APPENDIX A

A-1 THREE-DIMENSIONAL CONTROL MODEL

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NOTE ----- CONSTANTS -----
N M=W/G
NOTE M-MASS OF VEHICLE (LB-SEC^2/FT)
C W=6000
NOTE W-WEIGHT OF VEHICLE (LB)
C G=32.2
NOTE G-ACCEL. DUE TO GRAVITY (FT/SEC^2)

C TEC=120
NOTE TEC-TIME ENTERING THE CURVE

NOTE ---- CIRCULAR CURVE CHARACTERISTICS -----
C CCR=3280
NOTE CCR-CIRCULAR CURVE RADIUS(FT)
N SEMAX=30*3.1416/180
NOTE SEMAX-MAXIMUM SUPERLEVATION RATE (RAD)

NOTE ---- SPIRAL CURVE CHARACTERISTICS -----
C TSCL=250
TSCL-TOTAL SPIRAL CURVE LENGTH (FT)
A SCR=TSCL*CCR/SCL
SCR-SPIRAL CURVE RADIUS (FT)
A SCL=(TIME.K-TEC)*XV.K
SCL-DISTANCE TRAVELED ON SPIRAL CURVE (FT)

NOTE ---- VERTICAL POSITION CONTROL ----
L Z.K=Z.J+(DT)(ZC.JK)
N Z=ZN
NOTE Z-VERTICAL POSITION
C ZN=1.00
NOTE ZN-VERTICAL POSITION INITIAL VALUE (FT)
R ZC.KL=ZV.K
NOTE ZC-VERTICAL POSITION CHANGE(FT/SEC)
L ZV.K=ZV.J+(DT)(ZAL.JK+ZAP.JK-ZAD.JK+ZAC.JK)
N ZV=ZVN
NOTE ZV-VERTICAL VELOCITY
N ZVN=ZAW.K*TAU
NOTE ZVN-VERTICAL VELOCITY INITIAL VALUE (FT/SEC)
A ZAW.K=ZWF.K/M
NOTE ZAW-VERTICAL ACCEL. DUE TO WIND FORCE (FT/SEC^2)
A ZWF.K=NORMRN(0,1200)
NOTE ZWF-WIND FORCE OVER A SHORT PERIOD OF TIME (LB)
C TAU=1.0
R ZAL.KL=MAX(0,(ZL.K-W)/M)
NOTE ZAL-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL.K=.5*RHO*440**2*AREA*CL
NOTE ZL-LIFT FORCE
C RHO=0.076487
NOTE RHO-AIR DENSITY (LB/FT^3)
N AREA=30
NOTE AREA-FRONTAL AREA OF VEHICLE (FT^2)
C CL=0.0225
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NOTE CL-LIFT COEFFICIENT
R ZAP.KL=-(ZK/M)*(Z.K-DZ)
NOTE ZAP-VERTICAL ACCEL. DUE TO LEVITATION MAGNETS (FT/SEC^2)
C DZ=3.0
NOTE DZ-DESIRED VERTICAL POSITION (FT)
R ZAD.KL=(ZD/M)*ZV.K
NOTE ZAD-VERTICAL ACCEL. DUE TO DAMPING(FT/SEC^2)
A ZA.K=ZAL.KL+ZAP.KL-ZAD.KL
C ZK=1500
NOTE ZK-SUSPENSION MAGNETIC CONSTANT (LB/FT)
N ZD=SQRT(4*ZK*M)
NOTE ZD-SUSPENSION DAMPING CONSTANT (LB/FT PER SEC)
A ZAC.K=CLIP(300*300/R.K*SIN(SEMAX),0,TIME.K,TEC)
A R.K=CLIP(CCR,SCR,TIME.K,120+250/XV.K)

NOTE ---- LATERAL POSITION CONTROL ----
L Y.K=Y.J+(DT)(YC.JK)
N Y=YN
NOTE Y-LATERAL POSITION (FT)
C YN=0
NOTE YN-LATERAL POSITION INITIAL VALUE (FT)
R YC.KL=YV.K
NOTE YC-LATERAL POSITION CHANGE (FT/SEC)
L YV.K=YV.J+(DT)(YAW.JK+YAP.JK-YAD.JK+YAC.K)
N YV=YVN
NOTE YV-LATERAL VELOCITY (FT/SEC)
C YVN=0
NOTE YVN-LATERAL VELOCITY INITIAL VALUE (FT/SEC)
R YAW.KL=YWF.K/M
NOTE YAW-VERTICAL ACCEL. DUE TO WIND FORCE (FT/SEC^2)
A YWF.K=PULSE(YWGN.K,DT,90,1000)
NOTE YWF-WIND FORCE OVER A SHORT PERIOD OF TIME (LB)
A YWGN.K=NORMRN(0,1200)
NOTE YWGN-RANDOM MAGNITUDE OF WIND FORCE GENERATOR
R YAP.KL=-(YK/M)*Y.K
NOTE YAP-LATERAL ACCEL DUE TO GUIDANCE MAGNETS (FT/SEC^2)
R YAD.KL=(YD/M)*YV.K
NOTE YAD-LATERAL ACCEL DUE TO DAMPING (FT/SEC^2)
A YA.K=YAP.KL-YAD.KL
C YK=1000
NOTE YK-GUIDANCE MAGNETIC CONSTANT (LB/FT)
N YD=SQRT(4*YK*M)
NOTE YD-GUIDANCE DAMPING CONSTANT (LB/FT PER SEC)
A YAC.K=CLIP(300*300/R.K*COS(SEMAX),0,TIME.K,TEC)


NOTE ---- LONGITUDINAL POSITION CONTROL ----
L X.K=X.J+(DT)(XC.JK)
N X=XN
NOTE X-LONGITUDINAL DIST. BETWEEN VEHICLES(FT)
N XN=12.0
NOTE XN-LONGITUDINAL DIST. BETWEEN VEHICLES INITIALLY (FT)
R XC.KL=XV.K
NOTE XC-CHANGE IN LONGITUDINAL DISTANCE BETWEEN VEHICLES (FT/SEC)
L XV.K=XV.J+(DT)(XAP.JK-XAD.JK)
N XV=XVN
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NOTE XV-VELOCITY DIFFERENTIAL BETWEEN VEHICLES (FT/SEC)
C XVN=0
NOTE XVN-VELOCITY DIFFERENTIAL BETWEEN VEHICLES INITIAL VALUE (FT/SEC)
R XAP.KL=-(XK/M)*(X.K-DX)
NOTE XAP-LONGITUDINAL ACCEL. DUE TO SPACING MAGNETS (FT/SEC)
R XAD.KL=(XD/M)*XV.K
NOTE XAD-LONGITUDINAL ACCEL. DUE TO DAMPING (FT/SEC^2)
A XA.K=XAP.KL-XAD.KL
C XK=500
NOTE XK-SPACING MAGNETIC CONSTANT (LB/FT)
N XD=SQRT(4*XK*M)
NOTE XD-SPACING DAMPING CONSTANT (LB/FT PER SEC)
C DX=6.0
NOTE DX-DESIRED LONGITUDINAL DISTANCE BETWEEN VEHICLES (FT)
SPEC DT=.1/LENGTH=180/PLTPER=2/SAVPER=2
SAVE X,Y,Z
SAVE XV,YV,ZV
SAVE XA,YA,ZA
SAVE ZVN
SAVE ZAC,YAC
```

A-2 LONGITUDINAL CONTROL MODEL

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NOTE ----- CONSTANTS -----

N M=W/G
NOTE M-MASS OF VEHICLE (LB-SEC^2/FT)
C W=6000
NOTE W-WEIGHT OF VEHICLE (SLUGS)
C G=32.2
NOTE G-GRAVITATIONAL FORCE
C TRT=0.05
NOTE TRT-TECHNOLOGY RESPONSE TIME
C SP=1320
NOTE SP-INTERPLATOON SPACING
C SC=50
NOTE SC-INTRAPLATOON SPACING
C ISFD=100
NOTE ISFD-INITIAL SAFE FOLLOWING DISTANCE (FT)

NOTE FLUID ANALOGY TERM
N C=UF/KJ
NOTE C-CONSTANT
N UF=450*5280/3600
NOTE UF-FREE FLOW SPEED
N KJ=1/8
NOTE KJ-JAM DENSITY

NOTE SPACING DEPENDENT TERM
C B=1E-4
NOTE B-CONSTANT
C L=3
NOTE L-CONSTANT

NOTE MAGNETIC INFLUENCE TERM
C XK=400
NOTE XK-SPACING MAGNETIC CONSTANT (LB/FT)
N XD=SQRT(4*XK*M)
NOTE XD-SPACING DAMPING CONSTANT (LB/FT PER SEC)



NOTE ----- MACROS -----

MACRO AT(AFA,ASD,AMI,XL,XR)
A AT.K=CLIP(AFA.K+ASD.K,AMI.K,XL.K-XR.K,SC)
NOTE AT-THEORITICAL ACCELERATION
MEND

MACRO AFA(XP,XL,XR,XF,KL,KR,KF,DK,DKF,DKS,DKT,RXPL,RXLR,RXRF,RXLF)
A AFA.K=-C**2*KR.K*DK.K
NOTE AFA-ACCELERATION ACCORDING TO PRINCIPAL OF FLUID ANALOGY
A DK.K=DKF.K+DKS.K+DKT.K
NOTE DK-RATE OF CHANGE OF DENSITY
A DKF.K=RXRF.K*KL.K/(RXLR.K*RXLF.K)
A DKS.K=(RXRF.K-RXLR.K)*KR.K/(RXLF.K*RXRF.K)
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A DKT.K=-RXLR.K*KF.K/(RXLF.K*RXRF.K)
NOTE DKF,DKS,DKT-THREE TERMS IN LAGRANGE INTERPOLATION
A KL.K=DELAY1(1/RXPL.K,TRT)
NOTE KL-DENSITY OF THE LEADING VEHICLE
A KR.K=DELAY1(1/RXLR.K,TRT)
NOTE KR-DENSITY OF THE REFERENCE VEHICLE
A KF.K=DELAY1(1/RXRF.K,TRT)
NOTE KF-DENSITY OF THE FOLLOWING VEHICLE
A RXPL.K=XP.K-XL.K
NOTE RXPL-HEADWAY BETWEEN THE LEADING VEHICLE AND ITS PREDECESSOR
A RXLR.K=XL.K-XR.K
NOTE RXLR-HEADWAY BETWEEN THE LEADING AND THE REFERENCE VEHICLES
A RXRF.K=XR.K-XF.K
NOTE RXRF-HEADWAY BETWEEN THE REFERENCE AND THE FOLLOWING VEHICLES
A RXLF.K=XL.K-XF.K
NOTE RXLF-HEADWAY BETWEEN THE LEADING AND THE FOLLOWING VEHICLES
MEND

MACRO ASD(XL,XR,ERR,DLRXLR)
A ASD.K=CLIP(B*ERR.K**L,-B*ERR.K**L,DLRXLR.K-SC,0)
NOTE ASD-ACCELERATION DUE TO SPACING DEPENDENCY
A ERR.K=CLIP(DLRXLR.K-SC,SC-DLRXLR.K,DLRXLR.K-SC,0)
NOTE ERR-DIFFERENCE BETWEEN ACTUAL AND DESIRED SPACINGS
A DLRXLR.K=DELAY1(XL.K-XR.K,TRT)
NOTE DLRXLR-DELAYED RELATIVE POSITION BTW THE LEADING AND THE REFERENCE
VEHICLES
MEND

MACRO AMI(AL,XAP,XAD,XL,XR,VL,VR)
A AMI.K=AL.KL-(XAP.K-XAD.K)
NOTE AMI-ACCELERTION DUE TO MAGLEV LONGITUDINAL CONTROL CONCEPT
A XAP.K=-(XK/M)*(XL.K-XR.K-DX)
NOTE XAP-LONGITUDINAL ACCEL. DUE TO SPACING MAGNETS (FT/SEC)
C DX=15.0
NOTE DX-DESIRED LONGITUDINAL DISTANCE BETWEEN VEHICLES (FT)
A XAD.KL=(XD/M)*(VL.K-VR.K)
NOTE XAD-LONGITUDINAL ACCEL. DUE TO DAMPING (FT/SEC^2)
MEND


NOTE ----- VEHICLE CONTROL SCHEME -----

NOTE DESCRIPTION OF THE DUMMY LEADING VEHICLE
A X0.K=X1.K+SP
NOTE X0-POSITION OF THE DUMMY LEADING VEHICLE

NOTE DESCRIPTION OF THE FIRST VEHICLE
L X1.K=X1.J+(DT)(XC1.JK)
N X1=X1N
C X1N=0
R XC1.KL=MIN(450,MAX(0,V1.K))
L V1.K=V1.J+(DT)(A1.JK)
N V1=150*5280/3600
R A1.KL=SWITCH(0,A1S.K,XC1.KL)
A A1S.K=CLIP(A1D.K,A1I.K,TIME.K,180)
A A1D.K=-.2*G
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NOTE A1D-DECELERATION RATE OF THE FIRST VEHICLE
A A1I.K=CLIP(0,A1A.K,V1.K,400*5280/3600)
NOTE A1I-INITIAL ACCELERATION RATE OF THE FIRST VEHICLE
A A1A.K=.2*G
NOTE A1A-ACCELERATION RATE OF THE FIRST VEHICLE

NOTE DESCRIPTION OF THE SECOND VEHICLE
L X2.K=X2.J+(DT)(XC2.JK)
N X2=X2N
N X2N=X1N-ISFD
R XC2.KL=MIN(450,MAX(0,V2.K))
L V2.K=V2.J+(DT)(A2.JK)
N V2=150*5280/3600
R A2.KL=MIN(G,ACDC2.K)
A ACDC2.K=MAX(-G,AT2.K)
NOTE ACDC2-ACCELERATION/DECELERATION RATE OF THE SECOND VEHICLE
A AT2.K=AT(AFA2,ASD2,AMI2,X1,X2)
A AFA2.K=AFA(X0,X1,X2,X3,K12,K22,K32,DK2,DKF2,DKS2,DKT2,RX012,RX122,RX232,RX132)
A ASD2.K=ASD(X1,X2,ERR2,DLRX12)
A AMI2.K=AMI(A1,XAP2,XAD2,X1,X2,V1,V2)

NOTE DESCRIPTION OF THE THIRD VEHICLE
L X3.K=X3.J+(DT)(XC3.JK)
N X3=X3N
N X3N=X2N-ISFD
R XC3.KL=MIN(450,MAX(0,V3.K))
L V3.K=V3.J+(DT)(A3.JK)
N V3=150*5280/3600
R A3.KL=MIN(G,ACDC3.K)
A ACDC3.K=MAX(-G,AT3.K)
NOTE ACDC3-ACCELERATION/DECELERATION RATE OF THE THIRD VEHICLE
A AT3.K=AT(AFA3,ASD3,AMI3,X2,X3)
A AFA3.K=AFA(X1,X2,X3,X4,K23,K33,K43,DK3,DKF3,DKS3,DKT3,RX123,RX233,RX343,RX243)
A ASD3.K=ASD(X2,X3,ERR3,DLRX23)
A AMI3.K=AMI(A2,XAP3,XAD3,X2,X3,V2,V3)

NOTE DESCRIPTION OF THE FOURTH VEHICLE
L X4.K=X4.J+(DT)(XC4.JK)
N X4=X4N
N X4N=X3N-ISFD
R XC4.KL=MIN(450,MAX(0,V4.K))
L V4.K=V4.J+(DT)(A4.JK)
N V4=150*5280/3600
R A4.KL=MIN(G,ACDC4.K)
A ACDC4.K=MAX(-G,AT4.K)
NOTE ACDC-ACCELERATION/DECELERATION RATE OF THE FOURTH VEHICLE
A AT4.K=AT(AFA4,ASD4,AMI4,X3,X4)
A AFA4.K=AFA(X2,X3,X4,X5,K34,K44,K54,DK4,DKF4,DKS4,DKT4,RX234,RX344,RX454,RX354)
A ASD4.K=ASD(X3,X4,ERR4,DLRX34)
A AMI4.K=AMI(A3,XAP4,XAD4,X3,X4,V3,V4)

NOTE DESCRIPTION OF THE DUMMY FOLLOWING VEHICLE
A X5.K=X4.K-SP
NOTE X5-POSITION OF THE DUMMY FOLLOWING VEHICLE

SPEC DT=.1/LENGTH=600/PLTPER=2/SAVPER=2
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SAVE X1,X2,X3,X4
SAVE RX123,RX233,RX343
SAVE XC1,XC2,XC3,XC4
SAVE A1,A2,A3,A4
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A-3 VEHICLE MOTION IN CURVE

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NOTE ----- CONSTANTS -----
N M=W/G
NOTE M-MASS OF VEHICLE (LB-SEC^2/FT)
C W=6000
NOTE W-WEIGHT OF VEHICLE (LB)
C G=32.2
NOTE G-ACCEL. DUE TO GRAVITY (FT/SEC^2)

C TEC=120
NOTE TEC-TIME ENTERING THE CURVE

NOTE ---- CIRCULAR CURVE CHARACTERISTICS -----
C CCR=3280
NOTE CCR-CIRCULAR CURVE RADIUS(FT)
N CLENGTH=2*3.1416*CCR/4
NOTE CLENGTH-CURVE LENGTH
N SEMAX=30*3.1416/180
NOTE SEMAX-MAXIMUM SUPERELEVATION RATE (RAD)

NOTE ---- SPIRAL CURVE CHARACTERISTICS -----
C TSCL=250
TSCL-TOTAL SPIRAL CURVE LENGTH (FT)
A SCR.K=TSCL*CCR/SCL.K
SCR-SPIRAL CURVE RADIUS (FT)
A SCL.K=(TIME.K-TEC)*XV.K
SCL-DISTANCE TRAVELED ON SPIRAL CURVE (FT)
A XV.K=250*5280/3600
NOTE XV-VELOCITY ENTERING THE CURVE (FT/SEC)

A TDISTC.K=MIN(CCR,DISTC.K)
NOTE TDISTC-TRUE DISTANCE TRAVELED IN CURVE SECTION (FT)
L DISTC.K=DISTC.J+(DT)(XVC.JK)
N DISTC=0
NOTE DISTC-DISTANCE COMPUTED TRAVELED IN CURVE SECTION (FT)
R XVC.KL=CLIP(XV.K,0,TIME.K,TEC)

NOTE ---- VEHICLE TILTED ANGLE ----
NOTE ----ENTERING THE CURVE ----
A TANGLEE.K=MIN(SEMAX+10*3.1416/180,ANGLEE.K)
NOTE TANGLEE-TRUE ANGLE ENTERING THE CURVE (RAD)
L ANGLEE.K=ANGLEE.J+(DT)(ANGLECE.JK)
N ANGLEE=0
NOTE ANGLEE-ENTERING ANGLE COMPUTED IN THE CURVE (RAD)
R ANGLECE.KL=CLIP(ANGLERE.K,ANGLETE.K,TIME,TEC)
NOTE ANGLECE-RATE OF ANGLE CHANGE ENTERING THE CURVE(RAD/SEC)
A ANGLETE.K=CLIP(0.5*3.1416/180,0,TIME,TEC-20)
NOTE ANGLETE-ANGLE CHANGE ON TANGENT SECTION ENTERING THE CURVE (RAD/SEC)
A ANGLERE.K=3*3.1416/180
NOTE ANGLERE-ANGLE CHANGE ON CURVE SECTION ENTERING THE CURVE (RAD/SEC)
NOTE ---- LEAVING THE CURVE ----
A TADJ.K=SEMAX/ANGLERE.K
NOTE TADJ-TIME NEEDED TO ADJUST THE ANGLE FROM 10 TO 40 (SEC)
A DADJ.K=XV.K*TADJ.K
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NOTE DADJ-DISTANCE NEEDED TO ADJUST THE ANGLE FROM 10 TO 40 (SEC)
A DADJI.K=CLENGTH-DADJ.K
NOTE DADJI-DISTANCE TO BEGIN TILTING BACK
L ANGLEL.K=ANGLEL.J+(DT)(-ANGLECL.K)
N ANGLEL=SEMAX+10*3.1416/180
NOTE ANGLEL-LEAVING ANGLE COMPUTED IN THE CURVE (RAD)
A ANGLECL.K=CLIP(ANGLETL.K,ANGLERL.K,DISTC.K,CLENGTH)
NOTE ANGLECL-RATE OF ANGLE CHANGE LEAVING THE CURVE(RAD/SEC)
A ANGLETL.K=CLIP(0.5*3.1416/180,0,TANGLE.K,0)
NOTE ANGLETL-ANGLE CHANGE ON TANGENT SECTION ENTERING THE CURVE (RAD/SEC)
A ANGLERL.K=CLIP(3*3.1416/180,0,DISTC.K,DADJI)
NOTE ANGLERL-ANGLE CHANGE ON CURVE SECTION ENTERING THE CURVE (RAD/SEC)

NOTE ---- *TRUE ANGLE* ----
A TANGLE.K=CLIP(ANGLEL.K,TANGLEE.K,DISTC.K,CLENGTH/2)
NOTE TANGLE-TRUE ANGLE (RAD)

NOTE ---- VERTICAL POSITION CONTROL ----
L Z.K=Z.J+(DT)(ZC.JK)
N Z=ZN
NOTE Z-VERTICAL POSITION
C ZN=1.00
NOTE ZN-VERTICAL POSITION INITIAL VALUE (FT)
R ZC.KL=ZV.K
NOTE ZC-VERTICAL POSITION CHANGE(FT/SEC)
L ZV.K=ZV.J+(DT)(ZAL.JK+ZAP.JK-ZAD.JK-ZAC.JK)
N ZV=ZVN
NOTE ZV-VERTICAL VELOCITY
N ZVN=ZAW.K*TAU
NOTE ZVN-VERTICAL VELOCITY INITIAL VALUE (FT/SEC)
A ZAW.K=ZWF.K/M
NOTE ZAW-VERTICAL ACCEL. DUE TO WIND FORCE (FT/SEC^2)
A ZWF.K=NORMRN(0,1200)
NOTE ZWF-WIND FORCE OVER A SHORT PERIOD OF TIME (LB)
C TAU=1.0
R ZAL.KL=MAX(0,(ZL.K-W)/M)
NOTE ZAL-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL.K=.5*RHO*440**2*AREA*CL
NOTE ZL-LIFT FORCE
C RHO=0.076487
NOTE RHO-AIR DENSITY (LB/FT^3)
N AREA=30
NOTE AREA-FRONTAL AREA OF VEHICLE (FT^2)
C CL=0.0225
NOTE CL-LIFT COEFFICIENT
R ZAP.KL=-(ZK/M)*(Z.K-DZ)
NOTE ZAP-VERTICAL ACCEL. DUE TO LEVITATION MAGNETS (FT/SEC^2)
C DZ=3.0
NOTE DZ-DESIRED VERTICAL POSITION (FT)
R ZAD.KL=(ZD/M)*ZV.K
NOTE ZAD-VERTICAL ACCEL. DUE TO DAMPING(FT/SEC^2)
A ZA.K=ZAL.KL+ZAP.KL-ZAD.KL
C ZK=2000
NOTE ZK-SUSPENSION MAGNETIC CONSTANT (LB/FT)
N ZD=SQRT(4*ZK*M)
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NOTE ZD-SUSPENSION DAMPING CONSTANT (LB/FT PER SEC)
R ZAC.JK=CLIP(XV.K*XV.K/R.K*SIN(TANGLE.K),0,TIME.K,TEC)
A R.K=CLIP(CCR,SCR.K,TIME.K,120+250/300)

NOTE ---- LATERAL POSITION CONTROL ----
L Y.K=Y.J+(DT)(YC.JK)
N Y=YN
NOTE Y-LATERAL POSITION (FT)
C YN=0
NOTE YN-LATERAL POSITION INITIAL VALUE (FT)
R YC.KL=YV.K
NOTE YC-LATERAL POSITION CHANGE (FT/SEC)
L YV.K=YV.J+(DT)(YAW.JK+YAP.JK-YAD.JK+YAC.JK)
N YV=YVN
NOTE YV-LATERAL VELOCITY (FT/SEC)
C YVN=0
NOTE YVN-LATERAL VELOCITY INITIAL VALUE (FT/SEC)
R YAW.KL=YWF.K/M
NOTE YAW-VERTICAL ACCEL. DUE TO WIND FORCE (FT/SEC^2)
A YWF.K=PULSE(YWGN.K,DT,90,1000)
NOTE YWF-WIND FORCE OVER A SHORT PERIOD OF TIME (LB)
A YWGN.K=NORMRN(0,1200)
NOTE YWGN-RANDOM MAGNITUDE OF WIND FORCE GENERATOR
R YAP.KL=-(YK/M)*Y.K
NOTE YAP-LATERAL ACCEL DUE TO GUIDANCE MAGNETS (FT/SEC^2)
R YAD.KL=(YD/M)*YV.K
NOTE YAD-LATERAL ACCEL DUE TO DAMPING (FT/SEC^2)
A YA.K=YAP.KL-YAD.KL
C YK=2000
NOTE YK-GUIDANCE MAGNETIC CONSTANT (LB/FT)
N YD=SQRT(4*YK*M)
NOTE YD-GUIDANCE DAMPING CONSTANT (LB/FT PER SEC)
R YAC.JK=CLIP(0,YAC1.K,DISTC.K,CLENGTH)
A YAC1.K=CLIP(XV.K*XV.K/R.K*COS(TANGLE.K),0,TIME.K,TEC)


SPEC DT=.1/LENGTH=180/PLTPER=2/SAVPER=2
SAVE Y,Z
SAVE YV,ZV
SAVE YA,ZA
SAVE ZVN
SAVE ZAC,YAC
SAVE TANGLE,ANGLECE,TDISTC
SAVE R
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A-4 THE INTEGRATION OF THE THREE MODELS

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NOTE ----- CONSTANTS -----
N M=W/G
NOTE M-MASS OF VEHICLE (LB-SEC^2/FT)
C W=6000
NOTE W-WEIGHT OF VEHICLE (LB)
C G=32.2
NOTE G-ACCEL. DUE TO GRAVITY (FT/SEC^2)
C PI=3.1416

C BC=7.5E4
NOTE BC-BEGINNING OF THE CURVE (FT)

NOTE ---- CIRCULAR CURVE CHARACTERISTICS -----
C CCR=3280
NOTE CCR-CIRCULAR CURVE RADIUS(FT)
N CCLENGTH=CCR*PI/2-(2*SCLENGTH)
NOTE CCLENGTH-CIRCULAR CURVE LENGTH(FT)
N SEMAX=30*3.1416/180
NOTE SEMAX-MAXIMUM SUPERLEVATION RATE (RAD)

NOTE ---- SPIRAL CURVE CHARACTERISTICS -----
C SCLENGTH=250
NOTE SCLENGTH-SPIRAL CURVE LENGTH (FT)

NOTE ---- SUPERELEVATION -----
N TCLENGTH=CCLENGTH+2*SCLENGTH
NOTE TCLENGTH=TOTAL CURVE LENGTH (FT)
N ANGLEPD=SEMAX/(TCLENGTH/2)
NOTE ANGLEPD-ANGLE CHANGE IN CURVE PER DISTANCE (RAD/FT)
A ANGLEPT=ANGLEPD*XVC1
NOTE ANGLEPT-ANGLE CHANGE IN CURVE PER TIME (RAD/SEC)

NOTE ---- CALCULATION OF SUPERELEVATION -----
MACRO TANGLE(ANGLE,ANGLEA,ANGLEB,DEGREE,X)
A TANGLE.K=10*PI/180+ANGLE.K
NOTE TANGLE-TRUE ANGLE OF THE VEHICLE IN THE CURVE (RAD)
A ANGLE.K=CLIP(ANGLEA.K,0,X.K,BC)
A ANGLEA.K=CLIP(0,ANGLEB.K,X.K,BC+TCLENGTH)
A ANGLEB.K=DEGREE.K*PI/180
A DEGREE.K=TABXT(ANGLETAB,X.K,BC,BC+TCLENGTH,TCLENGTH/6)
T ANGLETAB=0/10/20/30/20/10/0
NOTE ANGLE-SUPERELEVATION
MEND

NOTE ---- CALCULATION OF CURVE RADIUS ----
MACRO R(RCA,SCR,SCX,SCXA,SCXB,SCXC,SCXD,SCXE,X)
NOTE R-CURVE RADIUS
A R.K=CLIP(RCA.K,SCR.K,X.K,BC+SCLENGTH)
A RCA.K=CLIP(SCR.K,CCR,X.K,BC+SCLENGTH+CCLENGTH)
A SCR.K=SCLENGTH*CCR/SCX.K
NOTE SCR-SPIRAL CURVE RADIUS (FT)
A SCX.K=CLIP(SCXA.K,1E-6,X.K,BC)
A SCXA.K=CLIP(1E-6,SCXB.K,X.K,BC+(TCLENGTH/2))
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A SCXB.K=CLIP(SCXD.K,SCXC.K,X.K,BC+SCLENGTH)
A SCXC.K=X.K-BC
A SCXD.K=CLIP(SCXE.K,1E-6,X.K,BC+TCLENGTH-SCLENGTH)
A SCXE.K=X.K-BC-TCLENGTH+SCLENGTH
NOTE SCX-DISTANCE TRAVELED ON SPIRAL CURVE (FT)
MEND

NOTE ---- VERTICAL POSITION CONTROL ----
L Z.K=Z.J+(DT)(ZC.JK)
N Z=ZN
NOTE Z-VERTICAL POSITION
C ZN=1.00
NOTE ZN-VERTICAL POSITION INITIAL VALUE (FT)
R ZC.KL=ZV.K
NOTE ZC-VERTICAL POSITION CHANGE(FT/SEC)
L ZV.K=ZV.J+(DT)(ZAL.JK+ZAP.JK-ZAD.JK)
N ZV=ZVN
C ZVN=0
R ZAL.KL=MAX(0,(ZL.K-W)/M)
NOTE ZAL-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL.K=.5*RHO*XC1.K*XC1.K*AREA*CL
NOTE ZL-LIFT FORCE
C RHO=0.076487
NOTE RHO-AIR DENSITY (LB/FT^3)
N AREA=30
NOTE AREA-FRONTAL AREA OF VEHICLE (FT^2)
C CL=0.0225
NOTE CL-LIFT COEFFICIENT
R ZAP.KL=-(ZK/M)*(Z.K-DZ)
NOTE ZAP-VERTICAL ACCEL. DUE TO LEVITATION MAGNETS (FT/SEC^2)
C DZ=3.0
NOTE DZ-DESIRED VERTICAL POSITION (FT)
R ZAD.KL=(ZD/M)*ZV.K
NOTE ZAD-VERTICAL ACCEL. DUE TO DAMPING(FT/SEC^2)
C ZK=2000
NOTE ZK-SUSPENSION MAGNETIC CONSTANT (LB/FT)
N ZD=SQRT(4*ZK*M)
NOTE ZD-SUSPENSION DAMPING CONSTANT (LB/FT PER SEC)
R ZAC.KL=CLIP(ZACA.K,0,X1.K,BC)
A ZACA.K=CLIP(0,XC1.K*XC1.K/R1.K*SIN(TANGLE1.K),X1.K,BC+TCLENGTH)
A R1.K=R(RCA1,SCR1,SCX1,SCXA1,SCXB1,SCXC1,SCXD1,SCXE1,X1)
A TANGLE1.K=TANGLE(ANGLE1,ANGLEA1,ANGLEB1,DEGREE1,X1)
A ZA.K=ZAL.JK-ZAP.JK-ZAD.JK-ZAC.JK


NOTE ---- LATERAL POSITION CONTROL ----
L Y.K=Y.J+(DT)(YC.JK)
N Y=YN
NOTE Y-LATERAL POSITION (FT)
C YN=0
NOTE YN-LATERAL POSITION INITIAL VALUE (FT)
R YC.KL=YV.K
NOTE YC-LATERAL POSITION CHANGE (FT/SEC)
L YV.K=YV.J+(DT)(YAP.JK-YAD.JK)
N YV=YVN
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NOTE YV-LATERAL VELOCITY (FT/SEC)
C YVN=0
NOTE YVN-LATERAL VELOCITY INITIAL VALUE (FT/SEC)
R YAW.KL=YWF.K/M
NOTE YAW-VERTICAL ACCEL. DUE TO WIND FORCE (FT/SEC^2)
A YWF.K=PULSE(YWGN.K,DT,90,1000)
NOTE YWF-WIND FORCE OVER A SHORT PERIOD OF TIME (LB)
A YWGN.K=NORMRN(0,1200)
NOTE YWGN-RANDOM MAGNITUDE OF WIND FORCE GENERATOR
R YAP.KL=-(YK/M)*Y.K
NOTE YAP-LATERAL ACCEL DUE TO GUIDANCE MAGNETS (FT/SEC^2)
R YAD.KL=(YD/M)*YV.K
NOTE YAD-LATERAL ACCEL DUE TO DAMPING (FT/SEC^2)
A YA.K=YAP.KL-YAD.KL
C YK=5
NOTE YK-GUIDANCE MAGNETIC CONSTANT (LB/FT)
N YD=SQRT(4*YK*M)
NOTE YD-GUIDANCE DAMPING CONSTANT (LB/FT PER SEC)

NOTE DESCRIPTION OF THE DUMMY LEADING VEHICLE
A X0.K=X1.K+SP
NOTE X0-POSITION OF THE DUMMY LEADING VEHICLE

N XVMAX=450

NOTE DESCRIPTION OF THE FIRST VEHICLE
L X1.K=X1.J+(DT)(XC1.JK)
N X1=X1N
C X1N=0
R XC1.KL=MIN(XVMAX,MAX(0,XV1.K))
L XV1.K=XV1.J+(DT)(XA1.JK)
N XV1=150*5280/3600
R XA1.KL=SWITCH(0,XA1S.K,XC1.KL)
A XA1S.K=CLIP(XA1J.K,XA1I.K,X1.K,XPS1.K)
A XA1J.K=CLIP(XA1K.K,XA1D.K,X1.K,BC)
A XA1K.K=CLIP(XA1I.K,0,X1.K,BC+TCLENGTH)
A XA1D.K=-.25*G
NOTE A1D-DECELERATION RATE OF THE FIRST VEHICLE
A XA1I.K=CLIP(0,XA1A.K,XV1.K,XVMAX)
NOTE A1I-INITIAL ACCELERATION RATE OF THE FIRST VEHICLE
A XA1A.K=.25*G
NOTE A1A-ACCELERATION RATE OF THE FIRST VEHICLE
N XS1=(XVC1*XVC1-XVMAX**2)/2/XA1D.K
NOTE XS1.K-DISTANCE NEEDED TO ADJUST SPEED TO XCR
N XVC1=250*5280/3600
NOTE XVC-SPEED ENTERING THE CURVE
N XPS1=BC-XS1
NOTE XPS1-POSITION WHERE THE FIRST VEHICLE SLOW DOWN

C TRT=0.05
NOTE TRT-TECHNOLOGY RESPONSE TIME
C SP=1320
NOTE SP-INTERPLATOON SPACING
C SC=50
NOTE SC-INTRAPLATOON SPACING
C ISFD=100
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NOTE ISFD-INITIAL SAFE FOLLOWING DISTANCE (FT)

NOTE FLUID ANALOGY TERM
N C=UF/KJ
NOTE C-CONSTANT
N UF=450*5280/3600
NOTE UF-FREE FLOW SPEED
N KJ=1/8
NOTE KJ-JAM DENSITY

NOTE SPACING DEPENDENT TERM
C B=1E-4
NOTE B-CONSTANT
C L=3
NOTE L-CONSTANT

NOTE MAGNETIC INFLUENCE TERM
C XK=400
NOTE XK-SPACING MAGNETIC CONSTANT (LB/FT)
N XD=SQRT(4*XK*M)
NOTE XD-SPACING DAMPING CONSTANT (LB/FT PER SEC)



NOTE ----- MACROS -----

MACRO AT(AFA,ASD,AMI,XL,XR)
A AT.K=CLIP(AFA.K+ASD.K,AMI.K,XL.K-XR.K,SC)
NOTE AT-THEORITICAL ACCELERATION
MEND

MACRO AFA(XP,XL,XR,XF,KL,KR,KF,DK,DKF,DKS,DKT,RXPL,RXLR,RXRF,RXLF)
A AFA.K=-C**2*KR.K*DK.K
NOTE AFA-ACCELERATION ACCORDING TO PRINCIPAL OF FLUID ANALOGY
A DK.K=DKF.K+DKS.K+DKT.K
NOTE DK-RATE OF CHANGE OF DENSITY
A DKF.K=RXRF.K*KL.K/(RXLR.K*RXLF.K)
A DKS.K=(RXRF.K-RXLR.K)*KR.K/(RXLF.K*RXRF.K)
A DKT.K=-RXLR.K*KF.K/(RXLF.K*RXRF.K)
NOTE DKF,DKS,DKT-THREE TERMS IN LAGRANGE INTERPOLATION
A KL.K=DELAY1(1/RXPL.K,TRT)
NOTE KL-DENSITY OF THE LEADING VEHICLE
A KR.K=DELAY1(1/RXLR.K,TRT)
NOTE KR-DENSITY OF THE REFERENCE VEHICLE
A KF.K=DELAY1(1/RXRF.K,TRT)
NOTE KF-DENSITY OF THE FOLLOWING VEHICLE
A RXPL.K=XP.K-XL.K
NOTE RXPL-HEADWAY BETWEEN THE LEADING VEHICLE AND ITS PREDECESSOR
A RXLR.K=XL.K-XR.K
NOTE RXLR-HEADWAY BETWEEN THE LEADING AND THE REFERENCE VEHICLES
A RXRF.K=XR.K-XF.K
NOTE RXRF-HEADWAY BETWEEN THE REFERENCE AND THE FOLLOWING VEHICLES
A RXLF.K=XL.K-XF.K
NOTE RXLF-HEADWAY BETWEEN THE LEADING AND THE FOLLOWING VEHICLES
MEND
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MACRO ASD(XL,XR,ERR,DLRXLR)
A ASD.K=CLIP(B*ERR.K**L,-B*ERR.K**L,DLRXLR.K-SC,0)
NOTE ASD-ACCELERATION DUE TO SPACING DEPENDENCY
A ERR.K=CLIP(DLRXLR.K-SC,SC-DLRXLR.K,DLRXLR.K-SC,0)
NOTE ERR-DIFFERENCE BETWEEN ACTUAL AND DESIRED SPACINGS
A DLRXLR.K=DELAY1(XL.K-XR.K,TRT)
NOTE DLRXLR-DELAYED RELATIVE POSITION BTW THE LEADING AND THE REFERENCE
VEHICLES
MEND

MACRO AMI(AL,XAP,XAD,XL,XR,VL,VR)
A AMI.K=AL.KL-(XAP.K-XAD.K)
NOTE AMI-ACCELERTION DUE TO MAGLEV LONGITUDINAL CONTROL CONCEPT
A XAP.K=-(XK/M)*(XL.K-XR.K-DX)
NOTE XAP-LONGITUDINAL ACCEL. DUE TO SPACING MAGNETS (FT/SEC)
C DX=15.0
NOTE DX-DESIRED LONGITUDINAL DISTANCE BETWEEN VEHICLES (FT)
A XAD.KL=(XD/M)*(VL.K-VR.K)
NOTE XAD-LONGITUDINAL ACCEL. DUE TO DAMPING (FT/SEC^2)
MEND

NOTE DESCRIPTION OF THE SECOND VEHICLE
L X2.K=X2.J+(DT)(XC2.JK)
N X2=X2N
N X2N=X1N-ISFD
R XC2.KL=MIN(450,MAX(0,XV2.K))
L XV2.K=XV2.J+(DT)(XA2.JK)
N XV2=150*5280/3600
R XA2.KL=MIN(G,ACDC2.K)
A ACDC2.K=MAX(-G,AT2.K)
NOTE ACDC2-ACCELERATION/DECELERATION RATE OF THE SECOND VEHICLE
A AT2.K=AT(AFA2,ASD2,AMI2,X1,X2)
A AFA2.K=AFA(X0,X1,X2,X3,K12,K22,K32,DK2,DKF2,DKS2,DKT2,RX012,RX122,RX232,RX132)
A ASD2.K=ASD(X1,X2,ERR2,DLRX12)
A AMI2.K=AMI(XA1,XAP2,XAD2,X1,X2,XV1,XV2)

NOTE DESCRIPTION OF THE THIRD VEHICLE
L X3.K=X3.J+(DT)(XC3.JK)
N X3=X3N
N X3N=X2N-ISFD
R XC3.KL=MIN(450,MAX(0,XV3.K))
L XV3.K=XV3.J+(DT)(XA3.JK)
N XV3=150*5280/3600
R XA3.KL=MIN(G,ACDC3.K)
A ACDC3.K=MAX(-G,AT3.K)
NOTE ACDC3-ACCELERATION/DECELERATION RATE OF THE THIRD VEHICLE
A AT3.K=AT(AFA3,ASD3,AMI3,X2,X3)
A AFA3.K=AFA(X1,X2,X3,X4,K23,K33,K43,DK3,DKF3,DKS3,DKT3,RX123,RX233,RX343,RX243)
A ASD3.K=ASD(X2,X3,ERR3,DLRX23)
A AMI3.K=AMI(XA2,XAP3,XAD3,X2,X3,XV2,XV3)

NOTE DESCRIPTION OF THE FOURTH VEHICLE
L X4.K=X4.J+(DT)(XC4.JK)
N X4=X4N
N X4N=X3N-ISFD
R XC4.KL=MIN(450,MAX(0,XV4.K))
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```
L XV4.K=XV4.J+(DT)(XA4.JK)
N XV4=150*5280/3600
R XA4.KL=MIN(G,ACDC4.K)
A ACDC4.K=MAX(-G,AT4.K)
NOTE ACDC-ACCELERATION/DECELERATION RATE OF THE FOURTH VEHICLE
A AT4.K=AT(AFA4,ASD4,AMI4,X3,X4)
A AFA4.K=AFA(X2,X3,X4,X5,K34,K44,K54,DK4,DKF4,DKS4,DKT4,RX234,RX344,RX454,RX354)
A ASD4.K=ASD(X3,X4,ERR4,DLRX34)
A AMI4.K=AMI(XA3,XAP4,XAD4,X3,X4,XV3,XV4)

NOTE DESCRIPTION OF THE DUMMY FOLLOWING VEHICLE
A X5.K=X4.K-SP
NOTE X5-POSITION OF THE DUMMY FOLLOWING VEHICLE

SPEC DT=.1/LENGTH=300/PRTPER=2/PLTPER=2/SAVPER=2

SAVE Z,ZV,ZA,ZAC,ZAP,ZAD,ZAL
SAVE R1
SAVE TANGLE1
SAVE X1,X2,X3,X4
SAVE XC1
SAVE XA1
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APPENDIX B

B1. MERGING AND WEAVING MANEUVERS

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NOTE CONSTANTS
C G=32.2
C AMP1=0.1
N OMEGA1=PI/2
C PI=3.1416
C M=3000
N W=M*G
C XK=100
N XD=SQRT(4*XK*M)
C DX=16
C YK=400
N YD=SQRT(4*YK*M)
C ZK=50
N ZD=SQRT(4*ZK*M)
C RHO=0.076487
NOTE RHO-AIR DENSITY (LB/FT^3)
N AREA=30
NOTE AREA-FRONTAL AREA OF VEHICLE (FT^2)
C CL=0.0225
NOTE CL-LIFT COEFFICIENT


NOTE --DESCRIPTION OF VEHICLE 1--

NOTE LONGITUDINAL SEPARATION
L X1.K=X1.J+(DT)(XC1.JK)
N X1=X1N
C X1N=0
R XC1.KL=MAX(0,XV1.K)
L XV1.K=XV1.J+(DT)(XA1.JK)
N XV1=200*5280/3600
R XA1.KL=0
NOTE OMEGA1*AMP1*COS(OMEGA1*TIME.K)

NOTE LATERAL POSITION
L Y1.K=Y1.J+(DT)(YC1.JK)
N Y1=Y1N
C Y1N=18
R YC1.KL=YV1.K
L YV1.K=YV1.J+(DT)(YA1.JK)
N YV1=0
R YA1.KL=YAP1.K-YAD1.K
A YAP1.K=-YK/M*(Y1.K-DY1.K)
A YAD1.K=YD/M*YV1.K
A DY1.K=18

NOTE VERTICAL POSITION
L Z1.K=Z1.J+(DT)(ZC1.JK)
N Z1=Z1N
C Z1N=3
R ZC1.KL=ZV1.K
L ZV1.K=ZV1.J+(DT)(ZA1.JK)
N ZV1=0
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R ZA1.KL=ZAL1.K+ZAP1.K-ZAD1.K
A ZAP1.K=-ZK/M*(Z1.K-DZ1.K)
A ZAD1.K=ZD/M*ZV1.K
A DZ1.K=3
A ZAL1.K=MAX(0,(ZL1.K-W)/M)
NOTE ZAL1-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL1.K=.5*RHO*440**2*AREA*CL
NOTE ZL1-LIFT FORCE


NOTE --DESCRIPTION OF VEHICLE 2--

NOTE LONGITUDINAL SEPARATION
L X2.K=X2.J+(DT)(XC2.JK)
N X2=X2N
C X2N=-20
R XC2.KL=MAX(0,XV2.K)
L XV2.K=XV2.J+(DT)(XA2.JK)
N XV2=200*5280/3600
R XA2.K=CLIP(XA2G.K,XA2R.K,Y2.K,0)
A XA2G.K=XAP2.K-XAD2.K
A XAP2.K=XK/M*(RX2.K-DX)
A RX2.K=X1.K-X2.K
A XAD2.K=-XD/M*RV2.K
A RV2.K=XC1.K-XC2.K
A XA2R.K=-.025*G

NOTE LATERAL POSITION
L Y2.K=Y2.J+(DT)(YC2.JK)
N Y2=Y2N
C Y2N=18
R YC2.KL=YV2.K
L YV2.K=YV2.J+(DT)(YA2.JK)
N YV2=0
R YA2.K=YAP2.K-YAD2.K
A YAP2.K=-YK/M*(Y2.K-DY2.K)
A DY2.K=CLIP(DY22.K,18,TIME.K,30)
A DY22.K=CLIP(-12,6,TIME.K,120)
A YAD2.K=YD/M*YV2.K

NOTE VERTICAL POSITION
L Z2.K=Z2.J+(DT)(ZC2.JK)
N Z2=Z2N
C Z2N=3
R ZC2.KL=ZV2.K
L ZV2.K=ZV2.J+(DT)(ZA2.JK)
N ZV2=0
R ZA2.KL=ZAL2.K+ZAP2.K-ZAD2.K
A ZAP2.K=-ZK/M*(Z2.K-DZ2.K)
A ZAD2.K=ZD/M*ZV2.K
A DZ2.K=CLIP(3,2,Y2.K,6)
A ZAL2.K=MAX(0,(ZL2.K-W)/M)
NOTE ZAL2-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL2.K=.5*RHO*440**2*AREA*CL
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NOTE ZL2-LIFT FORCE


NOTE --DESCRIPTION OF VEHICLE 3--

NOTE LONGITUDINAL SEPARATION
L X3.K=X3.J+(DT)(XC3.JK)
N X3=X3N
C X3N=-40
R XC3.KL=MAX(0,XV3.K)
L XV3.K=XV3.J+(DT)(XA3.JK)
N XV3=200*5280/3600
R XA3.K=XAP3.K-XAD3.K
A XAP3.K=XK/M*(RX3.K-DX3.K)
A RX3.K=CLIP(X2.K-X3.K,X1.K-X3.K,Y2.K,6)
A DX3.K=CLIP(DX,2*DX,Y2.K,6)
A XAD3.K=-XD/M*RV3.K
A RV3.K=CLIP(XC2.K-XC3.K,XC1.K-XC3.K,Y2.K,6)

NOTE LATERAL POSITION
L Y3.K=Y3.J+(DT)(YC3.JK)
N Y3=Y3N
C Y3N=6
R YC3.KL=YV3.K
L YV3.K=YV3.J+(DT)(YA3.JK)
N YV3=0
R YA3.KL=YAP3.K-YAD3.K
A YAP3.K=-YK/M*(Y3.K-DY3.K)
A YAD3.K=YD/M*(YV3.K)
A DY3.K=6

NOTE VERTICAL POSITION
L Z3.K=Z3.J+(DT)(ZC3.JK)
N Z3=Z1N
C Z3N=3
R ZC3.KL=ZV3.K
L ZV3.K=ZV3.J+(DT)(ZA3.JK)
N ZV3=0
R ZA3.KL=ZAL3.K+ZAP3.K-ZAD3.K
A ZAP3.K=-ZK/M*(Z3.K-DZ3.K)
A ZAD3.K=ZD/M*ZV3.K
A DZ3.K=3
A ZAL3.K=MAX(0,(ZL3.K-W)/M)
NOTE ZAL3-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL3.K=.5*RHO*440**2*AREA*CL
NOTE ZL3-LIFT FORCE


NOTE --DESCRIPTION OF VEHICLE 4--

NOTE LONGITUDINAL SEPARATION
L X4.K=X4.J+(DT)(XC4.JK)
N X4=X4N
C X4N=-30
R XC4.KL=MAX(0,XV4.K)
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L XV4.K=XV4.J+(DT)(XA4.JK)
N XV4=170*5280/3600
R XA4.KL=XA4B.K
NOTE CLIP(XA4B.K,XA4A.K,Y4.K,0)
A XA4A.K=.3*G
A XA4B.K=XAP4.K-XAD4.K
A XAP4.K=XK/M*(RX4.K-DX)
A RX4.K=X3.K-X4.K
A XAD4.K=-XD/M*RV4.K
A RV4.K=XC3.K-XC4.K

NOTE LATERAL POSITION
L Y4.K=Y4.J+(DT)(YC4.JK)
N Y4=Y4N
C Y4N=-12
R YC4.KL=YV4.K
L YV4.K=YV4.J+(DT)(YA4.JK)
N YV4=0
R YA4.KL=YAP4.K-YAD4.K
A YAP4.K=-YK/M*(Y4.K-DY4.K)
A DY4.K=CLIP(18,6,TIME.K,120)
A YAD4.K=YD/M*YV4.K

NOTE VERTICAL POSITION
L Z4.K=Z4.J+(DT)(ZC4.JK)
N Z4=Z4N
C Z4N=2
R ZC4.KL=ZV4.K
L ZV4.K=ZV4.J+(DT)(ZA4.JK)
N ZV4=0
R ZA4.KL=ZAL4.K+ZAP4.K-ZAD4.K
A ZAP4.K=-ZK/M*(Z4.K-DZ4.K)
A ZAD4.K=ZD/M*ZV4.K
A DZ4.K=3
A ZAL4.K=MAX(0,(ZL4.K-W)/M)
NOTE ZAL4-VERTICAL ACCEL. DUE TO DIFFERENCE OF LIFT FORCE AND WEIGHT
(FT/SEC^2)
A ZL4.K=.5*RHO*440**2*AREA*CL
NOTE ZL4-LIFT FORCE

A RX12.K=X1.K-X2.K
A RX23.K=X2.K-X3.K
A RX34.K=X3.K-X4.K
A RX13.K=X1.K-X3.K

SPEC DT=.05/LENGTH=150/PLTPER=.5/SAVPER=.5
SAVE X1,X2,X3,X4
SAVE Y1,Y2,Y3,Y4
SAVE XV1,XV2,XV3,XV4
SAVE YV1,YV2,YV3,YV4
SAVE XA1,XA2,XA3,XA4
SAVE YA1,YA2,YA3,YA4
SAVE RX12,RX23,RX34,RX13
SAVE Z1,Z2,Z3,Z4
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