171
4-24-78

LA. 2035

MASTER

**GA-A14600
UC-77**

**COCO
A COMPUTER PROGRAM
FOR SEISMIC ANALYSIS OF A
SINGLE COLUMN OF THE HTGR CORE**

**by
N. D. RICKARD**

**Prepared in part under
Contract EY-76-C-03-0167
Project Agreement No. 51
for the San Francisco Operations Office
Department of Energy**

DATE PUBLISHED: FEBRUARY 1978

GENERAL ATOMIC COMPANY

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161
Price: Printed Copy \$5.25; Microfiche \$3.00

GA-A14600
UC-77

COCO
A COMPUTER PROGRAM
FOR SEISMIC ANALYSIS OF A
SINGLE COLUMN OF THE HTGR CORE

by
N. D. RICKARD

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Prepared in part under
Contract EY-76-C-03-0167
Project Agreement No. 51
for the San Francisco Operations Office
Department of Energy

GENERAL ATOMIC PROJECT 3219
DATE PUBLISHED: FEBRUARY 1978

GENERAL ATOMIC COMPANY

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ABSTRACT

This document serves as a user's manual and theoretical manual for the COCO code. COCO is a nonlinear numerical integration program designed to analyze a single column of the HTGR core for seismic excitation. Output of the code includes dowel forces, collision forces and a time history of the motion of the blocks.

TABLE OF CONTENTS

ABSTRACT	iii
SYMBOLS	vii
1. INTRODUCTION	1
2. MATHEMATICAL MODEL	4
2.1. Sign Convention	4
2.2. Equations of Motion	4
2.3. Collision Forces	6
2.4. Dowel Forces	8
2.5. Friction Forces	12
2.6. Initial Conditions	12
2.7. Locked Degrees of Freedom	14
2.8. PCRV Motion	14
2.8.1. Sinusoidal Dwell	15
2.8.2. Displacement Time History	15
2.8.3. Acceleration Time Histories	16
2.9. Small Angle Approximations	16
3. NUMERICAL INTEGRATION METHODS	17
3.1. Central Difference	17
3.2. Second-Order Runge-Kutta	18
4. DESCRIPTION OF INPUT	20
5. DESCRIPTION OF OUTPUT	27
5.1. Input Data	27
5.2. Time History Output	27
5.3. Output Summary	28
6. SAMPLE PROBLEM	29
REFERENCES	33
APPENDIX A: INPUT DATA FORMS	A-1
APPENDIX B: SAMPLE PROBLEM OUTPUT	B-1

FIGURES

1. Typical COCO model	2
2. COCO spring-damper model	3
3. Forces acting on a fuel element	5
4. Tapered dowel	8
5. Friction force	13
6. Sampling problem	30
7. Block properties	31

TABLES

1. Collision force coordinates	10
2. Sample problem data	32

SYMBOLS

b = block geometric half width
 b_i = block rocking half width
 C = damping coefficient
 D = displacement due to static weight
 DT = time step between time history points
 F_D = damping component of force
 F_N = normal force
 F_S = stiffness component of force
 FBL = horizontal collision force acting at the bottom of the left side
 FBR = horizontal collision force acting at the bottom of the right side
 FC = collision force
 FCL = horizontal collision force acting at the center of the left side
 FCR = horizontal collision force acting at the center of the right side
 FD = dowel force
 FR = friction force
 FTL = horizontal collision force acting at the top of the left side
 FTR = horizontal collision force acting at the top of the right side
 FVC = vertical collision force acting at the center
 FVL = vertical collision force acting at the left corner
 FVR = vertical collision force acting at the right corner
 G^P = initial gap between point p on the block and the PCRV
 G_L = gap on the left side of the dowel
 G_R = gap on the right side of the dowel
 h = integration time step
 h_i = block half height
 I = block mass moment of inertia
 K = spring stiffness
 K_T = torsional spring stiffness
 M = block mass

N = total number of blocks in column
 Q = sum of dowel and friction forces
 u = horizontal block displacement at c.g.
 u^p = horizontal block displacement at point p
 u_o = PCRV horizontal displacement
 w = vertical block displacement at c.g.
 w^p = vertical block displacement at point p
 w_o = PCRV vertical displacement
 W_1 = block weight
 WR_1 = sum of the weights of all blocks above and including block 1
 x = spring displacement
 $\bar{x}$ = horizontal coordinate of point P
 $\bar{z}$ = vertical coordinate of point P
 β = damping coefficient associated with the friction force
 θ = block rotation
 μ = coefficient of friction
 ω = frequency of excitation

1. INTRODUCTION

COCO is designed to analyze single vertical column of the HTGR core constrained within a rigid boundary (Fig. 1). The gaps between the blocks and the boundary are input variables. The column is excited by defining the vertical and horizontal motion of the boundary. The boundary is not permitted to rotate.

Each block is represented by three degrees of freedom; vertical, displacement, horizontal displacement, and rotational about the block's center of gravity. Collision forces are represented by springs and dampers located at the corners and centers of each side of each block (Fig. 2). Dowel forces and friction forces are also computed.

The program has an optional restart capability which, if selected, prints and punches a restart deck. At the termination of each run, a summary of maximum and minimum output values is printed.

Fig. 1. Typical COCO model

Fig. 2. COCO spring-damper model

2. MATHEMATICAL MODEL

COCO models each block as a rigid mass with springs and dampers attached to model the elasticity and damping of the blocks and the connecting dowels. Friction forces are computed at the horizontal interfaces between the blocks.

The following sections discuss in detail the various aspects of the COCO mathematical model.

2.1. SIGN CONVENTION

The sign convention for the blocks is shown in Fig. 2; where u is positive to the right, w is positive up, and θ is positive when the top of the block rotates to the right. The sign convention for the PCRIV is the same except that there is no PCRIV rotation.

All collision forces are positive. Friction forces and dowel forces acting at the top of a block are positive to the right and at the bottom of a block they are positive to the left.

The blocks are numbered from the bottom up. The PCRIV is block 0.

2.2. EQUATIONS OF MOTION

Fig. 3 shows the forces that act upon an individual block. The equations of motion for the block (Ref. 1) are:

$$m_i \ddot{u}_i = FTL_i + FCL_i + FBL_i - FTR_i - FCR_i - FBR_i - Q_i + Q_{i+1} \quad (1)$$

$$Q_i = FD_i + FR_i$$

Fig. 3. Forces acting on a fuel element

$$m_i \ddot{w}_i = FVL_i + FVC_i + FVR_i - FVL_{i+1} - FVC_{i+1} - FVR_{i+1} - w_i \quad (2)$$

$$\begin{aligned} I_i \ddot{\theta}_i = & +FVR_{i+1} (b_{i+1} \cos \theta_i + h_i \sin \theta_i) + FVC_{i+1} (h_i \sin \theta_i) \\ & - FVL_{i+1} (b_{i+1} \cos \theta_i - h_i \sin \theta_i) \\ & - FVR_i (b_i \cos \theta_i - h_i \sin \theta_i) + FVC_i (h_i \sin \theta_i) \\ & + FVL_i (b_i \cos \theta_i + h_i \sin \theta_i) \\ & - FTR_i (h_i \cos \theta_i - b \sin \theta_i) + FCR_i (b \sin \theta_i) \\ & + FBR_i (h_i \cos \theta_i + b \sin \theta_i) \\ & - FBL_i (h_i \cos \theta_i - b \sin \theta_i) + FCL_i (b \sin \theta_i) \\ & + FTL_i (h_i \cos \theta_i + b \sin \theta_i) + Q_i (h_i \cos \theta_i) \\ & + Q_{i+1} (h_i \cos \theta_i) \quad . \end{aligned} \quad (3)$$

Note that b is the geometric half width and b_i is the rocking half width.

The bottom block of the column has an optional rotational spring connecting it to the PCRV. This spring produces a moment equal to $K_T \theta_1$, which is subtracted from the right side of Eq. 3 for block 1.

2.3. COLLISION FORCES

Collision forces are modeled at the corners and center of each face of the block. The collision model is a linear spring and damper in series. Forces are computed using the following equations:

$$F_C = F_S + F_D \quad (4)$$

where

$$F_S = Kx \quad (5)$$

$$F_D = C\dot{x} \quad (6)$$

If the deflection of the collision spring x is computed to be less than zero, the collision springs are not in contact and no collision force is calculated.

Collision spring deflections are computed as follows:

right side

$$x = u_1^p - G_1^p - u_0 \quad (7)$$

left side

$$x = u_0 - u_1^p - G_1^p \quad (8)$$

bottom

$$x = w_{1-1}^p - w_1^p \quad (9)$$

The horizontal and vertical translation of each point is evaluated using the following equations (Ref. 2):

$$u_1^p = u_1 + \bar{z}_1 \sin \theta_1 - \bar{x}_1 (1 - \cos \theta_1) \quad (10)$$

$$w_1^p = w_1 - \bar{x}_1 \sin \theta_1 - \bar{z}_1 (1 - \cos \theta) \quad (11)$$

The equations for computing $\dot{x}$ are generated by differentiating x with respect to t . The results are as follows:

for the right side,

$$\dot{x} = \dot{u}_1^P - \dot{u}_0 \quad (12)$$

for the left side,

$$\dot{x} = \dot{u}_0 - \dot{u}_1^P \quad (13)$$

for the bottom,

$$\dot{x} = \dot{w}_{i-1}^P - \dot{w}_i^P \quad (14)$$

where

$$\dot{u}_1^P = \dot{u}_1 + \dot{\theta}_1 (\bar{z} \cos \theta_1 - \bar{x} \sin \theta_1) \quad (15)$$

$$\dot{w}_i^P = \dot{w}_i - \dot{\theta}_i (\bar{x} \cos \theta_i + z \sin \theta_i) \quad (16)$$

Table 1 summarizes the values of $\bar{x}$ and $\bar{z}$ required to compute the various collision forces.

2.4. DOWEL FORCES

The dowels are modeled as shown in Fig. 2. Gaps are provided on both the left and right side of the dowel. The dowels are assumed to be tapered such that two blocks can freely rotate even if the dowel gaps are zero (Fig. 4). If cylindrical dowels were used, a block with zero dowel gaps could not rotate.

The following equations define the tapered dowel forces:

$$F_D = F_S + F_D \quad (17)$$

Fig. 4. Tapered dowel

TABLE 1
COLLISION FORCE COORDINATES

Force	$\bar{x}$	$\bar{z}$
FTL_i	$-b$	h_i
FCL_i	$-b$	0
FBL_i	$-b$	$-h_i$
FTR_i	b	h_i
FCR_i	b	0
FBR_i	b	$-h_i$
FVL_i	$-b_i$	$-h_i$
FVC_i	0	$-h_i$
FVR_i	b_i	$-h_i$

where

$$F_s = Kx \quad (18)$$

$$F_D = C\dot{x} \quad (19)$$

The deflections are defined as follows: if the top block has a relative displacement to the right,

$$x = u_1^p - u_{1-1}^p - G_L + b_1 (\cos \theta_1 - \cos \theta_{1-1}) \quad (20)$$

if $x < 0$, then x is set to zero, and for a relative displacement to the left

$$x = u_1^p - u_{1-1}^p + G_R - b_1 (\cos \theta_1 - \cos \theta_{1-1}) \quad (21)$$

if $x > 0$, then x is set to zero. The b_1 terms occur due to the model having tapered dowels.

If the dowel deflection is computed to be greater than zero, the dowel damping force is computed using the following value for relative velocity

$$\dot{x} = \dot{u}_1^p - \dot{u}_{1-1}^p \quad (22)$$

The terms associated with the tapered dowels have been dropped from Eq. 22. The velocities $\dot{u}_1^p$ and $\dot{u}_{1-1}^p$ are evaluated by using the following coordinates in Eq. 15

$$\bar{z}_1 = -h_1$$

$$\bar{z}_{1-1} = h_{1-1}$$

$$\bar{x}_1 = \bar{x}_{1-1} = 0$$

Substituting these values into Eq. 22 yields

$$\dot{x} = \dot{u}_i - \dot{\theta}_i h_i \cos \theta_i - \dot{u}_{i-1} - \dot{\theta}_{i-1} h_{i-1} \cos \theta_{i-1} \quad (16)$$

2.5. FRICTION FORCES

Friction forces are computed at the horizontal interfaces between the blocks. The friction force is computed to be the minimum of the following expressions

$$FR_i = \mu(FVL_i + FVC_i + FVR_i) \text{ sign } (\dot{x}) \quad (17a)$$

or

$$FR_i = \beta \dot{x} \quad (17b)$$

where $\dot{x}$ is as defined by Eq. 16 and μ and β are input values. If only the first expression were used to define FR, the friction force as a function of velocity would be as shown in Fig. 5a. The discontinuity of FR at $\dot{x} = 0$ can be a major numerical integration problem. By defining the friction force to be the minimum value defined by the two equations, the discontinuity of the friction force is eliminated as shown in Fig. 5b.

2.6. INITIAL CONDITIONS

The code automatically computes the initial conditions required for static equilibrium. The equilibrium position is determined by letting the blocks settle to a position such that the vertical spring forces at a surface just balance the static weight of the blocks above the surface. The code automatically computes this position and sets the initial vertical displacements.

In addition, the code will compute the initial conditions for the case where the blocks have initial angular displacements. The following equations are used to compute these initial displacements:

A) FRICTION FORCE AS DEFINED BY EQ. 17a

B) FRICTION FORCE AS DEFINED BY THE MINIMUM OF EQS. 17a AND 17b

Fig. 5. Friction force

$$w_i = w_{i-1} + \text{sign}(\theta_i - \theta_{i-1}) \{b_i \sin \theta_i - b_{i-1} \sin \theta_{i-1}\} \\ - h_i (1 - \cos \theta_i) - h_{i-1} (1 - \cos \theta_{i-1}) - D_i \quad (18)$$

where if $\text{abs}(\theta_i - \theta_{i-1}) < 0.002$ radians

$$D_i = WR_i / (2 \text{VCRNS}_i + \text{VCNTS}_i) \quad (19)$$

or if $\text{abs}(\theta_i - \theta_{i-1}) \geq 0.002$ radians

$$D_i = WR_i / (\text{VCRNS}_i) \quad (20)$$

$$u_i = u_{i-1} + h_i \sin \theta_i + h_{i-1} \sin \theta_{i-1} \\ + b_i (\cos \theta_{i-1} - \cos \theta_i) \quad (21)$$

$$WR_i = \sum_{k=1}^N W_k \quad (22)$$

where N is the total number of blocks in the column.

2.7. LOCKED DEGREES OF FREEDOM

The code has the option to lock any degree of freedom to that of the PCRv. This is done at each step of the integration procedure. The rotational degrees of freedom are set to zero (in COCO the PCRv has no rotational degree of freedom). The vertical degrees of freedom are set to w_o and $\dot{w}_o$, and the horizontal degrees of freedom are set to u_o and $\dot{u}_o$.

2.8. PCRv MOTION

The code allows the PCRv motion to be specified in three different ways; sinusoidal dwells, acceleration time histories and displacement time histories. In each case both vertical and horizontal motion can be specified.

2.8.1. Sinusoidal Dwell

Motion for sinusoidal dwells are defined by the following equations

$$u_o = -\frac{\ddot{u}_o}{\omega^2} \sin \omega t \quad (23)$$

$$\dot{u}_o = -\frac{\ddot{u}_o}{\omega} \cos \omega t \quad (24)$$

$$w_o = -\frac{\ddot{w}_o}{\omega^2} \sin \omega t \quad (25)$$

$$\dot{w}_o = -\frac{\ddot{w}_o}{\omega} \cos \omega t \quad (26)$$

2.8.2. Displacement Time History

The displacement time histories are input as tables of equally spaced ground displacements. The code automatically computes tables of ground velocities using the following relationships

$$\dot{u}_{o_{j+1}} = (u_{o_{j+1}} - u_{o_j})/DT \quad (27)$$

$$\dot{w}_{o_{j+1}} = (w_{o_{j+1}} - w_{o_j})/DT \quad (28)$$

$$\dot{u}_{o_1} = \dot{w}_{o_1} = 0 \quad (29)$$

The code interpolates from these tables to determine the ground displacements and velocities.

2.8.3. Acceleration Time Histories

Acceleration time histories are input as tables of equally spaced acceleration points. The code interpolates from these tables to determine the acceleration at any time. The velocities and displacements are determined by using the following second-order Runge-Kutta equations to integrate the acceleration input.

$$u_{o_{j+1}} = u_{o_j} + h \dot{u}_{o_j} + \frac{h^2}{6} (2 \ddot{u}_{o_j} + \ddot{u}_{o_{j+1}}) \quad (30)$$

$$\dot{u}_{o_{j+1}} = \dot{u}_{o_j} + \frac{h}{2} (\ddot{u}_{o_j} + \ddot{u}_{o_{j+1}}) \quad (31)$$

The equations for determining w_o and $\dot{w}_o$ are identical to those for u_o and $\dot{u}_o$.

2.9. SMALL ANGLE APPROXIMATIONS

The following small angle approximations were made in the code:

$$\cos \theta \simeq 1 \quad (32)$$

$$\sin \theta \simeq \theta \quad (33)$$

$$1 - \cos \theta \simeq 1/2 \theta^2 \quad (34)$$

$$\cos \theta_1 - \cos \theta_{1+1} \simeq 1/2 (\theta_{1+1}^2 - \theta_1^2) \quad (35)$$

3. NUMERICAL INTEGRATION METHODS

Two integration methods are available in COCO; central difference and second-order Runge-Kutta. The results of the study presented in Ref. 3 indicate that for COCO the central difference method is the most economical.

3.1. CENTRAL DIFFERENCE

The central difference method which is used in COCO is based on the central difference method presented in Ref. 4. This method uses the following equations:

$$\dot{x}_{n+1/2} = \dot{x}_{n-1/2} + h \ddot{x}_n \quad (36)$$

$$x_{n+1} = x_n + h \dot{x}_{n+1/2} \quad (37)$$

where

$$\ddot{x}_n = f(x_n, \dot{x}_{n-1/2}, t_n) \quad (38)$$

The method is not self-starting since one past value of $\dot{x}$ is required. It is started in the code by using the following equation which is based on Euler's method:

$$\dot{x}_{n+1/2} = \dot{x}_n + \frac{h}{2} \ddot{x}_n \quad (39)$$

Stability of the central difference method for linear systems requires that

$$h < \frac{2}{\omega_{\max}}$$

where $\omega_{\max}$ = highest linear frequency of the system.

Reference 4 states "there is considerable empirical evidence that these stability limits are valid for nonlinear problems if the current highest frequency is used in the equation."

3.2. SECOND-ORDER RUNGE-KUTTA

The second-order Runge-Kutta method, which is used, was taken from Ref. 5, Eq. 3.12. The values selected for the constants are

$$\gamma_1 = \gamma_2 = 1/2$$

$$\alpha_1 = \alpha_2 = 2/3$$

$$\alpha_3 = 4/3$$

$$\sigma_1 = 1/2$$

$$\sigma_2 = 3/2$$

The selection of these constants causes the method to use the acceleration at $t = t_0$ and $t_0 + 2/3 h$ to evaluate the displacements and velocities at $t = t_0 + h$.

The following equations are used in the code:

$$\ddot{x}_n = f(t_n, x_n, \dot{x}_n)$$

$$x_{n+2/3} = x_n + 2/3 h \dot{x}_n + 1/3 h^2 \ddot{x}_n$$

$$\dot{x}_{n+2/3} = \dot{x}_n + 2/3 h \ddot{x}_n$$

$$t_{n+2/3} = t_n + 2/3 h$$

$$\ddot{x}_{n+2/3} = f(t_{n+2/3}, x_{n+2/3}, \dot{x}_{n+2/3})$$

$$t_{n+1} = t_n + h$$

$$x_{n+1} = x_n + h \dot{x}_n + \frac{h^2}{4} (\ddot{x}_n + \ddot{x}_{n+2/3})$$

$$\dot{x}_{n+1} = \dot{x}_n + \frac{h}{4} (\ddot{x}_n + 3 \ddot{x}_{n+2/3})$$

This method is self-starting.

4. DESCRIPTION OF INPUT

This section describes the input required by COCO. The data is entered in either A, F or I (standard FORTRAN). Data read in A format can be any combination of alpha-numeric characters (e.g., ABC1234*ETC). F format data is numeric and requires a decimal point. It can be located anywhere in the data field except when entered in exponential form (e.g., 7.15E-6). In this case, the number should be entered in the columns furthest to the right. I format data is numeric, cannot have a decimal, and must be entered in the columns furthest to the right. Input data forms are presented in Appendix A.

CARD 1

TITLE - any 72 character title

CARD 2

N - Number of blocks

NPRT - Print interval

The code will print output every NPRT integration steps.

NSTRT - Restart deck punch option

If = 0, punch restart deck

If = 1, do not punch restart deck

IMETH - Integration method

If = 0, central difference

If = 1, second-order Runge-Kutta

IGM - Type of PCRV ground motion

If = 0, no PCRV motion

If = 1, sine dwell

If = 2, horizontal acceleration time history

If = 3, vertical acceleration time history

If = 4, horizontal and vertical acceleration time history
 If = 5, horizontal displacement time history
 If = 6, vertical displacement time history
 If = 7, horizontal and vertical displacement time history

 IQD - Option to input initial angular displacements
 If = 0, no angular displacements
 If = 1, input angular displacements
 IQDN - Option to input initial velocities
 If = 0, no initial velocities
 If = 1, input initial velocities

 NLDOF - Number of locked degrees of freedom

CARD 3

LBLK(I) - Block number of the Ith locked degree of freedom
 LCOMP(I) - Component of the Ith locked degree of freedom
 If = 1, θ
 If = 2, u
 If = 3, w

CARD 4

TO - Starting time
 TEND - Ending time
 HH - Integration time step

CARD 5

BG - Element geometric width

 BG is used to compute b ($b = 1/2 \text{ BG}$), which in turn is used as a moment arm in the equations of motion and is used to compute collision spring deflections. In addition, b is used in the following equation to compute the mass moment of inertia of the blocks:

$$I_i = 1/3 (b^2 + h_i^2) M_i .$$

RSPRING - Rotational spring stiffness for the bottom block
UO - Initial PCRV horizontal displacement
UOD - Initial PCRV horizontal velocity
WO - Initial PCRV vertical displacement
WOD - Initial PCRV vertical velocity

CARD 6

VCRNS(I) - Vertical corner spring stiffness for block I
VCRND(I) - Vertical corner spring damping for block I
VCENS(I) - Vertical center spring stiffness for block I
VCEND(I) - Vertical center spring damping for block I
HCRNS(I) - Horizontal corner spring stiffness for block I
HCRND(I) - Horizontal corner spring damping for block I
HCENS(I) - Horizontal center spring stiffness for block I
HCEND(I) - Horizontal center spring damping for block I

CARD 7

GAP(3,I)* - Horizontal gap between the PCRV and the upper left corner
of block I

CARD 8

GAP(4,I) - Horizontal gap between the PCRV and the lower left corner
of block I

CARD 9

GAP(1,I) - Horizontal gap between the PCRV and the upper right corner
of block I

CARD 10

GAP(2,I) - Horizontal gap between the PCRV and the lower right corner
of block I

*The center gap is computed as the average of the upper and lower gaps.

CARD 11

SK - Dowel stiffness
CDW - Dowel damping coefficient
GAP1 - Gap on the right side of the dowel
GAP2 - Gap on the left side of the dowel
COF - Block-on-block coefficient of friction
SLP - Viscous damping coefficient for friction force (β)

CARD 12

AMPLU - Horizontal g level for sine dwell
FREQU - Horizontal frequency for sine dwell
AMPLW - Vertical g level for sine dwell
FREQUW - Vertical frequency for sine dwell

CARD 13

H(I) - Height of block I

CARD 14

B(I) - Rocking width of block I

CARD 15

WT(I) - Weight of block I

CARD 16

THETA(I) - Initial angular displacement of block I

CARD 17

THETAD(I) - Initial angular velocity for block I

CARD 18

UD(I) - Initial horizontal velocity for block I

CARD 19

WD(I) - Initial vertical velocity for block I

CARD 20

NINPU - Number of points in the PCRV horizontal displacement time history table

FACTOR - A factor to convert the input time history to 1.0 g

SCALE - G level of the analysis

DELT - Time step between time history points

CARD 21

GG(1,I) - Point I of the PCRV horizontal displacement time history table

CARD 22

NINPUV - Number of points in the vertical displacement time history table

FACTOR - A factor to convert the input time history to 1.0 g

SCALE - G level of the analysis

DELTV - Time step between time history points

DELT on card 20 must be the same as DELTV.

CARD 23

GG(4,I) - Point I of the vertical displacement time history

CARD 24

NFORMT - Time history input format

If = 0, 8F9.0

If = 1, 8F10.0

NINPU - Number of points in the horizontal acceleration time history

FACTOR - A factor to convert the input time history to 1.0 g

SCALE - G level of the analysis

DELT - Time step between time history points

CARD 25

GG(1,I) - Point I of the horizontal acceleration time history table

CARD 26

NFORMT - Time history input format

If = 0, 8F9.0

If = 1, 8F10.0

NINPUV - Number of points in the PCRV vertical acceleration time history

FACTOR - A factor to convert the input time history to 1.0 g

SCALE - G level of the analysis

DELTV - Time step between time history points

DELT on card 24 must be the same as DELTV

CARD 27

GG(3,1) - Point I of the vertical acceleration time history

CARD 28 (Restart deck)*

LL - Integration time step counter

CARD 29 (Restart deck)

THETA(I) - Angular displacement of block I

U(I) - Horizontal displacement of block I

W(I) - Vertical displacement of block I

CARD 30 (Restart deck)

THETAD(I) - Angular velocity of block I

UD(I) - Horizontal velocity of block I

WD(I) - Vertical velocity of block I

*The restart deck is automatically punched by the code.

CARD 31 (Restart deck)

UO - PCRV horizontal displacement
UOD - PCRV horizontal velocity
WO - PCRV vertical displacement
WOD - PCRV vertical velocity

5. DESCRIPTION OF OUTPUT

Printed output consists of input data, time history results and an output summary. These are discussed in the following sections.

5.1. INPUT DATA

Input data is printed in two formats. The first is printed by the input repeat subroutine. This subroutine reads the data and then prints it in exactly the same format as it was read. If the input repeat does not list the complete input deck, then most likely the input deck has a control card error.

Immediately following the input repeat, the program lists the data as interpreted by the code. This data should be checked carefully, since errors in input format (e.g., data entered in the wrong columns or missing decimal points) will be obvious.

In addition to input data, this section also prints some data which was automatically computed by the code.

5.2. TIME HISTORY OUTPUT

The main section of the output data is the time history output. This data is printed every NPRT (print interval) integration steps and describes the motion as a function of time. The first line of the time history output is the title. The following is a description of the remaining data:

TIME	- Current value of time (sec)
LL	- Integration time step counter
BK	- Block number
THETA	- Angular displacement (deg.)

THETAD - Angular velocity (rad/sec)
U - Horizontal displacement (in.)
UD - Horizontal velocity (in./sec)
W - Vertical displacement (in.)
WD - Vertical velocity (in./sec)
FVL - Vertical force on the left corner of the block (lb)
FVC - Vertical force on the center of the block (lb)
FVR - Vertical force on the right corner of the block (lb)
FBL - Sum of the horizontal forces acting on the left side of the
block (lb)
FBR - Sum of the horizontal forces acting on the right side of the
block (lb)
FRI - Friction force (lb)
FDS - Dowel force (lb)

All of the printed forces are the maximum which occurred during the print interval. Only the stiffness portion of the dowel forces and collision forces are printed.

5.3. OUTPUT SUMMARY

At the termination of a run, an output summary is printed which gives all of the maximum forces, velocities and displacements along with the times that these maximums occur.

6. SAMPLE PROBLEM

The sample problem consists of five stacked blocks supported on two core support posts as shown in Fig. 6. The model does not represent any real structure. The properties have been selected to minimize computer running time and to illustrate how the program can be used. The current modeling technique is to eliminate the use of the center springs (Ref. 6). To make the sample problem more general, the center springs have been included and are assumed to be 40% of the surface stiffness. The remaining 60% is divided between the corner springs.

Figure 7 presents the block properties which are used for the analysis. Table 2 presents other sample problem data. Appendix B presents the output from the sample problem analysis. The first page of output is a computer listing of the sample problem input deck.

The following control cards are required to run COCO:

VASG,X	COCO*PRODUCTION
VXQT	COCO*PRODUCTION. ABS

where Δ represents a 7-8 punch in column 1. The input deck is placed immediately after the VXQT card. The sample problem can be automatically run by placing the following card in back of the two card shown above.

VADD	COCO*PRODUCTION. SAMPLE
------	-------------------------

Fig. 6. Sample problem

A) FULL HEIGHT BLOCK

B) HALF HEIGHT BLOCK

Fig. 7. Block properties

TABLE 2
SAMPLE PROBLEM DATA

Spring	Stiffness (lb/in.)	Damping (lb-sec/in.)
Between full and half height blocks	13,333	35.3
Between full height blocks	10,000	37.4
Between full height blocks and PCRV	20,000	74.8
Between half height blocks and PCRV	10,000	37.4
Support posts (two)	4,000	7.8
Dowels	800	0.18

Gaps

Block 1 = 0.05 in.

Blocks 2-5 = 0.50 in.

Dowels = 0.05 in.

Core support post spacing = 12.0 in.

Coefficient of friction = 0.2

Friction force damping coefficient = 100 lb-sec/in.

Integration time step = 0.001 sec

Sinusoidal excitation

Horizontal - 0.5 g at 2.0 Hz

Vertical - 0.25 g at 1.0 Hz

REFERENCES

1. Lee, T. H., "Nonlinear Dynamic Analysis of a Stacked Fuel Column Subjected to Boundary Motion," GA-A12933, General Atomic Company, 29 August 1974.
2. Lee, T. H. and D. A. Wesley, "Nonlinear Seismic Response of a Series of Interacting Fuel Columns Consisting of Stacked Elements," GA-A13224, General Atomic Company, 1 June 1975.
3. Rickard, N. D., "Numerical Integration of Discontinuous Forcing Functions," unpublished data, General Atomic Company, 22 June 1976.
4. Belytschko, T., "Comparative Evaluation of Numerical Methods for Dynamic Structural Analysis," Methods for Dynamic Structural Analysis, Berlin, Paper No. T1/1, September 1975.
5. Gear, William, Numerical Initial Value Problems in Ordinary Differential Equations, 1971.
6. Thompson, R. W., "Revised COCO Model," unpublished data, General Atomic Company, 13 September 1976.

APPENDIX A
INPUT DATA FORMS

WORD		
COLUMN	1-72	
FORMAT	A	
CARD 1	Title	
SYMBOL	Title	

WORD	1	2	3	4	5	6
COLUMN	5-6	7-12	18	24	30	36
FORMAT	I	I	I	I	I	I
CARD 2	No. of blocks $1 \leq NE \leq 14$	Print interval $1 \leq NPRT$	Not used	Punch restart deck 0 - yes 1 - no	Integration method 0 - central difference 1 - 2nd order Runge-Kutta	0 - No PCRV motion 1 - Sine dwell 2 - Horiz. accel. time history 3 - Vert. accel. time history 4 - Horiz & Vert. accel. time history 5.- Horiz displ. time history 6 - Vert. displ. time history 7 - Hor.&ver. dis. time history
SYMBOL	NE	NPRT		NSTRT	IMETH	IGM

WORD	7	8	9	
COLUMN	42	48	53-54	
FORMAT	2	I	I	
CARD 2 (Cont.)	Initial angular displacements 0 - no 1 - yes	Initial velocities 0 - no 1 - yes	No of locked degrees of freedom	
SYMBOL	IQD	IQON	NLDOF	

WORD	1	2	3	4	5-12
COLUMN	1-6	7-12	13-18	19-24	25-72
FORMAT	I6	I6	I6	I6	8I6
CARD 3 Use only if NLDOF > 0	Block No. of first locked degree of freedom	Component of first locked degree of freedom	Block No. of second locked degree of freedom	Component of second locked degree of freedom	Addition pairs of data
					LBLK(3), LCOMP(3)... LBLK (NLDOF), LCOMP(NLDOF)
SYMBOL	LBLK(1)	LCOMP(1)	LBLK(2)	LCOMP(2)	

Enter NLDOF pairs
of block and com-
ponent numbers.
Enter up to 6
pairs per card.
Use as many cards
as required.

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL	

A-3

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL	

WORD	1	2	3	
COLUMN	1-12	13-24	25-36	
FORMAT	F	F	F	
CARD 4	Starting time (sec.)	Ending time (sec.)	Integration time step (sec.)	
SYMBOL	TO	TEND	HH	

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 5	Element geometric width (in.)	Rotational spring stiff- ness for bottom block (lb/rad)	Initial conditions for PCRV				
			Horizontal displacement (in.)	Horizontal velocity (in./sec)	Vertical displacement (in.)	Vertical velocity (in./sec)	
SYMBOL	BG	RSPRING	UO	UOD	WO	WOD	

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL	

WORD	1	2	3	4	5	6	7
COLUMN	1-10	11-20	21-30	31-40	41-50	51-60	61-70
FORMAT	F	F	F	F	F	F	F
CARD 6	Vertical corner spring stiffness (lb/in.)	Vertical corner spring damping (lb-sec/in.)	Vertical center spring stiffness (lb/in.)	Vertical center spring damping (lb-sec/in.)	Horizontal corner spring stiffness (lb/in.)	Horizontal corner spring damping (lb-sec/in.)	Horizontal center spring stiffness (lb/in.)
SYMBOL	VCRNS(I)	VCRND(I)	VCENS(I)	VCEND(I)	HCRNS(I)	HCRND(I)	HCENS(I)

WORD	8	
COLUMN	71-80	
FORMAT	F	
CARD 6 (Cont.)	Horizontal center spring damping (lb-sec/in.)	
SYMBOL	HCEND(I)	

Enter one card
for each block.

WORD	1	2	3	4	5	6	7-12
COLUMN	1-6	7-12	13-18	19-24	25-30	31-36	37-42,..., 67-72
FORMAT	F	F	F	F	F	F	
CARD 7	Upper left corner horizontal gap Block 1 (in.)	Block 2	Block 3	Block 4	Block 5	Block 6	Blocks 7-12
SYMBOL	GAP(3,1)	GAP(3,2)	GAP(3,3)	GAP(3,4)	GAP(3,5)	GAP(3,6)	GAP(3,7)-GAP(3,12)

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	5	6	7-12
COLUMN	1-6	7-12	13-18	19-24	25-30	31-36	37-42,...,67-72
FORMAT	F	F	F	F	F	F	
CARD 8	Lower left corner horizontal gap Block 1 (in.)	Block 2	Block 3	Block 4	Block 5	Block 6	Blocks 7-12
SYMBOL	GAP(4,1)	GAP(4,2)	GAP(4,3)	GAP(4,4)	GAP(4,5)	GAP(4,6)	GAP(4,7)-GAP(4,12)

Enter NE values.
Use as many cards
as required

A-6

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL	

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL	

WORD	1	2	3	4	5	6	7-12
COLUMN	1-6	7-12	13-18	19-24	25-30	31-36	37-42,---,67-72
FORMAT	F	F	F	F	F	F	F
CARD 9	Upper right corner hori- zontal gap Block 1 (in.)	Block 2	Block 3	Block 4	Block 5	Block 6	Blocks 7-12
SYMBOL	GAP (1,1)	GAP (1,2)	GAP (1,3)	GAP (1,4)	GAP (1,5)	GAP (1,6)	GAP (1,7)-GAP (1,12)

Enter NE
values. Use
as many cards
as required.

WORD	1	2	3	4	5	6	7-12
COLUMN	1-6	7-12	13-18	19-24	25-30	31-36	37-42,...,67-72
FORMAT	F	F	F	F	F	F	F
CARD 10	Lower right corner hori- zontal gap Block 1 (in.)	Block 2	Block 3	Block 4	Block 5	Block 6	Blocks 7-12
SYMBOL	GAP (2,1)	GAP (2,2)	GAP (2,3)	GAP (2,4)	GAP (2,5)	GAP (2,6)	GAP (2,7)-GAP (2,12)

Enter NE
values. Use
as many cards
as required.

WORD	1	2	3	4	5	6
COLUMN	1-12	13-24	25-36	26-48	49-60	61-72
FORMAT	F	F	F	F	F	F
CARD 11	Dowel stiffness (lb/in.)	Dowel damping coefficient (lb-sec/in.)	Right side dowel gap (in.)	Left side dowel gap (in.)	Coefficient of friction	Friction force damping coefficient (lb-sec/in.)
SYMBOL	SK	CDW	GAP1	GAP2	COF	SLP

WORD	1	2	3	4	
COLUMN	1-12	13-24	25-36	37-48	
FORMAT	F	F	F	F	
CARD 12 Use only if IGM = 1	Horizontal g level (g)	Horizontal frequency (Hz)	Vertical g level (g)	Vertical frequency (He)	
SYMBOL	AMPLU	FREQU	AMPLW	FREQW	

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 13	Height of block 1 (in.)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	H(1)	H(2)	H(3)	H(4)	H(5)	H(6)	

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT							
CARD 14	Rocking width of block 1 (in.)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	B(1)	B(2)	B(3)	B(4)	B(5)	B(6)	

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 15	Weight of block 1 (1b)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	WT(1)	WT(2)	WT(3)	WT(4)	WT(5)	WT(6)	

Enter NE value.
Use as many cards
as required.

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 16 Use only if IQD = 1	Initial angular displacement of block 1 (rad)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	THETA(1)	THETA(2)	THETA(3)	THETA(4)	THETA(5)	THETA(6)	

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 17 Use only if IQDN = 1	Initial angular velocity of block 1 (rad/sec)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	THETAD(1)	THETAD(2)	THETAD(3)	THETAD(4)	THETAD(5)	THETAD(6)	

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 18 Use only if IQDN = 1	Initial horizontal velocity Block 1 (in./sec)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	UD(1)	UD(2)	UD(3)	UD(4)	UD(5)	UD(6)	

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 19 Use only if IQDN = 1	Initial vertical velocity Block 1 (in./sec)	Block 2	Block 3	Block 4	Block 5	Block 6	
SYMBOL	WD(1)	WD(2)	WD(3)	WD(4)	WD(5)	WD(6)	

Enter NE values.
Use as many cards
as required.

WORD	1	2	3	4	
COLUMN	1-12	13-24	25-36	37-48	
FORMAT	I	F	F	F	
CARD 20 Use only if IGM = 5 or 7	No. of horizontal displacement time history points	Scaling factor	G level	Time step between points (sec)	
SYMBOL	NINPU	FACTOR	SCALE	DELT	

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 21 Use only if IGM = 5 or 7	PCRV Horizontal displacement time history Point 1 (in./sec ²)	Point 2	Point 3	Point 4	Point 5	Point 6	
SYMBOL	GG(1,1)	GG(1,2)	GG(1,3)	GG(1,4)	GG(1,5)	GG(1,6)	

Enter NINPU
values. Use as
many cards as
required.

WORD	1	2	3	4	
COLUMN	1-12	13-24	25-36	37-48	
FORMAT	I	F	F	F	
CARD 22 Use only if IGM = 6 or 7	No. of vertical displacement time history points	Scaling factor	G level	Time step between points (sec)	
SYMBOL	NINPUV	FACTOR	SCALE	DELTU	

A-11

WORD	1	2	3	4	5	6	
COLUMN	1-12	13-24	25-36	37-48	49-60	61-72	
FORMAT	F	F	F	F	F	F	
CARD 23 Use only if IGM = 6 or 7	PCRV vertical displacement time history Point 1 (in./sec ²)	Point 2	Point 3	Point 4	Point 5	Point 6	
SYMBOL	GG(4,1)	GG(4,2)	GG(4,3)	GG(4,4)	GG(4,5)	GG(4,6)	

Enter NINPUV
values. Use as
many cards as
required.

WORD	1	2	3	4	5	
COLUMN	1-6	7-12	13-24	25-36	37-48	
FORMAT	I	I	F	F	F	
CARD 24 Use only if IGM = 2 or 4	Input format of horizontal acceleration time history 0 - 8F9.0 1 - 8F10.0	No. of points in horizontal acceleration time history	Scale factor	G level	Time step between points (sec)	
SYMBOL	NFORMT	NINPU	FACTOR	SCALE	DELT	

WORD	1	2	3	4	5	6	7	8	
COLUMN	1-9	10-18	19-27	28-36	37-45	46-54	55-63	64-72	
FORMAT	F	F	F	F	F	F	F	F	
CARD 25A Use only if IGM = 2 or 4 & NFORMT = 0	PCRV horizontal acceleration time history Point 1 (in./sec ²)	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	
SYMBOL	GG(1,1)	GG(1,2)	GG(1,3)	GG(1,4)	GG(1,5)	GG(1,6)	GG(1,7)	GG(1,8)	

See note on
card 21.

WORD	1	2	3	4	5	6	7	8	
COLUMN	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	
FORMAT	F	F	F	F	F	F	F	F	
CARD 25B Use only if IGM = 2 or 4 & NFORMT = 1	PCRV horizontal acceleration time history Point 1 (in./sec ²)	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	
SYMBOL	GG(1,1)	GG(1,2)	GG(1,3)	GG(1,4)	GG(1,5)	GG(1,6)	GG(1,7)	GG(1,8)	

See note on
card 21.

WORD	1	2	3	4	5	
COLUMN	1-6	7-12	13-24	25-36	37-48	
FORMAT	I	I	F	F	F	
CARD 26 Use only if IGM = 3 or 4	Input format for vertical acceleration time history 0 - 8F9.0 1 - 8F10.0	No. of points in vertical acceleration time history	Scale factor	G level	Time step between points (sec)	
SYMBOL	NFORMT	NINPUV	FACTOR	SCALE	DELTU	

WORD	1	2							
COLUMN	1-9	10-18	19-27	28-36	37-45	46-54	55-63	64-72	
FORMAT	F	F	F	F	F	F	F	F	
CARD 27A Use only if IGM = 3 or 4 and NFORMT = 0	PCRV vertical acceleration time history Point 1 (in./sec ²)	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	
SYMBOL	GG(3,1)	GG(3,2)	GG(3,3)	GG(3,4)	GG(3,5)	GG(3,6)	GG(3,7)	GG(3,8)	

WORD	1	2	3	4	5	6	7	8	
COLUMN	1-10	11-20	21-30	31-40	31-50	51-60	61-70	71-80	
FORMAT	F	F	F	F	F	F	F	F	
CARD 27B Use only if IGM = 3 or 4 and NFORMT = 1	PCRV vertical acceleration time history Point 1 (in./sec ²)	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	
SYMBOL	GG(3,1)	GG(3,2)	GG(3,3)	GG(3,4)	GG(3,5)	GG(3,6)	GG(3,7)	GG(3,8)	

See note on
card 23.

See note on
card 23.

WORD	1	
COLUMN	1-10	
FORMAT	I	
Restart Deck CARD 28 (Optional)	Integration time step counter	
SYMBOL	LL	

The restart deck is automatically punch by the code if NSTRT = 0.

WORD	1	2	3	4	5	
COLUMN	1-16	17-32	33-48	49-64	65-80	
FORMAT	F	F	F	F	F	
Restart Deck CARD 29 (Optional)	Angular displacement of block 1 (rad)	Angular displacement of block NE (rad)	Horizontal displacement of block 1 (in.)	Horizontal displacement of block NE (in.)	Vertical displacement of block 1 (in.)	
SYMBOL	THETA(1)	THETA(NE)	U(1)	U(NE)	W(1)	

Enter NE values of THETA followed by NE values of U followed by NE values of W. Use as many cards as required.

WORD	1	2	3	4	5	
COLUMN	1-16	17-32	33-48	49-64	65-80	
FORMAT	F	F	F	F	F	
Restart Deck CARD 29 (Optional)	Angular velocity of block 1 (rad/sec)	Angular velocity of block NE (rad/sec)	Horizontal velocity of block 1 (in./sec)	Horizontal velocity of block NE (in./sec)	Vertical velocity of block 1 (in./sec)	
SYMBOL	THETAD(1)	THETAD(NE)	UD(1)	UD(NE)	WD(1)	

Enter NE values of THETAD followed by NE values of UD followed by NE values of WD. Use as many cards as required.

WORD	1	2	3	4
COLUMN	1-16	17-32	33-48	49-64
FORMAT				
Restart Deck CARD 31 (Optional)	PCRV horizontal displacement (in.)	PCRV horizontal velocity (in./sec)	PCRV vertical displacement (in.)	PCRV vertical velocity (in./sec)
SYMBOL	UO	UOD	WO	WOD

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL

WORD	
COLUMN	
FORMAT	
CARD	
SYMBOL

A-15

APPENDIX B
SAMPLE PROBLEM OUTPUT

INPUT REPEAT

CARD
NO.

SAMPLE PROBLEM

0.	5	20	1	0	1	0	0	0
14.2	2.0	.001						
2000.	3.9	0.	0.	3000.	11.2	4000.	15.0	
4000.	10.6	5333.	14.1	4000.	22.4	8000.	29.9	
3000.	11.2	4000.	15.0	6000.	22.4	8000.	29.9	
3000.	11.2	4000.	15.0	6000.	22.4	8000.	29.9	
4000.	10.6	5333.	14.1	3000.	11.2	4000.	15.0	
.05	.5	.5	.5					
.05	.5	.5	.5					
.05	.5	.5	.5					
.05	.5	.5	.5					
800.	.18	.05	.05	.2	100.			
.5	.25	.25	1.					
15.6	31.2	31.2	31.2	15.6				
12.0	13.45	13.45	13.45	13.45				
150.	300.	300.	300.	150.				

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

SAMPLE PROBLEM

PROBLEM START TIME= .000
 PROBLEM END TIME= 2.000
 INTEGRATION TIME STEP=.001000

CENTRAL DIFFERENCE INTEGRATION

NUMBER OF ELEMENTS= 5
 NUMBER OF EQUATIONS= 15

BOUNDARY EXCITATION IN HORIZ.DIRECTION

EXCITATION FREQUENCY = 2.00 HZ
 ACCELERATION AMPLITUDE OF EXCITATION = .5000 G

BOUNDARY EXCITATION IN VERT. DIRECTION

EXCITATION FREQUENCY = 1.00 HZ
 ACCELERATION AMPLITUDE OF EXCITATION = .2500 G

IN HORIZ. DIRECTION

DISPLACEMENT AMPLITUDE OF EXCITATION = -1.223 INCH
 VELOCITY AMPLITUDE OF EXCITATION = -15.374 INCH PER SEC

IN VERTICAL DIRECTION

DISPLACEMENT AMPLITUDE OF EXCITATION = -2.447 INCH
 VELOCITY AMPLITUDE OF EXCITATION = -15.374 INCH PER SEC

BLOCK GEOMETRIC WITH: B0= 14.20

ELEMENT HEIGHT, H(I)
 15.60 31.20 31.20 31.20 15.60

ELEMENT ROCKING WIDTH, B(I)
 12.00 13.45 13.45 13.45 13.45

ELEMENT WEIGHTS, WT(I)
 150.00 300.00 300.00 300.00 150.00

ELEMENT MASS MATRIX

.38820+00 .77640+00 .77640+00 .77640+00 .38820+00

ROTARY INERTIA MATRIX

.14396+02 .76027+02 .76027+02 .76027+02 .14396+02

LOWER LEFT LATERAL GAPS: GAPL(4,1),...GAPL(4,NE)
.0500 .5000 .5000 .5000 .5000

CENTER LEFT LATERAL GAPS: GAPL(6,1),...GAPL(6,NE)
.0500 .5000 .5000 .5000 .5000

UPPER LEFT LATERAL GAPS: GAPL(3,1),...GAPL(3,NE)
.0500 .5000 .5000 .5000 .5000

UPPER RIGHT LATERAL GAPS: GAPR(1,1),...GAPR(1,NE)
.0500 .5000 .5000 .5000 .5000

CENTER RIGHT LATERAL GAPS: GAPR(5,1),...GAPR(5,NE)
.0500 .5000 .5000 .5000 .5000

LOWER RIGHT LATERAL GAPS: GAPR(2,1),...GAPR(2,NE)
.0500 .5000 .5000 .5000 .5000

DOWEL GAP 1 = .0500

DOWEL GAP 2 = .0500

DOWEL K = .800+03

DOWEL DAMPER CDW = .1800

COEFF. OF FRICTION = .20

CONSTANT FOR INITIAL SLOPE OF COULOMB FRICTION = .100+03

TOTAL WT. OF COLUMN = 1200.00

SUPPORT POST STIFFNESS, K = .0000

SUPPORT POST GAPL = .000000

SUPPORT POST GAPR = .000000

CORE SUPPORT POST ROTATIONAL SPRING = .000000 LB/IN

	VCNRS	VCNRS	VCNRS	VCNRS	HCRNS	HCRNS	HCNRS	HCNRS
1	.200000+04	.390000+01	.000000	.000000	.300000+04	.112000+02	.400000+04	.150000+02
2	.400000+04	.106000+02	.533300+04	.141000+02	.600000+04	.224000+02	.800000+04	.299000+02
3	.300000+04	.112000+02	.400000+04	.150000+02	.600000+04	.224000+02	.800000+04	.299000+02
4	.300000+04	.112000+02	.400000+04	.150000+02	.600000+04	.224000+02	.800000+04	.299000+02
5	.400000+04	.106000+02	.533300+04	.141000+02	.300000+04	.112000+02	.400000+04	.150000+02

THETA(T=0)

.0000 .0000 .0000 .0000 .0000

U(T=0)

.0000 .0000 .0000 .0000 .0000

W(T=0)

-.3000 -.3788 -.4538 -.4988 -.5100

INITIAL CONDITIONS FOR QN(T=0)

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
-1.300+00	-1.379+00	-1.484+00	-1.499+00	-1.510+00	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

COCO SIMULATION
SAMPLE PROBLEM

- 1 -

BK	THEYA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FPI	FDS
TIME	.00000 LL		0										
1	.00	.00	.00	.00	-.30	.00	600.00	.00	600.00	.00	.00	.00	.00
2	.00	.00	.00	.00	-.38	.00	315.01	419.98	315.01	.00	.00	.00	.00
3	.00	.00	.00	.00	-.45	.00	225.00	300.00	225.00	.00	.00	.00	.00
4	.00	.00	.00	.00	-.50	.00	135.00	180.00	135.00	.00	.00	.00	.00
5	.00	.00	.00	.00	-.51	.00	45.00	60.00	45.00	.00	.00	.00	.00
PCRV			.00	.00	.00	.00							
TIME	.02000 LL		20										
1	.15	2.96	-.22	-21.60	-.40	-8.53	569.25	.00	569.25	.00	720.79	.00	.00
2	.16	15.26	-.03	-3.37	-.42	-6.15	315.01	419.98	315.01	.00	.00	182.00	59.66
3	.01	-.15	.01	.55	-.47	-2.55	225.00	300.00	225.00	.00	.00	-43.09	.00
4	.00	-.84	.00	.08	-.50	-.72	135.00	180.00	135.00	.00	.00	-20.23	.00
5	.00	.36	-.00	-.05	-.51	-.31	45.03	60.00	45.00	.00	.00	5.12	.00
PCRV			-.30	-14.89	-.31	-15.25							
TIME	.04000 LL		40										
1	.54	11.91	-.59	-15.30	-.62	-13.39	138.51	.00	201.23	66.15	310.08	.00	.00
2	.46	-.24	-.16	-11.33	-.63	-13.67	76.56	127.01	113.98	.00	348.14	63.51	148.76
3	.02	-1.23	-.03	-11.81	-.59	-9.06	183.25	156.19	51.03	.00	1112.76	-19.82	.00
4	.00	2.87	-.03	-10.91	-.58	-7.52	93.75	130.32	101.74	.00	1131.13	-31.66	.00
5	.01	.28	-.04	-10.29	-.57	-6.50	33.28	47.48	37.95	.00	516.08	7.15	.00
PCRV			-.59	-13.47	-.61	-14.89							
TIME	.06000 LL		60										
1	.34	-11.13	-.82	-9.42	-.95	-18.77	24.39	.00	166.62	77.86	71.16	.00	.00
2	.43	8.61	-.47	-17.65	-.96	-18.80	50.90	37.32	84.02	.00	352.01	-23.90	157.74
3	-.02	-1.91	-.39	-17.99	-.85	-16.91	18.97	.00	.00	.00	1113.29	-3.79	.00
4	.00	-.82	-.39	-17.94	-.81	-15.25	.00	.00	.00	.00	1147.43	.00	.00
5	.01	.69	-.38	-17.75	-.78	-14.23	.00	.00	.00	.00	531.09	.00	.00
PCRV			-.84	-11.21	-.90	-14.29							
TIME	.08000 LL		80										
1	.27	7.74	-1.02	-11.60	-1.33	-17.78	240.92	.00	353.94	.00	57.53	.00	.00
2	.48	-10.95	-.83	-17.44	-1.35	-19.92	.00	139.58	215.78	.00	.00	-71.07	97.16
3	-.06	-1.91	-.75	-17.99	-1.27	-24.64	.00	.00	.00	.00	.00	.00	.00
4	-.02	-.82	-.74	-17.94	-1.20	-22.98	.00	.00	.00	.00	.00	.00	.00
5	.02	.69	-.74	-17.75	-1.15	-21.95	.00	.00	.00	.00	.00	.00	.00
PCRV			-1.03	-8.24	-1.18	-13.47							
TIME	.10000 LL		100										
1	.05	-27.50	-1.23	-7.12	-1.67	-17.48	449.51	.00	471.10	148.43	.00	.00	.00
2	.11	-19.39	-1.17	-16.99	-1.73	-20.29	222.02	335.85	281.78	.00	.00	-86.97	.00
3	.03	13.02	-1.11	-18.59	-1.80	-23.69	236.42	274.35	176.30	.00	.00	83.69	.00
4	-.03	-.82	-1.10	-17.94	-1.74	-30.71	.00	.00	.00	.00	.00	.00	.00
5	.03	.69	-1.09	-17.75	-1.67	-29.68	.00	.00	.00	.00	.00	.00	.00
PCRV			-1.16	-4.75	-1.44	-12.44							

B-6

COCO SIMULATION
SAMPLE PROBLEM

- 2 -

RK	THETA	THETAD	U	UD	V	VD	FVL	FVC	FVR	FBL	FBR	FBI	FBS
TIME	.12000 LL	120											
1	-.29	-14.49	-1.30	-.67	-2.05	-18.28	989.45	.00	686.52	320.63	.00	.00	.00
2	-.38	-24.33	-1.46	-11.38	-2.15	-21.07	439.67	513.25	370.25	.00	.00	-212.05	.00
3	.12	-6.64	-1.50	-19.57	-2.25	-24.60	231.00	402.86	477.53	.00	.00	82.29	.00
4	.03	10.65	-1.46	-18.15	-2.33	-24.10	295.25	332.63	215.41	.00	.00	-73.40	.00
5	.04	-3.18	-1.45	-17.74	-2.34	-26.58	45.82	70.42	59.81	.00	.00	-35.21	.00
PCRVR			-1.22	-.97	-1.68	-11.21							
TIME	.14000 LL	140											
1	-.65	-12.76	-1.26	2.85	-2.42	-18.26	1202.81	.00	932.10	335.30	.00	.00	.00
2	-.66	9.44	-1.60	.23	-2.57	-20.21	617.59	768.13	539.19	449.17	.00	-344.64	-16.08
3	-.09	-1.09	-1.78	2.23	-2.72	-21.34	249.08	597.08	646.76	1551.73	.00	-272.65	.00
4	.03	-16.98	-1.79	-2.92	-2.81	-20.08	271.61	396.02	364.75	1739.10	.00	117.51	.00
5	.11	-6.98	-1.77	-8.30	-2.83	-19.39	244.29	274.37	171.47	652.90	.00	-89.99	.00
PCRVR			-1.20	2.88	-1.80	-9.80							
TIME	.16000 LL	160											
1	-.29	20.09	-1.18	6.48	-2.72	-10.74	1370.11	.00	1246.74	360.30	.00	.00	.00
2	-.45	7.10	-1.46	10.38	-2.89	-11.41	764.93	903.25	635.29	440.58	.00	-344.04	-50.41
3	-.06	-3.30	-1.57	11.36	-3.04	-12.09	320.07	610.71	645.35	1525.26	.00	86.42	.00
4	-.01	2.92	-1.58	11.75	-3.13	-12.86	249.33	375.02	316.96	1811.18	.00	112.05	.00
5	-.05	3.25	-1.59	12.90	-3.15	-12.77	110.40	122.68	101.72	848.52	.00	-34.21	.00
PCRVR			-1.11	6.55	-2.07	-8.24							
TIME	.18000 LL	180											
1	-.23	1.29	-1.00	10.79	-2.85	-3.19	1370.60	.00	1272.59	277.81	.00	.00	.00
2	-.29	5.40	-1.23	12.38	-3.02	-2.52	783.54	928.51	645.71	.00	.00	-69.91	-55.81
3	-.17	-4.94	-1.33	12.39	-3.19	-2.73	472.71	684.75	594.45	.00	.00	-17.07	.00
4	.03	.77	-1.35	11.26	-3.29	-3.34	249.30	420.85	388.59	.00	.00	47.41	.00
5	.08	5.22	-1.33	12.47	-3.32	-3.55	106.55	143.69	129.03	.00	.00	28.71	.00
PCRVR			-.94	9.80	-2.21	-6.55							
TIME	.20000 LL	200											
1	-.16	1.04	-.77	12.21	-2.87	.82	1302.50	.00	1207.10	106.24	.00	.00	.00
2	-.25	.45	-.97	12.77	-3.01	2.50	719.42	908.58	643.54	.00	.00	31.73	-55.83
3	-.21	.66	-1.08	12.82	-3.16	4.61	483.92	685.05	551.28	.00	.00	-25.81	.00
4	.01	-3.07	-1.12	12.17	-3.25	6.22	242.42	427.36	402.11	.00	.00	-5.36	.00
5	.06	-5.59	-1.10	10.83	-3.28	6.70	85.32	146.59	140.43	.00	.00	34.14	.00
PCRVR			-.72	12.44	-2.33	-4.75							
TIME	.22000 LL	220											
1	-.18	-1.68	-.50	14.09	-2.81	4.65	1098.73	.00	1032.06	91.27	.00	.00	.00
2	-.26	-1.48	-.71	13.37	-2.91	6.75	626.09	768.33	526.48	.00	.00	26.27	-52.21
3	-.17	1.78	-.81	13.39	-3.02	9.04	424.56	585.21	453.26	.00	.00	-24.77	.00
4	-.09	-5.67	-.87	12.44	-3.07	10.55	200.82	368.40	351.78	.00	.00	11.13	.00
5	-.08	-7.10	-.89	9.99	-3.09	10.92	69.97	122.97	114.50	.00	.00	25.45	.00
PCRVR			-.45	14.29	-2.40	-2.88							

COCO SIMULATION
SAMPLE PROBLEM

- 3 -

BK	THETA	THETA0	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME .24000 LL 240													
1	-.22	-1.27	-.20	15.64	-2.69	6.01	832.08	.00	754.91	98.15	.00	.00	.00
2	-.29	-1.30	-.43	15.01	-2.76	7.85	863.38	557.58	373.04	.00	.00	-14.12	-52.87
3	-.18	-4.03	-.54	13.61	-2.82	9.44	264.37	394.61	327.54	.00	.00	6.46	.00
4	-.17	2.08	-.62	12.78	-2.86	10.26	142.96	227.90	198.88	81.84	.00	-29.79	.00
5	-.09	7.86	-.67	14.43	-2.87	10.45	49.89	71.96	73.80	168.16	.00	-25.45	.00
PCRV			-.15	15.25	-2.44	-.97							
TIME .26000 LL 260													
1	-.24	-2.53	.12	16.58	-2.59	4.11	535.40	.00	444.70	84.80	.00	.00	.00
2	-.33	-2.82	-.12	15.74	-2.63	8.06	304.98	343.50	210.30	.00	.00	27.38	-53.12
3	-.28	-2.24	-.27	13.90	-2.66	6.08	147.32	245.86	221.46	20.01	.00	-46.11	.00
4	-.03	4.69	-.34	14.40	-2.68	7.20	100.73	144.83	150.69	96.89	.00	-27.96	.00
5	-.02	2.72	-.34	16.60	-2.69	7.26	19.61	46.74	74.69	171.46	.00	15.88	.00
PCRV			.15	15.25	-2.44	.97							
TIME .28000 LL 280													
1	-.33	-3.69	.45	16.01	-2.54	1.65	341.97	.00	240.63	42.58	.00	.00	.00
2	-.37	-.66	.19	15.48	-2.57	1.46	202.26	196.39	92.35	.00	.00	31.53	-51.14
3	-.27	-.89	.02	15.35	-2.59	1.60	87.31	138.26	120.08	54.99	.00	-42.53	.00
4	-.03	-1.87	-.04	15.20	-2.59	1.75	.00	73.23	148.00	15.99	.00	-23.13	.00
5	.01	-2.42	-.01	16.04	-2.60	2.00	19.66	29.07	29.92	.00	.00	14.53	.00
PCRV			.45	14.29	-2.40	2.89							
TIME .30000 LL 300													
1	-.26	5.80	.74	13.44	-2.52	.49	432.98	.00	324.04	.00	27.70	.00	.00
2	-.35	3.65	.51	15.57	-2.56	-.68	240.39	244.68	126.65	.00	.00	34.98	-46.91
3	-.26	-.08	.34	16.22	-2.60	-1.96	75.85	144.95	141.58	.00	.00	-32.42	.00
4	-.10	-3.68	.26	15.27	-2.62	-3.52	.00	69.70	109.75	6.06	.00	14.47	.00
5	-.08	-2.31	.30	15.27	-2.62	-3.82	11.65	27.04	28.92	.00	.00	13.52	23.78
PCRV			.72	12.44	-2.33	4.75							
TIME .32000 LL 320													
1	-.14	8.24	.99	11.29	-2.51	-.03	626.01	.00	568.41	.00	46.82	.00	.00
2	-.23	7.50	.81	14.93	-2.59	-1.85	360.30	413.27	259.64	.00	.00	47.29	-43.34
3	-.26	.49	.67	16.87	-2.66	-3.79	232.35	293.78	278.33	.00	.00	-33.08	.00
4	-.16	-3.67	.57	15.92	-2.71	-4.94	100.01	181.02	171.53	.00	.00	-5.81	.00
5	-.13	-6.05	.59	13.99	-2.72	-5.21	32.80	63.46	62.42	.00	.00	16.66	26.09
PCRV			.94	9.80	-2.21	6.55							
TIME .34000 LL 340													
1	.04	7.28	1.18	6.94	-2.50	1.56	866.05	.00	881.67	.00	185.68	.00	.00
2	-.03	13.70	1.09	12.91	-2.62	-.19	485.90	607.67	425.66	.00	.00	124.85	-36.80
3	-.23	2.81	1.01	17.83	-2.72	-1.74	391.69	429.16	252.05	.00	.00	-25.88	.00
4	-.26	-5.66	.90	16.30	-2.79	-2.62	204.58	258.61	184.37	.00	.00	-15.88	.00
5	-.26	-6.28	.87	13.67	-2.81	-2.85	66.34	87.55	64.99	.00	.00	-23.55	25.12
PCRV			1.11	6.55	-2.07	8.24							

COCO SIMULATION
SAMPLE PROBLEM

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME	.36000	LL	360										
1	.21	11.35	1.27	2.77	-2.43	6.06	1039.97	.00	1126.40	.00	206.98	.00	.00
2	.28	15.57	1.32	9.94	-2.57	4.94	528.99	763.28	616.00	.00	.00	138.35	-21.62
3	-.13	7.61	1.35	16.46	-2.71	3.64	551.94	546.84	268.32	.00	.00	20.77	.00
4	-.37	-4.94	1.23	16.80	-2.79	2.78	333.51	329.52	182.90	.00	.00	-38.08	.00
5	-.39	-7.03	1.14	14.12	-2.81	2.53	93.88	111.22	73.03	.00	.00	-37.57	22.10
PCRV			1.20	2.88	-1.89	9.80							
TIME	.38000	LL	380										
1	.46	12.33	1.28	-1.44	-2.25	11.15	1068.07	.00	1250.37	.00	247.27	.00	.00
2	.60	17.00	1.49	8.64	-2.41	11.03	541.63	823.62	706.47	.00	.00	177.68	-.59
3	.06	10.71	1.66	14.61	-2.56	10.79	644.62	607.73	275.13	.00	.00	43.09	.00
4	-.43	-4.44	1.57	16.97	-2.65	10.63	453.83	374.12	158.85	.00	.00	-44.59	.00
5	-.50	-2.71	1.44	15.89	-2.68	10.59	130.11	126.62	72.82	.00	.00	-58.76	17.23
PCRV			1.22	-.97	-1.68	11.21							
TIME	.40000	LL	400										
1	.66	-7.48	1.23	-3.17	-1.98	15.79	1054.58	.00	1258.05	.00	357.02	.00	.00
2	.62	-16.27	1.52	-5.31	-2.13	16.77	566.74	823.64	723.00	.00	286.97	351.58	.00
3	.03	.59	1.70	-10.33	-2.27	17.74	688.32	608.42	265.14	.00	1289.67	147.56	.00
4	.09	9.30	1.73	-7.63	-2.36	18.66	465.71	374.84	283.87	.00	1386.42	-90.99	.00
5	.07	61.61	1.75	4.45	-2.38	18.48	228.16	126.72	67.86	.00	825.61	-69.10	9.12
PCRV			1.16	-4.75	-1.44	12.44							
TIME	.42000	LL	420										
1	.27	-5.73	1.11	-9.17	-1.62	19.61	936.33	.00	1209.80	.00	370.80	.00	.00
2	.46	-8.03	1.34	-11.15	-1.74	21.25	565.17	769.55	604.80	.00	130.49	319.15	18.77
3	.12	9.20	1.49	-10.61	-1.86	22.84	631.16	571.17	228.81	.00	543.51	-75.11	.00
4	-.02	-6.99	1.51	-10.25	-1.93	23.80	261.02	347.36	282.67	.00	1213.08	-83.58	.00
5	-.07	-16.79	1.50	-14.68	-1.94	24.18	91.05	110.89	152.88	.00	926.74	55.45	.00
PCRV			1.03	-8.24	-1.18	13.47							
TIME	.44000	LL	440										
1	.26	-2.50	.88	-12.13	-1.21	20.98	816.50	.00	928.23	.00	259.03	.00	.00
2	.36	-.71	1.10	-12.46	-1.29	22.82	367.06	620.63	563.94	.00	.00	93.72	27.68
3	.26	1.73	1.27	-11.72	-1.37	24.65	451.93	454.30	237.65	.00	15.91	45.73	.00
4	-.12	.31	1.30	-11.11	-1.42	25.73	290.75	276.86	151.41	.00	.00	-19.76	.00
5	-.20	1.70	1.22	-12.86	-1.43	26.00	99.46	90.28	41.83	.00	.00	-40.40	.00
PCRV			.84	-11.21	-.90	14.29							
TIME	.46000	LL	460										
1	.27	2.63	.63	-13.35	-.80	19.94	550.71	.00	658.98	.00	87.08	.00	.00
2	.37	.54	.85	-12.55	-.85	21.36	264.23	429.97	380.76	.00	.00	29.18	30.18
3	.23	-3.07	1.02	-12.97	-.89	22.92	268.68	316.22	205.66	.00	13.91	46.54	.00
4	-.01	8.21	1.07	-11.67	-.92	23.90	278.79	190.02	6.24	.00	.00	-11.33	.00
5	-.05	9.19	.98	-11.36	-.93	24.20	80.17	62.20	13.13	.00	.00	-31.10	-22.09
PCRV			.59	-13.47	-.61	14.89							

COCO SIMULATION
SAMPLE PROBLEM

- 5 -

BK	THETA	THETAD	U	UD	W	WD	FVI	FVC	FVR	FBL	FBR	FRI	FDS
TIME	.49000	LL	480										
1	.27	-2.14	.35	-14.24	-.42	17.41	310.89	.00	426.00	.00	100.29	.00	.00
2	.37	.34	.59	-14.02	-.45	17.99	134.64	255.42	248.51	.00	.00	45.76	36.82
3	.21	-.03	.75	-13.67	-.48	18.53	185.59	180.59	85.29	.00	46.28	27.01	.00
4	.03	-4.09	.81	-14.67	-.49	19.21	155.57	102.04	3.42	.00	122.98	16.44	.00
5	.05	.08	.77	-10.02	-.49	19.23	41.25	32.50	24.23	.00	.00	-16.25	-34.02
PCRVR			.30	-14.89	-.31	15.25							

TIME	.50000	LL	500										
1	.27	1.54	.05	-15.79	-.11	13.95	173.11	.00	287.11	.00	110.93	.00	.00
2	.37	-.67	.29	-15.37	-.14	13.66	52.28	150.48	173.46	.00	.00	40.25	42.99
3	.17	-1.11	.46	-15.69	-.16	13.61	132.59	96.64	15.26	.00	68.80	32.50	.00
4	.01	.87	.50	-15.84	-.17	13.33	98.04	43.89	.00	.00	110.63	11.19	.00
5	-.00	1.18	.51	-17.33	-.17	13.30	17.13	18.24	27.36	.00	207.92	9.12	.00
PCRVR			.00	-15.37	-.00	15.37							

TIME	.52000	LL	520										
1	.28	-.44	-.27	-16.21	.14	11.49	274.94	.00	391.85	.00	105.50	.00	.00
2	.35	-1.88	-.03	-16.77	.10	10.40	119.51	220.12	210.69	.00	.00	38.33	46.86
3	.19	1.70	.13	-16.62	.08	9.23	159.21	139.54	50.10	.00	26.27	21.15	.00
4	.04	2.52	.18	-15.64	.04	8.24	111.12	78.31	6.34	.00	13.89	-24.97	.00
5	.03	1.45	.17	-16.74	.04	8.06	25.99	25.85	12.79	.00	117.10	-12.93	.00
PCRVR			-.30	-14.89	.31	15.25							

TIME	.54000	LL	540										
1	.26	-3.41	-.59	-15.31	.35	9.75	463.86	.00	572.04	.00	51.86	.00	.00
2	.29	-3.40	-.37	-16.98	.28	8.35	241.89	358.05	295.23	.00	.00	-34.93	46.84
3	.23	1.79	-.21	-17.28	.22	6.92	209.19	252.37	169.36	.00	.00	19.69	.00
4	.10	2.89	-.13	-15.98	.18	6.04	159.82	153.14	69.90	.00	.00	-15.27	.00
5	.07	1.93	-.15	-15.64	.17	5.84	55.73	52.97	23.74	.00	.00	-26.49	-7.74
PCRVR			-.59	-13.47	.61	14.89							

TIME	.56000	LL	560										
1	.13	-9.85	-.89	-13.93	.54	9.83	690.17	.00	746.20	48.05	.00	.00	.00
2	.22	-3.70	-.71	-16.74	.45	8.61	328.36	502.20	424.99	.00	.00	-46.30	43.25
3	.25	-.13	-.56	-17.89	.36	7.42	259.28	357.04	276.28	.00	.00	19.30	.00
4	.17	3.94	-.46	-16.54	.30	6.71	190.01	215.48	133.21	.00	.00	5.37	.00
5	.15	5.86	-.45	-14.68	.29	6.53	64.35	73.03	46.61	.00	.00	-27.54	-9.37
PCRVR			-.84	-11.21	.90	14.29							

TIME	.58000	LL	580										
1	-.04	-6.27	-1.10	-8.00	.75	11.50	856.92	.00	840.81	210.65	.00	.00	.00
2	.04	-14.90	-1.02	-14.16	.64	10.90	417.14	681.24	491.05	.00	.00	-129.20	37.28
3	.24	-.75	-.91	-18.22	.53	10.19	272.67	436.05	398.99	.00	.00	35.49	.00
4	.26	5.49	-.79	-16.75	.47	9.69	194.27	245.06	205.57	.00	.00	17.41	.00
5	.26	5.36	-.74	-14.45	.45	9.56	67.49	89.57	66.87	.00	.00	7.39	-9.37
PCRVR			-1.03	-8.24	1.18	13.47							

B-10

COCO SIMULATION
SAMPLE PROBLEM

- 6 -

BK	THETA	THETA0	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME	.60000	LL	600										
1	-.20	-10.91	-1.23	-4.80	1.01	13.46	907.51	.00	850.79	199.82	.00	.00	.00
2	-.26	-13.62	-1.28	-11.33	.89	13.68	502.99	623.04	482.60	.00	.00	-134.18	19.70
3	.16	-7.67	-1.27	-17.33	.77	13.84	252.14	459.10	489.89	.00	.00	-19.78	.00
4	.38	5.55	-1.13	-17.49	.70	13.94	191.12	281.91	289.19	.00	.00	41.78	.00
5	.39	7.96	-1.03	-14.67	.69	13.96	71.63	95.01	76.36	.00	.00	22.46	-8.49
PCRV			-1.16	-4.75	1.44	12.44							
TIME	.62000	LL	620										
1	-.41	-9.94	-1.28	-.75	1.29	14.92	907.54	.00	819.51	252.16	.00	.00	.00
2	-.54	-15.21	-1.47	-8.03	1.19	15.87	504.06	617.34	422.49	.00	.00	-178.20	.00
3	-.03	-10.50	-1.60	-15.49	1.09	16.83	193.63	456.55	494.37	.00	.00	-45.82	.00
4	.45	.73	-1.49	-17.72	1.02	17.47	127.30	280.53	355.81	.00	.00	43.28	.00
5	.52	2.89	-1.34	-16.32	1.01	17.63	64.06	94.31	97.96	.00	.00	43.78	-6.32
PCRV			-1.22	-.97	1.68	11.21							
TIME	.64000	LL	640										
1	-.60	3.46	-1.26	2.94	1.59	14.94	847.87	.00	671.37	281.12	.00	.00	.00
2	-.67	20.49	-1.57	.04	1.51	16.37	493.59	543.47	321.68	317.70	.00	-240.72	-3.35
3	-.05	2.80	-1.75	6.46	1.44	17.75	120.52	402.15	486.53	1177.57	.00	-178.99	.00
4	-.02	-34.78	-1.76	-2.77	1.39	18.23	133.01	245.60	363.59	1231.56	.00	91.36	.00
5	.28	-43.29	-1.69	-17.82	1.38	20.10	24.31	81.62	168.10	78.79	.00	42.68	.00
PCRV			-1.20	2.88	1.89	9.80							
TIME	.66000	LL	660										
1	-.25	11.38	-1.19	4.80	1.88	13.28	695.92	.00	449.54	314.22	.00	.00	.00
2	-.32	6.31	-1.49	7.32	1.83	14.72	363.71	411.38	254.63	267.62	.00	-205.70	-101.18
3	-.08	-1.91	-1.58	8.61	1.78	16.25	58.88	304.42	438.13	923.90	.00	60.66	.00
4	.00	5.77	-1.59	9.93	1.75	16.91	150.86	187.98	140.29	1334.37	.00	59.25	.00
5	-.03	24.78	-1.62	14.75	1.74	16.89	91.21	40.97	134.52	872.55	.00	-28.25	.00
PCRV			-1.11	6.55	2.07	8.24							
TIME	.68000	LL	680										
1	-.21	-3.68	-1.01	11.60	2.11	9.93	419.63	.00	319.64	341.21	.00	.00	.00
2	-.31	-2.26	-1.30	10.64	2.08	10.79	242.06	256.84	143.22	.00	.00	-71.90	-105.58
3	-.12	-2.73	-1.40	9.11	2.06	11.48	51.27	180.90	220.08	.00	.00	-16.99	.00
4	.11	4.74	-1.39	9.82	2.04	12.54	50.63	107.92	121.07	.00	.00	22.55	.00
5	.19	2.72	-1.35	13.15	2.04	12.78	38.75	40.69	52.71	41.89	.00	-20.02	.00
PCRV			-.94	9.80	2.21	6.55							
TIME	.70000	LL	700										
1	-.27	-1.72	-.76	12.63	2.24	4.89	244.64	.00	153.69	164.13	.00	.00	.00
2	-.37	-3.39	-1.07	11.81	2.24	5.01	158.61	138.20	48.70	.00	.00	35.19	-105.12
3	-.13	3.71	-1.20	11.56	2.23	5.98	10.60	101.60	141.80	99.97	.00	-35.22	.00
4	.12	-6.70	-1.19	10.65	2.24	6.53	.00	46.85	119.09	39.29	.00	-21.78	.00
5	.14	-5.86	-1.09	12.81	2.24	6.64	.00	12.19	37.86	.00	.00	8.01	2.52
PCRV			-.72	12.44	2.33	4.75							

B-11

COCO SIMULATION
SAMPLE PROBLEM

- 7 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME	.72000	LL	720										
1	-.30	-1.18	-.50	13.88	2.31	1.00	249.15	.00	121.44	112.45	.00	.00	.00
2	-.42	-1.84	-.62	13.29	2.29	.53	151.51	110.77	14.66	.00	.00	33.09	-100.05
3	-.05	3.20	-.95	13.51	2.20	.54	.00	36.61	117.94	96.67	.00	-29.80	.00
4	-.01	-.36	-.96	13.84	2.29	-.98	2.55	21.37	57.97	168.02	.00	-10.68	.00
5	.11	6.00	-.85	11.03	2.30	-.10	.00	10.56	21.11	.00	.00	6.33	45.67
PCRV			-.45	14.29	2.40	2.88							
TIME	.74000	LL	740										
1	-.32	-.22	-.20	15.23	2.30	-2.19	351.16	.00	218.17	133.52	.00	.00	.00
2	-.42	2.11	-.53	15.60	2.26	-3.20	210.00	193.94	80.93	.00	.00	-17.50	-98.15
3	-.03	-1.60	-.65	15.63	2.24	-5.08	.00	105.15	217.51	63.48	.00	-17.56	.00
4	.01	.37	-.65	15.47	2.22	-5.55	37.90	69.22	65.93	171.41	.00	18.33	.00
5	.17	-7.90	-.43	10.94	2.23	-6.38	.00	.00	35.85	10.35	.00	-7.17	34.58
PCRV			-.15	15.25	2.44	.97							
TIME	.76000	LL	760										
1	-.27	4.72	.11	15.82	2.22	-5.22	497.57	.00	385.68	133.45	.00	.00	.00
2	-.34	4.61	-.20	17.96	2.16	-6.42	280.24	307.90	181.65	.00	.00	25.02	-99.47
3	-.11	-5.96	-.32	17.46	2.11	-7.63	86.78	223.61	248.84	51.88	.00	-13.99	.00
4	-.00	-1.29	-.34	15.56	2.07	-8.93	69.79	144.45	146.88	19.17	.00	25.63	.00
5	-.00	8.05	-.36	16.68	2.06	-8.66	66.15	63.66	46.70	160.12	.00	31.48	.00
PCRV			.15	15.25	2.44	-.97							
TIME	.78000	LL	780										
1	-.20	1.47	.43	15.99	2.10	-6.76	654.37	.00	570.34	92.96	.00	.00	.00
2	-.25	4.23	.17	18.30	2.02	-7.75	356.05	430.44	289.65	.00	.00	96.64	-98.46
3	-.23	-4.08	.04	18.07	1.94	-8.52	226.76	310.18	248.52	23.75	.00	-27.41	.00
4	-.03	-2.59	-.03	16.19	1.89	-8.86	74.99	186.17	211.82	.00	.00	11.36	.00
5	.02	-3.16	-.04	15.34	1.88	-8.97	38.53	63.69	71.34	87.04	.00	29.39	.00
PCRV			.45	14.29	2.40	-2.88							
TIME	.80000	LL	800										
1	-.15	1.87	.75	16.17	1.97	-6.20	753.49	.00	691.26	.00	.00	.00	.00
2	-.20	1.44	.53	17.63	1.87	-6.68	413.23	508.89	350.14	.00	.00	99.66	-87.61
3	-.24	1.96	.40	18.41	1.78	-7.28	287.73	363.51	257.54	.00	.00	-27.55	.00
4	-.13	-6.87	.31	17.02	1.72	-7.69	124.68	218.36	217.25	.00	.00	-9.41	.00
5	-.10	-8.64	.26	14.11	1.71	-7.81	40.49	73.22	71.44	.00	.00	28.41	.60
PCRV			.72	12.44	2.33	-4.75							
TIME	.82000	LL	820										
1	.02	7.29	1.02	9.79	1.85	-5.65	760.29	.00	733.84	.00	233.98	.00	.00
2	-.10	12.59	.87	15.85	1.75	-5.45	455.84	526.10	353.68	.00	.00	165.81	-74.09
3	-.21	-.27	.77	18.93	1.65	-5.36	330.20	387.81	273.76	.00	.00	-31.67	.00
4	-.27	-6.58	.65	17.06	1.59	-5.38	198.82	238.44	200.88	.00	.00	-5.35	.00
5	-.29	-8.44	.54	14.03	1.58	-5.39	69.15	80.47	68.91	.00	.00	13.08	.00
PCRV			.94	9.80	2.21	-6.55							

B-12

COCO SIMULATION
SAMPLE PROBLEM

- 8 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FAL	FAR	FRI	FDS
TIME	.84000	LL	840										
1	.15	10.29	1.17	6.46	1.74	-5.57	723.87	.00	733.19	.00	230.62	.00	.00
2	.21	14.18	1.16	13.17	1.65	-4.85	441.23	521.23	385.96	.00	.00	162.56	-54.22
3	-.19	4.21	1.15	18.40	1.56	-4.04	400.52	386.83	245.57	.00	.00	-25.33	.00
4	-.40	-6.48	.99	17.35	1.51	-3.48	234.65	238.34	156.59	.00	.00	-42.92	.00
5	-.42	-6.25	.82	14.59	1.49	-3.34	70.98	80.42	50.77	.00	.00	-14.34	.00
PCRV			1.11	6.55	2.07	-8.24							

TIME	.86000	LL	860										
1	.37	8.85	1.27	3.08	1.62	-6.10	617.36	.00	686.76	.00	250.34	.00	.00
2	.47	13.62	1.39	9.95	1.55	-5.16	313.33	464.97	384.18	.00	.00	190.75	-31.02
3	-.05	9.29	1.50	16.50	1.48	-4.34	402.07	343.34	113.71	.00	.00	32.67	.00
4	-.49	-2.38	1.34	17.91	1.44	-3.34	274.19	209.83	78.01	.00	.00	-47.55	.00
5	-.55	-3.97	1.13	15.84	1.43	-3.33	68.63	69.56	45.99	.00	.00	-29.85	.00
PCRV			1.20	2.88	1.89	-9.80							

TIME	.88000	LL	880										
1	.50	5.94	1.28	-1.82	1.48	-8.47	439.75	.00	598.56	.00	267.48	.00	.00
2	.70	3.03	1.55	6.40	1.42	-7.80	205.54	367.52	345.78	.00	145.87	183.77	-2.58
3	.09	-9.59	1.77	4.99	1.38	-5.84	387.22	268.84	16.04	.00	1078.59	116.19	.00
4	-.35	41.77	1.69	13.82	1.36	-5.45	280.18	152.81	.00	.00	403.41	71.83	.00
5	-.51	10.47	1.46	17.20	1.36	-4.38	100.14	55.32	16.16	.00	.00	-27.66	-14.14
PCRV			1.22	-4.97	1.68	-11.21							

TIME	.90000	LL	900										
1	.28	-18.56	1.23	-1.79	1.29	-10.05	280.85	.00	491.26	.00	227.88	.00	.00
2	.26	-18.27	1.58	-2.26	1.25	-9.61	140.02	277.76	327.74	.00	245.59	138.89	155.48
3	.03	1.95	1.66	-7.23	1.22	-10.67	354.67	179.84	1.92	.00	1220.53	-59.56	.00
4	.05	-14.22	1.68	-10.77	1.20	-9.21	178.31	106.22	113.18	.00	1252.99	53.11	.00
5	.08	33.18	1.76	-4.11	1.24	-8.68	148.16	26.84	.00	.00	925.47	-29.63	-64.45
PCRV			1.16	-4.75	1.44	-12.44							

TIME	.92000	LL	920										
1	.18	2.34	1.11	-10.28	1.05	-13.88	245.01	.00	354.97	.00	412.36	.00	.00
2	.23	7.64	1.46	-8.20	1.01	-13.68	136.40	190.28	165.44	.00	.00	95.04	172.69
3	.01	-2.48	1.52	-6.80	.98	-13.38	167.62	131.93	45.26	.00	2.14	-51.76	.00
4	-.12	-5.64	1.49	-9.27	.97	-13.68	90.64	69.61	52.88	.00	259.01	-25.71	.00
5	.02	-10.62	1.49	-14.62	.99	-16.40	.00	.00	.00	.00	944.44	.00	13.08
PCRV			1.03	-8.24	1.18	-13.47							

TIME	.94000	LL	940										
1	.27	1.84	.89	-11.50	.74	-16.57	261.69	.00	375.13	.00	281.63	.00	.00
2	.31	-6.62	1.26	-11.96	.70	-17.19	128.56	212.76	190.61	.00	69.72	-63.06	171.62
3	.02	1.61	1.35	-11.52	.67	-18.50	207.41	140.77	7.30	.00	207.41	51.84	.00
4	-.16	2.84	1.30	-10.26	.64	-19.13	144.32	106.42	15.31	.00	64.05	-36.83	.00
5	-.31	-8.69	1.21	-13.57	.63	-17.69	101.15	71.37	53.21	.00	.00	-35.69	.00
PCRV			.84	-11.21	.90	-14.29							

B-13

COCO SIMULATION
SAMPLE PROBLEM

- 9 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBW	FRI	FDS
TIME .96000 LL 960													
1	.21	-2.02	.65	-12.88	.38	-19.36	414.67	.00	501.07	.00	145.11	.00	.00
2	.29	-1.55	1.00	-14.15	.32	-20.33	186.12	316.65	288.89	.00	36.04	-65.80	162.64
3	.04	2.27	1.09	-13.84	.26	-20.85	257.00	221.99	75.99	.00	182.97	16.83	.00
4	-.04	5.51	1.08	-11.71	.23	-20.98	145.54	120.69	61.87	.00	63.67	-6.45	.00
5	-.20	12.38	.95	-12.28	.24	-21.89	99.56	32.67	.00	.00	.00	-26.45	-35.89
PCRVR			.59	-13.47	.61	-14.89							
TIME .98000 LL 980													
1	.21	.41	.36	-15.57	-.01	-18.89	583.71	.00	670.43	.00	155.35	.00	.00
2	.28	.09	.69	-16.18	-.09	-20.05	278.85	429.37	365.26	.00	.00	-68.66	152.83
3	.08	1.08	.79	-15.74	-.16	-21.55	287.90	290.27	147.50	.00	66.31	13.94	.00
4	.01	.99	.81	-15.31	-.21	-22.67	158.97	178.42	108.66	.00	137.99	13.70	.00
5	.04	7.61	.73	-10.55	-.22	-22.43	72.84	71.68	65.41	.00	.00	35.84	-50.14
PCRVR			.30	-14.89	.31	-15.25							
TIME 1.00000 LL 1000													
1	.21	-.09	.04	-16.18	-.38	-18.44	714.97	.00	803.03	.00	112.45	.00	.00
2	.26	-1.34	.35	-17.44	-.48	-19.22	368.04	538.60	439.91	.00	.00	-88.95	143.35
3	.12	3.55	.46	-16.74	-.58	-20.02	346.26	396.05	247.82	.00	45.23	11.60	.00
4	.04	1.76	.50	-15.45	-.64	-20.66	211.87	241.39	150.23	.00	95.17	-23.82	.00
5	.07	-2.38	.50	-12.52	-.66	-20.88	48.97	83.30	77.42	.00	49.86	41.65	-29.02
PCRVR			.00	-15.37	.00	-15.37							
TIME 1.02000 LL 1020													
1	.20	-.94	-.28	-16.01	-.73	-16.60	807.97	.00	891.81	.00	52.83	.00	.00
2	.23	-1.61	.00	-17.66	-.84	-16.96	424.58	599.81	475.18	.00	.00	-116.50	130.41
3	.20	2.73	.13	-17.17	-.95	-17.23	347.26	433.75	313.05	.00	.00	18.89	.00
4	.05	1.00	.18	-16.17	-1.02	-17.25	250.34	263.93	155.09	.00	68.59	-13.34	.00
5	.02	.48	.19	-16.08	-1.04	-17.24	80.25	88.60	74.30	.00	110.79	43.56	.00
PCRVR			-.30	-14.89	-.31	-15.25							
TIME 1.04000 LL 1040													
1	.17	-.86	-.60	-15.94	-1.04	-14.00	826.79	.00	902.75	.00	.00	.00	.00
2	.21	-.86	-.35	-17.27	-1.15	-13.79	431.29	610.65	485.89	.00	.00	-109.17	113.76
3	.21	-.67	-.22	-17.55	-1.26	-13.66	336.89	440.16	329.02	.00	.00	17.86	.00
4	.10	3.80	-.15	-16.69	-1.33	-13.63	251.31	264.19	159.51	.00	.00	2.79	.00
5	.07	5.17	-.12	-15.09	-1.34	-13.64	82.39	88.19	53.22	.00	.00	-26.71	.00
PCRVR			-.59	-13.47	-.61	-14.89							
TIME 1.06000 LL 1060													
1	.06	-10.33	-.90	-12.75	-1.29	-11.96	818.62	.00	889.22	136.61	.00	.00	.00
2	.18	-4.47	-.69	-16.87	-1.40	-11.32	424.48	604.34	482.08	.00	.00	-149.44	97.14
3	.19	-.15	-.58	-17.91	-1.50	-10.73	328.48	437.54	327.84	.00	.00	21.67	.00
4	.19	4.68	-.48	-16.79	-1.56	-10.37	234.74	263.86	185.25	.00	.00	-5.62	.00
5	.19	5.69	-.42	-14.78	-1.58	-10.28	78.24	88.09	64.06	.00	.00	-13.06	.00
PCRVR			-.84	-11.21	-.90	-14.29							

B-14

COCO SIMULATION
SAMPLE PROBLEM

- 10 -

BK	THETA	THETA0	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME 1.08000 LL 1080													
1	-.07	-6.30	-1.10	-7.94	-1.52	-10.71	749.49	.00	791.79	187.63	.00	.00	.00
2	-.05	-14.29	-1.00	-14.16	-1.61	-9.93	357.11	554.46	474.64	.00	.00	-161.77	81.17
3	.21	-.89	-.94	-18.28	-1.70	-9.06	297.35	406.58	351.73	.00	.00	30.04	.00
4	.28	5.03	-.82	-16.87	-1.75	-8.50	185.94	247.73	186.06	.00	.00	27.68	.00
5	.28	3.99	-.71	-14.94	-1.76	-8.35	59.75	82.62	64.27	.00	.00	3.92	.00
PCRV			-1.03	-8.24	-1.18	-13.47							
TIME 1.10000 LL 1100													
1	-.24	-9.76	-1.23	-5.01	-1.73	-10.14	649.59	.00	654.52	207.17	.00	.00	.00
2	-.31	-12.09	-1.26	-11.47	-1.80	-9.52	358.87	474.73	354.86	.00	.00	-183.76	56.45
3	.11	-7.53	-1.30	-17.01	-1.87	-8.87	161.21	343.26	362.87	.00	.00	-20.29	.00
4	.38	3.89	-1.16	-17.62	-1.91	-8.46	126.29	206.46	219.06	.00	.00	41.30	.00
5	.40	6.99	-1.01	-15.40	-1.93	-8.37	49.79	67.97	52.18	.00	.00	22.40	.00
PCRV			-1.16	-4.75	-1.44	-12.44							
TIME 1.12000 LL 1120													
1	-.42	-8.97	-1.28	-.57	-1.93	-10.40	622.78	.00	517.00	259.11	.00	.00	.00
2	-.57	-13.24	-1.45	-7.89	-2.00	-10.25	356.84	397.08	253.55	.00	.00	-190.03	30.03
3	-.08	-12.08	-1.62	-15.17	-2.06	-10.16	61.72	281.21	361.17	.00	.00	-37.91	.00
4	.41	-.22	-1.52	-18.04	-2.09	-9.34	27.61	166.32	267.58	.00	.00	47.34	.00
5	.46	-1.58	-1.34	-16.74	-2.10	-9.34	28.95	54.45	65.99	.00	.00	26.78	.00
PCRV			-1.22	-.97	-1.68	-11.21							
TIME 1.14000 LL 1140													
1	-.57	3.42	-1.25	3.24	-2.15	-11.23	640.21	.00	417.72	259.18	.00	.00	.00
2	-.67	21.47	-1.56	-1.12	-2.22	-11.24	385.41	359.57	191.42	242.41	.00	-179.79	.00
3	-.03	4.53	-1.75	6.39	-2.27	-10.53	17.38	252.34	404.69	1132.26	.00	-125.18	.00
4	-.08	-20.77	-1.77	1.42	-2.30	-11.96	126.04	145.27	275.56	1363.60	.00	-75.95	.00
5	.22	-31.71	-1.69	-18.39	-2.30	-10.02	18.61	53.39	140.40	46.74	.00	31.05	34.31
PCRV			-1.20	2.88	-1.89	-9.80							
TIME 1.16000 LL 1160													
1	-.26	13.80	-1.19	4.16	-2.36	-10.06	643.20	.00	525.21	339.31	.00	.00	.00
2	-.30	5.05	-1.50	6.51	-2.43	-10.77	339.52	402.77	270.55	209.37	.00	-190.97	-110.58
3	-.05	-.65	-1.59	7.93	-2.50	-11.56	117.28	275.38	371.83	859.34	.00	50.29	.00
4	.03	6.40	-1.58	9.66	-2.54	-12.76	144.38	155.47	139.35	1355.48	.00	66.37	.00
5	.00	23.36	-1.62	14.65	-2.55	-13.07	91.13	74.55	94.09	890.45	.00	31.90	10.05
PCRV			-1.11	6.55	-2.07	-8.24							
TIME 1.18000 LL 1180													
1	-.23	-5.34	-1.01	11.96	-2.56	-9.79	733.05	.00	636.42	386.61	.00	.00	.00
2	-.33	-4.14	-1.32	10.30	-2.65	-10.70	417.48	479.95	302.50	.00	.00	-83.81	-115.51
3	-.08	-1.50	-1.42	8.39	-2.73	-11.48	174.56	350.23	350.77	21.30	.00	-34.04	.00
4	.16	6.79	-1.39	9.75	-2.79	-11.76	96.77	216.61	246.00	.00	.00	22.86	.00
5	.21	3.53	-1.36	12.36	-2.80	-11.99	60.86	75.02	80.72	70.71	.00	-32.70	.00
PCRV			-.94	9.80	-2.21	-6.55							

B-15

COCO SIMULATION
SAMPLE PROBLEM

- 11 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME 1.20000 LL 1200													
1	-.34	-4.25	-.76	12.72	-2.74	-7.87	889.29	.00	748.45	174.56	.00	.00	.00
2	-.41	-2.37	-1.10	11.60	-2.84	-8.68	477.86	569.04	375.75	.00	.00	36.03	-114.87
3	-.04	3.68	-1.22	11.81	-2.94	-9.33	178.00	399.94	431.19	123.85	.00	-45.28	.00
4	.17	-4.06	-1.18	11.57	-3.00	-9.64	107.19	238.11	264.20	30.59	.00	-22.72	.00
5	.25	-3.37	-1.13	10.48	-3.02	-9.71	37.85	78.89	96.89	.00	.00	39.44	.00
PCRV			-.72	12.44	-2.33	-4.75							

TIME 1.22000 LL 1220													
1	-.32	6.44	-.50	12.96	-2.84	-4.49	977.27	.00	844.43	134.48	.00	.00	.00
2	-.39	2.99	-.84	14.61	-2.98	-4.98	528.95	640.21	431.43	7.50	.00	-10.75	-111.76
3	-.03	-2.05	-.95	14.82	-3.09	-5.65	216.96	457.53	469.33	138.83	.00	-12.15	.00
4	.06	-6.77	-.93	12.47	-3.16	-6.16	173.68	274.58	248.26	21.73	.00	-12.94	.00
5	.07	-9.64	-.94	9.38	-3.18	-6.30	67.07	92.29	97.27	.00	.00	39.67	.00
PCRV			-.45	14.29	-2.40	-2.88							

TIME 1.24000 LL 1240													
1	-.24	.95	-.21	16.00	-2.91	-1.14	992.33	.00	893.74	172.84	.00	.00	.00
2	-.32	2.70	-.52	17.14	-3.04	-1.18	556.82	668.23	447.71	.00	.00	27.85	-111.98
3	-.10	-4.08	-.64	16.63	-3.16	-1.25	288.08	488.46	469.43	82.04	.00	-14.05	.00
4	-.01	2.21	-.66	15.99	-3.24	-1.30	200.45	298.89	258.00	141.50	.00	-20.12	.00
5	.03	2.42	-.67	17.31	-3.26	-1.30	77.45	100.70	90.92	251.40	.00	50.32	.00
PCRV			-.15	15.25	-2.44	-.97							

TIME 1.26000 LL 1260													
1	-.23	-.15	.12	16.80	-2.90	2.31	992.28	.00	894.15	137.99	.00	.00	.00
2	-.28	1.98	-.16	18.11	-3.02	2.70	553.90	668.34	452.10	.00	.00	78.37	-110.43
3	-.17	-3.21	-.29	17.57	-3.14	3.14	314.80	488.61	442.41	67.64	.00	-20.78	.00
4	.00	-1.10	-.33	16.47	-3.21	3.46	188.23	298.95	275.87	85.57	.00	20.49	.00
5	.03	-.93	-.33	16.24	-3.23	3.55	61.66	100.66	90.77	120.36	.00	41.81	.00
PCRV			.15	15.25	-2.44	.97							

TIME 1.28000 LL 1280													
1	-.21	2.62	.45	16.32	-2.82	5.42	961.15	.00	866.49	33.95	.00	.00	.00
2	-.24	1.50	.20	17.89	-2.93	6.11	520.61	645.74	448.06	.00	.00	95.28	-101.08
3	-.20	-.03	.07	18.14	-3.04	6.75	315.83	467.85	386.58	.00	.00	-21.24	.00
4	-.06	-4.49	.00	16.92	-3.10	7.13	148.59	282.52	275.19	.00	.00	7.43	.00
5	-.02	-5.05	-.02	15.19	-3.12	7.22	56.94	93.84	83.86	.00	.00	21.24	.00
PCRV			.45	14.29	-2.40	2.88							

TIME 1.30000 LL 1300													
1	-.12	9.04	.77	14.81	-2.69	7.45	872.17	.00	783.73	.00	53.98	.00	.00
2	-.20	3.22	.55	17.71	-2.78	8.21	463.63	544.46	413.11	.00	.00	80.22	-87.56
3	-.20	.25	.43	18.52	-2.88	8.97	303.57	422.34	329.94	.00	.00	-14.68	.00
4	-.16	-5.56	.34	17.12	-2.93	9.43	154.04	253.94	240.67	.00	.00	4.66	.00
5	-.16	-7.18	.28	14.65	-2.95	9.54	53.76	84.15	78.91	.00	.00	17.56	.00
PCRV			.72	12.44	-2.33	4.75							

B-16

COCO SIMULATION
SAMPLE PROBLEM

- 12 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME 1.32000 LL 1320													
1	.03	5.91	1.01	9.61	-2.53	8.54	741.26	.00	693.32	.00	172.19	.00	.00
2	-.02	13.86	.89	15.62	-2.61	9.13	424.60	505.08	333.06	.00	.00	145.87	-75.16
3	-.21	-.90	.81	19.03	-2.69	9.76	300.14	365.08	275.09	.00	.00	-26.47	.00
4	-.27	-5.66	.69	17.07	-2.73	10.16	159.22	219.80	175.05	.00	.00	-17.11	.00
5	-.28	-5.13	.57	14.79	-2.74	10.25	54.57	72.68	55.03	.00	.00	-4.37	.00
PCRVR			.94	9.80	-2.21	6.55							

TIME 1.34000 LL 1340													
1	.19	9.89	1.17	6.78	-2.35	9.06	613.15	.00	630.28	.00	182.98	.00	.00
2	.24	12.00	1.17	13.05	-2.42	9.28	346.51	433.59	329.16	.00	.00	166.55	-53.93
3	-.17	5.68	1.18	18.05	-2.49	9.52	349.80	308.22	158.86	.00	.00	18.21	.00
4	-.39	-5.27	1.03	17.74	-2.53	9.67	199.97	183.27	115.12	.00	.00	-42.18	.00
5	-.40	-7.26	.87	15.15	-2.54	9.69	49.00	60.20	41.29	.00	.00	-16.07	.00
PCRVR			1.11	6.55	-2.07	8.24							

TIME 1.36000 LL 1360													
1	.38	9.08	1.27	2.74	-2.17	9.21	524.23	.00	641.17	.00	258.11	.00	.00
2	.50	13.54	1.40	9.51	-2.24	9.00	257.71	391.59	366.76	.00	.00	185.66	-29.76
3	-.00	10.09	1.52	16.29	-2.31	8.69	382.36	274.91	60.17	.00	.00	33.43	.00
4	-.45	-1.35	1.39	18.20	-2.35	9.02	272.56	161.74	39.14	.00	.00	-46.08	.00
5	-.51	-1.45	1.19	16.43	-2.36	8.90	69.41	57.10	33.33	.00	.00	-28.55	.00
PCRVR			1.20	2.88	-1.89	9.80							

TIME 1.38000 LL 1380													
1	.57	10.35	1.28	-1.40	-1.98	9.33	493.87	.00	733.43	.00	270.17	.00	.00
2	.75	1.22	1.55	4.59	-2.06	8.83	215.06	425.63	435.27	.00	197.69	212.82	-5.57
3	.08	-11.53	1.78	2.04	-2.14	9.23	456.19	294.33	32.07	.00	1102.89	128.16	.00
4	-.19	51.27	1.74	12.25	-2.17	7.80	303.45	180.86	11.33	.00	512.73	87.18	.00
5	-.43	16.43	1.53	18.14	-2.18	9.18	139.09	59.29	21.60	.00	.00	-35.90	-34.37
PCRVR			1.22	-4.97	-1.68	11.21							

TIME 1.40000 LL 1400													
1	.38	-12.60	1.23	-2.14	-1.78	10.76	607.80	.00	768.26	.00	289.91	.00	.00
2	.42	-9.39	1.53	-5.01	-1.87	10.14	321.99	478.18	429.94	.00	244.81	237.37	65.54
3	.06	2.40	1.65	-7.36	-1.96	9.59	457.92	336.24	127.23	.00	1128.56	-75.75	.00
4	.02	-8.69	1.67	-9.36	-2.00	9.30	185.79	193.93	167.09	.00	1267.45	-71.39	.00
5	.14	-4.75	1.75	-8.99	-2.02	7.28	162.37	69.12	109.72	.00	913.57	-36.33	-54.17
PCRVR			1.16	-4.75	-1.44	12.44							

TIME 1.42000 LL 1420													
1	.22	3.10	1.11	-9.97	-1.55	12.02	704.96	.00	796.73	.00	335.00	.00	.00
2	.35	.16	1.38	-9.19	-1.65	11.50	326.21	529.63	468.28	.00	.00	145.26	78.69
3	.13	3.46	1.50	-7.92	-1.75	10.86	374.76	388.63	213.94	.00	21.94	28.90	.00
4	-.12	-7.38	1.49	-8.90	-1.81	10.77	267.67	262.87	123.10	.00	14.30	-83.61	.00
5	-.20	-9.12	1.48	-12.53	-1.83	10.68	93.99	96.49	115.77	.00	785.25	-48.25	6.56
PCRVR			1.03	-8.24	-1.18	13.47							

B-17

COCO SIMULATION
SAMPLE PROBLEM

- 13 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FRL	FBR	FRI	FDS
TIME 1.44000 LL 1440													
1	.31	3.81	.88	-11.93	-1.30	13.55	734.02	.00	844.42	.00	237.33	.00	.00
2	.40	3.27	1.18	-10.48	-1.41	13.42	363.76	561.27	478.20	.00	.00	26.35	79.66
3	.11	-3.90	1.32	-10.32	-1.51	13.43	404.60	403.65	223.98	.00	74.85	42.19	.00
4	-.16	2.64	1.30	-10.62	-1.57	13.44	290.39	243.75	93.13	.00	17.91	26.20	.00
5	-.23	3.53	1.25	-10.44	-1.58	13.50	97.92	83.21	27.41	.00	.00	-41.61	.00
PCRV			.84	-11.21	-.90	14.29							
TIME 1.46000 LL 1460													
1	.35	-1.31	.63	-12.54	-1.00	15.81	735.01	.00	875.95	.00	124.53	.00	.00
2	.43	-.23	.95	-12.45	-1.11	16.01	369.11	564.91	479.24	.00	.00	33.10	82.96
3	.05	-1.55	1.09	-12.77	-1.21	16.09	433.91	403.34	197.97	.00	75.69	32.00	.00
4	-.07	6.11	1.07	-11.62	-1.27	16.11	275.20	243.62	136.08	.00	16.94	-8.68	.00
5	-.10	8.32	1.06	-8.96	-1.29	16.11	94.13	81.25	48.70	.00	.00	-40.63	.00
PCRV			.59	-13.47	-.61	14.89							
TIME 1.48000 LL 1480													
1	.29	-1.94	.36	-14.86	-.67	17.23	717.86	.00	862.44	.00	185.54	.00	.00
2	.39	-2.44	.67	-15.45	-.77	17.76	362.26	558.01	474.80	.00	.00	44.05	89.29
3	.06	1.94	.80	-15.48	-.87	18.25	433.98	401.78	168.68	.00	98.53	15.83	.00
4	.01	-1.93	.81	-15.44	-.92	18.52	222.47	240.83	164.12	.00	176.94	10.09	.00
5	-.01	-2.78	.82	-16.66	-.94	18.60	70.72	80.23	58.09	.00	252.51	-40.10	.00
PCRV			.30	-14.89	-.31	15.25							
TIME 1.50000 LL 1500													
1	.26	-1.76	.05	-16.39	-.32	17.86	665.19	.00	787.86	.00	183.31	.00	.00
2	.34	-3.05	.34	-17.66	-.40	18.55	326.47	515.46	446.77	.00	.00	32.85	91.00
3	.12	4.13	.47	-17.21	-.49	19.31	398.00	377.63	168.45	.00	89.65	15.46	.00
4	-.02	.03	.49	-16.21	-.54	19.81	195.24	230.42	152.44	.00	138.60	-12.90	.00
5	-.04	-1.20	.49	-16.38	-.55	19.94	65.46	77.07	50.15	.00	177.33	-33.02	.00
PCRV			.00	-15.37	-.00	15.37							
TIME 1.52000 LL 1520													
1	.23	-1.32	-.28	-16.29	.04	17.74	579.64	.00	689.34	.00	89.74	.00	.00
2	.27	-3.42	-.02	-18.15	-.03	18.41	286.49	447.67	385.05	.00	.00	-75.75	90.05
3	.20	2.99	.12	-18.02	-.10	19.08	319.46	324.24	176.33	.00	20.45	24.57	.00
4	.01	3.21	.17	-16.36	-.14	19.47	194.59	195.11	98.13	.00	.00	-21.93	.00
5	-.02	1.95	.17	-15.45	-.15	19.57	59.22	64.30	37.24	.00	.00	-22.42	.00
PCRV			-.30	-14.89	.31	15.25							
TIME 1.54000 LL 1540													
1	.17	-3.35	-.60	-15.93	.38	16.62	484.79	.00	581.39	.00	1.87	.00	.00
2	.22	-2.57	-.38	-17.78	.32	17.09	249.46	373.51	310.85	.00	.00	-80.24	81.58
3	.22	-.55	-.25	-18.48	.27	17.56	223.54	246.75	177.06	.00	.00	24.95	.00
4	.11	6.01	-.17	-16.96	.23	17.84	185.28	188.58	61.68	.00	.00	4.23	.00
5	.08	7.93	-.13	-14.38	.22	17.90	55.79	52.04	22.83	.00	.00	-23.05	.00
PCRV			-.59	-13.47	.61	14.89							

B-18

COCO SIMULATION
SAMPLE PROBLEM

- 14 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FAL	FAR	FPI	FDS
TIME 1.56000 LL 1560													
1	.04	-10.06	-.90	-12.63	.70	14.84	414.07	.00	484.38	158.45	.00	.00	.00
2	.15	-6.72	-.74	-17.19	.64	15.00	204.71	313.05	265.13	.00	.00	-135.89	70.32
3	.21	-.01	-.62	-18.78	.59	15.21	164.98	222.70	169.08	.00	.00	24.51	.00
4	.24	6.37	-.51	-17.07	.56	15.33	135.64	132.57	99.45	.00	.00	2.94	.00
5	.25	7.79	-.41	-14.21	.56	15.35	45.64	43.62	33.86	.00	.00	-12.64	.00
PCRV			-.84	-11.21	.90	14.29							
TIME 1.58000 LL 1580													
1	-.10	-7.44	-1.10	-8.09	.97	12.94	431.67	.00	413.45	197.19	.00	.00	.00
2	-.11	-14.53	-1.05	-14.43	.92	12.78	220.74	282.91	265.02	.00	.00	-140.71	57.07
3	.21	-1.24	-1.00	-18.79	.87	12.63	124.51	196.91	259.27	.00	.00	26.07	.00
4	.36	6.02	-.88	-17.16	.84	12.53	72.92	116.10	138.72	.00	.00	33.42	.00
5	.37	5.34	-.70	-14.69	.83	12.48	22.91	38.30	36.94	.00	.00	10.46	.00
PCRV			-1.03	-8.24	1.18	13.47							
TIME 1.60000 LL 1600													
1	-.28	-8.41	-1.23	-4.77	1.21	11.16	508.36	.00	392.28	215.06	.00	.00	.00
2	-.36	-11.19	-1.31	-11.67	1.15	10.75	286.07	312.26	200.68	.00	.00	-156.13	30.92
3	.11	-8.06	-1.36	-17.18	1.10	10.26	31.16	220.42	331.55	.00	.00	-27.20	.00
4	.46	4.04	-1.20	-17.82	1.07	10.29	32.25	126.23	217.65	.00	.00	48.78	.00
5	.50	6.07	-1.00	-15.55	1.06	10.13	23.97	45.82	50.38	.00	.00	22.91	.00
PCRV			-1.16	-4.75	1.44	12.44							
TIME 1.62000 LL 1620													
1	-.43	-7.76	-1.28	-.78	1.42	9.52	602.72	.00	423.22	250.45	.00	.00	.00
2	-.58	-11.35	-1.51	-8.23	1.35	9.04	361.29	359.40	182.17	.00	.00	-179.71	.00
3	-.10	-12.56	-1.68	-15.14	1.28	8.64	26.01	258.76	362.14	.00	.00	-40.55	.00
4	.50	-.91	-1.56	-18.35	1.26	9.04	.00	125.84	288.88	.00	.00	46.20	.00
5	.55	-.87	-1.33	-16.85	1.25	9.03	18.04	52.67	62.11	.00	.00	26.33	.00
PCRV			-1.22	-.97	1.68	11.21							
TIME 1.64000 LL 1640													
1	-.48	13.49	-1.26	2.02	1.60	9.03	671.70	.00	470.13	261.78	.00	.00	.00
2	-.48	24.88	-1.59	.94	1.53	8.96	388.91	391.30	269.58	273.89	.00	-195.66	-72.11
3	-.03	-2.03	-1.73	7.62	1.46	8.15	43.78	266.24	406.66	1124.42	.00	-123.19	.00
4	-.11	-7.00	-1.76	4.54	1.41	7.31	161.60	180.29	292.61	1222.66	.00	-79.32	.00
5	.21	-35.57	-1.69	-19.20	1.43	8.82	16.95	52.99	164.36	39.92	.00	33.77	61.64
PCRV			-1.20	2.88	1.89	9.80							
TIME 1.66000 LL 1660													
1	-.20	4.01	-1.19	7.23	1.78	8.23	668.24	.00	539.54	362.24	.00	.00	.00
2	-.31	.03	-1.50	7.50	1.70	8.39	373.24	414.32	287.43	105.06	.00	-201.65	-114.40
3	-.06	-1.59	-1.59	7.03	1.62	8.45	133.66	300.08	349.33	403.38	.00	77.93	.00
4	.05	7.44	-1.58	8.80	1.58	7.47	163.19	183.45	174.57	1121.29	.00	64.19	.00
5	.02	25.18	-1.62	14.81	1.56	7.59	113.79	94.30	69.71	923.13	.00	47.15	-10.58
PCRV			-1.11	6.55	2.07	8.24							

B-19

COCO SIMULATION
SAMPLE PROBLEM

- 15 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FHL	FHR	FRI	FDS
TIME	1.68000 LL	1680											
1	-.27	-4.44	-.99	11.06	1.93	7.20	622.06	.00	540.01	338.90	.00	.00	.00
2	-.36	-3.66	-1.32	9.75	1.86	7.36	373.58	410.91	250.94	.00	.00	29.77	-115.20
3	-.09	1.73	-1.43	8.82	1.78	7.67	142.20	305.13	321.39	81.43	.00	-40.98	.00
4	.17	1.36	-1.40	9.64	1.73	8.14	98.08	201.19	230.83	33.35	.00	25.87	.00
5	.25	.24	-1.36	12.27	1.72	8.10	73.27	91.65	82.54	77.47	.00	33.54	-5.37
PCRV			-.94	9.80	2.21	6.55							

TIME	1.70000 LL	1700											
1	-.32	-.34	-.77	11.63	2.06	6.27	620.92	.00	504.14	120.46	.00	.00	.00
2	-.40	.09	-1.11	11.53	2.00	6.65	355.30	403.09	249.36	.00	.00	30.12	-113.00
3	-.03	1.73	-1.22	11.94	1.93	7.08	127.47	299.88	329.82	101.83	.00	-40.83	.00
4	.10	-5.43	-1.19	10.95	1.89	7.39	70.37	179.85	224.75	36.56	.00	7.67	.00
5	.13	-7.20	-1.13	10.83	1.88	7.47	24.56	59.62	81.66	.00	.00	29.81	.00
PCRV			-.72	12.44	2.33	4.75							

TIME	1.72000 LL	1720											
1	-.27	2.99	-.51	14.08	2.18	4.80	589.90	.00	454.15	201.37	.00	.00	.00
2	-.36	2.35	-.84	14.96	2.12	5.28	327.31	364.96	220.17	6.98	.00	-27.35	-114.64
3	-.04	-2.55	-.95	14.85	2.06	5.66	61.64	258.14	326.62	116.15	.00	-11.69	.00
4	-.01	-3.52	-.96	13.21	2.02	5.82	93.61	154.00	159.04	177.96	.00	-10.58	.00
5	.00	-9.87	-.93	9.94	2.01	5.85	25.94	50.29	50.48	.00	.00	25.15	.00
PCRV			-.45	14.29	2.40	2.88							

TIME	1.74000 LL	1740											
1	-.24	.98	-.20	16.19	2.25	2.37	906.28	.00	393.76	200.67	.00	.00	.00
2	-.32	2.32	-.52	17.37	2.20	2.76	294.94	317.55	181.42	.00	.00	40.73	-115.02
3	-.10	-3.83	-.63	16.82	2.15	3.22	70.42	230.08	282.90	85.25	.00	-14.34	.00
4	-.01	.68	-.65	15.96	2.12	3.53	93.09	138.03	121.72	216.47	.00	7.38	.00
5	-.01	4.29	-.66	16.96	2.11	3.62	49.52	45.75	39.14	173.82	.00	-22.88	.00
PCRV			-.15	15.25	2.44	.97							

TIME	1.76000 LL	1760											
1	-.22	1.45	.12	16.36	2.27	-.30	436.44	.00	334.46	95.37	.00	.00	.00
2	-.27	2.72	-.16	18.14	2.22	-.11	251.12	270.16	154.14	.00	.00	84.63	-112.34
3	-.19	-3.79	-.29	17.61	2.18	.12	98.63	195.22	221.49	36.09	.00	-24.12	.00
4	-.02	-1.72	-.33	16.15	2.16	.28	54.82	118.13	134.35	17.07	.00	13.25	.00
5	.01	-2.31	-.33	15.92	2.15	.32	24.94	39.09	41.81	73.87	.00	19.54	.00
PCRV			.15	15.25	2.44	-.97							

TIME	1.78000 LL	1780											
1	-.18	2.62	.45	16.00	2.23	-3.08	393.28	.00	304.90	21.66	.00	.00	.00
2	-.22	1.98	.20	17.75	2.19	-3.16	215.00	240.10	148.08	.00	.00	97.51	-101.98
3	-.22	.25	.07	18.19	2.15	-3.25	123.39	166.81	150.03	.00	.00	-25.25	.00
4	-.11	-6.19	-.01	16.54	2.12	-3.34	31.33	97.36	134.47	.00	.00	3.67	.00
5	-.08	-6.54	-.02	15.11	2.12	-3.37	12.00	31.92	39.31	.30	.00	15.96	.00
PCRV			.45	14.29	2.40	-2.88							

B-20

COCO SIMULATION
SAMPLE PROBLEM

- 16 -

AK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FBI	FBS
TIME	1.80000	LL	1800										
1	-.13	6.58	.76	15.79	2.14	-5.87	398.73	.00	345.89	.00	36.87	.00	.00
2	-.18	2.47	.55	17.58	2.09	-6.17	222.66	257.11	163.41	.00	.00	85.03	-87.77
3	-.21	.32	.44	18.31	2.05	-6.46	147.90	180.29	122.53	.00	.00	-15.45	.00
4	-.22	-5.24	.33	16.95	2.02	-6.64	84.60	107.50	111.03	.00	.00	-5.85	.00
5	-.22	-7.32	.27	14.51	2.01	-6.69	24.90	36.00	35.80	.00	.00	17.10	.00
PCRVR			.72	12.44	2.33	-4.75							

TIME	1.82000	LL	1820										
1	.03	5.16	1.01	9.55	2.00	-8.15	424.29	.00	437.78	.00	189.03	.00	.00
2	-.04	12.20	.89	15.77	1.94	-8.59	262.16	298.51	193.56	.00	.00	149.26	-75.23
3	-.23	-1.30	.81	18.61	1.89	-9.01	224.67	209.40	122.66	.00	.00	-21.87	.00
4	-.32	-4.69	.67	16.83	1.86	-9.28	125.85	124.68	75.26	.00	.00	-14.35	.00
5	-.34	-4.17	.56	14.89	1.85	-9.36	40.95	41.79	28.27	.00	.00	-10.09	.00
PCRVR			.94	9.80	2.21	-6.55							

TIME	1.84000	LL	1840										
1	.18	9.10	1.17	6.77	1.82	-9.78	459.72	.00	534.38	.00	185.12	.00	.00
2	.23	12.14	1.18	12.92	1.75	-10.24	252.40	346.70	291.58	.00	.00	161.36	-48.53
3	-.20	4.88	1.17	17.73	1.69	-10.71	333.72	246.05	85.89	.00	.00	17.09	.00
4	-.41	-4.34	1.01	17.42	1.65	-11.01	187.22	147.75	60.71	.00	.00	-44.93	.00
5	-.42	-5.42	.87	15.36	1.64	-11.10	41.39	49.68	33.42	.00	.00	-13.82	.00
PCRVR			1.11	6.55	2.07	-8.24							

TIME	1.86000	LL	1860										
1	.36	8.75	1.27	2.74	1.61	-10.90	475.85	.00	627.98	.00	259.21	.00	.00
2	.47	13.03	1.40	9.32	1.54	-11.27	229.16	387.56	360.15	.00	.00	183.71	-23.43
3	-.04	10.07	1.51	15.93	1.47	-11.72	390.87	279.79	34.33	.00	.00	32.50	.00
4	-.47	-8.85	1.36	17.98	1.42	-11.66	273.06	164.33	31.96	.00	.00	-46.51	.00
5	-.52	-2.00	1.18	16.59	1.41	-11.79	70.30	58.69	32.81	.00	.00	-29.35	.00
PCRVR			1.20	2.88	1.89	-9.80							

TIME	1.88000	LL	1880										
1	.55	10.15	1.28	-1.46	1.38	-11.80	477.31	.00	701.18	.00	269.19	.00	.00
2	.74	6.73	1.55	5.04	1.30	-11.95	220.05	413.88	427.61	.00	151.92	206.95	.00
3	.09	-10.04	1.77	4.45	1.23	-11.66	451.65	299.63	35.28	.00	1083.30	144.97	.00
4	-.27	44.35	1.71	13.74	1.19	-12.21	310.85	163.56	.00	.00	383.24	-51.91	.00
5	-.45	14.58	1.53	18.18	1.18	-11.31	123.23	62.51	21.99	.00	.00	-35.14	.00
PCRVR			1.22	-.97	1.68	-11.21							

TIME	1.90000	LL	1900										
1	.37	-15.51	1.23	-2.40	1.14	-11.87	511.33	.00	714.79	.00	266.97	.00	.00
2	.41	-12.39	1.53	-4.52	1.07	-11.84	276.75	416.97	424.53	.00	240.25	208.49	74.54
3	.06	2.14	1.66	-7.71	.99	-11.78	455.47	295.98	99.36	.00	1171.46	-57.95	.00
4	.04	-11.88	1.68	-10.60	.95	-11.61	218.64	184.40	166.10	.00	1324.03	85.80	.00
5	.19	-5.50	1.75	-8.96	.94	-13.17	160.47	48.26	106.93	.00	936.93	-36.56	-32.57
PCRVR			1.16	-4.75	1.44	-12.44							

B-21

COCO SIMULATION
SAMPLE PROBLEM

- 17 -

BK	THETA	THETAD	U	UD	W	WD	FVL	FVC	FVR	FBL	FBR	FRI	FDS
TIME 1.92000 LL 1920													
1	.21	1.75	1.11	-9.81	.90	-12.54	526.73	.00	663.60	.00	339.68	.00	.00
2	.33	.27	1.39	-9.21	.83	-12.37	274.60	413.18	368.25	.00	.00	206.60	88.05
3	.11	3.36	1.50	-8.05	.75	-12.34	339.55	295.50	142.51	.00	41.27	-41.25	.00
4	-.10	-7.63	1.49	-9.28	.71	-12.14	211.84	185.65	114.40	.00	145.14	-83.04	.00
5	-.19	-8.05	1.48	-13.05	.70	-12.03	85.32	75.52	111.49	.00	810.91	-37.76	.00
PCRVR			1.03	-8.24	1.18	-13.47							
TIME 1.94000 LL 1940													
1	.29	3.77	.88	-12.01	.64	-13.66	512.79	.00	600.49	.00	251.07	.00	.00
2	.38	3.46	1.18	-10.62	.57	-13.41	231.33	394.12	361.53	.00	.00	25.28	88.78
3	.11	-3.46	1.32	-10.23	.50	-12.98	294.22	291.50	144.20	.00	72.68	41.99	.00
4	-.16	3.09	1.29	-10.28	.46	-12.69	230.71	182.73	59.17	.00	5.85	15.91	.00
5	-.21	2.07	1.23	-11.60	.45	-12.59	84.33	87.20	20.86	.00	.00	-28.60	.00
PCRVR			.84	-11.21	.90	-14.29							
TIME 1.96000 LL 1960													
1	.33	-1.14	.64	-12.52	.36	-14.33	466.63	.00	589.94	.00	121.91	.00	.00
2	.41	-.31	.95	-12.50	.29	-14.20	219.87	368.84	333.43	.00	.00	26.55	89.83
3	.05	-1.29	1.09	-12.78	.23	-14.12	310.10	263.41	99.71	.00	82.66	36.77	.00
4	-.05	7.02	1.08	-11.23	.19	-14.07	210.56	157.75	72.94	.00	17.89	5.02	.00
5	-.08	8.62	1.01	-10.33	.18	-14.06	61.76	52.28	20.65	.00	.00	-26.14	.00
PCRVR			.59	-13.47	.61	-14.89							
TIME 1.98000 LL 1980													
1	.28	-1.77	.36	-14.93	.06	-15.40	437.21	.00	572.13	.00	186.78	.00	.00
2	.38	-2.20	.67	-15.49	-.01	-15.43	207.27	349.95	319.30	.00	.00	38.11	95.19
3	.06	1.17	.80	-15.66	-.07	-15.47	310.11	245.63	72.88	.00	110.26	15.17	.00
4	.02	-.89	.81	-15.67	-.10	-15.53	140.14	147.59	99.20	.00	232.64	14.78	.00
5	.08	-1.44	.81	-11.25	-.11	-15.55	49.79	49.44	63.42	.00	59.08	24.72	-4.84
PCRVR			.30	-14.89	.31	-15.25							
TIME 2.00000 LL 2000													
1	.25	-2.01	.05	-16.38	-.26	-16.35	466.90	.00	572.26	.00	183.40	.00	.00
2	.33	-3.04	.34	-17.76	-.33	-16.58	223.04	340.39	318.38	.00	.00	-28.51	96.39
3	.12	4.84	.47	-17.14	-.39	-16.75	294.51	254.08	119.03	.00	78.71	13.69	.00
4	.01	-.46	.49	-16.02	-.43	-16.82	153.04	151.48	96.73	.00	152.83	-8.56	.00
5	-.02	-1.10	.50	-16.42	-.44	-16.83	50.13	50.39	61.63	.00	157.21	-25.09	.00
PCRVR			.00	-15.37	.00	-15.37							
TIME 2.00000 LL 2000													
1	.25	-2.01	.05	-16.38	-.26	-16.35	466.90	.00	572.26	.00	89.79	.00	.00
2	.33	-3.04	.34	-17.76	-.33	-16.58	223.04	360.39	317.57	.00	.00	-28.51	95.14
3	.12	4.84	.47	-17.14	-.39	-16.75	262.10	254.08	119.03	.00	23.06	13.69	.00
4	.01	-.46	.49	-16.02	-.43	-16.82	153.04	151.48	74.18	.00	.00	-7.77	.00
5	-.02	-1.10	.50	-16.42	-.44	-16.83	50.13	50.39	25.47	.00	8.42	-11.62	.00
PCRVR			.00	-15.37	.00	-15.37							

B-22

OUTPUT SUMMARY

SUMMATION OF FORCES

BLK NO	MAX (LB)	TIME (SEC)	BOTTOM SIDE		TIME (SEC)	MAX (LB)	RIGHT SIDE		MAX (LB)	LEFT SIDE	
			MIN (LB)				TIME (SEC)			TIME (SEC)	
1	2640.5374	.1650	128.3551		.0490	720.7917	.0120		386.6114	1.1650	
2	2321.3578	.1720	72.4867		.0360	352.0119	.0410		449.1710	.1390	
3	1712.6196	.1810	.0000		.0430	1289.6711	.3920		1551.7303	.1400	
4	1068.4116	.1850	.0000		.0370	1386.4169	.3980		1811.1818	.1420	
5	685.9523	.1260	.0000		.0340	944.4351	.9010		923.1289	1.6490	

VERTICAL FORCES

BLK NO	RIGHT		CENTER		LEFT	
	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)
1	1272.5930	.1660	.0000	.0000	1370.5991	.1620
2	723.0027	.3870	928.5083	.1720	783.5403	.1650
3	646.7597	.1390	685.0479	.1810	688.3214	.3910
4	402.1051	.1870	427.3647	.1850	465.7134	.3830
5	171.4715	.1260	274.3706	.1260	244.2864	.1270

OUTPUT SUMMARY

HORIZONTAL FORCES RIGHT SIDE

BLK NO	TOP		CENTER		BOTTOM	
	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)
1	307.2906	.4000	288.3383	.0120	181.2798	.0110
2	352.0119	.0410	.0000	.0000	.0000	.0000
3	483.4914	.3910	515.8842	.3920	311.2064	.0410
4	578.4815	1.8900	554.5901	.3980	472.3628	.3900
5	362.3929	.4040	377.8061	.9010	243.6560	.9000

LEFT SIDE

BLK NO	TOP		CENTER		BOTTOM	
	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)
1	305.3797	.1440	154.7600	1.1650	80.1750	.0950
2	449.1710	.1390	.0000	.0000	.0000	.0000
3	614.0053	.1400	620.7350	.1400	316.9900	.1400
4	562.6805	1.1420	724.4728	.1420	564.1201	.1400
5	334.4468	.6500	369.2999	1.6490	277.7725	.1430

OUTPUT SUMMARY

DISPLACEMENTS AND VELOCITIES

BLK NO	THETA		THETA DOT		U	U DOT	
	MAX (DEG)	TIME (SEC)	MAX (DEG/SEC)	TIME (SEC)		MAX (IN/SEC)	TIME (SEC)
1	.6753	.3980	30.7533	.0350	-1.3002	.1220	-21.6001 .0200
2	.7532	1.3800	-30.7551	.8910	-1.5989	.1390	18.4783 .7720
3	-.2881	.2640	-18.0596	.1320	-1.7816	.1390	-19.6365 .1160
4	-.5077	.8720	-59.9209	.8850	-1.7888	.1410	-19.8927 .1320
5	-.5614	.8660	80.8179	.3970	-1.7758	.1430	19.3266 1.3880

BLK NO	W		W DOT	
	MAX (IN)	TIME (SEC)	MAX (IN/SEC)	TIME (SEC)
2	2.3138	.7270	20.9770	.4400
3	2.2901	.7230	22.8235	.4390
4	2.2933	.7210	-27.8166	.0910
5	2.2898	.7160	-32.8140	.1060
	2.2982	.7190	-37.0236	.1190

OUTPUT SUMMARY

BLK NO	DOWEL FORCE		FRICTION FORCE	
	MAX (LB)	TIME (SEC)	MAX (LB)	TIME (SEC)
1	.0000	.0000	.0000	.0000
2	172.8904	.9130	351.5800	.3960
3	.0000	.0000	-272.6509	.1330
4	.0000	.0000	117.5144	.1320
5	-64.4517	.8870	-89.9904	.1220

EXIT LOC022042

FIN

CR