E-12	.8601E-12	.7897E-13	.2228E-12	.8710E-12	.1411E-11	.1371E-15	.2493E-12
4.59719	.1246E-13	.1917E-12	.8373E-12	.2178E-13	.1914E-12	.8452E-12	.2111E-11	.4027E-16	.3993E-12
4.73143	.5629E-14	.1628E-12	.8055E-12	.3648E-14	.1628E-12	.8065E-12	.2294E-11	.4774E-18	.4638E-12
4.86959	.1465E-14	.1365E-12	.7649E-12	.3914E-13	.1366E-12	.7586E-12	.1863E-11	.2383E-16	.4025E-12
5.01179	.6000E-14	.1129E-12	.7156E-12	.1003E-12	.1130E-12	.7060E-12	.1069E-11	.9614E-16	.2470E-12
5.15813	.3367E-13	.9198E-13	.6591E-12	.1360E-12	.9198E-13	.6516E-12	.3418E-12	.1839E-15	.8452E-13
5.30875	.8986E-13	.7375E-13	.5977E-12	.1150E-12	.7374E-13	.5962E-12	.9842E-14	.2404E-15	.2611E-14
5.46377	.1563E-12	.5808E-13	.5348E-12	.5774E-13	.5814E-13	.5388E-12	.1132E-12	.2264E-15	.3219E-13
5.62332	.1966E-12	.4478E-13	.4731E-12	.2336E-13	.4489E-13	.4790E-12	.4223E-12	.1410E-15	.1292E-12
5.78752	.1832E-12	.3363E-13	.4142E-12	.5800E-13	.3371E-13	.4178E-12	.6344E-12	.3835E-16	.2091E-12
5.95652	.1261E-12	.2443E-13	.3584E-12	.1476E-12	.2442E-13	.3579E-12	.5901E-12	.1251E-17	.2098E-12
6.13045	.7313E-13	.1705E-13	.3052E-12	.2240E-12	.1697E-13	.3020E-12	.3522E-12	.7333E-16	.1352E-12
6.30946	.7348E-13	.1138E-13	.2543E-12	.2261E-12	.1130E-13	.2515E-12	.1087E-12	.2060E-15	.4509E-13
6.49370	.1324E-12	.7286E-14	.2067E-12	.1607E-12	.7272E-14	.2062E-12	.2314E-14	.2841E-15	.1039E-14
6.68332	.2010E-12	.4612E-14	.1638E-12	.9753E-13	.4649E-14	.1651E-12	.3376E-13	.2307E-15	.1633E-13
6.87848	.2191E-12	.3157E-14	.1267E-12	.9773E-13	.3194E-14	.1280E-12	.1016E-12	.9239E-16	.5301E-13
7.07933	.1735E-12	.2716E-14	.9546E-13	.1494E-12	.2722E-14	.9569E-13	.1163E-12	.2692E-17	.6516E-13
7.28605	.1111E-12	.3093E-14	.6945E-13	.1847E-12	.3078E-14	.6885E-13	.7094E-13	.4002E-16	.4252E-13
7.49881	.8656E-13	.4093E-14	.4800E-13	.1600E-12	.4081E-14	.4746E-13	.1834E-13	.1383E-15	.1169E-13
7.71778	.1044E-12	.5520E-14	.3085E-13	.1036E-12	.5518E-14	.3082E-13	.2275E-17	.1678E-15	.1481E-17
7.94314	.1209E-12	.7189E-14	.1801E-13	.7161E-13	.7188E-14	.1821E-13	.1018E-13	.9491E-16	.7140E-14
8.17509	.1029E-12	.8940E-14	.9160E-14	.7644E-13	.8939E-14	.9247E-14	.1937E-13	.1338E-16	.1402E-13
8.41380	.6524E-13	.1064E-13	.3655E-14	.8174E-13	.1064E-13	.3616E-14	.1390E-13	.7049E-17	.1026E-13
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8.91235	.3649E-13	.1336E-13	.4028E-16	.3567E-13	.1336E-13	.4100E-16	.4816E-17	.4852E-16	.3522E-17
9.17260	.3189E-13	.1418E-13	.8797E-15	.2224E-13	.1417E-13	.8696E-15	.1693E-14	.1833E-16	.1231E-14
9.44044	.1954E-13	.1456E-13	.2748E-14	.1794E-13	.1456E-13	.2743E-14	.2159E-14	.3943E-18	.1540E-14
9.71611	.8530E-14	.1450E-13	.5134E-14	.1121E-13	.1450E-13	.5150E-14	.7508E-15	.3214E-17	.5293E-15
9.99982	.3556E-14	.1400E-13	.7647E-14	.4077E-14	.1400E-13	.7656E-14	.2206E-16	.4108E-17	.1600E-16
10.29182	.1098E-14	.1309E-13	.9943E-14	.8838E-15	.1309E-13	.9939E-14	.1950E-16	.7596E-18	.1754E-16
10.59235	.5649E-16	.1184E-13	.1174E-13	.5698E-16	.1184E-13	.1174E-13	.6632E-17	.3556E-20	.5437E-18
10.90165	.7850E-15	.1032E-13	.1287E-13	.9754E-15	.1032E-13	.1286E-13	.9083E-16	.2585E-18	.1951E-16
11.21998	.2843E-14	.8640E-14	.1327E-13	.3046E-14	.8640E-14	.1326E-13	.8250E-17	.2789E-17	.2187E-17
11.54761	.6781E-14	.6899E-14	.1292E-13	.5498E-14	.6900E-14	.1292E-13	.3022E-15	.3081E-17	.7982E-16
11.88481	.1006E-13	.5204E-14	.1192E-13	.1023E-13	.5203E-14	.1192E-13	.1026E-14	.1542E-19	.2562E-15
12.23185	.1177E-13	.3649E-14	.1043E-13	.1403E-13	.3648E-14	.1041E-13	.4375E-15	.7136E-17	.1009E-15
12.58903	.1628E-13	.2318E-14	.8582E-14	.1459E-13	.2318E-14	.8583E-14	.1674E-15	.1103E-16	.3526E-16
12.95663	.1941E-13	.1271E-14	.6589E-14	.1798E-13	.1272E-14	.6593E-14	.1579E-14	.8914E-18	.3021E-15
13.33498	.1760E-13	.5411E-15	.4670E-14	.2043E-13	.5409E-15	.4661E-14	.9437E-15	.6091E-17	.1634E-15
13.72436	.1848E-13	.1298E-15	.2959E-14	.1748E-13	.1299E-15	.2957E-14	.6323E-16	.1213E-16	.9877E-17
14.12512	.1849E-13	.1159E-16	.1588E-14	.1717E-13	.1160E-16	.1589E-14	.1336E-14	.1043E-17	.1863E-15
14.53758	.1405E-13	.1330E-15	.6450E-15	.1591E-13	.1331E-15	.6425E-15	.6270E-15	.4578E-17	.7965E-16
14.96209	.1213E-13	.4213E-15	.1309E-15	.1127E-13	.4212E-15	.1308E-15	.1022E-15	.6321E-17	.1169E-16
15.39899	.9196E-14	.7918E-15	.8946E-17	.9044E-14	.7917E-15	.8958E-17	.6789E-15	.3219E-19	.7011E-16
15.84865	.5405E-14	.1160E-14	.1901E-15	.5879E-14	.1160E-14	.1907E-15	.8591E-16	.2468E-17	.8015E-17
16.31143	.3287E-14	.1451E-14	.5573E-15	.2986E-14	.1451E-14	.5573E-15	.1078E-15	.8359E-18	.9118E-17
16.78772	.1232E-14	.1612E-14	.9808E-15	.1322E-14	.1612E-14	.9811E-15	.7030E-16	.1168E-18	.5446E-17
17.27792	.2180E-15	.1616E-14	.1344E-14	.2117E-15	.1616E-14	.1344E-14	.4526E-18	.9869E-19	.3377E-19
17.78244	.2384E-16	.1467E-14	.1559E-14	.2359E-16	.1467E-14	.1559E-14	.1707E-17	.3400E-22	.6600E-19
18.30170	.4878E-15	.1198E-14	.1584E-14	.5074E-15	.1198E-14	.1583E-14	.2063E-17	.1997E-18	.1008E-18
18.83611	.1467E-14	.8624E-15	.1420E-14	.1391E-14	.8624E-15	.1420E-14	.7288E-16	.8885E-19	.3307E-17
19.38612	.2320E-14	.5245E-15	.1117E-14	.2468E-14	.5244E-15	.1117E-14	.3576E-16	.6880E-18	.1473E-17
19.95219	.3350E-14	.2439E-15	.7486E-15	.3151E-14	.2439E-15	.7486E-15	.1245E-15	.3672E-18	.4621E-17
20.53481	.3495E-14	.6371E-16	.4002E-15	.3714E-14	.6368E-16	.3997E-15	.6734E-16	.8166E-18	.2244E-17

RMS VALUES-ALIGNMENT INPUT

RMS(1) =0.406E-02
RMS(2) =0.238E-03
RMS(3) =0.104E-03
RMS(4) =0.404E-02
RMS(5) =0.237E-03
RMS(6) =0.103E-03
RMS(7) =0.249E-02
RMS(8) =0.197E-03
RMS(9) =0.178E-04

RMS(10) =0.253E-02

***** PSD VALUES FOR CROSS LEVEL INPUT *****

FREQUENCY	PSD(1)	PSD(2)	PSD(3)	PSD(4)	PSD(5)	PSD(6)	PSD(7)	PSD(8)	PSD(9)
0.10000	.1199E-05	.4407E-10	.2090E-11	.1199E-05	.4401E-10	.2119E-11	.1075E-04	.2910E-09	.5450E-06
0.10593	.1202E-05	.4245E-10	.2633E-11	.1203E-05	.4238E-10	.2673E-11	.1066E-04	.3268E-09	.5390E-06
0.11220	.1207E-05	.4066E-10	.3318E-11	.1208E-05	.4059E-10	.3375E-11	.1056E-04	.3671E-09	.5323E-06
0.11885	.1211E-05	.3869E-10	.4182E-11	.1213E-05	.3863E-10	.4263E-11	.1045E-04	.4125E-09	.5249E-06
0.12589	.1217E-05	.3653E-10	.5275E-11	.1218E-05	.3649E-10	.5389E-11	.1033E-04	.4635E-09	.5167E-06
0.13335	.1223E-05	.3418E-10	.6656E-11	.1225E-05	.3417E-10	.6817E-11	.1019E-04	.5210E-09	.5077E-06
0.14125	.1230E-05	.3163E-10	.8404E-11	.1233E-05	.3169E-10	.8632E-11	.1004E-04	.5859E-09	.4977E-06
0.14962	.1239E-05	.2890E-10	.1062E-10	.1242E-05	.2908E-10	.1094E-10	.9870E-05	.6590E-09	.4866E-06
0.15849	.1248E-05	.2600E-10	.1343E-10	.1252E-05	.2639E-10	.1388E-10	.9683E-05	.7415E-09	.4744E-06
0.16788	.1259E-05	.2301E-10	.1699E-10	.1264E-05	.2371E-10	.1763E-10	.9477E-05	.8348E-09	.4611E-06
0.17783	.1272E-05	.1999E-10	.2153E-10	.1278E-05	.2120E-10	.2243E-10	.9249E-05	.9404E-09	.4464E-06
0.18836	.1287E-05	.1711E-10	.2731E-10	.1294E-05	.1908E-10	.2859E-10	.8999E-05	.1060E-08	.4304E-06
0.19953	.1304E-05	.1459E-10	.3470E-10	.1314E-05	.1774E-10	.3651E-10	.8723E-05	.1196E-08	.4130E-06
0.21135	.1325E-05	.1281E-10	.4418E-10	.1337E-05	.1772E-10	.4672E-10	.8422E-05	.1352E-08	.3942E-06
0.22387	.1349E-05	.1235E-10	.5637E-10	.1365E-05	.1993E-10	.5997E-10	.8094E-05	.1529E-08	.3738E-06
0.23714	.1378E-05	.1415E-10	.7214E-10	.1398E-05	.2571E-10	.7724E-10	.7737E-05	.1734E-08	.3519E-06
0.25119	.1414E-05	.1967E-10	.9265E-10	.1438E-05	.3722E-10	.9987E-10	.7352E-05	.1970E-08	.3286E-06
0.26607	.1457E-05	.3133E-10	.1195E-09	.1488E-05	.5782E-10	.1298E-09	.6937E-05	.2246E-08	.3038E-06
0.28184	.1511E-05	.5304E-10	.1551E-09	.1551E-05	.9298E-10	.1697E-09	.6496E-05	.2571E-08	.2777E-06
0.29854	.1579E-05	.9142E-10	.2028E-09	.1629E-05	.1517E-09	.2236E-09	.6027E-05	.2959E-08	.2505E-06
0.31623	.1666E-05	.1579E-09	.2677E-09	.1730E-05	.2491E-09	.2975E-09	.5536E-05	.3431E-08	.2224E-06
0.33496	.1780E-05	.2732E-09	.3578E-09	.1863E-05	.4120E-09	.4008E-09	.5025E-05	.4017E-08	.1937E-06
0.35481	.1935E-05	.4758E-09	.4865E-09	.2043E-05	.6894E-09	.5491E-09	.4501E-05	.4767E-08	.1649E-06
0.37584	.2152E-05	.8427E-09	.6768E-09	.2293E-05	.1176E-08	.7689E-09	.3970E-05	.5765E-08	.1363E-06
0.39811	.2469E-05	.1537E-08	.9715E-09	.2657E-05	.2070E-08	.1109E-08	.3440E-05	.7157E-08	.1086E-06
0.42169	.2956E-05	.2934E-08	.1455E-08	.3210E-05	.3809E-08	.1666E-08	.2917E-05	.9216E-08	.8250E-07
0.44668	.3738E-05	.5962E-08	.2304E-08	.4086E-05	.7444E-08	.2631E-08	.2399E-05	.1244E-07	.5875E-07
0.47315	.4980E-05	.1293E-07	.3843E-08	.5433E-05	.1541E-07	.4333E-08	.1848E-05	.1748E-07	.3834E-07
0.50118	.6307E-05	.2715E-07	.6093E-08	.6736E-05	.3042E-07	.6643E-08	.1122E-05	.2296E-07	.2239E-07
0.53088	.5278E-05	.3866E-07	.6376E-08	.5453E-05	.4052E-07	.6645E-08	.3314E-06	.1969E-07	.1078E-07
0.56234	.2439E-05	.3144E-07	.3675E-08	.2476E-05	.3179E-07	.3730E-08	.3304E-07	.9271E-08	.2688E-08
0.59566	.9019E-06	.2139E-07	.1683E-08	.8824E-06	.2108E-07	.1648E-08	.2344E-09	.3399E-08	.1251E-10
0.63095	.3277E-06	.1519E-07	.7473E-09	.2921E-06	.1455E-07	.6800E-09	.2758E-07	.1165E-08	.3479E-08
0.66834	.1177E-06	.1161E-07	.3189E-09	.8694E-07	.1081E-07	.2543E-09	.1084E-06	.3628E-09	.1286E-07
0.70794	.3962E-07	.9437E-08	.1205E-09	.2170E-07	.8565E-08	.7745E-10	.2538E-06	.8935E-10	.2754E-07
0.74989	.1152E-07	.8033E-08	.3672E-10	.8138E-08	.7152E-08	.2502E-10	.4628E-06	.1323E-10	.4651E-07
0.79432	.2864E-08	.7076E-08	.1745E-10	.1266E-07	.6231E-08	.4121E-10	.7221E-06	.6510E-11	.6831E-07
0.84139	.1710E-08	.6392E-08	.3976E-10	.2161E-07	.5621E-08	.9802E-10	.1009E-05	.1768E-10	.9108E-07
0.89125	.3307E-08	.5880E-08	.9264E-10	.2928E-07	.5214E-08	.1794E-09	.1294E-05	.2668E-10	.1127E-06
0.94406	.5867E-08	.5481E-08	.1707E-09	.3346E-07	.4944E-08	.2747E-09	.1542E-05	.2763E-10	.1307E-06
0.99999	.8823E-08	.5155E-08	.2710E-09	.3371E-07	.4761E-08	.3765E-09	.1723E-05	.2133E-10	.1431E-06
1.02919	.1041E-07	.5012E-08	.3289E-09	.3249E-07	.4692E-08	.4281E-09	.1778E-05	.1662E-10	.1466E-06
1.05925	.1205E-07	.4879E-08	.3916E-09	.3054E-07	.4631E-08	.4796E-09	.1807E-05	.1164E-10	.1480E-06
1.09018	.1376E-07	.4753E-08	.4587E-09	.2802E-07	.4575E-08	.5307E-09	.1807E-05	.6999E-11	.1473E-06
1.12201	.1551E-07	.4634E-08	.5299E-09	.2511E-07	.4522E-08	.5813E-09	.1778E-05	.3226E-11	.1444E-06
1.15477	.1728E-07	.4521E-08	.6047E-09	.2198E-07	.4469E-08	.6314E-09	.1720E-05	.7815E-12	.1393E-06
1.18849	.1904E-07	.4411E-08	.6825E-09	.1884E-07	.4412E-08	.6813E-09	.1635E-05	.5212E-14	.1322E-06
1.22320	.2074E-07	.4305E-08	.7624E-09	.1586E-07	.4351E-08	.7314E-09	.1524E-05	.1098E-11	.1232E-06
1.25891	.2232E-07	.4202E-08	.8437E-09	.1322E-07	.4284E-08	.7822E-09	.1391E-05	.4106E-11	.1125E-06
1.29567	.2372E-07	.4103E-08	.9253E-09	.1104E-07	.4211E-08	.8343E-09	.1241E-05	.8917E-11	.1005E-06
1.33351	.2487E-07	.4005E-08	.1006E-08	.9428E-08	.4130E-08	.8883E-09	.1079E-05	.1527E-10	.8766E-07
1.37245	.2571E-07	.3911E-08	.1085E-08	.8443E-08	.4042E-08	.9447E-09	.9110E-06	.2275E-10	.7429E-07
1.41252	.2618E-07	.3818E-08	.1160E-08	.8092E-08	.3948E-08	.1004E-08	.7432E-06	.3085E-10	.6089E-07
1.45377	.2622E-07	.3729E-08	.1231E-08	.8332E-08	.3850E-08	.1066E-08	.5817E-06	.3899E-10	.4794E-07
1.49622	.2581E-07	.3643E-08	.1297E-08	.9070E-08	.3749E-08	.1132E-08	.4326E-06	.4656E-10	.3590E-07
1.53991	.2493E-07	.3559E-08	.1355E-08	.1017E-07	.3646E-08	.1199E-08	.3010E-06	.5296E-10	.2518E-07
1.58487	.2360E-07	.3479E-08	.1406E-08	.1145E-07	.3545E-08	.1268E-08	.1910E-06	.5768E-10	.1613E-07
1.63115	.2184E-07	.3401E-08	.1448E-08	.1273E-07	.3446E-08	.1337E-08	.1055E-06	.6033E-10	.9002E-08
1.67878	.1973E-07	.3325E-08	.1482E-08	.1381E-07	.3352E-08	.1404E-08	.4578E-07	.6069E-10	.3951E-08
1.72780	.1736E-07	.3252E-08	.1507E-08	.1452E-07	.3262E-08	.1466E-08	.1131E-07	.5870E-10	.9894E-09
1.77826	.1482E-07	.3181E-08	.1523E-08	.1471E-07	.3179E-08	.1521E-08	.1649E-10	.5454E-10	.1523E-11
1.83018	.1223E-07	.3110E-08	.1533E-08	.1431E-07	.3102E-08	.1567E-08	.8264E-08	.4854E-10	.7415E-09
1.88362	.9721E-08	.3039E-08	.1535E-08	.1330E-07	.3028E-08	.1601E-08	.3119E-07	.4121E-10	.2848E-08
1.93863	.7391E-08	.2968E-08	.1533E-08	.1174E-07	.2958E-08	.1622E-08	.6313E-07	.3317E-10	.5872E-08
1.99523	.5337E-08	.2894E-08	.1527E-08	.9768E-08	.2888E-08	.1629E-08	.9813E-07	.2506E-10	.9312E-08

2.05350	.3624E-08	.2817E-08	.1518E-08	.7568E-08	.2817E-08	.1623E-08	.1306E-06	.1750E-10	.1266E-07
2.11346	.2288E-08	.2737E-08	.1509E-08	.5364E-08	.2741E-08	.1604E-08	.1557E-06	.1101E-10	.1545E-07
2.17517	.1327E-08	.2652E-08	.1498E-08	.3380E-08	.2659E-08	.1576E-08	.1702E-06	.5956E-11	.1731E-07
2.23869	.7094E-09	.2561E-08	.1488E-08	.1804E-08	.2569E-08	.1541E-08	.1723E-06	.2494E-11	.1801E-07
2.30406	.3779E-09	.2466E-08	.1477E-08	.7580E-09	.2471E-08	.1504E-08	.1624E-06	.5842E-12	.1747E-07
2.37134	.2604E-09	.2366E-08	.1465E-08	.2708E-09	.2366E-08	.1466E-08	.1423E-06	.6919E-15	.1580E-07
2.44058	.2822E-09	.2261E-08	.1451E-08	.2745E-09	.2255E-08	.1431E-08	.1154E-06	.3861E-12	.1326E-07
2.51185	.3774E-09	.2154E-08	.1432E-08	.6158E-09	.2142E-08	.1400E-08	.8565E-07	.1319E-11	.1022E-07
2.58520	.4974E-09	.2044E-08	.1408E-08	.1091E-08	.2027E-08	.1372E-08	.5717E-07	.2392E-11	.7107E-08
2.66069	.6136E-09	.1933E-08	.1377E-08	.1494E-08	.1915E-08	.1344E-08	.3324E-07	.3276E-11	.4323E-08
2.73838	.7154E-09	.1823E-08	.1338E-08	.1674E-08	.1807E-08	.1313E-08	.1585E-07	.3771E-11	.2167E-08
2.81834	.8017E-09	.1714E-08	.1292E-08	.1575E-08	.1703E-08	.1277E-08	.5396E-08	.3813E-11	.781CE-09
2.90064	.8720E-09	.1607E-08	.1238E-08	.1246E-08	.1602E-08	.1232E-08	.8083E-09	.3462E-11	.1249E-09
2.98534	.9194E-09	.1504E-08	.1178E-08	.8242E-09	.1505E-08	.1178E-08	.4034E-10	.2851E-11	.6729E-11
3.07251	.9300E-09	.1404E-08	.1115E-08	.4655E-09	.1409E-08	.1117E-08	.8404E-09	.2135E-11	.1545E-09
3.16223	.8894E-09	.1306E-08	.1050E-08	.2771E-09	.1313E-08	.1052E-08	.1512E-08	.1445E-11	.3159E-09
3.25457	.7935E-09	.1212E-08	.9844E-09	.2661E-09	.1217E-08	.9854E-09	.1370E-08	.8597E-12	.3453E-09
3.34960	.6566E-09	.1120E-08	.9207E-09	.3460E-09	.1123E-08	.9213E-09	.6902E-09	.4154E-12	.2387E-09
3.44741	.5091E-09	.1030E-08	.8588E-09	.4030E-09	.1031E-08	.8595E-09	.1778E-09	.1241E-12	.9427E-10
3.54808	.3866E-09	.9425E-09	.7984E-09	.3808E-09	.9424E-09	.7987E-09	.2964E-09	.2035E-14	.2011E-10
3.65168	.3155E-09	.8574E-09	.7388E-09	.3202E-09	.8580E-09	.7368E-09	.8981E-09	.7745E-13	.4903E-10
3.75831	.3069E-09	.7754E-09	.6789E-09	.3164E-09	.7772E-09	.6736E-09	.1399E-08	.3705E-12	.1217E-09
3.86806	.3601E-09	.6971E-09	.6184E-09	.4244E-09	.6996E-09	.6104E-09	.1316E-08	.8528E-12	.1479E-09
3.98101	.4694E-09	.6229E-09	.5574E-09	.5950E-09	.6250E-09	.5497E-09	.6966E-09	.1412E-11	.9268E-10
4.09725	.6217E-09	.5532E-09	.4970E-09	.7044E-09	.5540E-09	.4935E-09	.9217E-10	.1857E-11	.1395E-10
4.21690	.7874E-09	.4881E-09	.4389E-09	.6565E-09	.4875E-09	.4418E-09	.1181E-09	.1984E-11	.1984E-10
4.34003	.9157E-09	.4275E-09	.3847E-09	.4772E-09	.4260E-09	.3929E-09	.9710E-09	.1685E-11	.1796E-09
4.46676	.9495E-09	.3710E-09	.3353E-09	.3154E-09	.3695E-09	.3450E-09	.2268E-08	.1045E-11	.4583E-09
4.59719	.8603E-09	.3186E-09	.2909E-09	.3412E-09	.3177E-09	.2974E-09	.3298E-08	.3570E-12	.7249E-09
4.73143	.6818E-09	.2701E-09	.2507E-09	.6128E-09	.2700E-09	.2514E-09	.3492E-08	.4704E-14	.8325E-09
4.86959	.5130E-09	.2256E-09	.2136E-09	.1013E-08	.2261E-09	.2091E-09	.2769E-08	.2453E-12	.7145E-09
5.01179	.4747E-09	.1856E-09	.1786E-09	.1313E-08	.1861E-09	.1721E-09	.1555E-08	.1016E-11	.4339E-09
5.15813	.6332E-09	.1501E-09	.1457E-09	.1335E-08	.1504E-09	.1409E-09	.4878E-09	.1906E-11	.1470E-09
5.30875	.9408E-09	.1191E-09	.1154E-09	.1084E-08	.1192E-09	.1143E-09	.1381E-10	.2367E-11	.4501E-11
5.46377	.1243E-08	.9259E-10	.8883E-10	.7606E-09	.9257E-10	.9082E-10	.1569E-09	.2075E-11	.5497E-10
5.62332	.1365E-08	.7006E-10	.6669E-10	.6126E-09	.7003E-10	.6949E-10	.5794E-09	.1192E-11	.2187E-09
5.78752	.1233E-08	.5116E-10	.4895E-10	.7396E-09	.5116E-10	.5051E-10	.8650E-09	.3021E-12	.3509E-09
5.95652	.9375E-09	.3560E-10	.3488E-10	.1011E-08	.3560E-10	.3469E-10	.8027E-09	.6476E-14	.3493E-09
6.13045	.6760E-09	.2318E-10	.2360E-10	.1177E-08	.2318E-10	.2252E-10	.4801E-09	.4433E-12	.2234E-09
6.30946	.6062E-09	.1375E-10	.1454E-10	.1082E-08	.1374E-10	.1371E-10	.1492E-09	.1157E-11	.7392E-10
6.49370	.7200E-09	.7066E-11	.7665E-11	.8032E-09	.7071E-11	.7506E-11	.3214E-11	.1475E-11	.1691E-11
6.68332	.8550E-09	.2799E-11	.3081E-11	.5659E-09	.2810E-11	.3260E-11	.4780E-10	.1112E-11	.2639E-10
6.87848	.8441E-09	.5665E-12	.6770E-12	.5200E-09	.5717E-12	.7778E-12	.1474E-09	.4174E-12	.8509E-10
7.07933	.6676E-09	.1135E-13	.2394E-13	.6045E-09	.1121E-13	.2071E-13	.1737E-09	.1249E-13	.1039E-09
7.28605	.4584E-09	.8196E-12	.6477E-12	.6379E-09	.8235E-12	.7259E-12	.1098E-09	.1508E-12	.6740E-10
7.49881	.3539E-09	.2684E-11	.2270E-11	.5276E-09	.2690E-11	.2423E-11	.2955E-10	.4990E-12	.1841E-10
7.71778	.3578E-09	.5274E-11	.4727E-11	.3558E-09	.5271E-11	.4755E-11	.3877E-14	.5759E-12	.2311E-14
7.94314	.3631E-09	.8265E-11	.7722E-11	.2533E-09	.8251E-11	.7577E-11	.1794E-10	.3109E-12	.1112E-10
8.17509	.2959E-09	.1138E-10	.1082E-10	.2381E-09	.1137E-10	.1071E-10	.3571E-10	.4254E-13	.2173E-10
8.41380	.1916E-09	.1440E-10	.1370E-10	.2261E-09	.1440E-10	.1378E-10	.2675E-10	.2017E-13	.1581E-10
8.65949	.1228E-09	.1711E-10	.1629E-10	.1668E-09	.1712E-10	.1644E-10	.7192E-11	.1234E-12	.4094E-11
8.91235	.9892E-10	.1933E-10	.1856E-10	.9729E-10	.1933E-10	.1858E-10	.9998E-14	.1320E-12	.5376E-14
9.17260	.7927E-10	.2091E-10	.2028E-10	.6015E-10	.2090E-10	.2021E-10	.3615E-11	.4834E-13	.1872E-11
9.44044	.4737E-10	.2177E-10	.2123E-10	.4419E-10	.2177E-10	.2122E-10	.4724E-11	.1051E-14	.2333E-11
9.71611	.2097E-10	.2191E-10	.2141E-10	.2607E-10	.2191E-10	.2145E-10	.1677E-11	.7765E-14	.7987E-12
9.99982	.8493E-11	.2132E-10	.2090E-10	.9474E-11	.2132E-10	.2092E-10	.5045E-13	.9676E-14	.2406E-13
10.29182	.2402E-11	.2005E-10	.1976E-10	.2002E-11	.2005E-10	.1976E-10	.4723E-13	.1714E-14	.2633E-13
10.59235	.8720E-13	.1822E-10	.1802E-10	.8797E-13	.1822E-10	.1802E-10	.1024E-13	.5489E-17	.8393E-15
10.90165	.1760E-11	.1595E-10	.1584E-10	.2098E-11	.1595E-10	.1583E-10	.1794E-12	.5613E-15	.2885E-13
11.21998	.6173E-11	.1340E-10	.1336E-10	.6533E-11	.1340E-10	.1335E-10	.1676E-13	.6014E-14	.3232E-14
11.54761	.1405E-10	.1073E-10	.1073E-10	.1180E-10	.1073E-10	.1074E-10	.6150E-12	.6545E-14	.1176E-12
11.88481	.2066E-10	.8114E-11	.8148E-11	.2093E-10	.8114E-11	.8148E-11	.2077E-11	.2805E-16	.3766E-12
12.23185	.2421E-10	.5704E-11	.5772E-11	.2808E-10	.5703E-11	.5759E-11	.8770E-12	.1446E-13	.1479E-12
12.58903	.3224E-10	.3631E-11	.3701E-11	.2936E-10	.3632E-11	.3699E-11	.3317E-12	.2209E-13	.5154E-13
12.95663	.3765E-10	.1995E-11	.2047E-11	.3519E-10	.1996E-11	.2049E-11	.3091E-11	.1784E-14	.4404E-12
13.33498	.3424E-10	.8477E-12	.8902E-12	.3898E-10	.8474E-12	.8861E-12	.1825E-11	.1173E-13	.2376E-12
13.72436	.3513E-10	.1954E-12	.2187E-12	.3345E-10	.1955E-12	.2177E-12	.1207E-12	.2316E-13	.1433E-13
14.12512	.3441E-10	.1032E-15	.2062E-14	.3221E-10	.1013E-15	.1969E-14	.2520E-11	.1989E-14	.2725E-12
14.53758	.2620E-10	.1799E-12	.1644E-12	.2925E-10	.1800E-12	.1659E-12	.1169E-11	.8469E-14	.1150E-12
14.96209	.2217E-10	.6225E-12	.5945E-12	.2076E-10	.6224E-12	.5953E-12	.1882E-12	.1162E-13	.1685E-13

15.39899	.1658E-10	.1196E-11	.1165E-11	.1632E-10	.1196E-11	.1165E-11	.1237E-11	.6131E-16	.1008E-12
15.84865	.[illegible]	.1770E-11	.1736E-11	.1050E-10	.1770E-11	.1739E-11	.1549E-12	.4424E-14	.1150E-13
16.31143	.5806E-11	.2227E-11	.2201E-11	.5318E-11	.2226E-11	.2201E-11	.1926E-12	.1491E-14	.1306E-13
16.78772	.2168E-11	.2482E-11	.2466E-11	.2311E-11	.2482E-11	.2466E-11	.1244E-12	.2041E-15	.7795E-14
17.27792	.3791E-12	.2494E-11	.2488E-11	.3690E-12	.2494E-11	.2488E-11	.7935E-15	.1719E-15	.4846E-16
17.78244	.4158E-13	.2268E-11	.2272E-11	.4115E-13	.2268E-11	.2273E-11	.2957E-14	.6278E-19	.9071E-16
18.30170	.8425E-12	.1855E-11	.1867E-11	.8737E-12	.1855E-11	.1867E-11	.3557E-14	.3442E-15	.1420E-15
18.83611	.2499E-11	.1338E-11	.1353E-11	.2377E-11	.1338E-11	.1353E-11	.1248E-12	.1531E-15	.4660E-14
19.38612	.3947E-11	.8153E-12	.8302E-12	.4181E-11	.8152E-12	.8294E-12	.6082E-13	.1167E-14	.2073E-14
19.95219	.5635E-11	.3801E-12	.3911E-12	.5318E-11	.3801E-12	.3911E-12	.2104E-12	.6225E-15	.6492E-14
20.53481	.5870E-11	.9965E-13	.1058E-12	.6214E-11	.9961E-13	.1055E-12	.1131E-12	.1367E-14	.3146E-14

RMS VALUES-CROSS LEVEL INPUT

RMS(1) =0.113E-02
RMS(2) =0.122E-03
RMS(3) =0.693E-04
RMS(4) =0.116E-02
RMS(5) =0.123E-03
RMS(6) =0.696E-04
RMS(7) =0.188E-02
RMS(8) =0.602E-04
RMS(9) =0.448E-03

RMS(10) =0.692E-03

PSD VALUES FOR ALIGNMENT INPUT

FREQUENCY (HZ)	LATERAL CONTACT FORCES AXLE 1	AXLE 2	AXLE 3	AXLE 4	CENTERPLATE FORCE LATERAL POSITION	LATERAL MAGNITUDE
0.100	0.2574E+03	0.8440E+02	0.1024E+05	0.8940E+04	0.8378E-07	0.1188E+02
0.106	0.2738E+03	0.8448E+02	0.1135E+05	0.9919E+04	0.9425E-07	0.1337E+02
0.112	0.2928E+03	0.8489E+02	0.1258E+05	0.1101E+05	0.1060E-06	0.1505E+02
0.119	0.3145E+03	0.8564E+02	0.1395E+05	0.1222E+05	0.1192E-06	0.1693E+02
0.126	0.3394E+03	0.8671E+02	0.1545E+05	0.1356E+05	0.1340E-06	0.1905E+02
0.133	0.3679E+03	0.8809E+02	0.1711E+05	0.1504E+05	0.1506E-06	0.2144E+02
0.141	0.4003E+03	0.8976E+02	0.1894E+05	0.1668E+05	0.1693E-06	0.2412E+02
0.150	0.4373E+03	0.9168E+02	0.2094E+05	0.1849E+05	0.1902E-06	0.2715E+02
0.158	0.4793E+03	0.9382E+02	0.2314E+05	0.2048E+05	0.2137E-06	0.3055E+02
0.168	0.5271E+03	0.9607E+02	0.2553E+05	0.2268E+05	0.2402E-06	0.3438E+02
0.178	0.5815E+03	0.9833E+02	0.2813E+05	0.2508E+05	0.2698E-06	0.3870E+02
0.188	0.6432E+03	0.1004E+03	0.3095E+05	0.2772E+05	0.3032E-06	0.4358E+02
0.200	0.7133E+03	0.1021E+03	0.3399E+05	0.3060E+05	0.3407E-06	0.4909E+02
0.211	0.7925E+03	0.1031E+03	0.3727E+05	0.3375E+05	0.3830E-06	0.5531E+02
0.224	0.8819E+03	0.1028E+03	0.4077E+05	0.3717E+05	0.4306E-06	0.6236E+02
0.237	0.9821E+03	0.1005E+03	0.4451E+05	0.4091E+05	0.4842E-06	0.7037E+02
0.251	0.1093E+04	0.9530E+02	0.4850E+05	0.4498E+05	0.5449E-06	0.7947E+02
0.266	0.1215E+04	0.8602E+02	0.5273E+05	0.4944E+05	0.6137E-06	0.8987E+02
0.282	0.1344E+04	0.7133E+02	0.5725E+05	0.5435E+05	0.6921E-06	0.1018E+03
0.299	0.1473E+04	0.5048E+02	0.6211E+05	0.5982E+05	0.7818E-06	0.1156E+03
0.316	0.1589E+04	0.2537E+02	0.6743E+05	0.6607E+05	0.8854E-06	0.1317E+03
0.335	0.1662E+04	0.7444E+01	0.7349E+05	0.7344E+05	0.1006E-05	0.1506E+03
0.355	0.1639E+04	0.3957E+02	0.8081E+05	0.8263E+05	0.1150E-05	0.1734E+03
0.376	0.1432E+04	0.2704E+03	0.9053E+05	0.9496E+05	0.1325E-05	0.2013E+03
0.398	0.9574E+03	0.1229E+04	0.1052E+06	0.1133E+06	0.1544E-05	0.2367E+03
0.422	0.5925E+03	0.4954E+04	0.1310E+06	0.1442E+06	0.1826E-05	0.2829E+03
0.447	0.4522E+04	0.2029E+05	0.1847E+06	0.2046E+06	0.2196E-05	0.3442E+03
0.473	0.4379E+05	0.8860E+05	0.3148E+06	0.3369E+06	0.2620E-05	0.4162E+03
0.501	0.2731E+06	0.3478E+06	0.5951E+06	0.5751E+06	0.2648E-05	0.4270E+03
0.531	0.6425E+06	0.6087E+06	0.7093E+06	0.5858E+06	0.1342E-05	0.2202E+03

0.562	0.4411E+06	0.3403E+06	0.4044E+06	0.2906E+06	0.1930E-06	0.3236E+02
0.596	0.1978E+06	0.1312E+06	0.1977E+06	0.1327E+06	0.2301E-08	0.3774E+00
0.631	0.9218E+05	0.5446E+05	0.1089E+06	0.7287E+05	0.1015E-06	0.1763E+02
0.668	0.4815E+05	0.2595E+05	0.6620E+05	0.4585E+05	0.2297E-06	0.4114E+02
0.708	0.2777E+05	0.1389E+05	0.4165E+05	0.3053E+05	0.3315E-06	0.6136E+02
0.750	0.1726E+05	0.8112E+04	0.2568E+05	0.2030E+05	0.3979E-06	0.7650E+02
0.794	0.1135E+05	0.5058E+04	0.1477E+05	0.1289E+05	0.4301E-06	0.8642E+02
0.841	0.7773E+04	0.3311E+04	0.7443E+04	0.7493E+04	0.4316E-06	0.9133E+02
0.891	0.5492E+04	0.2248E+04	0.2950E+04	0.3758E+04	0.4067E-06	0.9151E+02
0.944	0.3970E+04	0.1569E+04	0.6904E+03	0.1459E+04	0.3608E-06	0.8742E+02
1.000	0.2918E+04	0.1118E+04	0.3884E+02	0.3281E+03	0.3004E-06	0.7964E+02
1.029	0.2514E+04	0.9491E+03	0.1037E+03	0.9753E+02	0.2670E-06	0.7462E+02
1.059	0.2171E+04	0.8083E+03	0.3154E+03	0.2763E+02	0.2327E-06	0.6900E+02
1.090	0.1879E+04	0.6902E+03	0.5952E+03	0.7033E+02	0.1985E-06	0.6291E+02
1.122	0.1628E+04	0.5904E+03	0.8749E+03	0.1797E+03	0.1653E-06	0.5650E+02
1.155	0.1413E+04	0.5058E+03	0.1101E+04	0.3146E+03	0.1340E-06	0.4992E+02
1.188	0.1226E+04	0.4337E+03	0.1237E+04	0.4412E+03	0.1052E-06	0.4332E+02
1.223	0.1065E+04	0.3719E+03	0.1267E+04	0.5350E+03	0.7973E-07	0.3686E+02
1.259	0.9245E+03	0.3190E+03	0.1192E+04	0.5816E+03	0.5789E-07	0.3068E+02
1.296	0.8022E+03	0.2734E+03	0.1032E+04	0.5768E+03	0.3993E-07	0.2490E+02
1.334	0.6955E+03	0.2340E+03	0.8155E+03	0.5255E+03	0.2587E-07	0.1965E+02
1.372	0.6022E+03	0.2000E+03	0.5791E+03	0.4396E+03	0.1552E-07	0.1500E+02
1.413	0.5206E+03	0.1706E+03	0.3578E+03	0.3350E+03	0.8468E-08	0.1101E+02
1.454	0.4492E+03	0.1451E+03	0.1801E+03	0.2286E+03	0.4153E-08	0.7712E+01
1.496	0.3868E+03	0.1231E+03	0.6288E+02	0.1352E+03	0.1900E-08	0.5097E+01
1.540	0.3323E+03	0.1042E+03	0.9544E+01	0.6491E+02	0.9990E-09	0.3126E+01
1.585	0.2847E+03	0.8789E+02	0.1054E+02	0.2240E+02	0.7902E-09	0.1731E+01
1.631	0.2434E+03	0.7395E+02	0.4681E+02	0.6294E+01	0.7519E-09	0.8243E+00
1.679	0.2075E+03	0.6207E+02	0.9524E+02	0.1053E+02	0.5796E-09	0.3034E+00
1.728	0.1765E+03	0.5201E+02	0.1347E+03	0.2629E+02	0.2421E-09	0.6209E-01
1.778	0.1498E+03	0.4352E+02	0.1513E+03	0.4436E+02	0.1111E-11	0.3814E-04
1.830	0.1268E+03	0.3641E+02	0.1409E+03	0.5734E+02	0.3789E-09	0.3179E-01
1.884	0.1071E+03	0.3047E+02	0.1092E+03	0.6105E+02	0.2069E-08	0.9373E-01
1.939	0.9026E+02	0.2551E+02	0.6808E+02	0.5504E+02	0.5792E-08	0.1476E+00
1.995	0.7588E+02	0.2137E+02	0.3094E+02	0.4196E+02	0.1210E-07	0.1800E+00
2.053	0.6360E+02	0.1790E+02	0.7423E+01	0.2622E+02	0.2119E-07	0.1974E+00
2.113	0.5309E+02	0.1497E+02	0.4494E+00	0.1235E+02	0.3269E-07	0.2175E+00
2.175	0.4409E+02	0.1247E+02	0.6139E+01	0.3505E+01	0.4560E-07	0.2593E+00
2.239	0.3636E+02	0.1031E+02	0.1655E+02	0.6435E+00	0.5830E-07	0.3330E+00
2.304	0.2972E+02	0.8437E+01	0.2386E+02	0.2553E+01	0.6874E-07	0.4335E+00
2.371	0.2403E+02	0.6818E+01	0.2394E+02	0.6600E+01	0.7483E-07	0.5390E+00
2.441	0.1916E+02	0.5433E+01	0.1754E+02	0.9939E+01	0.7493E-07	0.6172E+00
2.512	0.1505E+02	0.4278E+01	0.8844E+01	0.1070E+02	0.6840E-07	0.6357E+00
2.585	0.1163E+02	0.3347E+01	0.2343E+01	0.8634E+01	0.5595E-07	0.5765E+00
2.661	0.8833E+01	0.2635E+01	0.1547E+00	0.5019E+01	0.3979E-07	0.4461E+00
2.738	0.6603E+01	0.2124E+01	0.1303E+01	0.1757E+01	0.2319E-07	0.2778E+00
2.818	0.4872E+01	0.1782E+01	0.3147E+01	0.2492E+00	0.9660E-08	0.1215E+00
2.901	0.3566E+01	0.1569E+01	0.3619E+01	0.6355E+00	0.1778E-08	0.2304E-01
2.985	0.2609E+01	0.1436E+01	0.2498E+01	0.1905E+01	0.1089E-09	0.1402E-02
3.073	0.1925E+01	0.1339E+01	0.9681E+00	0.2767E+01	0.2854E-08	0.3635E-01
3.162	0.1448E+01	0.1242E+01	0.1781E+00	0.2602E+01	0.6595E-08	0.7913E-01
3.255	0.1123E+01	0.1126E+01	0.2856E+00	0.1745E+01	0.8096E-08	0.8533E-01
3.350	0.9099E+00	0.9894E+00	0.6862E+00	0.9419E+00	0.6285E-08	0.5124E-01
3.447	0.7797E+00	0.8457E+00	0.8501E+00	0.6181E+00	0.2998E-08	0.2301E-01
3.548	0.7092E+00	0.7140E+00	0.7294E+00	0.6782E+00	0.1553E-08	0.6006E-01
3.652	0.6770E+00	0.6090E+00	0.5044E+00	0.8688E+00	0.3790E-08	0.1729E+00
3.758	0.6623E+00	0.5334E+00	0.2922E+00	0.1055E+01	0.7959E-08	0.2915E+00
3.868	0.6492E+00	0.4774E+00	0.1986E+00	0.1103E+01	0.9780E-08	0.3099E+00
3.981	0.6329E+00	0.4251E+00	0.3330E+00	0.8497E+00	0.6541E-08	0.1883E+00
4.097	0.6225E+00	0.3641E+00	0.5485E+00	0.4568E+00	0.1073E-08	0.2875E-01
4.217	0.6351E+00	0.2916E+00	0.4807E+00	0.4361E+00	0.1679E-08	0.4253E-01
4.340	0.6810E+00	0.2148E+00	0.1513E+00	0.8522E+00	0.1681E-07	0.4044E+00
4.467	0.7504E+00	0.1459E+00	0.1247E+00	0.9619E+00	0.4753E-07	0.1091E+01
4.597	0.8095E+00	0.9476E-01	0.5848E+00	0.3998E+00	0.8348E-07	0.1830E+01
4.731	0.8138E+00	0.6511E-01	0.8290E+00	0.4504E-01	0.1065E-06	0.2230E+01
4.870	0.7352E+00	0.5686E-01	0.4140E+00	0.4992E+00	0.1016E-06	0.2031E+01
5.012	0.5880E+00	0.7251E-01	0.1858E-01	0.7865E+00	0.6864E-07	0.1307E+01
5.158	0.4301E+00	0.1185E+00	0.1841E+00	0.2972E+00	0.2587E-07	0.4688E+00
5.309	0.3290E+00	0.1951E+00	0.3242E+00	0.1407E+00	0.8806E-09	0.1514E-01
5.464	0.3131E+00	0.2840E+00	0.7985E-01	0.5803E+00	0.1198E-07	0.1953E+00
5.623	0.3478E+00	0.3508E+00	0.4897E-01	0.3917E+00	0.5304E-07	0.8176E+00

5.788	0.3621E+00	0.3664E+00	0.3206E+00	0.4591E-02	0.9476E-07	0.1378E+01
5.957	0.3078E+00	0.3340E+00	0.2926E+00	0.4052E+00	0.1050E-06	0.1438E+01
6.130	0.2052E+00	0.2947E+00	0.4769E-01	0.4456E+00	0.7485E-07	0.9632E+00
6.309	0.1265E+00	0.2999E+00	0.2857E-01	0.5387E-01	0.2761E-07	0.3334E+00
6.494	0.1227E+00	0.3609E+00	0.1183E+00	0.3182E+00	0.7039E-09	0.7967E-02
6.683	0.1688E+00	0.4298E+00	0.6861E-01	0.2444E+00	0.1227E-07	0.1304E+00
6.878	0.1939E+00	0.4410E+00	0.2435E-01	0.2896E-01	0.4416E-07	0.4406E+00
7.079	0.1651E+00	0.3764E+00	0.1420E+00	0.3498E+00	0.6025E-07	0.5655E+00
7.286	0.1243E+00	0.2833E+00	0.8936E-01	0.1346E+00	0.4368E-07	0.3871E+00
7.499	0.1302E+00	0.2240E+00	0.2691E-01	0.1541E+00	0.1335E-07	0.1122E+00
7.718	0.1768E+00	0.2117E+00	0.1735E+00	0.1993E+00	0.1898E-11	0.1561E-04
7.943	0.2032E+00	0.2086E+00	0.4045E-01	0.4887E-01	0.1012E-07	0.7840E-01
8.175	0.1830E+00	0.1808E+00	0.9765E-01	0.2429E+00	0.2217E-07	0.1672E+00
8.414	0.1572E+00	0.1346E+00	0.1335E+00	0.8416E-01	0.1810E-07	0.1344E+00
8.659	0.1645E+00	0.9828E-01	0.8993E-01	0.1851E+00	0.5261E-08	0.3892E-01
8.912	0.1830E+00	0.8779E-01	0.1773E+00	0.8014E-01	0.7780E-11	0.5850E-04
9.173	0.1758E+00	0.9600E-01	0.7649E-01	0.1634E+00	0.3032E-08	0.2304E-01
9.440	0.1524E+00	0.1053E+00	0.1519E+00	0.1162E+00	0.4232E-08	0.3293E-01
9.716	0.1413E+00	0.1063E+00	0.1064E+00	0.1426E+00	0.1614E-08	0.1283E-01
10.000	0.1384E+00	0.1057E+00	0.1404E+00	0.1086E+00	0.5337E-10	0.4223E-03
10.292	0.1278E+00	0.1094E+00	0.1048E+00	0.1317E+00	0.6038E-10	0.4186E-03
10.592	0.1154E+00	0.1095E+00	0.1116E+00	0.1134E+00	0.3061E-13	0.1574E-03
10.902	0.1059E+00	0.1027E+00	0.9893E-01	0.1130E+00	0.1309E-09	0.2442E-02
11.220	0.9271E-01	0.9598E-01	0.8519E-01	0.1040E+00	0.1492E-10	0.2488E-03
11.548	0.8278E-01	0.8679E-01	0.7090E-01	0.1062E+00	0.5998E-09	0.1022E-01
11.885	0.7780E-01	0.7170E-01	0.7916E-01	0.7256E-01	0.2163E-08	0.3892E-01
12.232	0.6402E-01	0.6221E-01	0.4210E-01	0.9205E-01	0.9665E-09	0.1861E-01
12.589	0.5369E-01	0.6229E-01	0.5180E-01	0.7657E-01	0.3853E-09	0.7984E-02
12.957	0.5296E-01	0.5878E-01	0.4098E-01	0.4517E-01	0.3781E-08	0.8445E-01
13.335	0.4307E-01	0.5184E-01	0.2987E-01	0.5963E-01	0.2351E-08	0.5662E-01
13.724	0.4011E-01	0.5427E-01	0.3858E-01	0.5607E-01	0.1639E-09	0.4255E-02
14.125	0.4335E-01	0.5543E-01	0.3082E-01	0.4135E-01	0.3613E-08	0.1009E+00
14.538	0.3904E-01	0.4674E-01	0.2836E-01	0.3196E-01	0.1772E-08	0.5309E-01
14.962	0.4486E-01	0.4365E-01	0.3804E-01	0.3168E-01	0.3024E-09	0.9704E-02
15.399	0.4575E-01	0.4215E-01	0.4437E-01	0.4390E-01	0.2111E-08	0.7235E-01
15.849	0.4629E-01	0.3683E-01	0.4159E-01	0.4248E-01	0.2814E-09	0.1027E-01
16.311	0.4851E-01	0.3744E-01	0.3777E-01	0.4295E-01	0.3732E-09	0.1446E-01
16.788	0.4549E-01	0.3922E-01	0.4284E-01	0.4057E-01	0.2581E-09	0.1058E-01
17.279	0.4370E-01	0.3946E-01	0.4249E-01	0.4022E-01	0.1776E-11	0.7639E-04
17.782	0.3954E-01	0.3905E-01	0.3937E-01	0.3920E-01	0.6500E-11	0.3234E-03
18.302	0.3447E-01	0.3624E-01	0.3280E-01	0.3835E-01	0.8955E-11	0.4383E-03
18.836	0.2986E-01	0.3158E-01	0.2736E-01	0.3368E-01	0.3403E-09	0.1737E-01
19.386	0.2438E-01	0.2606E-01	0.2140E-01	0.3067E-01	0.1794E-09	0.9566E-02
19.952	0.2106E-01	0.2321E-01	0.1718E-01	0.2332E-01	0.6722E-09	0.3736E-01
20.535	0.1746E-01	0.1966E-01	0.1498E-01	0.1983E-01	0.3920E-09	0.2267E-01

RMS VALUES -ALIGNMENT INPUT

LATERAL CONTACT FORCES

AXLE 1 =0.244E+03
AXLE 2 =0.228E+03
AXLE 3 =0.320E+03
AXLE 4 =0.300E+03

LATERAL POSITION OF RESULTANT CENTERPLATE FORCE = 0.955E-03

LATERAL FORCE AT THE CENTERPLATE = 0.113E+02

PSD VALUES FOR CROSS LEVEL INPUT

FREQUENCY(HZ)	LATERAL CONTACT FORCES AXLE 1	AXLE 2	AXLE 3	AXLE 4	CENTERPLATE FORCE LATERAL POSITION	LATERAL MAGNITUDE
0.100	0.1623E+03	0.1712E+03	0.2611E+03	0.2736E+03	0.5925E-05	0.7629E+03
0.106	0.1786E+03	0.1884E+03	0.2875E+03	0.3011E+03	0.5995E-05	0.7642E+03
0.112	0.1970E+03	0.2076E+03	0.3167E+03	0.3316E+03	0.6073E-05	0.7656E+03
0.119	0.2176E+03	0.2291E+03	0.3491E+03	0.3652E+03	0.6159E-05	0.7671E+03
0.126	0.2406E+03	0.2532E+03	0.3849E+03	0.4023E+03	0.6254E-05	0.7686E+03
0.133	0.2665E+03	0.2799E+03	0.4246E+03	0.4433E+03	0.6359E-05	0.7702E+03
0.141	0.2954E+03	0.3098E+03	0.4687E+03	0.4886E+03	0.6475E-05	0.7719E+03
0.150	0.3279E+03	0.3431E+03	0.5176E+03	0.5388E+03	0.6602E-05	0.7735E+03
0.158	0.3643E+03	0.3801E+03	0.5723E+03	0.5944E+03	0.6740E-05	0.7752E+03
0.168	0.4051E+03	0.4212E+03	0.6335E+03	0.6564E+03	0.6891E-05	0.7767E+03
0.178	0.4508E+03	0.4668E+03	0.7025E+03	0.7258E+03	0.7054E-05	0.7780E+03
0.188	0.5019E+03	0.5173E+03	0.7808E+03	0.8041E+03	0.7228E-05	0.7790E+03
0.200	0.5593E+03	0.5731E+03	0.8707E+03	0.8930E+03	0.7413E-05	0.7795E+03
0.211	0.6234E+03	0.6345E+03	0.9750E+03	0.9952E+03	0.7606E-05	0.7794E+03
0.224	0.6953E+03	0.7018E+03	0.1097E+04	0.1114E+04	0.7806E-05	0.7783E+03
0.237	0.7756E+03	0.7752E+03	0.1243E+04	0.1254E+04	0.8007E-05	0.7759E+03
0.251	0.8653E+03	0.8546E+03	0.1420E+04	0.1421E+04	0.8203E-05	0.7719E+03
0.266	0.9655E+03	0.9396E+03	0.1637E+04	0.1625E+04	0.8387E-05	0.7657E+03
0.282	0.1077E+04	0.1029E+04	0.1908E+04	0.1875E+04	0.8546E-05	0.7567E+03
0.299	0.1201E+04	0.1122E+04	0.2252E+04	0.2188E+04	0.8666E-05	0.7442E+03
0.316	0.1337E+04	0.1213E+04	0.2696E+04	0.2587E+04	0.8730E-05	0.7274E+03
0.335	0.1486E+04	0.1299E+04	0.3282E+04	0.3109E+04	0.8715E-05	0.7053E+03
0.355	0.1646E+04	0.1368E+04	0.4079E+04	0.3811E+04	0.8596E-05	0.6771E+03
0.376	0.1813E+04	0.1409E+04	0.5213E+04	0.4804E+04	0.8344E-05	0.6418E+03
0.398	0.1984E+04	0.1410E+04	0.6942E+04	0.6316E+04	0.7930E-05	0.5984E+03
0.422	0.2192E+04	0.1426E+04	0.9878E+04	0.8891E+04	0.7322E-05	0.5458E+03
0.447	0.2790E+04	0.1935E+04	0.1571E+05	0.1399E+05	0.6479E-05	0.4817E+03
0.473	0.6506E+04	0.5975E+04	0.2940E+05	0.2558E+05	0.5300E-05	0.3970E+03
0.501	0.2771E+05	0.2583E+05	0.5914E+05	0.4772E+05	0.3533E-05	0.2639E+03
0.531	0.6401E+05	0.4925E+05	0.7320E+05	0.4995E+05	0.1425E-05	0.9519E+02
0.562	0.4663E+05	0.2770E+05	0.4356E+05	0.2384E+05	0.2982E-06	0.1521E+02
0.596	0.2321E+05	0.1049E+05	0.2317E+05	0.1058E+05	0.1833E-08	0.1033E+00
0.631	0.1270E+05	0.4618E+04	0.1447E+05	0.5856E+04	0.5451E-06	0.2325E+02
0.668	0.8255E+04	0.2727E+04	0.1007E+05	0.3729E+04	0.2524E-05	0.1055E+03
0.708	0.6209E+04	0.2081E+04	0.7138E+04	0.2471E+04	0.6770E-05	0.2798E+03
0.750	0.5186E+04	0.1844E+04	0.4743E+04	0.1686E+04	0.1426E-04	0.5831E+03
0.794	0.4646E+04	0.1742E+04	0.2700E+04	0.1347E+04	0.2605E-04	0.1053E+04
0.841	0.4359E+04	0.1680E+04	0.1128E+04	0.1497E+04	0.4312E-04	0.1721E+04
0.891	0.4218E+04	0.1625E+04	0.2599E+03	0.2090E+04	0.6613E-04	0.2604E+04
0.944	0.4171E+04	0.1572E+04	0.2808E+03	0.2907E+04	0.9511E-04	0.3695E+04
1.000	0.4189E+04	0.1522E+04	0.1168E+04	0.3552E+04	0.1290E-03	0.4942E+04
1.029	0.4215E+04	0.1501E+04	0.1844E+04	0.3669E+04	0.1470E-03	0.5595E+04
1.059	0.4251E+04	0.1483E+04	0.2584E+04	0.3589E+04	0.1652E-03	0.6245E+04
1.090	0.4294E+04	0.1469E+04	0.3303E+04	0.3293E+04	0.1830E-03	0.6868E+04
1.122	0.4341E+04	0.1459E+04	0.3906E+04	0.2795E+04	0.1996E-03	0.7440E+04
1.155	0.4389E+04	0.1455E+04	0.4305E+04	0.2143E+04	0.2143E-03	0.7933E+04
1.188	0.4436E+04	0.1456E+04	0.4431E+04	0.1424E+04	0.2262E-03	0.8316E+04
1.223	0.4478E+04	0.1461E+04	0.4247E+04	0.7529E+03	0.2345E-03	0.8560E+04
1.259	0.4511E+04	0.1470E+04	0.3761E+04	0.2554E+03	0.2383E-03	0.8637E+04
1.296	0.4532E+04	0.1481E+04	0.3029E+04	0.4750E+02	0.2369E-03	0.8525E+04
1.334	0.4535E+04	0.1494E+04	0.2155E+04	0.2064E+03	0.2297E-03	0.8206E+04
1.372	0.4516E+04	0.1506E+04	0.1278E+04	0.7449E+03	0.2165E-03	0.7676E+04
1.413	0.4471E+04	0.1513E+04	0.5506E+03	0.1595E+04	0.1973E-03	0.6943E+04
1.454	0.4396E+04	0.1514E+04	0.1100E+03	0.2604E+04	0.1727E-03	0.6030E+04
1.496	0.4287E+04	0.1504E+04	0.4426E+02	0.3563E+04	0.1437E-03	0.4978E+04
1.540	0.4143E+04	0.1480E+04	0.3660E+03	0.4241E+04	0.1120E-03	0.3847E+04
1.585	0.3964E+04	0.1439E+04	0.9981E+03	0.4451E+04	0.7966E-04	0.2714E+04
1.631	0.3753E+04	0.1380E+04	0.1781E+04	0.4110E+04	0.4938E-04	0.1668E+04
1.679	0.3517E+04	0.1302E+04	0.2503E+04	0.3282E+04	0.2405E-04	0.8049E+03
1.728	0.3264E+04	0.1206E+04	0.2956E+04	0.2181E+04	0.6682E-05	0.2214E+03
1.778	0.3009E+04	0.1096E+04	0.2996E+04	0.1125E+04	0.1118E-07	0.3602E+00
1.830	0.2765E+04	0.9772E+03	0.2597E+04	0.4387E+03	0.6171E-05	0.2007E+03
1.884	0.2549E+04	0.8554E+03	0.1877E+04	0.3351E+03	0.2626E-04	0.8443E+03
1.939	0.2376E+04	0.7377E+03	0.1076E+04	0.8157E+03	0.5996E-04	0.1906E+04
1.995	0.2258E+04	0.6300E+03	0.4820E+03	0.1643E+04	0.1053E-03	0.3304E+04

2.053	0.2199E+04	0.5368E+03	0.3242E+03	0.2414E+04	0.1583E-03	0.4906E+04
2.113	0.2199E+04	0.4602E+03	0.6739E+03	0.2732E+04	0.2137E-03	0.6531E+04
2.175	0.2247E+04	0.4003E+03	0.1391E+04	0.2404E+04	0.2647E-03	0.7970E+04
2.239	0.2327E+04	0.3557E+03	0.2160E+04	0.1575E+04	0.3041E-03	0.9014E+04
2.304	0.2417E+04	0.3254E+03	0.2614E+04	0.6963E+03	0.3257E-03	0.9491E+04
2.371	0.2492E+04	0.3090E+03	0.2509E+04	0.3086E+03	0.3249E-03	0.9295E+04
2.441	0.2530E+04	0.3084E+03	0.1863E+04	0.7246E+03	0.3004E-03	0.8425E+04
2.512	0.2511E+04	0.3271E+03	0.9731E+03	0.1793E+04	0.2548E-03	0.6995E+04
2.585	0.2427E+04	0.3690E+03	0.2757E+03	0.2926E+04	0.1949E-03	0.5222E+04
2.661	0.2277E+04	0.4373E+03	0.1062E+03	0.3436E+04	0.1302E-03	0.3397E+04
2.738	0.2073E+04	0.5323E+03	0.4864E+03	0.3008E+04	0.7156E-04	0.1813E+04
2.818	0.1836E+04	0.6502E+03	0.1095E+04	0.1960E+04	0.2822E-04	0.6910E+03
2.901	0.1594E+04	0.7827E+03	0.1473E+04	0.1061E+04	0.4927E-05	0.1159E+03
2.985	0.1378E+04	0.9170E+03	0.1349E+04	0.9404E+03	0.2890E-06	0.6485E+01
3.073	0.1210E+04	0.1037E+04	0.8493E+03	0.1557E+04	0.7176E-05	0.1515E+03
3.162	0.1103E+04	0.1128E+04	0.4031E+03	0.2222E+04	0.1574E-04	0.3060E+03
3.255	0.1051E+04	0.1176E+04	0.3766E+03	0.2237E+04	0.1820E-04	0.3121E+03
3.350	0.1036E+04	0.1182E+04	0.7390E+03	0.1597E+04	0.1296E-04	0.1782E+03
3.447	0.1031E+04	0.1156E+04	0.1086E+04	0.9976E+03	0.5169E-05	0.5234E+02
3.548	0.1012E+04	0.1119E+04	0.1043E+04	0.1060E+04	0.2392E-05	0.9137E+02
3.652	0.9597E+03	0.1096E+04	0.6635E+03	0.1594E+04	0.7938E-05	0.3107E+03
3.758	0.8749E+03	0.1104E+04	0.3733E+03	0.1832E+04	0.1713E-04	0.5450E+03
3.868	0.7749E+03	0.1146E+04	0.4692E+03	0.1434E+04	0.2066E-04	0.5762E+03
3.981	0.6913E+03	0.1207E+04	0.7521E+03	0.9587E+03	0.1349E-04	0.3424E+03
4.097	0.6564E+03	0.1256E+04	0.7827E+03	0.1057E+04	0.2162E-05	0.5085E+02
4.217	0.6840E+03	0.1262E+04	0.4819E+03	0.1478E+04	0.3315E-05	0.7306E+02
4.340	0.7565E+03	0.1200E+04	0.2573E+03	0.1442E+04	0.3250E-04	0.6740E+03
4.467	0.8272E+03	0.1071E+04	0.4213E+03	0.8831E+03	0.9022E-04	0.1766E+04
4.597	0.8416E+03	0.9070E+03	0.7300E+03	0.5434E+03	0.1557E-03	0.2880E+04
4.731	0.7678E+03	0.7631E+03	0.7698E+03	0.7172E+03	0.1955E-03	0.3421E+04
4.870	0.6198E+03	0.6909E+03	0.5900E+03	0.8769E+03	0.1838E-03	0.3042E+04
5.012	0.4586E+03	0.7125E+03	0.5256E+03	0.7848E+03	0.1224E-03	0.1916E+04
5.158	0.3622E+03	0.8043E+03	0.5609E+03	0.8137E+03	0.4556E-04	0.6742E+03
5.309	0.3748E+03	0.9018E+03	0.4362E+03	0.9285E+03	0.1532E-05	0.2142E+02
5.464	0.4691E+03	0.9297E+03	0.2500E+03	0.7203E+03	0.2062E-04	0.2728E+03
5.623	0.5596E+03	0.8475E+03	0.2884E+03	0.4146E+03	0.9036E-04	0.1130E+04
5.788	0.5635E+03	0.6797E+03	0.4450E+03	0.4237E+03	0.1599E-03	0.1892E+04
5.957	0.4646E+03	0.5010E+03	0.4789E+03	0.5285E+03	0.1757E-03	0.1969E+04
6.130	0.3300E+03	0.3881E+03	0.4612E+03	0.5468E+03	0.1242E-03	0.1321E+04
6.309	0.2598E+03	0.3716E+03	0.4450E+03	0.5672E+03	0.4547E-04	0.4603E+03
6.494	0.2972E+03	0.4186E+03	0.3371E+03	0.4631E+03	0.1151E-05	0.1112E+02
6.683	0.3834E+03	0.4578E+03	0.2392E+03	0.2932E+03	0.1994E-04	0.1854E+03
6.878	0.4154E+03	0.4354E+03	0.2588E+03	0.2673E+03	0.7134E-04	0.6411E+03
7.079	0.3542E+03	0.3533E+03	0.3219E+03	0.3217E+03	0.9679E-04	0.8469E+03
7.286	0.2652E+03	0.2599E+03	0.3695E+03	0.3525E+03	0.6983E-04	0.5999E+03
7.499	0.2423E+03	0.2096E+03	0.3497E+03	0.2943E+03	0.2124E-04	0.1808E+03
7.718	0.2930E+03	0.2182E+03	0.2915E+03	0.2169E+03	0.3006E-08	0.2657E-01
7.943	0.3328E+03	0.2512E+03	0.2390E+03	0.1825E+03	0.1598E-04	0.1378E+03
8.175	0.3027E+03	0.2600E+03	0.2352E+03	0.2257E+03	0.3488E-04	0.3072E+03
8.414	0.2474E+03	0.2291E+03	0.2884E+03	0.2348E+03	0.2839E-04	0.2578E+03
8.659	0.2385E+03	0.1892E+03	0.2716E+03	0.1934E+03	0.8227E-05	0.7765E+02
8.912	0.2644E+03	0.1769E+03	0.2628E+03	0.1753E+03	0.1213E-07	0.1209E+00
9.173	0.2626E+03	0.1903E+03	0.2104E+03	0.1816E+03	0.4717E-05	0.4899E+02
9.440	0.2297E+03	0.1980E+03	0.2176E+03	0.2057E+03	0.6571E-05	0.7173E+02
9.716	0.2109E+03	0.1867E+03	0.2090E+03	0.1845E+03	0.2501E-05	0.2854E+02
10.000	0.2081E+03	0.1737E+03	0.2046E+03	0.1817E+03	0.8259E-07	0.9623E+00
10.292	0.1941E+03	0.1718E+03	0.1755E+03	0.1865E+03	0.9328E-07	0.1010E+01
10.592	0.1755E+03	0.1705E+03	0.1710E+03	0.1752E+03	0.4742E-10	0.2429E+00
10.902	0.1608E+03	0.1646E+03	0.1439E+03	0.1843E+03	0.2018E-06	0.4815E+01
11.220	0.1401E+03	0.1626E+03	0.1389E+03	0.1625E+03	0.2298E-07	0.5046E+00
11.548	0.1254E+03	0.1588E+03	0.1153E+03	0.1588E+03	0.9230E-06	0.2077E+02
11.885	0.1179E+03	0.1419E+03	0.1174E+03	0.1438E+03	0.3327E-05	0.7867E+02
12.232	0.9731E+02	0.1282E+03	0.9310E+02	0.1344E+03	0.1486E-05	0.3726E+02
12.589	0.8516E+02	0.1249E+03	0.7968E+02	0.1178E+03	0.5919E-06	0.1581E+02
12.957	0.8566E+02	0.1086E+03	0.8390E+02	0.9996E+02	0.5806E-05	0.1652E+03
13.335	0.7124E+02	0.8545E+02	0.7499E+02	0.9348E+02	0.3609E-05	0.1094E+03
13.724	0.6853E+02	0.7890E+02	0.6493E+02	0.7443E+02	0.2516E-06	0.8122E+01
14.125	0.7278E+02	0.7270E+02	0.6819E+02	0.6816E+02	0.5545E-05	0.1902E+03
14.538	0.6462E+02	0.5898E+02	0.7223E+02	0.6429E+02	0.2719E-05	0.9893E+02
14.962	0.7152E+02	0.5729E+02	0.6739E+02	0.5492E+02	0.4641E-06	0.1788E+02

15.399	0.7138E+02	0.6058E+02	0.7010E+02	0.6026E+02	0.3240E-05	0.1318E+03
15.849	0.7056E+02	0.5753E+02	0.7279E+02	0.5727E+02	0.4319E-06	0.1852E+02
16.311	0.7358E+02	0.6050E+02	0.6913E+02	0.5983E+02	0.5730E-06	0.2582E+02
16.788	0.6910E+02	0.6292E+02	0.7023E+02	0.6141E+02	0.3964E-06	0.1871E+02
17.278	0.6677E+02	0.6188E+02	0.6675E+02	0.6160E+02	0.2728E-08	0.1339E+00
17.782	0.6084E+02	0.6077E+02	0.6073E+02	0.6085E+02	0.9985E-08	0.5600E+00
18.302	0.5336E+02	0.5775E+02	0.5254E+02	0.5834E+02	0.1376E-07	0.7558E+00
18.836	0.4652E+02	0.5286E+02	0.4582E+02	0.5156E+02	0.5230E-06	0.2975E+02
19.386	0.3827E+02	0.4551E+02	0.3765E+02	0.4651E+02	0.2759E-06	0.1627E+02
19.952	0.3363E+02	0.4003E+02	0.3233E+02	0.3724E+02	0.1034E-05	0.6312E+02
20.535	0.2827E+02	0.3155E+02	0.2912E+02	0.3287E+02	0.6031E-06	0.3807E+02

RMS VALUES-CROSS LEVEL INPUT

LATERAL CONTACT FORCES

AXLE 1 =0.134E+03
AXLE 2 =0.107E+03
AXLE 3 =0.130E+03
AXLE 4 =0.127E+03

LATERAL POSITION OF RESULTANT CENTERPLATE FORCE = 0.254E-01

LATERAL FORCE AT THE CENTERPLATE = 0.123E+03

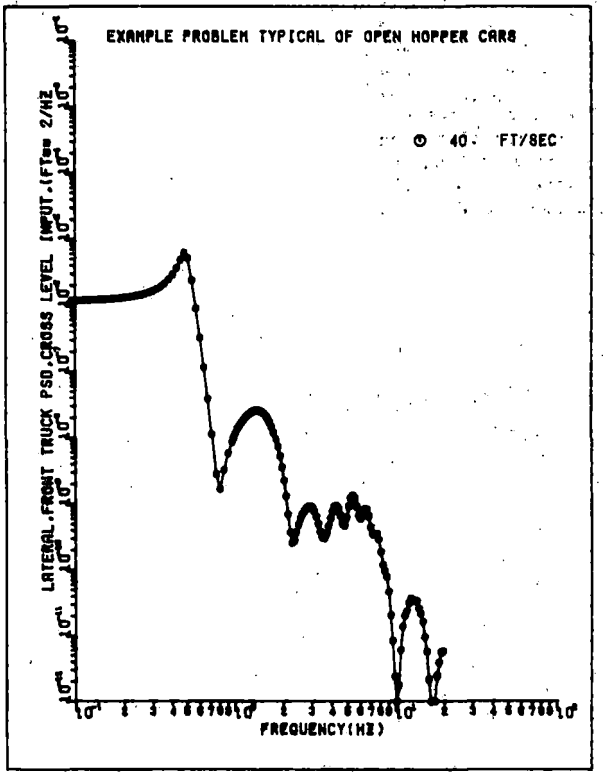
SAMPLE PLOTTED OUTPUT

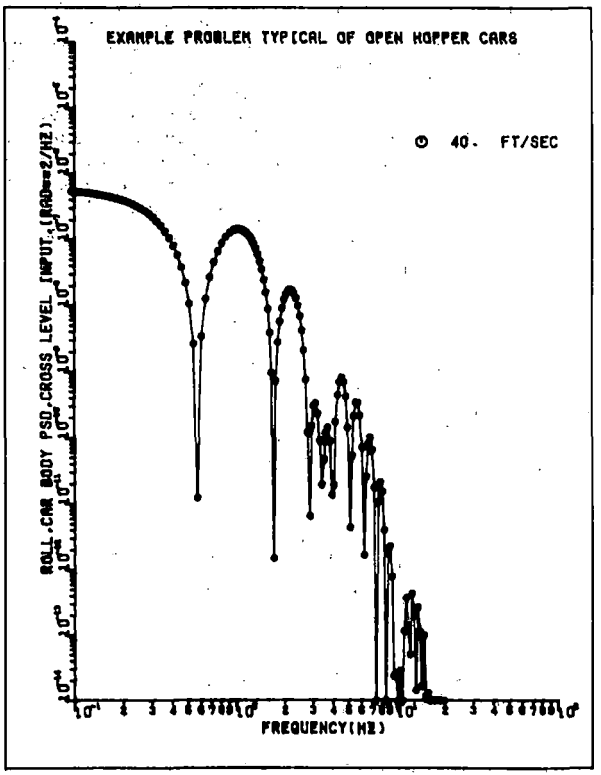
The following 12 plots depict the power spectral density of (PSD) information plotted by this computer program. The first six plots illustrate the PSD's for the following variables in response to a random, crosslevel input:

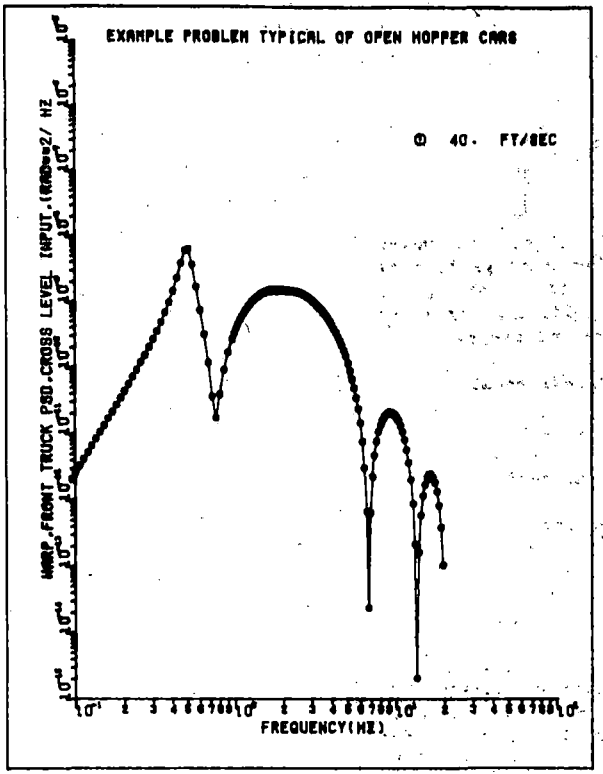
1. Front-truck lateral displacement
2. Front truck warp displacement
3. Car body lateral displacement
4. Car body roll displacement
5. Lateral contact force, axle 1
6. Lateral contact force, axle 3.

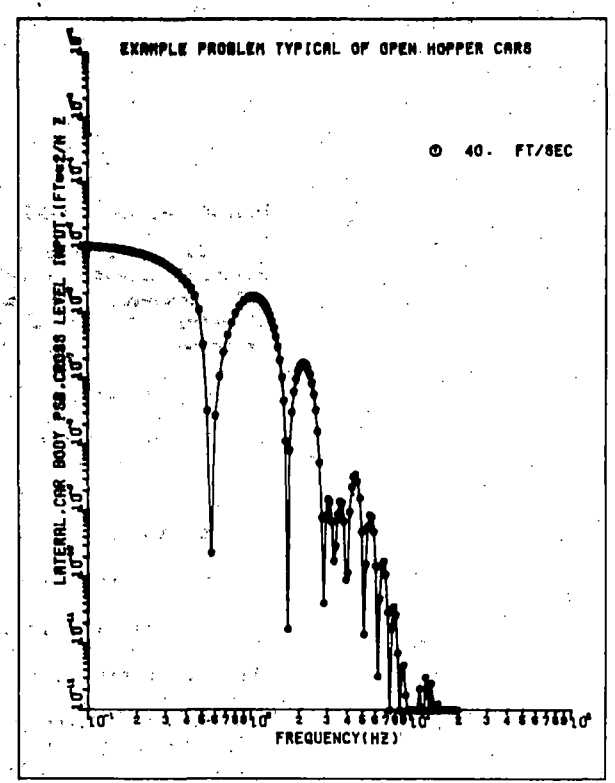
The second six plots show the response of the same variables to a random alignment disturbance. Although the response is shown at only one speed in this example, results for multiple speeds will be plotted on the same plots if multiple speed calculations are specified.

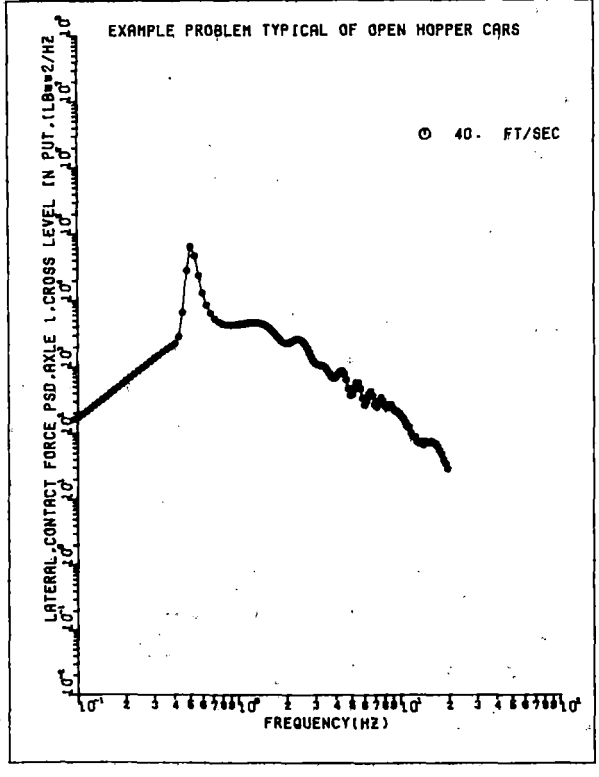
In the truck lateral and warp PSD's, the dominant kinematic mode at about 0.5 Hz is evident, both in response to crosslevel and alignment inputs. This mode is partially masked in the car body lateral and roll response by dropouts that occur at nearly the same frequency. These dropouts are due to the geometric filtering effect of the truck and car body acting as traveling chords. Higher harmonics of the fundamental filter frequencies cause the lobes in these plots at high frequencies.

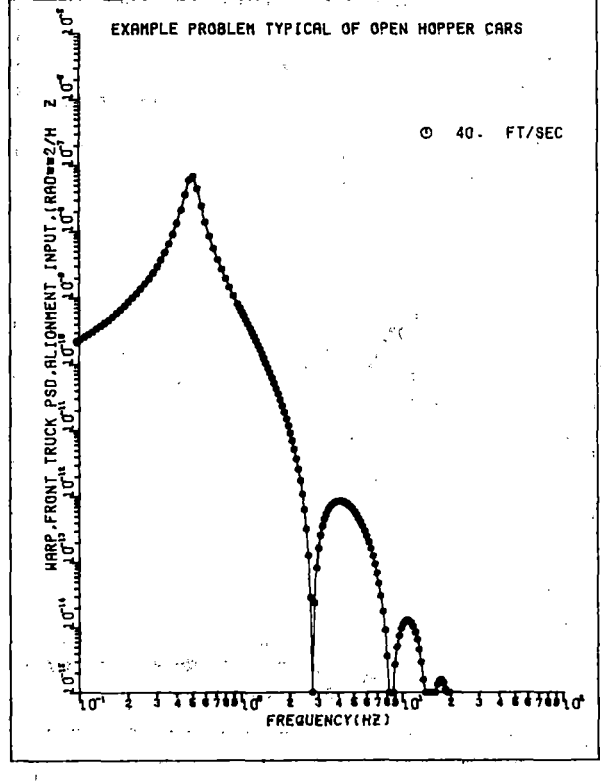

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL.FRONT TRUCK PSD.CROSS LEVEL [NPUT.(FT** 2/HZ
FREQUENCY(HZ)

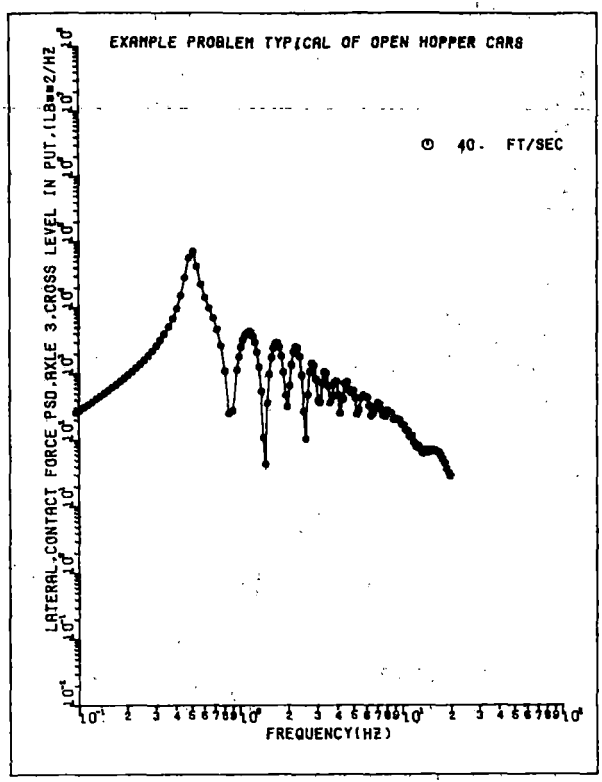

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
ROLL.CAR BODY PSD.CROSS LEVEL [NPUT.(RAD**2/HZ)
FREQUENCY(HZ)

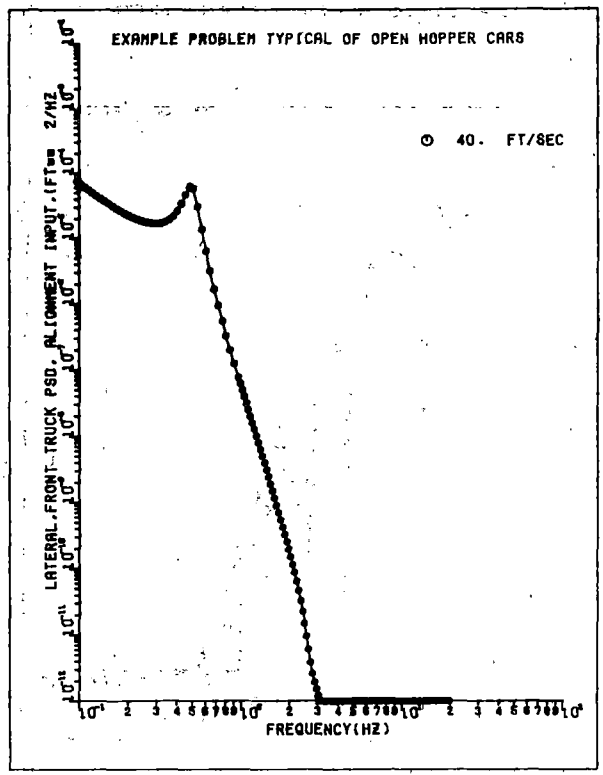

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
@ 40. FT/SEC
WARP.FRONT TRUCK PSD.CROSS LEVEL INPUT.(RAD**2/ HZ
FREQUENCY(HZ)

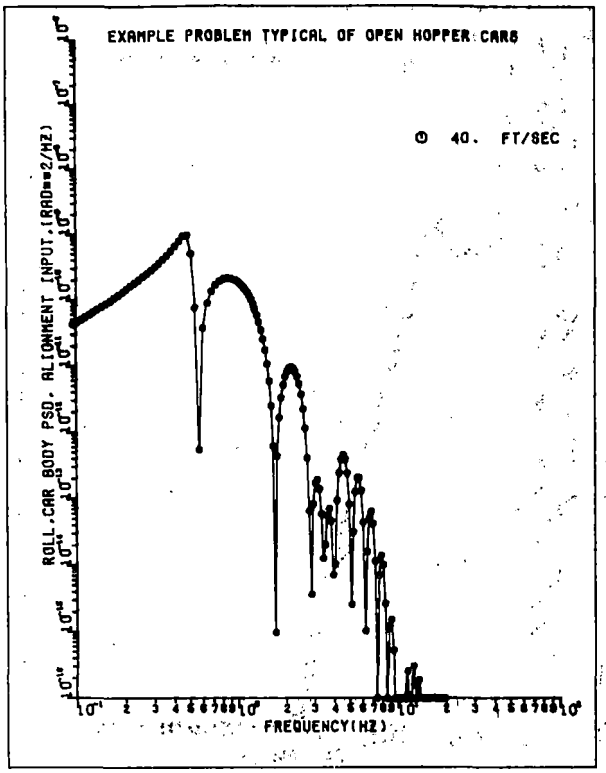

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
@ 40. FT/SEC
LATERAL.CAR BODY PSD.CROSS LEVEL INPUT.(FT**2/N Z
FREQUENCY(HZ)

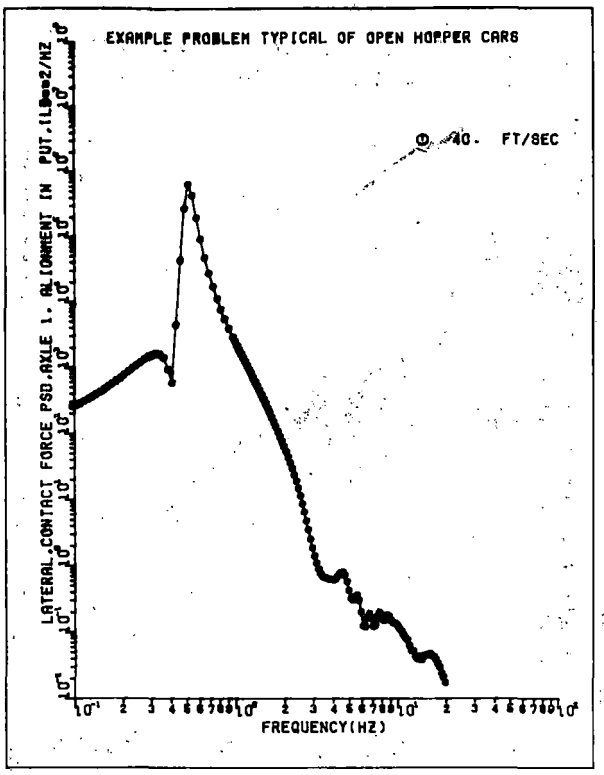

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL,CONTACT FORCE PSD,AXLE 1,CROSS LEVEL IN PUT,(LBS**2/HZ
FREQUENCY(HZ)

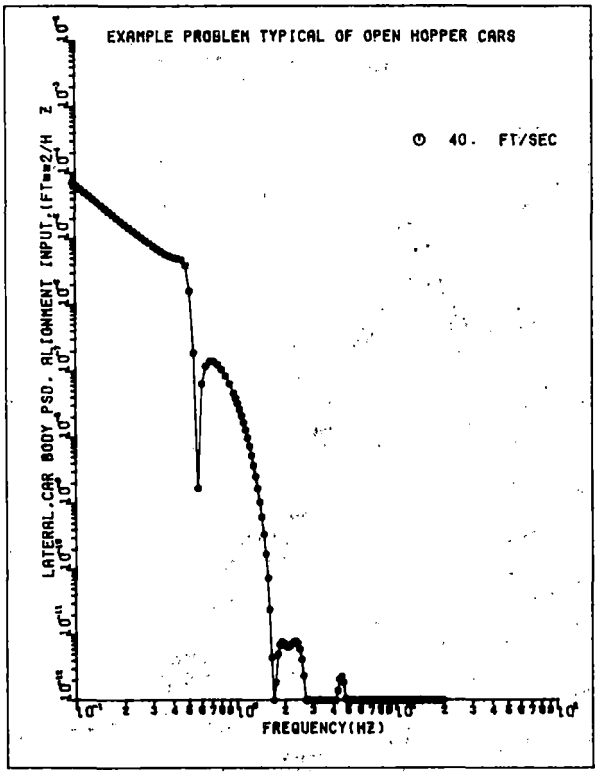

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
WARP,FRONT TRUCK PSD,ALIGNMENT INPUT,(RAD**2/H Z
FREQUENCY(HZ)

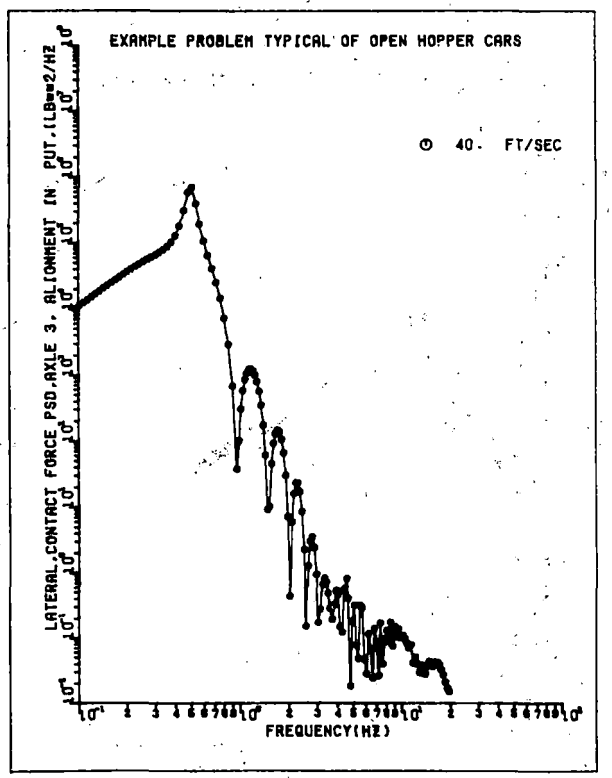

EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL,CONTACT FORCE PSD,AXLE 3,CROSS LEVEL IN PUT,(LBS**2/HZ
FREQUENCY(HZ)


EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL,FRONT TRUCK PSD, ALIGNMENT INPUT,(FT** 2/HZ
FREQUENCY(HZ)


EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
ROLL.CAR BODY PSD. ALIGNMENT INPUT.(RAD**2/HZ)
FREQUENCY(HZ)


EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL.CONTACT FORCE PSD.AXLE 1. ALIGNMENT IN PUT.(LB**2/HZ
FREQUENCY(HZ)


EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL.CAR BODY PSD. ALIGNMENT INPUT.(FT**2/H Z
FREQUENCY(HZ)


EXAMPLE PROBLEM TYPICAL OF OPEN HOPPER CARS
⊙ 40. FT/SEC
LATERAL.CONTACT FORCE PSD.AXLE 3. ALIGNMENT IN PUT.(LB**2/HZ
FREQUENCY(HZ)

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7. Law, E.H., Hadden, J.A. and Cooperrider, N.K., "General Models for Lateral Stability Analysis of Railway Freight Vehicles," FRA-OR+D-77-36 (PB 272371) June 1977.

8. Kalker, J.J., "On the Rolling Contact of Two Elastic Bodies in the Presence of Dry Friction," Doctoral Dissertation, Technische Hogeschool, Delft, The Netherlands, 1967.

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11. Haque, I., Law, E.H. and Cooperrider, N.K., "Users' Manual for Program for Calculation of Kalker's Linear Creep Coefficient," FRA-OR+D-78-71 (PB 297802/AS) May 1979.

12. Anis, Z. and Hedrick, J.K., "Characterization of Rail Track Irregularities," U.S. Dept. of Transportation Report No. DOT-TSC-1206, September 1977.

Appendix
COMPUTER PROGRAM LISTINGS

MAIN PROGRAM

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C                                                                       00001000
C                                                                       00002000
C***FR9DCF COMPUTES THE FORCED RESPONSE OF A 9 DOF FREIGHT CAR***       00003000
C                                                                       00004000
C***********************************************************          00005000
C                                                                       00006000
C   PROGRAM DEVELOPED AT ARIZONA STATE AND CLEMSON UNIVERSITIES         00007000
C   BY  N. K. COOPERRIDER   AND   E. H. LAW.                            00008000
C                                                                       00009000
C***********************************************************          00010000
C                                                                       00011000
C                                                                       00012000
C                                                                       00013000
C *** DEFINE SOME COMMON TERMS USED IN THE PROGRAM ***                  00014000
C     TERM1=WF/X                                                        00015000
C     TERM2=2.*F12/R0/X                                                 00016000
C     TERM3=-L1*WF/X+2.*F22/R0/X+2.*L1*F12/R0/X                         00017000
C     TERM4=L1*WF/X                                                     00018000
C     TERM5=2.*X*F33/R0                                                 00019000
C     TERM6=2.*F22/R0/X                                                 00020000
C     TERM7=2.*X*F33/R0                                                 00021000
C     TERM8=D*D*KYF/X                                                   00022000
C     TERM9=D*D*KYR/X                                                   00023000
C     TERM10=WR/X                                                       00024000
C     TERM11=-L1*WR/X+2.*F22/R0/X+2.*L1*F12/R0/X                        00025000
C     TERM12=L1*WR/X                                                    00026000
C     TERM13=2.*R0*F11/X/V                                              00027000
C     TERM14=TERM93-TERM88-TERM99                                       00028000
C     TERM15=TERM93-TERM88                                              00029000
C     TERM16=D*D*DYF/X                                                  00030000
C     TERM17=D*D*DYR/X                                                  00031000
C     TERM18=L1*WF/X+2.*F22/R0/X-2.*L1*F12/R0/X                         00032000
C     TERM19=L1*WR/X+2.*F22/R0/X-2.*L1*F12/R0/X                         00033000
C     TERM20=2.*F12*R0/X/V-1WX*V/R0/X+2.*L1*F11*R0/X/V                  00034000
C     TERM21=TERM13*X                                                   00035000
C     TERM22=(2.*F12/R0-WF)*R0/X                                        00036000
C     TERM23=2.*F33*X                                                   00037000
C     TERM24=(-WF*R0*L1+2.*F22+2.*L1*F12)/X                             00038000
C     TERM25=(WF*R0*L1+2.*F22-2.*L1*F12)/X                              00039000
C     TERM26=TERM15*X                                                   00040000
C     TERM27=TERM99*X                                                   00041000
C     TERM28=2.*F22/X                                                   00042000
C     TERM29=(2.*F12/R0-WR)*R0/X                                        00043000
C     TERM30=(-WR*R0*L1+2.*F22+2.*L1*F12)/X                             00044000
C     TERM31=(WR*R0*L1+2.*F22-2.*L1*F12)/X                              00045000
C     TERM32=D*D*KYF                                                    00046000
C     TERM33=D*D*KYR                                                    00047000
C     TERM34=D*D*DYF                                                    00048000
C     TERM35=D*D*DYR                                                    00049000
C     TERM38=-TERM60*W                                                  00050000
C     TERM40=-F11/V*(1.+R0*A11/X)*W                                     00051000
C     TERM41=-((A11+DT11)*WN-TERM61*DT11)/X                             00052000
C     TERM42=-(-TERM40*L1+TERM60*W)                                     00053000
C     TERM43=F11+L1/X*(TERM61*DT11-(A11+DT11)*WN)                       00054000
C     TERM44=DL01*(WN-TERM61)                                           00055000
C     TERM45=-F11/V*(1.+R0*A12/X)*W                                     00056000
C     TERM46=-((A12+DT12)*WN-TERM61*DT12)/X                             00057000
C     TERM47=-(TERM45*L1+TERM60*W)                                      00058000
C     TERM48=F11-L1/X*(TERM61*DT12-(A12+DT12)*WN)                       00059000
C     TERM49=DL02*(WN-TERM61)                                           00060000
C     TERM50=-F11/V*(1.+R0*A13/X)*W                                     00061000
C     TERM51=-((A13+DT13)*WN-TERM61*DT13)/X                             00062000
C     TERM52=-(-TERM50*L1+TERM60*W)                                     00063000
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C      TERM64=-W*W                                                      00073000
C      TERM65=ICZ/WC                                                    00074000
C      TERM73=TERM27*W                                                  00075000
C      TERM74=TERM26*W                                                  00076000
C      TERM75=TERM20*W                                                  00077000
C      TERM76=TERM17*W                                                  00078000
C      TERM77=TERM16*W                                                  00079000
C      TERM78=TERM15*W                                                  00080000
C      TERM79=TERM14*W                                                  00081000
C      TERM80=-TERM13*W                                                 00082000
C      TERM88=IWX*V/(RO*X)                                              00083000
C      TERM89=A13+A14                                                   00084000
C      TERM90=A13-A14                                                   00085000
C      TERM91=A11+A12                                                   00086000
C      TERM92=A11-A12                                                   00087000
C      TERM93=2.*RO*F12/(V*X)                                           00088000
C      TERM94=4.*L1*L1*F11/V                                            00089000
C      TERM96=4.*F12/V                                                  00090000
C      TERM98=4.*(F22+X*X*F33)/V                                        00091000
C      TERM99=2.*F11*RO*L1/(X*V)                                        00092000
C                                                                       00093000
       EQUIVALENCE (MW,XMW),(IWX,XIW1),(IWY,XIW2),(MB,XMB) ,            00094000
      1 (IBY,XIB2),(IBZ,XIB3),(MSF,XMS),(ISFY,XIS2),(MC,XMC),           00095000
      2 (ICY,XIC2),(ICZ,XIC3),(ICYZ,XIC23),(L1,TL),(X,A),(H2,H1,HCG),   00096000
      3 (L2,CLF),(L3,CLR),(A11,GAM1),(A12,GAM2),(A13,GAM3),(A14,GAM4),  00097000
      4 (DT11,BDEL1),(DT12,BDEL2),(DT13,BDEL3),(DT14,BDEL4) ,           00098000
      5 (DL01,DEL01),(DL02,DEL02),(DL03,DEL03),(DL04,DEL04),            00099000
      6 (LB11,ALAM11),(LB12,ALAM12),(LB13,ALAM13),(LB14,ALAM14),        00100000
      7 (KYF,XKYF),(KXF,XKXF),(KYR,XKYR),(KXR,XKXR),(DTHBF,DTCPF),      00101000
      8 (DTHWF,DTWF),(KTHBF,XKTCPF),(KTHWF,XKTWF),(DTHBR,DTCPR),        00102000
      9 (DTHWR,DTWR),(KTHBR,XKTCPR),(KTHWR,XKTWR)                       00103000
       COMMON BR,BI,TR,TI                                               00104000
       DOUBLE PRECISION BR,BI,DELR,DELI,DET                             00105000
       REAL L1,L2,L3,MW,MSF,MC,LB11,LB12,LB13,LB14,MB                   00106000
       REAL KXF,KXR,KYF,KYR,KTHBF,KTHBR,KTHWF,KTHWR                     00107000
       REAL ISFY,IBY,IBZ,IWX,IWY,ICY,ICZ,ICYZ,M,K                       00108000
       DIMENSION FR(200),BR(9),BI(9),FAR(9,8),FAI(9,8),UR(8),UI(8),     00109000
      1TFSD(10,200),TRMS(10),DR(81),DI(81),IC(9),MC1(9),TF(9),II(9),    00110000
      2M(9,9),K(9,9),C(9,9),T(9,200),T1RMS(10),T1PSD(10,200)           00111000
       DIMENSION FCLR(9,4),FCLI(9,4),U1R(4),U1I(4),B1R(9),B1I(9),       00112000
      1T1R(9),T1I(9),F1(9,200)                                          00113000
       DIMENSION FRL(6),FI(6),F(6,200),F1F(6),F1I(6),F1(6,200)          00114000
       DIMENSION TPSD0(10),T1PSD0(10), FPSD0(6),F1PSD0(6)               00115000
       DIMENSION FRMS(6),FPSD(6,200),F1RMS(6),F1PSD(6,200)              00116000
       DIMENSION LABEL(20)                                              00117000
       COMMON /NAME1/A11,A12,A13,A14,ALM11,ALM21,ALM31,ALM41,           00118000
      1 D,DELDF,DELDR,DL01,DL02,DL03,DL04,DT11,DT12,DT13,DT14,          00119000
      2 DTHBF,DTHBR,DXF,DXR,DYF,DYR,EPL11,EPL21,EPL31,EPL41,            00120000
      3 EPL51,EPL61,EPL71,EPL81,F11,F12,F22,F33,H1,IBY,IBZ,             00121000
      4 ICY,ICZ,ICYZ,IWX,IWY,KTHBF,KTHBR,KTHWF,KTHWR,KXF,KXR,           00122000
      5 KYF,KYR,L1,L2,L3,LB11,LB12,LB13,LB14,MB,MC,MSF,MW,              00123000
      6 RO,RHO11,RHO21,RHO31,RHO41,RHO51,RHO61,RHO71,RHO81,WB,WC,       00124000
      7 WF,WN,WR,WT,X,DTHWF,DTHWR,ISFY,ALM51,ALM61,ALM71,ALM81          00125000
       COMMON /NAME2/TERM13,TERM14,TERM15,TERM16,TERM17,TERM20,          00126000
      1 TERM26,TERM27,TERM34,TERM40,TERM41,TERM42,TERM43,TERM44,         00127000
      2 TERM45,TERM46,TERM47,TERM48,TERM49,TERM50,TERM51,                00128000
      3 TERM52,TERM53,TERM54,TERM55,TERM56,TERM57,TERM58,                00129000
      4 TERM59,TERM60,TERM64,TERM65,TERM88,TERM90,TERM91,                00130000
      5 TERM92,TERM21,TERM35                                             00131000
C                                                                        00132000
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C *** INPUT AND INITIALIZATION ***                                      00133000
      READ(1,*)IVO,IVP,IDV                                              00134000
      READ(1,*)FSTART,FSTEP,FSTOP                                       00135000
      FR(1)=FSTART                                                      00136000
      DTF=10.**(1./FSTEP)                                               00137000
      IFSTEP=FSTEP                                                      00138000
      DO 101 IWN=1,IFSTEP                                               00139000
      FR(IWN+1)=FR(IWN)*DTF                                             00140000
      N=IWN                                                             00141000
  101 CONTINUE                                                          00142000
      DTF=10.**(.5/FSTEP)                                               00143000
      DO 102 IWM=IWN,197                                                00144000
      FR(IWM+1)=FR(IWM)*DTF                                             00145000
      N=IWM                                                             00146000
      IF(FR(IWM).GT.FSTOP) GO TO 104                                    00147000
  102 CONTINUE                                                          00148000
      STOP                                                              00149000
  104 READ(1,*)AX,APHI,OMGC,OMGS                                        00150000
C                                                                       00151000
C   ***INPUT***                                                         00152000
      READ(1,151)(LABEL(I),I=1,20)                                      00153000
  151 FORMAT(20A4)                                                      00154000
      READ (1,*,END=50) XMW,XIW1,XIW2                                   00155000
      READ (1,*) XMB,XIB2,XIB3                                          00156000
      READ (1,*)XMS,XIS2                                                00157000
      READ (1,*) XMC,XIC2,XIC3,XIC23                                    00158000
      READ (1,*) TL,D ,RO,A                                             00159000
      READ (1,*) HCG,CLF,CLR                                            00160000
      READ (1,*) GAM1,BDEL1,DEL01,ALAM11                                00161000
      READ(1,*) GAM2,BDEL2,DEL02,ALAM12                                 00162000
      READ (1,*) GAM3,BDEL3,DEL03,ALAM13                                00163000
      READ (1,*) GAM4,BDEL4,DEL04,ALAM14                                00164000
      READ (1,*) F11,F12,F22,F33                                        00165000
      READ (1,*) DYF,DXF,XKYF,XKXF                                      00166000
      READ (1,*) DYR,DXR,XKYR,XKXR                                      00167000
      READ (1,*) DTCPF,DTWF,XKTCPF,XKTWF                                00168000
      READ (1,*) DTCPR,DTWR,XKTCPR,XKTWR                                00169000
      AIH11=.5*A11                                                      00170000
      AIH21=.5*A12                                                      00171000
      AIH31=.5*A13                                                      00172000
      AIH41=.5*A14                                                      00173000
      AIH51=.5*A11                                                      00174000
      AIH61=.5*A12                                                      00175000
      AIH71=.5*A13                                                      00176000
      AIH81=.5*A14                                                      00177000
      EEL11=.5*DT11                                                     00178000
      EEL21=.5*DT12                                                     00179000
      EEL31=.5*DT13                                                     00180000
      EEL41=.5*DT14                                                     00181000
      EEL51=.5*DT11                                                     00182000
      EEL61=.5*DT12                                                     00183000
      EEL71=.5*DT13                                                     00184000
      EEL81=.5*DT14                                                     00185000
      RHO11=.5*LB11                                                     00186000
      RHO21=.5*LB12                                                     00187000
      RHO31=.5*LB13                                                     00188000
      RHO41=.5*LB14                                                     00189000
      RHO51=.5*LB11                                                     00190000
      RHO61=.5*LB12                                                     00191000
      RHO71=.5*LB13                                                     00192000
      RHO81=.5*LB14                                                     00193000
C                                                                       00194000
      WF=(4.*MW+4.*MSF+MC+2.*ME)/4.*32.2                                00195000
      WF=WF                                                             00196000
      WT=32.2*(2.*MW+2.*MSF+MB)                                         00197000
      WE=32.2*ME                                                        00198000
      WC=MC*32.2                                                        00199000
      WR=WF/2                                                           00200000
      DELOF=16.1*(L3*MC+(L2+L3)*MB)/KYF/(L2+L3)                         00201000
      DELOR=16.1*(L2*MC+(L2+L3)*MB)/KYR/(L2+L3)                         00202000
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      NN=9                                                              00203000
      PI=3.141593                                                       00204000
      OMGC2=OMGC**2                                                     00205000
      OMGS2=OMGS**2                                                     00206000
C                                                                       00207000
C *** PRINT INPUT PARAMETERS ***                                        00208000
      WRITE(6,300) LABEL                                                00209000
  300 FORMAT(1H1,10X,20A4////)                                          00210000
      WRITE(6,320) MC,MB,MSF,MW,ICY,ICZ,ICYZ,IBY,IBZ,ISFY               00211000
  320 FORMAT(25X,'MASS PROPERTIES',///5X,                               00212000
     1'XMC    (MASS OF THE CAR BODY)',5X,'= ',E10.4,' SLUGS'/5X,        00213000
     2'XMB    (MASS OF THE BOLSTER)', 6X,'= ',E10.4,' SLUGS'/5X,        00214000
     3'XMS    (MASS OF THE SIDEFRAME)', 4X,'= ',E10.4,' SLUGS',/5X,     00215000
     4'XMW    (MASS OF THE WHEELSET)',5X,'= ',E10.4,' SLUGS',//5X,      00216000
     5'XIC2   (MOMENT OF INERTIA OF THE CAR BODY IN YAW)', 8X,          00217000
     6'= ',E10.4,' SLUG-FT**2',/5X,                                     00218000
     7'XIC3   (MOMENT OF INERTIA OF THE CAR BODY IN ROLL)', 7X,         00219000
     8'= ',E10.4,' SLUG-FT**2',/5X,                                     00220000
     9'XIC23 (CROSS PRODUCT OF INERTIA FOR CAR BODY)',11X,              00221000
     1'= ',E10.4,' SLUG-FT**2',/5X,                                     00222000
     2'XIB2   (MOMENT OF INERTIA OF THE BOLSTER IN YAW)', 9X,           00223000
     3'= ',E10.4,' SLUG-FT**2',/5X,                                     00224000
     4'XIB3   (MOMENT OF INERTIA OF THE BOLSTER IN ROLL)', 8X,          00225000
     5'= ',E10.4,' SLUG-FT**2',/5X,                                     00226000
     6'XIS2   (MOMENT OF INERTIA OF THE SIDEFRAME IN YAW)', 7X,         00227000
     7'= ',E10.4,' SLUG-FT**2')                                         00228000
      WRITE(6,325) IWX,IWY                                              00229000
  325 FORMAT(5X,                                                        00230000
     8'XIW1   (MOMENT OF INERTIA OF THE WHEELSET ABOUT AXLE)',4X,       00231000
     9'= ',E10.4,' SLUG-FT**2',/5X,                                     00232000
     1'XIW2   (MOMENT OF INERTIA OF THE WHEELSET IN YAW)',8X,           00233000
     2'= ',E10.4,' SLUG-FT**2'///)                                      00234000
      WRITE(6,330) KXF,KXR,KYF,KYR,KTHSF,KTHSR,KTHWF,KTHWR             00235000
  330 FORMAT(25X,'STIFFNESS PROPERTIES',///5X,                          00236000
     1'XKXF   (LATERAL STIFFNESS, SIDEFRAME TO BOLSTER -FRONT-)',5X,    00237000
     1'= ',E10.4,' LB/FT',/5X,                                          00238000
     2'XKXR   (LATERAL STIFFNESS, SIDEFRAME TO BOLSTER -REAR-)',6X,     00239000
     2'= ',E10.4,' LB/FT',/5X,                                          00240000
     3'XKYF   (VERTICAL STIFFNESS,SIDEFRAME TO BOLSTER -FRONT-)',4X,    00241000
     3'= ',E10.4,' LB/FT',/5X,                                          00242000
     4'XKYR   (VERTICAL STIFFNESS, SIDEFRAME TO BOLSTER -REAR-)', 5X,   00243000
     4'= ',E10.4,' LB/FT',/5X,                                          00244000
     5'XKTCPF(CENTERPLATE STIFFNESS -FRONT-)',23X,                      00245000
     5'= ',E10.4,' FT-LB/RAD',/5X,                                      00246000
     6'XKTCPR(CENTERPLATE STIFFNESS -REAR-)', 24X,                      00247000
     6'= ',E10.4,' FT-LB/RAD',/5X,                                      00248000
     7'XKTWF (TRUCK WARPING STIFFNESS -FRONT-)',21X,                    00249000
     7'= ',E10.4,' FT-LB/RAD',/5X,                                      00250000
     8'XKTWR (TRUCK WARPING STIFFNESS -REAR-)',22X,                     00251000
     8'= ',E10.4,' FT-LB/RAD',///)                                      00252000
      WRITE(6,350) DTHWF,DTHWR,DXF,DXR,DYF,DYR,DTHSF,DTHSR             00253000
  350 FORMAT(25X,'DAMPING PROPERTIES',///5X,                            00254000
     1'DTWF   (WARPING DAMPING-FRONT-)',27X,                            00255000
     1'= ',E10.4,' LB-SEC/FT',/5X,                                      00256000
     2'DTWR   (WARPING DAMPING -REAR-)',27X,                            00257000
     2'= ',E10.4,' LB-SEC/FT',/5X,                                      00258000
     3'DXF    (LATERAL SIDEFRAME TO BOLSTER DAMPING -FRONT-)', 5X,      00259000
     3'= ',E10.4,' LB-SEC/FT',/5X,                                      00260000
     4'DXR    (LATERAL SIDEFRAME TO BOLSTER DAMPING -REAR-)',  6X,      00261000
     4'= ',E10.4,' LB-SEC/FT',/5X,                                      00262000
     5'DYF    (VERTICAL SIDEFRAME TO BOLSTER DAMPING -FRONT-)',4X,      00263000
     5'= ',E10.4,' LB-SEC/FT',/5X,                                      00264000
     6'DYR    (VERTICAL SIDEFRAME TO BOLSTER DAMPING -REAR-)', 5X,      00265000
     6'= ',E10.4,' LB-SEC/FT',/5X,                                      00266000
     7'DTCPF (CENTERPLATE DAMPING -FRONT-)',22X,                        00267000
     7'= ',E10.4,' LB-SEC/FT',/5X,                                      00268000
     8'DTCPR (CENTERPLATE DAMPING -REAR-)', 23X,                        00269000
     8'= ',E10.4,' LB-SEC/FT',///)                                      00270000
      WRITE(6,360) X,D,H1,L1,L2,L3,RO                                   00271000
  360 FORMAT(1H1,24X,'DIMENSIONS',///5X,                                00272000
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     1'A      (SEMI-DISTANCE BETWEEN WHEEL CONTACT POINTS)', 8X,          00273000
     1'= ',E10.4,' FT',/5X,                                               00274000
     2'D      (SEMI-SPACING OF SIDEFRAME CENTER OF GRAVITIES)', 5X,       00275000
     2'= ',E10.4,' FT',/5X,                                               00276000
     3'HCG    (VERTICAL DISTANCE BETWEEN TRUCK CG AND BODY CG)', 4X,      00277000
     3'= ',E10.4,' FT',/5X,                                               00278000
     5'TL     (SEMI TRUCK WHEELBASE)',30X,                                00281000
     5'= ',E10.4,' FT',/5X,                                               00282000
     6'CLF    (DISTANCE FROM BODY CG TO FRONT TRUCK)',14X,                 00283000
     6'= ',E10.4,' FT',/5X,                                               00284000
     7'CLR    (DISTANCE FROM BODY CG TO REAR TRUCK)', 15X,                 00285000
     7'= ',E10.4,' FT',/5X,                                               00286000
     8'RO     (WHEEL ROLLING RADIUS)',30X,                                00287000
     8'= ',E10.4,' FT' ///)                                               00288000
      WRITE(6,370) A11,A12,A13,A14,DT11,DT12,DT13,DT14                    00289000
  370 FORMAT(25X,'WHEEL CHARACTERISTICS',///5X,                           00290000
     1'GAM1   (ROLL COEFFICIENT, AXLE 1)', 4X,'= ',E10.4,/5X,             00291000
     2'GAM2   (ROLL COEFFICIENT, AXLE 2)', 4X,'= ',E10.4,/5X,             00292000
     3'GAM3   (ROLL COEFFICIENT, AXLE 3)', 4X,'= ',E10.4,/5X,             00293000
     4'GAM4   (ROLL COEFFICIENT, AXLE 4)', 4X,'= ',E10.4,//5X,            00294000
     5'BDEL1 (CONTACT ANGLE COEFFICIENT,AXLE 1)',4X,'= ',E10.4,/5X,       00295000
     6'BDEL2 (CONTACT ANGLE COEFFICIENT,AXLE 2)',4X,'= ',E10.4,/5X,       00296000
     7'BDEL3 (CONTACT ANGLE COEFFICIENT,AXLE 3)',4X,'= ',E10.4,/5X,       00297000
     8'BDEL4 (CONTACT ANGLE COEFFICIENT,AXLE 4)',4X,'= ',E10.4/)          00298000
      WRITE(6,375) DL01,DL02,DL03,DL04,LB11,LB12,LB13,LB14                00299000
  375 FORMAT(5X,                                                          00300000
     9'DEL01 (INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 1)',4X,              00301000
     9'= ',E10.4,/5X,                                                     00302000
     1'DEL02 (INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 2)',4X,              00303000
     1'= ',E10.4,/5X,                                                     00304000
     2'DEL01 (INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 3)',4X,              00305000
     2'= ',E10.4,/5X,                                                     00306000
     3'DEL04 (INITIAL WHEEL/RAIL CONTACT ANGLE, AXLE 4)',4X,              00307000
     3'= ',E10.4 //5X,                                                    00308000
     4'ALAM11(CONICITY, AXLE 1)',4X,'= ',E10.4,/5X,                       00309000
     5'ALAM12(CONICITY, AXLE 2)',4X,'= ',E10.4,/5X,                       00310000
     6'ALAM13(CONICITY, AXLE 3)',4X,'= ',E10.4,/5X,                       00311000
     7'ALAM14(CONICITY, AXLE 4)',4X,'= ',E10.4 ///)                       00312000
      WRITE(6,390) F11,F12,F22,F33                                        00313000
  390 FORMAT(25X,'CREEP COEFFICIENTS',///5X,                              00314000
     1'F11    (LATERAL CREEP COEFFICIENT)', 9X,                           00315000
     1'= ',E10.4,' LB',/5X,                                               00316000
     2'F12    (LATERAL/SPIN CREEP COEFFICIENT)', 4X,                      00317000
     2'= ',E10.4,' LB-FT',/5X,                                            00318000
     3'F22    (SPIN CREEP COEFFICIENT)',12X,                              00319000
     3'= ',E10.4,' LB-FT**2',/5X,                                         00320000
     4'F33    (LONGITUDINAL CREEP COEFFICIENT)', 4X,                      00321000
     4'= ',E10.4,' LB'///)                                                00322000
      WRITE(6,395) AX,APHI,CMGC,CMGS                                      00323000
  395 FORMAT(25X,'TRACK PROPERTIES',///5X,                                00324000
     1'AX     (CENTERLINE ALIGNMENT PSD COEFFICIENT)',4X,'= ',E10.4,       00325000
     1' FT**2-RAD/FT',/5X,                                                00326000
     2'APHI   (CROSS LEVEL PSD COEFFICIENT)',11X,'= ',E10.4,              00327000
     2' FT**2-RAD/FT',/5X,                                                00328000
     3'CMGC   (PSD ROLL OFF FREQUENCY)',16X,                              00329000
     3'= ',E10.4,' RAD/FT',/5X,                                           00330000
     4'CMGS   (CROSS LEVEL PSD CONSTANT)',14X,                            00331000
     4'= ',E10.4,' RAD/FT')                                               00332000
C                                                                         00333000
C  ****INITIALIZATION OF PARAMETERS****                                   00334000
      CALL SETUP(M,C,K,FAR,FCLF)                                          00335000
      CALL PLOTS(0,0,3)                                                   00336000
      CALL EXTEND(72.0)                                                   00337000
       CALL PLOT (0.,0.,3)                                                00338000
       CALL FACTOR (.435)                                                 00339000
      CALL PLOTA(LABEL)                                                   00340000
      K1=0                                                                00341000
      S=0.                                                                00342000
C                                                                         00343000
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C   *** LOOP THROUGH EACH VELOCITY  ***                                  00344000
      IVN=0                                                              00345000
      DO 900 IV=IVO,IVF,IDV                                              00346000
      IVN=IVN+1                                                          00347000
      V=IV                                                               00348000
      PRINT 80,V                                                         00349000
   80 FORMAT(1H1,2X,'VELOCITY=',F8.2,'FT/SEC'//)                         00350000
C     ***TERMS PROPORTIONAL TO VELOCITY***                               00351000
      CALL VEL(M,C,K,V)                                                  00352000
C                                                                        00353000
C     ***FIND TRANSFER RATIO AT EACH FREQUENCY***                        00354000
      DO 180 IWN=1,N                                                     00355000
      W=FR(IWN)*6.2832                                                   00356000
      CALL FREQ(FAI,FCLI,V,W)                                            00357000
C                                                                        00358000
      NN2=NN*NN                                                          00359000
      DO 100 I=1,NN                                                      00360000
      DR(I)=0.                                                           00361000
      DI(I)=0.                                                           00362000
  100 CONTINUE                                                           00363000
      DO 110 I=1,NN                                                      00364000
      DO 110 J=1,NN                                                      00365000
        L=NN*(I-1)+J                                                     00366000
        DR(L)=TERM64*M(I,J)+K(I,J)                                       00367000
        DI(L)=W*C(I,J)                                                   00368000
  110 CONTINUE                                                           00369000
C     ****INVERT DR AND DI ***                                           00370000
      CALL DCMINV(DR,DI,NN,DETR,DETI,LC,MC1)                             00371000
C     ***CHECK FOR SINGULAR MATRIX ****                                  00372000
      DET=DETR+DETI                                                      00373000
      IF(DET) 140,120,140                                                00374000
  120 PRINT 130,V                                                        00375000
  130 FORMAT(2X,'******SINGULAR MATRIX    FOR  V=',F8.2,'*******')      00376000
      GO TO 290                                                          00377000
  140 CONTINUE                                                           00378000
      DO 144 I=1,NN                                                      00379000
      TR(I)=0.                                                           00380000
      TI(I)=0.                                                           00381000
      ER(I)=0.                                                           00382000
      EI(I)=0.                                                           00383000
  144 CONTINUE                                                           00384000
      DO 150 I=1,NN                                                      00385000
      TR(I)=0.                                                           00386000
      TI(I)=0.                                                           00387000
      ER(I)=0.                                                           00388000
      EI(I)=0.                                                           00389000
      T1R(I)=0.                                                          00390000
      T1I(I)=0.                                                          00391000
      E1R(I)=0.                                                          00392000
      E1I(I)=0.                                                          00393000
  150 CONTINUE                                                           00394000
C   *** DEFINE INPUT VECTOR, REAL AND IMAG ***                         00395000
C                                                                        00396000
      UR(1)=1.                                                           00397000
      UR(2)=1.                                                           00398000
      UR(3)=COS(2.*L1*W/V)                                               00399000
      UR(4)=UR(3)                                                        00400000
      UR(5)=COS((L2+L3)*W/V)                                             00401000
      UR(6)=UR(5)                                                        00402000
      UR(7)=COS((2.*L1+L2+L3)*W/V)                                       00403000
      UR(8)=UR(7)                                                        00404000
      UI(1)=0.                                                           00405000
      UI(2)=0.                                                           00406000
      UI(3)=SIN(2.*L1*W/V)                                               00407000
      UI(4)=UI(3)                                                        00408000
      UI(5)=SIN((L2+L3)*W/V)                                             00409000
      UI(6)=UI(5)                                                        00410000
      UI(7)=SIN((2.*L1+L2+L3)*W/V)                                       00411000
      UI(8)=UI(7)                                                        00412000
      U1R(1)=1.                                                          00413000
      U1R(2)=UR(3)                                                       00414000
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      U1R(3)=UR(5)                                                          00415000
      U1R(4)=UR(7)                                                          00416000
      U1I(1)=0.                                                             00417000
      U1I(2)=UI(3)                                                          00418000
      U1I(3)=UI(5)                                                          00419000
      U1I(4)=UI(7)                                                          00420000
      DO 152 I=1,9                                                          00421000
      DO 152 J=1,4                                                          00422000
        B1R(I)=B1R(I)+FCLR(I,J)*U1R(J)-FCLI(I,J)*U1I(J)                     00423000
        B1I(I)=B1I(I)+FCLR(I,J)*U1I(J)+FCLI(I,J)*U1R(J)                     00424000
  152 CONTINUE                                                              00425000
      DO 155 I=1,9                                                          00426000
      DO 155 J=1,8                                                          00427000
        BR(I)=BR(I)+FAR(I,J)*UR(J)-FAI(I,J)*UI(J)                           00428000
        BI(I)=BI(I)+FAR(I,J)*UI(J)+FAI(I,J)*UR(J)                           00429000
  155 CONTINUE                                                              00430000
C                                                                           00431000
      DO 160 I=1,NN                                                         00432000
      DO 160 J=1,NN                                                         00433000
      J1=J+(I-1)*NN                                                         00434000
      TR(I)=TR(I)+BR(J)*DR(J1)-BI(J)*DI(J1)                                 00435000
      TI(I)=TI(I)+BR(J)*DI(J1)+BI(J)*DR(J1)                                 00436000
      T1R(I)=T1R(I)+B1R(J)*DR(J1)-B1I(J)*DI(J1)                             00437000
      T1I(I)=T1I(I)+B1R(J)*DI(J1)+B1I(J)*DR(J1)                             00438000
  160 CONTINUE                                                              00439000
C                                                                           00440000
C ** LATERAL POSITION OF THE RESULTANT CENTERPLATE FORCE **                 00441000
      FBL(1)=TERM65*TERM64*TR(9)-H2*(TR(9)+TERM64*TR(7)/32.2)               00442000
      FI(1)=TERM65*TERM64*TI(9)-H2*(TI(9)+TERM64*TI(7)/32.2)                00443000
      F1R(1)=TERM65*TERM64*T1R(9)-H2*(T1R(9)+TERM64*T1R(7)/32.2)            00444000
      F1I(1)=TERM65*TERM64*T1I(9)-H2*(T1I(9)+TERM64*T1I(7)/32.2)            00445000
C                                                                           00446000
C ** LATERAL FORCE AT CENTERPLATE **                                        00447000
      FBL(2)=WC*(TR(9)+TERM64  *TR(7)/32.2)                                 00448000
      FI(2)=WC*(TI(9)+TERM64  *TI(7)/32.2)                                  00449000
      F1R(2)=WC*(T1R(9)+TERM64*T1R(7)/32.2)                                 00450000
      F1I(2)=WC*(T1I(9)+TERM64*T1I(7)/32.2)                                 00451000
C                                                                           00452000
C ** LATERAL CONTACT FORCE **                                               00453000
      FBL (3)=TERM40*TI (1)+TERM41*TR (1)+TERM42*TI (2)+TERM43*TR (2) +     00454000
     1TERM38*TI (3)+F11*TR (3)+TERM44                                       00455000
      FI (3)=TERM40*TR (1)+TERM41*TI (1)+TERM42*TR (2)+TERM43*TI (2) +      00456000
     1TERM38*TR (3)+F11*TI (3)+TERM44                                       00457000
      F1R(3)=TERM40*T1I(1)+TERM41*T1R(1)+TERM42*T1I(2)+TERM43*T1R(2) +      00458000
     1TERM38*T1I(3)+F11*T1R(3)+TERM44                                       00459000
      F1I(3)=TERM40*T1R(1)+TERM41*T1I(1)+TERM42*T1R(2)+TERM43*T1I(2) +      00460000
     1TERM38*T1R(3)+F11*T1I(3)+TERM44                                       00461000
      FBL (4)=TERM45*TI (1)+TERM46*TR (1)+TERM47*TI (2)+TERM48*TR (2) +     00462000
     1TERM38*TI (3)+F11*TR (3)+TERM49                                       00463000
      FI (4)=TERM45*TR (1)+TERM46*TI (1)+TERM47*TR (2)+TERM48*TI (2) +      00464000
     1TERM38*TR (3)+F11*TI (3)+TERM49                                       00465000
      F1R(4)=TERM45*T1I(1)+TERM46*T1R(1)+TERM47*T1I(2)+TERM48*T1R(2) +      00466000
     1TERM38*T1I(3)+F11*T1R(3)+TERM49                                       00467000
      F1I(4)=TERM45*T1R(1)+TERM46*T1I(1)+TERM47*T1R(2)+TERM48*T1I(2) +      00468000
     1TERM38*T1R(3)+F11*T1I(3)+TERM49                                       00469000
      FBL (5)=TERM50*TI (4)+TERM51*TR (4)+TERM52*TI (5)+TERM53*TR (5) +     00470000
     1TERM38*TI (6)+F11*TR (6)+TERM54                                       00471000
      FI (5)=TERM50*TR (4)+TERM51*TI (4)+TERM52*TR (5)+TERM53*TI (5) +      00472000
     1TERM38*TR (6)+F11*TI (6)+TERM54                                       00473000
      F1R(5)=TERM50*T1I(4)+TERM51*T1R(4)+TERM52*T1I(5)+TERM53*T1R(5) +      00474000
     1TERM38*T1I(6)+F11*T1R(6)+TERM54                                       00475000
      F1I(5)=TERM50*T1R(4)+TERM51*T1I(4)+TERM52*T1R(5)+TERM53*T1I(5) +      00476000
     1TERM38*T1R(6)+F11*T1I(6)+TERM54                                       00477000
      FBL (6)=TERM55*TI (4)+TERM56*TR (4)+TERM57*TI (5)+TERM58*TR (5) +     00478000
     1TERM38*TI (6)+F11*TR (6)+TERM59                                       00479000
      FI (6)=TERM55*TR (4)+TERM56*TI (4)+TERM57*TR (5)+TERM58*TI (5) +      00480000
     1TERM38*TR (6)+F11*TI (6)+TERM59                                       00481000
      F1R(6)=TERM55*T1I(4)+TERM56*T1R(4)+TERM57*T1I(5)+TERM58*T1R(5) +      00482000
     1TERM38*T1I(6)+F11*T1R(6)+TERM59                                       00483000
      F1I(6)=TERM55*T1R(4)+TERM56*T1I(4)+TERM57*T1R(5)+TERM58*T1I(5) +      00484000
     1TERM38*T1R(6)+F11*T1I(6)+TERM59                                       00485000
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C                                                                       00486000
C **** TRANSFER RATIO MAGNITUDE ***                                     00487000
      DO 170 J=1,9                                                      00488000
      T(J,IWN)=SQRT(TR(J)**2+TI(J)**2)                                  00489000
      T1(J,IWN)=SQRT(T1R(J)**2+T1I(J)**2)                               00490000
  170 CONTINUE                                                          00491000
      DO 175 J=1,6                                                      00492000
      F(J,IWN)=SQRT(FRL(J)**2+FI(J)**2)                                 00493000
      F1(J,IWN)=SQRT(F1R(J)**2+F1I(J)**2)                               00494000
  175 CONTINUE                                                          00495000
  180 CONTINUE                                                          00496000
C                                                                       00497000
C  ** FIND RMS AND PSD VALUES **                                        00498000
      N1=NN+1                                                           00499000
      DO 190 I=1,N1                                                     00500000
      TRMS(I)=0.                                                        00501000
      T1RMS(I)=0.                                                       00502000
      DO 190 J=1,N                                                      00503000
      TPSD(I,J)=0.                                                      00504000
      T1PSD(I,J)=0.                                                     00505000
  190 CONTINUE                                                          00506000
      DO 200 I=1,6                                                      00507000
      FRMS(I)=0.                                                        00508000
      F1RMS(I)=0.                                                       00509000
      DO 200 J=1,N                                                      00510000
      FPSD(I,J)=0.                                                      00511000
      F1PSD(I,J)=0.                                                     00512000
  200 CONTINUE                                                          00513000
C   *** LOOP THROUGH EACH FREQUENCY ***                                 00514000
      DO 280 IWN=1,N                                                    00515000
      W=2.*PI*FR(IWN)                                                   00516000
      W2=W**2                                                           00517000
      V2=V*V                                                            00518000
      V3=V*V2                                                           00519000
C                                                                       00520000
C   ***CHOOSE TRACK APPROXIMATION ***                                   00521000
C ** CENTERLINE ALIGNMENT TRACK APPROXIMATION **                        00522000
      PAX=2.*PI*AX*V/W2/(1.+W2/V2/OMGC2)                                00523000
C ** CROSS LEVEL TRACK APPROXIMATION **                                 00524000
      PAPHI=1.28*PI*APHI*V3*OMGC2/(W2+V2*OMG32)/(W2+V2*OMGC2)           00525000
C                                                                       00526000
      TPSD(N1,IWN)=PAX                                                  00527000
      T1PSD(N1,IWN)=PAPHI                                               00528000
      DO 230 I=1,NN                                                     00529000
      TPSD(I,IWN)=T(I,IWN)**2*PAX                                       00530000
      T1PSD(I,IWN)=T1(I,IWN)**2*PAPHI                                   00531000
  230 CONTINUE                                                          00532000
      DO 235 I=1,6                                                      00533000
      FPSD(I,IWN)=F(I,IWN)**2*PAX                                       00534000
      F1PSD(I,IWN)=F1(I,IWN)**2*PAPHI                                   00535000
  235 CONTINUE                                                          00536000
      IF(IWN-1)240,240,260                                              00537000
  240 FREQ0=FR(IWN)                                                     00538000
      DO 250 I=1,N1                                                     00539000
      TPSD0(I)=TPSD(I,IWN)                                              00540000
      T1PSD0(I)=T1PSD(I,IWN)                                            00541000
  250 CONTINUE                                                          00542000
      DO 255 I=1,6                                                      00543000
      FPSD0(I)=FPSD(I,IWN)                                              00544000
      F1PSD0(I)=F1PSD(I,IWN)                                            00545000
  255 CONTINUE                                                          00546000
      GO TO 280                                                         00547000
  260 DFREQ=FR(IWN)-FREQ0                                               00548000
      FREQ0=FR(IWN)                                                     00549000
      DO 270 I=1,N1                                                     00550000
      TRMS(I)=TRMS(I)+.5*DFREQ*(TPSD0(I)+TPSD(I,IWN))                   00551000
      T1RMS(I)=T1RMS(I)+.5*DFREQ*(T1PSD0(I)+T1PSD(I,IWN))               00552000
      TPSD0(I)=TPSD(I,IWN)                                              00553000
      T1PSD0(I)=T1PSD(I,IWN)                                            00554000
  270 CONTINUE                                                          00555000
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      DO 275 I=1,6                                                      00556000
      FRMS(I)=FRMS(I)+.5*DFREQ*(FPSD0(I)+FPSD(I,IWN))                   00557000
      F1RMS(I)=F1RMS(I)+.5*DFREQ*(F1PSD0(I)+F1PSD(I,IWN))               00558000
      FPSD0(I)=FPSD(I,IWN)                                              00559000
      F1PSD0(I)=F1PSD(I,IWN)                                            00560000
  275 CONTINUE                                                          00561000
  280 CONTINUE                                                          00562000
  290 CONTINUE                                                          00563000
      DO 310 I=1,N1                                                     00564000
      TRMS(I)=SQRT(TRMS(I))                                             00565000
      T1RMS(I)=SQRT(T1RMS(I))                                           00566000
  310 CONTINUE                                                          00567000
      DO 315 I=1,6                                                      00568000
      FRMS(I)=SQRT(FRMS(I))                                             00569000
      F1RMS(I)=SQRT(F1RMS(I))                                           00570000
  315 CONTINUE                                                          00571000
C                                                                       00572000
C  ****  OUTPUT   ****                                                 00573000
      PRINT 710                                                         00574000
  710 FORMAT(1H1,21X,'*****PSD VALUES FOR ALIGNMENT INPUTS*****')       00575000
      PRINT 760                                                         00576000
  760 FORMAT(///,4X,'FREQUENCY',3X,'PSD(1)',5X,'PSD(2)',5X,'PSD(3)',5X, 00577000
     1'PSD(4)',5X,'PSD(5)',5X,'PSD(6)',5X,'PSD(7)',5X,'PSD(8)',5X,      00578000
     1'PSD(9)'/)                                                        00579000
      DO 781 I=1,N                                                      00580000
      PRINT 770,FR(I),(TPSD(J,I),J=1,9)                                 00581000
  770 FORMAT(2X,F9.5, 9(2X,E9.4))                                       00582000
  781 CONTINUE                                                          00583000
      PRINT 790                                                         00584000
  790 FORMAT(  1H1,6X,'RMS VALUES-ALIGNMENT INPUT')                     00585000
      PRINT 800,(I,TRMS(I),I=1,10)                                      00586000
  800 FORMAT(/// 9(2X,'RMS(',I1,') =',E9.3/),//2X,'RMS(',I2,') =',E9.3) 00587000
      PRINT 801                                                         00588000
  801 FORMAT(1H1,21X,'***** PSD VALUES FOR CROSS LEVEL INPUT *****')    00589000
      PRINT 760                                                         00590000
      DO 780 I=1,N                                                      00591000
      PRINT 770,FR(I),(T1PSD(J,I),J=1,9)                                00592000
  780 CONTINUE                                                          00593000
      PRINT 791                                                         00594000
  791 FORMAT(1H1,6X,'RMS VALUES-CROSS LEVEL INPUT')                     00595000
      PRINT 800,(I,T1RMS(I),I=1,10)                                     00596000
      WRITE(6,850)                                                      00597000
  850 FORMAT(1H1,45X,'PSD VALUES FOR ALIGNMENT INPUT',//10X,'FREQUENCY (00598000
     1HZ)',11X,'LATERAL CONTACT FORCES',25X,'CENTERPLATE FORCE',/29X,    00599000
     2'AXLE 1',7X,'AXLE 2',7X,'AXLE 3',7X,'AXLE 4',5X,                  00600000
     34X,'LATERAL POSITION       LATERAL MAGNITUDE     '/)              00601000
      DO 860 IPR=1,N                                                    00602000
      WRITE(6,855) FR(IPR),(FPSD(JPR,IPR),JPR=3,6),FPSD(1,IPR),         00603000
     1 FPSD(2,IPR)                                                      00604000
  855 FORMAT(12X,F10.3,5X,4(E10.4,3X),5X, E10.4,12X,E10.4)              00605000
  860 CONTINUE                                                          00606000
      PRINT 810                                                         00607000
  810 FORMAT(1H1,6X,'RMS VALUES -ALIGNMENT INPUT')                      00608000
      PRINT 820,(FRMS(I),I=3,6),FRMS(1),FRMS(2)                         00609000
  820 FORMAT(///6X,'LATERAL CONTACT FORCES',//11X,                      00610000
     1 'AXLE 1 =',E9.3,/11X,                                            00611000
     1 'AXLE 2 =',E9.3,/11X,                                            00612000
     1 'AXLE 3 =',E9.3,/11X,                                            00613000
     1 'AXLE 4 =',E9.3,//6X,                                            00614000
     1 'LATERAL POSITION OF RESULTANT CENTERPLATE FORCE = ',E9.3,//6X,   00615000
     1 'LATERAL FORCE AT THE CENTERPLATE = ',E9.3)                      00616000
      WRITE(6,870)                                                      00617000
  870 FORMAT(1H1,46X,'PSD VALUES FOR CROSS LEVEL INPUT',//10X,'FREQUENCY00618000
     1(HZ)',11X,'LATERAL CONTACT FORCES',25X,'CENTERPLATE FORCE',/29X,   00619000
     2'AXLE 1',7X,'AXLE 2',7X,'AXLE 3',7X,'AXLE 4',5X,                  00620000
     34X,'LATERAL POSITION       LATERAL MAGNITUDE     '/)              00621000
      DO 873 IPR=1,N                                                    00622000
      WRITE(6,855) FR(IPR),(F1PSD(JPR,IPR),JPR=3,6),F1PSD(1,IPR),       00623000
     1 F1PSD(2,IPR)                                                     00624000
  873 CONTINUE                                                          00625000
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      PRINT 830                                                          00626000
  830 FORMAT(1H1,6X,'RMS VALUES-CROSS LEVEL INPUT')                      00627000
      PRINT 820,(F1RMS(I),I=3,6),F1RMS(1),F1RMS(2)                       00628000
      S=S+1.                                                             00629000
      K1=K1+1                                                            00630000
      CALL PLOTB(FR,TPSD,T1PSD,FRSD,F1PSD,N,K1,V,S)                      00631000
  900 CONTINUE                                                           00632000
      CALL PLOT(0,0,999)                                                 00633000
   50 STOP                                                               00634000
      END                                                                00635000
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      SUBROUTINE SETUP(M,C,K,FAR,FCLR)                                   00636000
C*****************************************************************      00637000
C                                                                        00638000
C   THIS SUBROUTINE COMPUTES THE VELOCITY INDEPENDENT TERMS  OF          00639000
C   THE M,C,K,FAR AND FCLR MATRICES.  THE VEHICLE EQUATIONS ARE          00640000
C   IN THE FOLLOWING FORM,                                               00641000
C                                                                        00642000
C          M*X2DOT + C*XDOT + D*X = FA*UA + FCC*UPHI                     00643000
C                                                                        00644000
C*****************************************************************      00645000
C                                                                        00646000
      DIMENSION M(9,9),C(9,9),K(9,9),FCLR(9,4),FAR(9,8)                  00647000
      COMMON /NAME1/A11,A12,A13,A14,ALH11,ALH21,ALH31,ALH41,             00648000
     1 D,DELOF,DELOR,DL01,DL02,DL03,DL04,DT11,DT12,DT13,DT14,            00649000
     2 DTHBF,DTHBR,DXF,DXR,DYF,DYR,EPL11,EPL21,EPL31,EPL41,              00650000
     3 EPL51,EPL61,EPL71,EPL81,F11,F12,F22,F33,H1,IBY,IBZ,               00651000
     4 ICY,ICZ,ICYZ,IWX,IWY,KTHBF,KTHBR,KTHSF,KTHWR,KXF,KXR,             00652000
     5 KYF,KYR,L1,L2,L3,LE11,LE12,LB13,LE14,MB,MC,MSF,MW,                00653000
     6 B0,RHO11,RHO21,RHO31,RHO41,RHO51,RHO61,RHO71,RHO81,WB,WC,         00654000
     7 WF,WN,WR,WT,X,DTHWF,DTHWR,ISFY,ALH51,ALH61,ALH71,ALH81            00655000
      COMMON /NAME2/TERM13,TERM14,TERM15,TERM16,TERM17,TERM20,            00656000
     1 TERM26,TERM27,TERM34,TERM40,TERM41,TERM42,TERM43,TERM44,          00657000
     2 TERM45,TERM46,TERM47,TERM48,TERM49,TERM50,TERM51,                 00658000
     3 TERM52,TERM53,TERM54,TERM55,TERM56,TERM57,TERM58,                 00659000
     4 TERM59,TERM60,TERM64,TERM65,TERM89,TERM90,TERM91,                 00660000
     5 TERM92,TERM21,TERM35                                              00661000
      REAL L1,L2,L3,MW,MSF,MC,LB11,LB12,LE13,LB14,MB                     00662000
      REAL KXF,KXR,KYF,KYR,KTHBF,KTHBR,KTHWF,KTHWR                       00663000
      REAL ISFY,IBY,IBZ,IWX,IWY,ICY,ICZ,ICYZ,M,K                         00664000
      B2=B1                                                              00665000
      DO 650 I=1,9                                                       00666000
      DO 650 J=1,9                                                       00667000
      M(I,J)=0.0                                                         00668000
      C(I,J)=0.0                                                         00669000
      K(I,J)=0.0                                                         00670000
  650 CONTINUE                                                           00671000
      M(1,1)=2.*(MSF+MW)                                                 00672000
      M(2,2)=2.*(IWY+ISFY+D*D*MSF+L1*L1*MW)+IBY                          00673000
      M(2,3)=IBY+2.*IWY+2.*MSF*D*D                                       00674000
      M(3,3)=M(2,3)                                                      00675000
      M(3,2)=M(2,3)                                                      00676000
      M(4,4)=M(1,1)                                                      00677000
      M(5,5)=M(2,2)                                                      00678000
      M(5,6)=M(2,3)                                                      00679000
      M(6,6)=M(2,3)                                                      00680000
      M(6,5)=M(2,3)                                                      00681000
      M(7,7)=MC+2.*MB                                                    00682000
      M(7,8)=MB*(L2-L3)                                                  00683000
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      M(7,9)=2.*H2*MB                                                   00684000
      M(8,7)=M(7,8)                                                     00685000
      M(8,8)=ICY+MB*(L2*L2+L3*L3)                                       00686000
      M(8,9)=-ICYZ+MB*(L2-L3)*H2                                        00687000
      M(9,7)= M(7,8)                                                    00688000
      M(9,8)=M(8,9)                                                     00689000
      M(9,9)=ICZ+2.*IBZ+2.*B2*H2*MB                                     00690000
C     **********                                                        00691000
      C(1,7)=-2.*DXF                                                    00692000
      C(1,8)=-2.*DXF*L2                                                 00693000
      C(1,9)=-2.*DXF*H2                                                 00694000
C                                                                       00695000
      C(2,8)=-DTHBF                                                     00696000
      C(2,9)=-DYF*L1*D*D/X*(A11-A12)                                    00697000
C                                                                       00698000
      C(3,8)=C(2,8)                                                     00699000
C                                                                       00700000
      C(4,7)=-2.*DXR                                                    00701000
      C(4,8)=2.*DXR*L3                                                  00702000
      C(4,9)=-2.*DXR*H2                                                 00703000
C                                                                       00704000
      C(5,8)=-DTHBR                                                     00705000
      C(5,9)=-DYR*L1*D*D/X*(A13-A14)                                    00706000
      C(6,8)=C(5,8)                                                     00707000
C                                                                       00708000
      C(7,7)=2.*(DXF+DXR)                                               00709000
      C(7,1)=-2.*DXF                                                    00710000
      C(7,4)=-2.*DXR                                                    00711000
      C(7,8)=2.*(DXF*L2-DXR*L3)                                         00712000
      C(7,9)=2.*H2*(DXF+DXR)                                            00713000
C                                                                       00714000
      C(8,8)=DTHBF+DTHBR+2.*(DXR*L3*L3+DXF*L2*L2)                       00715000
      C(8,9)=2.*H2*(DXF*L2-DXR*L3)                                      00716000
      C(8,7)=C(7,8)                                                     00717000
      C(8,1)=-2.*DXF*L2                                                 00718000
      C(8,4)=2.*DXR*L3                                                  00719000
      C(8,2)=-DTHBF                                                     00720000
      C(8,3)=C(8,2)                                                     00721000
      C(8,5)=-DTHBR                                                     00722000
      C(8,6)=C(8,5)                                                     00723000
C                                                                       00724000
      C(9,1)=-2.*H2*DXF-D*D/X*(A11+A12)*DYF                             00725000
      C(9,2)=-D*D*L1/X*(A11-A12)*DYF                                    00726000
      C(9,4)=-2.*H2*DXR-D*D/X*(A13+A14)*DYR                             00727000
      C(9,5)=-D*D*L1/X*(A13-A14)*DYR                                    00728000
      C(9,7)=2.*H2*(DXF+DXR)                                            00729000
      C(9,8)=2.*H2*(DXF*L2-DXR*L3)                                      00730000
      C(9,9)=2.*D*D*(DYF+DYR)+2.*H2*H2*(DXF+DXR)                        00731000
C                                                                       00732000
C     ***SPRING CONSTANT***                                             00733000
      K(1,1)=2.*(KXF-F12*(DT11+DT12)/(X*R0)+WF*(A11+A12+DT11+DT12)/X/2.)00734000
      K(1,2)=-4.*F11-2.*L1*F12*(DT11-DT12)/(X*R0)+   L1*WF*             00735000
     1(A11-A12+DT11-DT12)/X                                             00736000
      K(1,3)=-4.*F11                                                    00737000
      K(1,7)=-2.*KXF                                                    00738000
      K(1,8)=-2.*KXF*L2                                                 00739000
      K(1,9)=-2.*KXF*H2                                                 00740000
C                                                                       00741000
      K(2,1)=WF*L1/X*(DT11+A11-DT12-A12)+2.*(-F22/R0/X*(DT11+DT12)      00742000
     1+X*F33/R0*(LB11+LB12)-L1*F12/R0/X*(DT11-DT12))                    00743000
      K(2,2)=KTHBF+4.*F12-X*WF*(DL01+DL02)+                             00744000
     1   L1*L1*WF*(DT11+DT12+A11+A12)/X-2.*L1*F22*(DT11-DT12)           00745000
     1/(R0*X)+2.*X*F33*L1*(IB11-IB12)/R0                                00746000
     1-2.*L1*L1*F12*(DT11+DT12)/(R0*X)                                  00747000
      K(2,3)=KTHBF+4.*F12-X*WF*(DL01+DL02)                              00748000
      K(2,8)=-KTHBF                                                     00749000
      K(2,9)=-KYF*L1*D*D/X*(A11-A12)                                    00750000
C                                                                       00751000
      K(3,1)=2.*X*F33/R0*(LB11+LB12)-2.*F22/R0/X*(DT11+DT12)            00752000
      K(3,2)=KTHBF+4.*F12-X*WF*(DL01+DL02)                              00753000
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     1-2.*F22*L1/R0/X*(DT11-DT12)+2,*X*X*F33*L1                          00754000
     1/R0/X*(LB11-LB12)                                                  00755000
      K(3,3)=K(2,3)+KTHWF                                                00756000
      K(3,8)=K(2,8)                                                      00757000
C                                                                        00758000
      K(4,4)=2.*(KXR-F12/X/R0*(DT13+DT14))+WR/X*(A13+A14+                00759000
     1DT13+DT14)                                                         00760000
      K(4,5)=-4.*F11-2.*L1*F12/X/R0*(DT13-DT14)+   L1*WR                 00761000
     1/X*(A13-A14+DT13-DT14)                                             00762000
      K(4,6)=K(1,3)                                                      00763000
      K(4,7)=-2.*KXR                                                     00764000
      K(4,8)=2.*KXR*L3                                                   00765000
      K(4,9)=-2.*KXR*H2                                                  00766000
C                                                                        00767000
      K(5,4)=   WR*L1/X*(DT13+A13-DT14-A14)-2.*F22/R0/X*(DT13            00768000
     1+DT14)+2.*X*F33/R0*(LB13+LB14)-2.*L1*F12                           00769000
     1/R0/X*(DT13-DT14)                                                  00770000
      K(5,5)=KTHBR+4.*F12-X*WR*(DL03+DL04)+                              00771000
     1   L1*L1*WR/X*(DT13+DT14+A13+A14)-2.*L1*F22/R0/X*                  00772000
     1(DT13-DT14)+2.*X*F33*L1/R0*(LB13-LB14)                             00773000
     1-2.*L1*L1*F12/R0/X*(DT13+DT14)                                     00774000
      K(5,6)=KTHBR+4.*F12-X*WR*(DL03+DL04)                               00775000
      K(5,8)=-KTHBR                                                      00776000
      K(5,9)=-KYR*L1*D*D/X*(A13-A14)                                     00777000
C                                                                        00778000
      K(6,4)=2./R0*(X*F33*(LB13+LB14)-F22/X*(DT13+DT14))                 00779000
      K(6,5)=KTHBR+4.*F12-X*WR*(DL03+DL04)                               00780000
     1-2.*F22*L1/R0/X*(DT13-DT14)                                        00781000
     1+2.*X*X*F33*L1/R0/X*(LB13-LB14)                                    00782000
      K(6,6)=KTHWR+KTHBR+4.*F12-X*WR*(DL03+DL04)                         00783000
      K(6,8)=K(5,8)                                                      00784000
C                                                                        00785000
      K(7,7)=2.*(KXF+KXB)                                                00786000
      K(7,1)=-2.*KXF                                                     00787000
      K(7,4)=-2.*KXR                                                     00788000
      K(7,8)=2.*(KXF*L2-KXB*L3)                                          00789000
      K(7,9)=2.*H2*(KXF+KXB)                                             00790000
C                                                                        00791000
      K(8,8)=KTHBF+KTHBR+2.*(KXR*L3*L3+KXF*L2*L2)                        00792000
      K(8,9)=H2*K(7,8)                                                   00793000
      K(8,7)=K(7,8)                                                      00794000
      K(8,1)=-2.*KXF*L2                                                  00795000
      K(8,4)=2.*KXR*L3                                                   00796000
      K(8,2)=-KTHBF                                                      00797000
      K(8,3)=K(8,2)                                                      00798000
      K(8,5)=-KTHBR                                                      00799000
      K(8,6)=K(8,5)                                                      00800000
C                                                                        00801000
      K(9,1)=-2.*H2*KXF-D*D/X*(A11+A12)*KYF                              00802000
      K(9,2)=-D*D*L1/X*(A11-A12)*KYF                                     00803000
      K(9,4)=-2.*H2*KXR-D*D/X*(A13+A14)*KYR                              00804000
      K(9,5)=-D*D*L1/X*(A13-A14)*KYR                                     00805000
      K(9,7)=K(7,9)                                                      00806000
      K(9,8)=K(7,8)*H2                                                   00807000
      K(9,9)=2.*(H2*H2*(KXF+KXB)+D*D*(KYF+KYR)-H2*DEL0F*KYF-H2*DEL0R*KYR 00808000
     1)                                                                  00809000
C ****MATRIX SETUP****                                                   00810000
C INPUT MATRIX,VELOCITY INDEPENDENT TERMS                                00812000
      TERM1=WF/X                                                         00813000
      TERM2=2.*F12/R0/X                                                  00814000
      TERM3=-L1*WF/X+2.*F22/R0/X+2.*L1*F12/R0/X                          00815000
      TERM4=L1*WF/X                                                      00816000
      TERM5=2.*X*F33/R0                                                  00817000
      TERM6=2.*F22/R0/X                                                  00818000
      TERM7=2.*X*F33/R0                                                  00819000
      TERM8=D*D*KYF/X                                                    00820000
      TERM9=D*D*KYR/X                                                    00821000
      TERM10=WR/X                                                        00822000
      TERM11=-L1*WR/X+2.*F22/R0/X+2.*L1*F12/R0/X                         00823000
      TERM12=L1*WR/X                                                     00824000
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      TERM16=D*D*DYF/X                                                  00825000
      TERM17=D*D*DYR/X                                                  00826000
      TERM18=L1*WF/X+2.*F22/R0/X-2.*L1*F12/R0/X                         00827000
      TERM19=L1*WR/X+2.*F22/R0/X-2.*L1*F12/R0/X                         00828000
      TERM22=(2.*F12/R0-WF)*R0/X                                        00829000
      TERM23=2.*F33*X                                                   00830000
      TERM24=(-WF*R0*L1+2.*F22+2.*L1*F12)/X                             00831000
      TERM25=(WF*R0*L1+2.*F22-2.*L1*F12)/X                              00832000
      TERM28=2.*F22/X                                                   00833000
      TERM29=(2.*F12/R0-WR)*R0/X                                        00834000
      TERM30=(-WR*R0*L1+2.*F22+2.*L1*F12)/X                             00835000
      TERM31=(WR*R0*L1+2.*F22-2.*L1*F12)/X                              00836000
      TERM32=D*D*KYF                                                    00837000
      TERM33=D*D*KYR                                                    00838000
      TERM34=D*D*DYF                                                    00839000
      TERM35=D*D*DYR                                                    00840000
      TERM61=F12/R0                                                     00841000
      TERM65=ICZ/WC                                                     00842000
      TERM41=-((A11+DT11)*WN-TERM61*DT11)/X                             00843000
      TERM43=F11+L1/X*(TERM61*DT11-(A11+DT11)*WN)                       00844000
      TERM44=DL01 *(WN-TERM61)                                          00845000
      TERM46=-((A12+DT12)*WN-TERM61*DT12)/X                             00846000
      TERM48=F11-L1/X*(TERM61*DT12-(A12+DT12)*WN)                       00847000
      TERM49=DL02 *(WN-TERM61)                                          00848000
      TERM51=-((A13+DT13)*WN-TERM61*DT13)/X                             00849000
      TERM53=F11+L1/X*(TERM61*DT13-(A13+DT13)*WN)                       00850000
      TERM54=DL03 *(WN-TERM61)                                          00851000
      TERM56=-((A14+DT14)*WN-TERM61*DT14)/X                             00852000
      TERM58=F11-L1/X*(TERM61*DT14-(A14+DT14)*WN)                       00853000
      TERM59=DL04 *(WN-TERM61)                                          00854000
      TERM89=A13+A14                                                    00855000
      TERM90=A13-A14                                                    00856000
      TERM91=A11+A12                                                    00857000
      TERM92=A11-A12                                                    00858000
C                                                                       00859000
      FAR(1,1)=-TERM1*(ALH11+EPL11)+TERM2*EPL11                         00860000
      FAR(1,2)=-TERM1*(ALH21+EPL21)+TERM2*EPL21                         00861000
      FAR(1,3)=-TERM1*(ALH31+EPL31)+TERM2*EPL31                         00862000
      FAR(1,4)=-TERM1*(ALH41+EPL41)+TERM2*EPL41                         00863000
      FAR(2,1)=TERM3*EPL11-TERM4*ALH11-TERM5*RHO11                      00864000
      FAR(2,2)=TERM3*EPL21-TERM4*ALH21-TERM5*RHO21                      00865000
      FAR(2,3)=TERM18*EPL31-TERM4*ALH31-TERM5*RHO31                     00866000
      FAR(2,4)=TERM18*EPL41-TERM4*ALH41-TERM5*RHO41                     00867000
      FAR(3,1)=TERM6*EPL11-TERM7*RHO11                                  00868000
      FAR(3,2)=TERM6*EPL21-TERM7*RHO21                                  00869000
      FAR(3,3)=TERM6*EPL31-TERM7*RHO31                                  00870000
      FAR(3,4)=TERM6*EPL41-TERM7*RHO41                                  00871000
      FAR(4,5)=-TERM10*(ALH51+EPL51)+TERM2*EPL51                        00872000
      FAR(4,6)=-TERM10*(ALH61+EPL61)+TERM2*EPL61                        00873000
      FAR(4,7)=-TERM10*(ALH71+EPL71)+TERM2*EPL71                        00874000
      FAR(4,8)=-TERM10*(ALH81+EPL81)+TERM2*EPL81                        00875000
      FAR(5,5)=TERM11*EPL51-TERM12*ALH61-TERM5*RHO51                    00876000
      FAR(5,6)=TERM11*EPL61-TERM12*ALH61-TERM5*RHO61                    00877000
      FAR(5,7)=TERM19*EPL71-TERM12*ALH71-TERM5*RHO71                    00878000
      FAR(5,8)=TERM19*EPL81-TERM12*ALH81-TERM5*RHO81                    00879000
      FAR(6,5)=TERM6*EPL51-TERM7*RHO51                                  00880000
      FAR(6,6)=TERM6*EPL61-TERM7*RHO61                                  00881000
      FAR(6,7)=TERM6*EPL71-TERM7*RHO71                                  00882000
      FAR(6,8)=TERM6*EPL81-TERM7*RHO81                                  00883000
      FAR(9,1)=TERM8*ALH11                                              00884000
      FAR(9,2)=TERM8*ALH21                                              00885000
      FAR(9,3)=TERM8*ALH31                                              00886000
      FAR(9,4)=TERM8*ALH41                                              00887000
      FAR(9,5)=TERM9*ALH51                                              00888000
      FAR(9,6)=TERM9*ALH61                                              00889000
      FAR(9,7)=TERM9*ALH71                                              00890000
      FAR(9,8)=TERM9*ALH81                                              00891000
C                                                                       00892000
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      FCLR(1,1)=-WF+TERM22*DT11                                          00893000
      FCLR(1,2)=-WF+TERM22*DT12                                          00894000
      FCLR(2,1)=-L1*WF-TERM23*LB11+TERM24*DT11                           00895000
      FCLR(2,2)= L1*WF-TERM23*LB12+TERM25*DT12                           00896000
      FCLR(3,1)=-TERM23*LB11+TERM28*DT11                                 00897000
      FCLR(3,2)=-TERM23*LB12+TERM28*DT12                                 00898000
      FCLR(4,3)=-WR+TERM29*DT13                                          00899000
      FCLR(4,4)=-WR+TERM29*DT14                                          00900000
      FCLR(5,3)=-L1*WR-TERM23*LB13+TERM30*DT13                           00901000
      FCLR(5,4)=L1*WR-TERM23*LB14+TERM31*DT14                            00902000
      FCLR(6,3)=-TERM23*LB13+TERM28*DT13                                 00903000
      FCLR(6,4)=-TERM23*LB14+TERM28*DT14                                 00904000
      FCLR(9,1)=TERM32                                                   00905000
      FCLR(9,2)=TERM32                                                   00906000
      FCLR(9,3)=TERM33                                                   00907000
      FCLR(9,4)=TERM33                                                   00908000
      RETURN                                                             00909000
      END                                                                00910000
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      SUBROUTINE VEL(M,C,K,V)                                            00911000
C ******************************************************************     00912000
C     THIS SUBROUTINE COMPUTES THE VELOCITY DEPENDENT                    00913000
C     TERMS OF THE M,C, AND K MATRICES.                                  00914000
C ******************************************************************     00915000
C                                                                        00916000
      DIMENSION M(9,9),C(9,9),K(9,9)                                     00917000
      COMMON /NAME1/A11,A12,A13,A14,ALH11,ALH21,ALH31,ALH41,             00918000
     1 D,DELOF,DELOR,DL01,DL02,DL03,DL04,DT11,DT12,DT13,DT14,            00919000
     2 DTHBF,DTHBR,DXF,DXR,DYF,DYR,EPL11,EPL21,EPL31,EPL41,              00920000
     3 EPL51,EPL61,EPL71,EPL81,F11,F12,F22,F33,H1,IBY,IBZ,               00921000
     4 ICY,ICZ,ICYZ,IWX,IWY,KTHBF,KTHBR,KTHWF,KTHWR,KXF,KXR,             00922000
     5 KYF,KYR,L1,L2,L3,LB11,LB12,LB13,LB14,MB,MC,MSF,MW,                00923000
     6 R0,RHO11,RHO21,RHO31,RHO41,RHO51,RHO61,RHO71,RHO81,WB,WC,         00924000
     7 WF,WN,WR,WT,X,DIHWF,DIHWR,ISFY,ALH51,ALH61,ALH71,ALH81            00925000
      COMMON /NAME2/TERM13,TERM14,TERM15,TERM16,TERM17,TERM20,            00926000
     1 TERM26,TERM27,TERM34,TERM40,TERM41,TERM42,TERM43,TERM44,          00927000
     2 TERM45,TERM46,TERM47,TERM48,TERM49,TERM50,TERM51,                 00928000
     3 TERM52,TERM53,TERM54,TERM55,TERM56,TERM57,TERM58,                 00929000
     4 TERM59,TERM60,TERM64,TERM65,TERM89,TERM90,TERM91,                 00930000
     5 TERM92,TERM21,TERM35                                              00931000
      REAL L1,L2,L3,MW,MSF,MC,IB11,LB12,LB13,LB14,MB                     00932000
      REAL KXF,KXR,KYF,KYR,KTHBF,KTHBR,KTHWF,KTHWR                       00933000
      REAL ISFY,IBY,IBZ,IWX,IWY,ICY,ICZ,ICYZ,M,K                         00934000
      H2=H1                                                              00935000
      V2=V**2                                                            00936000
      V3=V**3                                                            00937000
      TERM60= F12/V                                                      00938000
      TERM88=IWX*V/(R0*X)                                                00939000
      TERM13=2.*R0*F11/X/V                                               00940000
      TERM21=TERM13*X                                                    00941000
      TERM93=2.*R0*F12/(V*X)                                             00942000
      TERM94=4.*L1*L1*F11/V                                              00943000
      TERM96=4.*F12/V                                                    00944000
      TERM98=4.*(F22+X*X*F33)/V                                          00945000
      TERM99=TERM13*L1                                                   00946000
      TERM15=TERM93-TERM88                                               00947000
      TERM14=TERM93-TERM88-TERM99                                        00948000
      TERM27=TERM99*X                                                    00949000
      TERM26=TERM15*X                                                    00950000
      TERM20=TERM93-TERM88+TERM99                                        00951000
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      SUBROUTINE FREQ(FAI,FCLI,V,W)                                     00987000
C ***************************************************************     00988000
C     THIS SUBROUTINE CALCULATES THE FREQUENCY DEPENDENT                00989000
C     TERMS  IN THE INPUT MATRICES, FAI AND FCLI.                       00990000
C ***************************************************************     00991000
C                                                                       00992000
      DIMENSION FAI(9,8),FCLI(9,4)                                      00993000
      COMMON /NAME1/A11,A12,A13,A14,ALH11,ALH21,ALH31,ALH41,            00994000
     1 L,DELOF,DELOR,DL01,DL02,DL03,DL04,DT11,DT12,DT13,DT14,           00995000
     2 DTHBF,DTHBR,DXF,DXB,DYF,DYR,EPL11,EPL21,EPL31,EPL41,             00996000
     3 EPL51,EPL61,EPL71,EPL81,F11,F12,F22,F33,H1,IBY,IBZ,              00997000
     4 ICY,ICZ,ICYZ,IWX,IWY,KTHBF,KTHBR,KTHWF,KTHWR,KXF,KXR,            00998000
     5 KYF,KYR,L1,L2,L3,LB11,LB12,LB13,LB14,MB,MC,MSF,MW,               00999000
     6 R0,RHO11,RHO21,RHO31,RHO41,RHO51,RHO61,RHO71,RHO81,WB,WC,        01000000
     7 WF,WN,WR,WT,X,DTHWF,DTHWB,ISFY,ALH51,ALH61,ALH71,ALH81           01001000
      COMMON /NAME2/TERM13,TERM14,TERM15,TERM16,TERM17,TERM20,           01002000
     1 TERM26,TERM27,TERM34,TERM40,TERM41,TERM42,TERM43,TERM44,         01003000
     2 TERM45,TERM46,TERM47,TERM48,TERM49,TERM50,TERM51,                01004000
     3 TERM52,TERM53,TERM54,TERM55,TERM56,TERM57,TERM58,                01005000
     4 TERM59,TERM60,TERM64,TERM65,TERM89,TERM90,TERM91,                01006000
     5 TERM92,TERM21,TERM35                                             01007000
      REAL L1,L2,L3,MW,MSF,MC,IB11,LB12,LB13,LB14,MB                    01008000
      REAL KXF,KXR,KYF,KYB,KTHBF,KTHBR,KTHWF,KTHWR                      01009000
      REAL ISFY,IBY,IBZ,IWX,IWY,ICY,ICZ,ICYZ,M,K                        01010000
      H2=H1                                                             01011000
      TERM64=-W*W                                                       01012000
      TERM38=-TERM60*W                                                  01013000
      TERM40=-F11/V*(1.+R0*A11/X)*W                                     01014000
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C INPUT MATRIX TERMS THAT DEPEND ON VELOCITY                                    00952000
      C(1,1)=4.*F11/V+2.*DXF                                                    00953000
      C(1,3)=TERM96-TERM88*TERM91                                               00954000
      C(1,2)=C(1,3)+TERM99*TERM92                                               00955000
      C(2,2)=DTHBF-TERM93*L1*TERM92+TERM98+TERM94+L1*TERM99*TERM91               00956000
      C(2,3)=DTHBF-TERM88*L1*TERM92+TERM98                                      00957000
      C(3,1)=(TERM88-TERM93)*TERM91-TERM96                                      00958000
      C(2,1)=C(3,1)+TERM99*TERM92                                               00959000
      C(3,2)=DTHBF+(TERM88-TERM93)*L1*TERM92+TERM98                             00960000
      C(3,3)=DTHBF+DTHWF+TERM98                                                 00961000
      C(4,4)=4.*F11/V+2.*DXB                                                    00962000
      C(4,6)=TERM96-TERM88*TERM89                                               00963000
      C(4,5)=C(4,6)+TERM99*TERM90                                               00964000
      C(5,5)=DTHBR-TERM93*L1*TERM90+TERM98+TERM94+L1*TERM99*TERM89              00965000
      C(5,6)=DTHBR-TERM88*L1*TERM90+TERM98                                      00966000
      C(6,4)=(TERM88-TERM93)*TERM89-TERM96                                      00967000
      C(5,4)=C(6,4)+TERM99*TERM90                                               00968000
      C(6,5)=DTHBR+(TERM88-TERM93)*L1*TERM90+TERM98                             00969000
      C(6,6)=DTHBR+DTHWR+TERM98                                                 00970000
      WRITE(6,91)                                                               00971000
C ***DEBUG CHECK* STIFFNESS,DAMPING AND MASS MATRICES***                        00972000
      DO 99 I=1,9                                                               00973000
   99 WRITE(6,92) (K(I,J),J=1,9)                                                00974000
      WRITE(6,93)                                                               00975000
      DO 98 I=1,9                                                               00976000
   98 WRITE(6,92) (C(I,J),J=1,9)                                                00977000
      WRITE(6,94)                                                               00978000
      DO 97 I=1,9                                                               00979000
   97 WRITE(6,92) (M(I,J),J=1,9)                                                00980000
   91 FORMAT(//1H ,'K-MATRIX')                                                  00981000
   92 FORMAT(2X,9(E9.3,3X))                                                     00982000
   93 FORMAT(//1H ,'C-MATRIX')                                                  00983000
   94 FORMAT(//1H ,'M-MATRIX')                                                  00984000
      RETURN                                                                    00985000
      END                                                                       00986000
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      TERM42=(TERM40*L1-TERM60*W)                                       01015000
      TERM45=-F11/V*(1.+R0*A12/X)*W                                     01016000
      TERM47=(-TERM45*L1-TERM60*W)                                      01017000
      TERM50=-F11/V*(1.+R0*A13/X)*W                                     01018000
      TERM52=(TERM50*L1-TERM60*W)                                       01019000
      TERM55=-F11/V*(1.+R0*A14/X)*W                                     01020000
      TERM57=(-TERM55*L1-TERM60*W)                                      01021000
      TERM74=TERM26*W                                                   01022000
      TERM75=TERM20*W                                                   01023000
      TERM73=TERM27*W                                                   01024000
      TERM76=TERM17*W                                                   01025000
      TERM77=TERM16*W                                                   01026000
      TERM78=TERM15*W                                                   01027000
      TERM79=TERM14*W                                                   01028000
      TERM80=-TERM13*W                                                  01029000
C                                                                       01030000
      FAI(1,1)=TERM80*ALH11                                             01031000
      FAI(1,2)=TERM80*ALH21                                             01032000
      FAI(1,3)=TERM80*ALH31                                             01033000
      FAI(1,4)=TERM80*ALH41                                             01034000
      FAI(2,1)=TERM79*ALH11                                             01035000
      FAI(2,2)=TERM79*ALH21                                             01036000
      FAI(2,3)=TERM75*ALH31                                             01037000
      FAI(2,4)=TERM75*ALH41                                             01038000
      FAI(3,1)=TERM78*ALH11                                             01039000
      FAI(3,2)=TERM78*ALH21                                             01040000
      FAI(3,3)=TERM78*ALH31                                             01041000
      FAI(3,4)=TERM78*ALH41                                             01042000
      FAI(4,5)=TERM80*ALH51                                             01043000
      FAI(4,6)=TERM80*ALH61                                             01044000
      FAI(4,7)=TERM80*ALH71                                             01045000
      FAI(4,8)=TERM80*ALH81                                             01046000
      FAI(5,5)=TERM79*ALH51                                             01047000
      FAI(5,6)=TERM79*ALH61                                             01048000
      FAI(5,7)=TERM75*ALH71                                             01049000
      FAI(5,8)=TERM75*ALH81                                             01050000
      FAI(6,5)=TERM78*ALH51                                             01051000
      FAI(6,6)=TERM78*ALH61                                             01052000
      FAI(6,7)=TERM78*ALH71                                             01053000
      FAI(6,8)=TERM78*ALH81                                             01054000
      FAI(9,1)=TERM77*ALH11                                             01055000
      FAI(9,2)=TERM77*ALH21                                             01056000
      FAI(9,3)=TERM77*ALH31                                             01057000
      FAI(9,4)=TERM77*ALH41                                             01058000
      FAI(9,5)=TERM76*ALH51                                             01059000
      FAI(9,6)=TERM76*ALH61                                             01060000
      FAI(9,7)=TERM76*ALH71                                             01061000
      FAI(9,8)=TERM76*ALH81                                             01062000
C                                                                       01063000
      FCLI(1,1)=-W*TERM21                                               01064000
      FCLI(1,2)=FCLI(1,1)                                               01065000
      FCLI(2,1)=TERM74-TERM73                                           01066000
      FCLI(2,2)=TERM74+TERM73                                           01067000
      FCLI(3,1)=TERM74                                                  01068000
      FCLI(3,2)=TERM74                                                  01069000
      FCLI(4,3)=FCLI(1,1)                                               01070000
      FCLI(4,4)=FCLI(1,1)                                               01071000
      FCLI(5,3)=FCLI(2,1)                                               01072000
      FCLI(5,4)=FCLI(2,2)                                               01073000
      FCLI(6,3)=FCLI(3,1)                                               01074000
      FCLI(6,4)=FCLI(3,2)                                               01075000
      FCLI(9,1)=TERM34*W                                                01076000
      FCLI(9,2)=FCLI(9,1)                                               01077000
      FCLI(9,3)=TERM35*W                                                01078000
      FCLI(9,4)=FCLI(9,3)                                               01079000
      RETURN                                                            01080000
      END                                                               01081000
```

SUBROUTINE DCMINV

```
      SUBROUTINE DCMINV(AR,AI,N,DR,DI,L,M)                              01082000
      IMPLICIT REAL*8 (A-H,O-Z)                                         01083000
      DIMENSION AR(81),AI(81),L(9),M(9)                                 01084000
      DR=1.0                                                            01086000
      DI=0.0                                                            01087000
      NK=-N                                                             01088000
      DO 80 K=1,N                                                       01089000
      NK=NK+N                                                           01090000
      L(K)=K                                                            01091000
      M(K)=K                                                            01092000
      KK=NK+K                                                           01093000
      BIGAR=AR(KK)                                                      01094000
      BIGAI=AI(KK)                                                      01095000
      BIGA=DSQRT(BIGAR**2+BIGAI**2)                                     01096000
      DO 20 J=K,N                                                       01097000
      IZ=N*(J-1)                                                        01098000
      DO 20 I=K,N                                                       01099000
      IJ=IZ+I                                                           01100000
      T=DSQRT(AR(IJ)**2+AI(IJ)**2)                                      01101000
   10 IF(BIGA-T) 15,20,20                                               01102000
   15 BIGAR=AR(IJ)                                                      01103000
      BIGAI=AI(IJ)                                                      01104000
      BIGA=DSQRT(BIGAR**2+BIGAI**2)                                     01105000
      L(K)=I                                                            01106000
      M(K)=J                                                            01107000
   20 CONTINUE                                                          01108000
      J=L(K)                                                            01109000
      IF(J-K) 35,35,25                                                  01110000
   25 KI=K-N                                                            01111000
      DO 30 I=1,N                                                       01112000
      KI=KI+N                                                           01113000
      HOLDR=-AR(KI)                                                     01114000
      HOLDI=-AI(KI)                                                     01115000
      JI=KI-K+J                                                         01116000
      AR(KI)=AR(JI)                                                     01117000
      AI(KI)=AI(JI)                                                     01118000
      AR(JI)=HOLDR                                                      01119000
   30 AI(JI)=HOLDI                                                      01120000
   35 I=M(K)                                                            01121000
      IF(I-K) 45,45,38                                                  01122000
   38 JP=N*(I-1)                                                        01123000
      DO 40 J=1,N                                                       01124000
      JK=NK+J                                                           01125000
      JI=JP+J                                                           01126000
      HOLDR=-AR(JK)                                                     01127000
      HOLDI=-AI(JK)                                                     01128000
      AR(JK)=AR(JI)                                                     01129000
      AI(JK)=AI(JI)                                                     01130000
      AR(JI)=HOLDR                                                      01131000
   40 AI(JI)=HOLDI                                                      01132000
   45 IF(BIGA) 48,46,48                                                 01133000
   46 DR=0.0                                                            01134000
      DI=0.0                                                            01135000
      RETURN                                                            01136000
   48 DO 55 I=1,N                                                       01137000
      IF(I-K) 50,55,50                                                  01138000
   50 IK=NK+I                                                           01139000
      CALL DDIV(AR(IK),AI(IK),-BIGAR,-BIGAI,CR,CI)                      01140000
      AR(IK)=CR                                                         01141000
      AI(IK)=CI                                                         01142000
   55 CONTINUE                                                          01143000
      DO 65 I=1,N                                                       01144000
      IK=NK+I                                                           01145000
      IJ=I-N                                                            01146000
      DO 65 J=1,N                                                       01147000
      IJ=IJ+N                                                           01148000
      IF(I-K) 60,65,60                                                  01149000
```

```
 60 IF(J-K) 62,65,62                                                    01150000
 62 IJ=IJ-I+K                                                           01151000
    CALL DMULT(AR(IK),AI(IK),AR(KJ),AI(KJ),CR,CI)                       01152000
    AR(IJ)=AR(IJ)+CR                                                    01153000
    AI(IJ)=AI(IJ)+CI                                                    01154000
 65 CONTINUE                                                            01155000
    KJ=K-N                                                              01156000
    DO 75 J=1,N                                                         01157000
    KJ=KJ+N                                                             01158000
    IF(J-K) 70,75,70                                                    01159000
 70 CALL DDIV(AR(KJ),AI(KJ),BIGAR,BIGAI,CR,CI)                          01160000
    AR(KJ)=CR                                                           01161000
    AI(KJ)=CI                                                           01162000
 75 CONTINUE                                                            01163000
    CALL DMULT(DR,DI,BIGAR,BIGAI,CR,CI)                                 01164000
    DR=CR                                                               01165000
    DI=CI                                                               01166000
    TR=1.0                                                              01167000
    TI=0.                                                               01168000
    CALL DDIV(TR,TI,BIGAR,BIGAI,CR,CI)                                  01169000
    AR(KK)=CR                                                           01170000
    AI(KK)=CI                                                           01171000
 80 CONTINUE                                                            01172000
    K=N                                                                 01173000
100 K=(K-1)                                                             01174000
    IF(K) 150,150,105                                                   01175000
105 I=L(K)                                                              01176000
    IF(I-K) 120,120,108                                                 01177000
108 JQ=N*(K-1)                                                          01178000
    JR=N*(I-1)                                                          01179000
    DO 110 J=1,N                                                        01180000
    JK=JQ+J                                                             01181000
    HOLDR=AR(JK)                                                        01182000
    HOLDI=AI(JK)                                                        01183000
    JI=JR+J                                                             01184000
    AR(JK)=-AR(JI)                                                      01185000
    AI(JK)=-AI(JI)                                                      01186000
    AR(JI)=HOLDR                                                        01187000
110 AI(JI)=HOLDI                                                        01188000
120 J=M(K)                                                              01189000
    IF(J-K) 100,100,125                                                 01190000
125 KI=K-N                                                              01191000
    DO 130 I=1,N                                                        01192000
    KI=KI+N                                                             01193000
    HOLDR=AR(KI)                                                        01194000
    HOLDI=AI(KI)                                                        01195000
    JI=KI-K+J                                                           01196000
    AR(KI)=-AR(JI)                                                      01197000
    AI(KI)=-AI(JI)                                                      01198000
    AR(JI)=HOLDR                                                        01199000
130 AI(JI)=HOLDI                                                        01200000
    GO TO 100                                                           01201000
150 RETURN                                                              01202000
    END                                                                 01203000
```

SUBROUTINE DDIV

```
    SUBROUTINE DDIV(AR,AI,BR,BI,CR,CI)                                  01204000
    DOUBLE PRECISION AR,AI,BR,BI,CR,CI,EE                               01205000
    EE=BR*BR+BI*BI                                                      01206000
    CR=(AR*BR+AI*BI)/EE                                                 01207000
    CI=(AI*BR-AR*BI)/EE                                                 01208000
    RETURN                                                              01209000
    END                                                                 01210000
```

SUBROUTINE BMULT

```
      SUBROUTINE BMULT(AR,AI,BR,BI,CR,CI)                              01211000
      DOUBLE PRECISION AR,AI,BR,BI,CR,CI                               01212000
      CR=AR*BR-AI*BI                                                   01213000
      CI=AI*BR+AR*BI                                                   01214000
      RETURN                                                           01215000
      END                                                              01216000
```

SUBROUTINE PLOTC

```
      SUBROUTINE PLOTC (LABEL)                                         01217000
      DIMENSION LABEL(20)                                              01218000
      CALL PLOT (8.5,0.,2)                                             01219000
      CALL PLOT (8.5,11.,2)                                            01220000
      CALL PLOT (0.,11.,2 )                                            01221000
      CALL PLOT (0.,0.,2)                                              01222000
      CALL SYMBOL(1.5,10.5,.14,LABEL,0.0,72)                           01223000
      CALL PLOT (1.0,1.0,-3)                                           01224000
      CALL LGAXS(0.,0.,13HFREQUENCY(HZ),-13,7.0,0.0,.1,.429)           01225000
      RETURN                                                           01226000
      END                                                              01227000
```

SUBROUTINE PLOTD

```
      SUBROUTINE PLOTD(K1,S1,S2,IVEL)                                  01228000
      CALL SYMBOL(5.07,S1,.14,K1,0.0,-1)                               01229000
      CALL SYMBOL(5.375,S2,.14,IVEL,0.0,4)                             01230000
      CALL SYMBOL(6.25,S2,.14,6HFT/SEC,0.0,6)                          01231000
      RETURN                                                           01232000
      END                                                              01233000
```

SUBROUTINE PLOTA

```
      SUBROUTINE PLOTA (LABEL)                                         01234000
      DIMENSION LABEL(20)                                              01235000
      CALL PLOT (0.5,0.5,-3)                                           01236000
      CALL PLOTC (LABEL)                                               01237000
      CALL LGAXS(0.,0.,'LATERAL,FRONT TRUCK PSD,CROSS LEVEL INPUT,(FT** 01238000
     12/HZ)',52,9.5,90.,.1E-11,1.053)                                  01239000
      CALL PLOT (-1.0,11.,-3)                                          01240000
      CALL PLOTC (LABEL)                                               01241000
      CALL LGAXS(0.,0.,'WARE,FRONT TRUCK PSD,CROSS LEVEL INPUT,(RAD**2/ 01242000
     1HZ)',50,9.5,90.,.1E-14,1.053)                                    01243000
      CALL PLOT(9.0,-1.0,-3)                                           01244000
      CALL PLOTC (LABEL)                                               01245000
      CALL LGAXS(0.,0.,'LATERAL,CAR BODY PSD,CROSS LEVEL INPUT,(FT**2/H 01246000
     1Z)',49,9.5,90.,.1E-11,1.053)                                     01247000
```

```
      CALL PLOT (-1.0,-13.0,-3)                                          01248000
      CALL PLOTC (LABEL)                                                 01249000
      CALL LGAXS(0.,0.,'ROLL,CAR BODY PSD,CROSS LEVEL INPUT,(RAD**2/HZ)  01250000
     1',48,9.5,90.,.1E-13,1.053)                                         01251000
      CALL PLOT (9.0,-1.0,-3)                                            01252000
      CALL PLOTC (LABEL)                                                 01253000
      CALL LGAXS(0.,0.,'LATERAL,CONTACT FORCE PSD,AXLE 1,CROSS LEVEL IN  01254000
     1PUT,(LB**2/HZ)',61,9.5,90.,.1E-1,1.053)                            01255000
      CALL PLOT (-1.0,11.,-3)                                            01256000
      CALL PLOTC (LABEL)                                                 01257000
      CALL LGAXS(0.,0.,'LATERAL,CONTACT FORCE PSD,AXLE 3,CROSS LEVEL IN  01258000
     1PUT,(LB**2/HZ)',61,9.5,90.,.1E-1,1.053)                            01259000
      CALL PLOT (9.0,-1.0,-3)                                            01260000
      CALL PLOTC (LABEL)                                                 01261000
      CALL LGAXS(0.,0.,'LATERAL,FRONT TRUCK PSD, ALIGNMENT INPUT,(FT**   01262000
     12/HZ)',52,9.5,90.,.1E-11,1.053)                                    01263000
      CALL PLOT (-1.0,-13.0,-3)                                          01264000
      CALL PLOTC (LABEL)                                                 01265000
      CALL LGAXS(0.,0.,'WARP,FRONT TRUCK PSD,ALIGNMENT INPUT,(RAD**2/H   01266000
     1Z)',49,9.5,90.,.1E-14,1.053)                                       01267000
      CALL PLOT (9.0,-1.0,-3)                                            01268000
      CALL PLOTC (LABEL)                                                 01269000
      CALL LGAXS(0.,0.,'LATERAL,CAR BODY PSD, ALIGNMENT INPUT,(FT**2/H   01270000
     1Z)',49,9.5,90.,.1E-11,1.053)                                       01271000
      CALL PLOT (-1.0,11.0,-3)                                           01272000
      CALL PLOTC (LABEL)                                                 01273000
      CALL LGAXS(0.,0.,'ROLL,CAR BODY PSD, ALIGNMENT INPUT,(RAD**2/HZ)'  01274000
     1,47,9.5,90.,.1E-15,1.053)                                          01275000
      CALL PLOT (9.0,-1.0,-3)                                            01276000
      CALL PLOTC (LABEL)                                                 01277000
      CALL LGAXS(0.,0.,'LATERAL,CONTACT FORCE PSD,AXLE 1, ALIGNMENT IN   01278000
     1PUT,(LB**2/HZ)',61,9.5,90.,.1E-1,1.053)                            01279000
      CALL PLOT (-1.0,-13.0,-3)                                          01280000
      CALL PLOTC (LABEL)                                                 01281000
      CALL LGAXS(0.,0.,'LATERAL,CONTACT FORCE PSD,AXLE 3, ALIGNMENT IN   01282000
     1PUT,(LB**2/HZ)',61,9.5,90.,.1E-1,1.053)                            01283000
      CALL PLOT(-50.05,0.,-3)                                            01284000
CC    CALL PLOT(9.0,-1.0,-3)                                             01285000
CC    CALL PLOTC (LABEL)                                                 01286000
CC    CALL LGAXS(0.,0.,'PSD CROSS LEVEL INPUT(RAD**2/HZ)',33,9.5,90.,    01287000
CC   1.1E-11,1.053)                                                      01288000
CC    CALL PLOT(-1.0,11.0,-3)                                            01289000
CC    CALL PLOTC (LABEL)                                                 01290000
CC    CALL LGAXS(0.,0.,'PSD  ALIGNMENT INPUT  (FT**2/HZ)',33,9.5,90.,    01291000
CC   1.1E-11,1.053)                                                      01292000
CC    CALL PLOT(-60.05,-12.0,-3)                                         01293000
CC    CALL PLOT(9.0,-1.0,-3)                                             01294000
CC    CALL PLOTC (LABEL)                                                 01295000
CC    CALL PLOT(-1.0,-13.0,-3)                                           01296000
CC    CALL PLOTC (LABEL)                                                 01297000
CC    CALL PLOT(-70.05,0.,-3)                                            01298000
      RETURN                                                             01299000
      END                                                                01300000
```

SUBROUTINE PLOTB

```
      SUBROUTINE PLOTB(FR,TPSD,T1PSD,FPSD,F1PSD,N,K1,V,S)                01301000
      DIMENSION FR(1),TPSD(10,1),T1PSD(10,1),FPSD(6,1),F1PSD(6,1),       01302000
     1 A1(200),A3(200),A7(200),A9(200),A10(200),                         01303000
     1 B1(200),B3(200),B7(200),B9(200),B10(200),                         01304000
     1 C3(200),C5(200),D3(200),D5(200)                                   01305000
      DO 100 I=1,N                                                       01306000
      A1(I)=TPSD(1,I)                                                    01307000
      A3(I)=TPSD(3,I)                                                    01308000
```

```
      A7(I)=TPSD(7,I)                                                  01309000
      A9(I)=TPSD(9,I)                                                  01310000
      A10(I)=TPSD(10,I)                                                01311000
      B1(I)=T1PSD(1,I)                                                 01312000
      B3(I)=T1PSD(3,I)                                                 01313000
      B7(I)=T1PSD(7,I)                                                 01314000
      B9(I)=T1PSD(9,I)                                                 01315000
      B10(I)=T1PSD(10,I)                                               01316000
      C3(I)=FPSD(3,I)                                                  01317000
      C5(I)=FPSD(5,I)                                                  01318000
      D3(I)=F1PSD(3,I)                                                 01319000
      D5(I)=F1PSD(5,I)                                                 01320000
C                                                                      01321000
C ** PROTECT PAPER LIMITS **                                           01322000
      IF(A1(I).LT..1E-11) A1(I)=.1E-11                                 01323000
      IF(A3(I).LT..1E-14) A3(I)=.1E-14                                 01324000
      IF(A7(I).LT..1E-11) A7(I)=.1E-11                                 01325000
      IF(A9(I).LT..1E-15) A9(I)=.1E-15                                 01326000
      IF(A10(I).LT..1E-11) A10(I)=.1E-11                               01327000
      IF(B1(I).LT..1E-11) B1(I)=.1E-11                                 01328000
      IF(B3(I).LT..1E-14) B3(I)=.1E-14                                 01329000
      IF(B7(I).LT..1E-11) B7(I)=.1E-11                                 01330000
      IF(B9(I).LT..1E-13) B9(I)=.1E-13                                 01331000
      IF(B10(I).LT..1E-11) B10(I)=.1E-11                               01332000
      IF(C3(I).LT..1E-1) C3(I)=.1E-1                                   01333000
      IF(C5(I).LT..1E-1) C5(I)=.1E-1                                   01334000
      IF(D3(I).LT..1E-1) D3(I)=.1E-1                                   01335000
      IF(D5(I).LT..1E-1) D5(I)=.1E-1                                   01336000
C                                                                      01337000
  100 CONTINUE                                                         01338000
      A1(N+1)=.1E-11                                                   01339000
      A3(N+1)=.1E-14                                                   01340000
      A7(N+1)=.1E-11                                                   01341000
      A9(N+1)=.1E-15                                                   01342000
      A10(N+1)=.1E-11                                                  01343000
      A1(N+2)=1.053                                                    01344000
      A3(N+2)=1.053                                                    01345000
      A7(N+2)=1.053                                                    01346000
      A9(N+2)=1.053                                                    01347000
      A10(N+2)=1.053                                                   01348000
      B1(N+1)=.1E-11                                                   01349000
      B3(N+1)=.1E-14                                                   01350000
      B7(N+1)=.1E-11                                                   01351000
      B9(N+1)=.1E-13                                                   01352000
      B10(N+1)=.1E-11                                                  01353000
      B1(N+2)=1.053                                                    01354000
      B3(N+2)=1.053                                                    01355000
      B7(N+2)=1.053                                                    01356000
      B9(N+2)=1.053                                                    01357000
      B10(N+2)=1.053                                                   01358000
      C3(N+1)=.1E-1                                                    01359000
      C5(N+1)=.1E-1                                                    01360000
      C3(N+2)=1.053                                                    01361000
      C5(N+2)=1.053                                                    01362000
      D3(N+1)=.1E-1                                                    01363000
      D5(N+1)=.1E-1                                                    01364000
      D3(N+2)=1.053                                                    01365000
      D5(N+2)=1.053                                                    01366000
C                                                                      01367000
      FR(N+1)=.1                                                       01368000
      FR(N+2)=.429                                                     01369000
C                                                                      01370000
      WRITE(8,10) V                                                    01371000
   10 FORMAT(F4.0)                                                     01372000
      BACKSPACE 8                                                      01373000
      READ(8,20) IVEL                                                  01374000
   20 FORMAT(A4)                                                       01375000
      S1=8.445-(.375*S)                                                01376000
      S2=8.375-(.375*S)                                                01377000
      CALL LGLIN(FR,B1,N,1,1,K1,0)                                     01378000
```

```
      CALL PLOTD(K1,S1,S2,IVEL)                                        01379000
      CALL PLOT (0.,12.,-3)                                            01380000
      CALL LGLIN(FR,B3,N,1,1,K1,0)                                     01381000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01382000
      CALL PLOT (10.,0.,-3)                                            01383000
      CALL LGLIN(FR,B7,N,1,1,K1,0)                                     01384000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01385000
      CALL PLOT (0.,-12.,-3)                                           01386000
      CALL LGLIN(FR,B9,N,1,1,K1,0)                                     01387000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01388000
      CALL PLOT (10.,0.,-3)                                            01389000
      CALL LGLIN(FR,D3,N,1,1,K1,0)                                     01390000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01391000
      CALL PLOT (0.,12.,-3)                                            01392000
      CALL LGLIN(FR,D5,N,1,1,K1,0)                                     01393000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01394000
      CALL PLOT (10.,0.,-3)                                            01395000
      CALL LGLIN(FR,A1,N,1,1,K1,0)                                     01396000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01397000
      CALL PLOT (0.,-12.,-3)                                           01398000
      CALL LGLIN(FR,A3,N,1,1,K1,0)                                     01399000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01400000
      CALL PLOT (10.,0.,-3)                                            01401000
      CALL LGLIN(FR,A7,N,1,1,K1,0)                                     01402000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01403000
      CALL PLOT (0.,12.,-3)                                            01404000
      CALL LGLIN(FR,A9,N,1,1,K1,0)                                     01405000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01406000
      CALL PLOT (10.,0.,-3)                                            01407000
      CALL LGLIN(FR,C3,N,1,1,K1,0)                                     01408000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01409000
      CALL PLOT (0.,-12.,-3)                                           01410000
      CALL LGLIN(FR,C5,N,1,1,K1,0)                                     01411000
      CALL PLOTD(K1,S1,S2,IVEL)                                        01412000
      CALL PLOT(-50.04,0.,-3)                                          01413000
CC    CALL PLOT(10.,0.,-3)                                             01414000
CC    CALL LGLIN(FR,B10,N,1,1,K1,0)                                    01415000
CC    CALL PLOTD(K1,S1,S2,IVEL)                                        01416000
CC    CALL PLOT(0.,12.,-3)                                             01417000
CC    CALL LGLIN(FR,A10,N,1,1,K1,0)                                    01418000
CC    CALL PLOTD(K1,S1,S2,IVEL)                                        01419000
CC    CALL PLOT(-60.04,-12.,-3)                                        01420000
CC    CALL PLOT(10.,0.,-3)                                             01421000
CC    CALL LGLIN(FR,F6,N,1,1,K1,0)                                     01422000
CC    CALL PLOTD(K1,S1,S2,IVEL)                                        01423000
CC    CALL PLOT(0.,-12.,-3)                                            01424000
CC    CALL LGLIN(FR,F5,N,1,1,K1,0)                                     01425000
CC    CALL PLOT(-70.05,0.,-3)                                          01426000
      RETURN                                                           01427000
      END                                                              01428000
```

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US DOT, FRA, Neil K Cooperrider, E Harry Law