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1960 KEY 8 , ""
1970 KEY 10 , "TRANSL"
1980 A$=INKEY$
1990 IF A$="" THEN 1980
2000 IF VAL(A$)<1 OR VAL(A$)>6 THEN RETURN
2010 ON VAL(A$) GOSUB 2030,2050,2100,2150,2270,2210,2030,2030,2030
2020 GOTO 1980
2030 RETURN
2040 ' *** level 6 subroutine to input X translation
2050 KEY OFF:LOCATE 25,1:PRINT "X Translation <";H;"> ";:INPUT A$
2060 IF A$<>"" THEN GOSUB 4710:H=VAL(A$):T(4,1)=H:GOSUB 2380
2070 KEY ON
2080 RETURN
2090 ' *** level 6 subroutine to input Y translation
2100 KEY OFF:LOCATE 25,1:PRINT "Y Translation <";K;"> ";:INPUT A$
2110 IF A$<>"" THEN GOSUB 4710:K=VAL(A$):T(4,2)=K:GOSUB 2380
2120 KEY ON
2130 RETURN
2140 ' *** level 6 subroutine to input Z translation
2150 KEY OFF:LOCATE 25,1:PRINT "Z Translation <";L;"> ";:INPUT A$
2160 IF A$<>"" THEN GOSUB 4710:L=VAL(A$):T(4,3)=L:GOSUB 2380
2170 KEY ON
2180 RETURN
2190 KEY ON
2200 ' *** level 6 subroutine to change Y axis origin
2210 KEY OFF:LOCATE 25,1:PRINT "Y axis centre<";CY;"> ";:INPUT A$
2220 IF A$<>"" THEN LET CY=VAL(A$)
2230 KEY ON
2240 RETURN
2250 RETURN
2260 ' *** level 6 subroutine to change axis origin
2270 KEY OFF:LOCATE 25,1:PRINT "X axis centre<";CX;"> ";:INPUT A$
2280 IF A$<>"" THEN LET CX=VAL(A$)
2290 KEY ON
2300 RETURN
2310 '*****
2320 ' *** assign a,b,c scaling values too transformation matrix
T(i,j)
2330 T(1,1)=A:T(2,2)=B:T(3,3)=C:T(4,4)=1
2340 T(1,1)=A:T(2,2)=B:T(3,3)=C:T(4,4)=1
2350 RETURN
2360 '*****
2370 ' *** multiply old points by transformation for new points
2380 CLS:LOCATE 10,40:PRINT "BUSY"
2390 X=PLOTXMIN*T(1,1)+PLOTYMIN*T(2,1)+PLOTZMIN*T(3,1)+T(4,1)
2400 Y=PLOTXMIN*T(1,2)+PLOTYMIN*T(2,2)+PLOTZMIN*T(3,2)+T(4,1)
2410 Z=PLOTXMIN*T(1,3)+PLOTYMIN*T(2,3)+PLOTZMIN*T(3,3)+T(4,1)
2420 IF ABS(X)<.000001 THEN LET X=0
2430 IF ABS(Y)<.000001 THEN LET Y=0
2440 IF ABS(Z)<.000001 THEN LET Z=0

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2450 PLOTXMIN=X:PLOTYMIN=Y:PLOTZMIN=Z
2460 X=PLOTXMAX*T(1,1)+PLOTYMAX*T(2,1)+PLOTZMAX*T(3,1)+T(4,1)
2470 Y=PLOTXMAX*T(1,2)+PLOTYMAX*T(2,2)+PLOTZMAX*T(3,2)+T(4,1)
2480 Z=PLOTXMAX*T(1,3)+PLOTYMAX*T(2,3)+PLOTZMAX*T(3,3)+T(4,1)
2490 IF ABS(X)<.000001 THEN LET X=0
2500 IF ABS(Y)<.000001 THEN LET Y=0
2510 IF ABS(Z)<.000001 THEN LET Z=0
2520 PLOTXMAX=X:PLOTYMAX=Y:PLOTZMAX=Z
2530 X=DISPXMIN*T(1,1)+DISPYMIN*T(2,1)+DISPZMIN*T(3,1)+T(4,1)
2540 Y=DISPXMIN*T(1,2)+DISPYMIN*T(2,2)+DISPZMIN*T(3,2)+T(4,1)
2550 Z=DISPXMIN*T(1,3)+DISPYMIN*T(2,3)+DISPZMIN*T(3,3)+T(4,1)
2560 DISPXMIN=X:DISPYMIN=Y:DISPZMIN=Z
2570 IF ABS(X)<.000001 THEN LET X=0
2580 IF ABS(Y)<.000001 THEN LET Y=0
2590 IF ABS(Z)<.000001 THEN LET Z=0
2600 X=DISPXMAX*T(1,1)+DISPYMAX*T(2,1)+DISPZMAX*T(3,1)+T(4,1)
2610 Y=DISPXMAX*T(1,2)+DISPYMAX*T(2,2)+DISPZMAX*T(3,2)+T(4,1)
2620 Z=DISPXMAX*T(1,3)+DISPYMAX*T(2,3)+DISPZMAX*T(3,3)+T(4,1)
2630 IF ABS(X)<.000001 THEN LET X=0
2640 IF ABS(Y)<.000001 THEN LET Y=0
2650 IF ABS(Z)<.000001 THEN LET Z=0
2660 DISPXMAX=X:DISPYMAX=Y:DISPZMAX=Z
2670 IF DISPXMAX<DISPXMIN THEN LET
D77=DISPXMIN:DISPXMIN=DISPXMAX:DISPXMAX=D77
2680 IF DISPYMAX<DISPYMIN THEN LET
D77=DISPYMIN:DISPYMIN=DISPYMAX:DISPYMAX=D77
2690 IF DISPZMAX<DISPZMIN THEN LET
D77=DISPZMIN:DISPZMIN=DISPZMAX:DISPZMAX=D77
2700 IF PLOTXMAX<PLOTXMIN THEN LET
D77=PLOTXMIN:PLOTXMIN=PLOTXMAX:PLOTXMAX=D77
2710 IF PLOTYMAX<PLOTYMIN THEN LET
D77=PLOTYMIN:PLOTYMIN=PLOTYMAX:PLOTYMAX=D77
2720 IF PLOTZMAX<PLOTZMIN THEN LET
D77=PLOTZMIN:PLOTZMIN=PLOTZMAX:PLOTZMAX=D77
2730 FOR I=1 TO NONODE
2740 X=X(I)*T(1,1)+Y(I)*T(2,1)+Z(I)*T(3,1)+T(4,1)
2750 Y=X(I)*T(1,2)+Y(I)*T(2,2)+Z(I)*T(3,2)+T(4,2)
2760 Z=X(I)*T(1,3)+Y(I)*T(2,3)+Z(I)*T(3,3)+T(4,3)
2770 X(I)=X:Y(I)=Y:Z(I)=Z
2780 NEXT I
2790 CLS
2800 RETURN
2810 *****
2820 '*** LEVEL 2 SUBROUTINE FOR rotation around an axis
2830 RETDUM=0:SUBDUM=2
2840 KEY 1, ""
2850 KEY 2, "-X"
2860 KEY 3, "-Y"
2870 KEY 4, "-Z"
2880 KEY 9, "EXIT"

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2890 KEY 5 , ""
2900 KEY 6 , ""
2910 KEY 7 , ""
2920 KEY 8 , ""
2930 KEY 10, "ROTATE"
2940 A$=INKEY$
2950 IF A$="" THEN 2940
2960 ON VAL(A$) GOSUB 3010,3040,3130,3220,3010,3010,3010,3010,3480
2970 IF RETDUM=1 THEN LET RETDUM=0:RETURN
2980 IF VAL(A$)>=5 AND VAL(A$)<=8 THEN 2940
2990 GOSUB 2380: '*** update the points data file
3000 GOTO 2940
3010 RETURN
3020 '*****
3030 ' *** level 6 subroutine to input x rotation
3040 KEY OFF:LOCATE 25,1:PRINT "Angle around X axis (<";THETAX;">"
";:INPUT A$
3050 IF A$<>"" THEN LET THETAX=VAL(A$)
3060 GOSUB 4710
3070 RTHETA=THETAX/180*PI
3080 T(2,2)=COS(RTHETA):T(2,3)=SIN(RTHETA):T(3,2)=-
SIN(RTHETA):T(3,3)=T(2,2)
3090 KEY ON
3100 RETURN
3110 '*****
3120 ' *** level 6 subroutine to input y rotation
3130 KEY OFF:LOCATE 25,1:PRINT "Angle around Y axis (<";THETAY;">"
";:INPUT A$
3140 IF A$<>"" THEN LET THETAY=VAL(A$)
3150 GOSUB 4710
3160 RTHETA=THETAY/180*PI
3170 T(1,1)=COS(RTHETA):T(3,1)=-
SIN(RTHETA):T(1,3)=SIN(RTHETA):T(3,3)=T(1,1)
3180 KEY ON
3190 RETURN
3200 '*****
3210 ' *** level 6 subroutine to input Z rotating
3220 KEY OFF:LOCATE 25,1:PRINT "Angle around Z axis (<";THETAZ;">"
";:INPUT A$
3230 IF A$<>"" THEN LET THETAZ=VAL(A$)
3240 GOSUB 4710
3250 RTHETA=THETAZ/180*PI
3260 T(1,1)=COS(RTHETA):T(1,2)=SIN(RTHETA):T(2,1)=-
SIN(RTHETA):T(2,2)=T(1,1)
3270 KEY ON
3280 RETURN
3290 '*****
3300 '*****
3310 ' ***Level 3 - Zoom onto object by changing distance from eye to
the origin - RHO

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3320 SUBDUM=3:KEY OFF
3330 LOCATE 25,1:PRINT "Distance from eye to origin (";RHO;" ) "
;:INPUT DUM$
3340 IF DUM$<>" " THEN LET RHO =VAL(DUM$)
3350 KEY ON :GOSUB 4710:RETURN
3360'*****
3370 '*** Level 3 - change perspective by changing distance from eye
to screen - D
3380 SUBDUM=3:KEY OFF
3390 LOCATE 25,1:PRINT "Distance from eye to screen (";D ;" "
;:INPUT DUM$
3400 IF DUM$<>" " THEN LET D =VAL(DUM$)
3410 KEY ON :GOSUB 4710:RETURN
3420'*****
3430 ' *** Level 2 subroutine to rotate object around specified axis
3440 '*** Reflect the object about an axis
3450 KEY 9 , " "
3460 '*** Rotate an object about an axis
3470 '*** ON KEY RETURN ROUTINE
3480 RETDUM=1:RETURN
3490'*****
3500 '*** LEVEL 3 SUBROUTINE to change angle of eye to object
3510 SUBDUM=3:KEY OFF
3520 LOCATE 25,1:PRINT "Angle on XY plane (";THETAD;" degrees) "
;:INPUT DUM$
3530 IF DUM$<>" " THEN LET THETAD=VAL(DUM$)
3540 THETA=THETAD/180*PI
3550 KEY ON :GOSUB 4710:RETURN
3560'*****
3570 '*** LEVEL 3 SUBROUTINE to change angle of eye to object
3580 SUBDUM=3:KEY OFF
3590 LOCATE 25,1:PRINT "Angle to Z axis (";PHID;" degrees) " ;:INPUT
DUM$
3600 IF DUM$<>" " THEN LET PHID=VAL(DUM$)
3610 PHI=PHID/180*PI
3620 KEY ON :GOSUB 4710:RETURN
3630'*****
3640 'level 3 subroutine to calculate and plot screen co-ordinates
3650 SUBDUM=3
3660 CLS:INPUT "TYPE E TO EDIT PICTURE LIMITS";A$
3670 IF A$<>"E" THEN GOTO 3800
3675 INPUT "SCREEN TYPE (2/9)";SCRN
3676 IF SCRN<>2 AND SCRN<>9 THEN 3675
3677 IF SCRN=9 THEN LET SC=1.5
3678 IF SCRN=2 THEN LET SC=2.4
3680 CLS: LOCATE 1,1:PRINT "X min <;DISPXMIN;"> ";:INPUT A$
3690 IF A$<>" " THEN LET DISPXMIN=VAL(A$)
3700 LOCATE 1,40:PRINT "X max <;DISPXMAX;"> ";:INPUT A$
3710 IF A$<>" " THEN LET DISPXMAX=VAL(A$)
3720 LOCATE 3,1:PRINT "Y min <;DISPYMIN;"> ";:INPUT A$

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3730 IF A$<>" " THEN LET DISPYMIN=VAL(A$)
3740 LOCATE 3,40:PRINT "Y max <"DISPYMAX;"> ";;INPUT A$
3750 IF A$<>" " THEN LET DISPYMAX=VAL(A$)
3760 LOCATE 5,3:PRINT "Z min <"DISPZMIN;"> ";;INPUT A$
3770 IF A$<>" " THEN LET DISPZMIN=VAL(A$)
3780 LOCATE 5,40:PRINT "Z max <"DISPZMAX;"> ";;INPUT A$
3790 IF A$<>" " THEN LET DISPZMAX=VAL(A$)
3800 GOSUB 4140: ' assign sin and cos to variables for speed
3810 CLS:SCREEN SCRN:'9:'2:' 9
3820 LOCATE 1,40:PRINT "Busy"
3830 GOSUB 9070 : ' *** draw axis and labels
3840 FOR I= 1 TO NOLIN
3850 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 4090
3860 I1=STPOINT(I):'*** IF PLOPT=2 OR PLOPT=3 THEN GOSUB 3295:' ***
find node
3870 X1=X(I1):Y1=Y(I1):Z1=Z(I1)
3880 ' *** clip picture
3890 IF X1<DISPXMIN OR X1>DISPXMAX THEN 4090
3900 IF Y1<DISPYMIN OR Y1>DISPYMAX THEN 4090
3910 IF Z1<DISPZMIN OR Z1>DISPZMAX THEN 4090
3920 I2=ENDPOINT(I):'*** IF PLOPT=2 OR PLOPT=3 THEN GOSUB 3325:'
*** find node
3930 X2=X(I2):Y2=Y(I2):Z2=Z(I2)
3940 ' *** clip picture
3950 IF X2<DISPXMIN OR X2>DISPXMAX THEN 4090
3960 IF Y2<DISPYMIN OR Y2>DISPYMAX THEN 4090
3970 IF Z2<DISPZMIN OR Z2>DISPZMAX THEN 4090
3980 XE1=-X1*S1+Y1*C1
3990 YE1=-X1*C1-C2-Y1*S1*C2+Z1*S2
4000 ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
4010 SX1=D*XE1/ZE1+CX
4020 SY1=(CY-D*YE1/ZE1)/SC
4030 XE2=-X2*S1+Y2*C1
4040 YE2=-X2*C1-C2-Y2*S1*C2+Z2*S2
4050 ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
4060 SX2=D*XE2/ZE2+CX
4070 SY2=(CY-D*YE2/ZE2)/SC
4080 LINE (SX1,SY1)-(SX2,SY2) : ' draw from start point to end point
4090 NEXT I
4100 LOCATE 1,40:PRINT " "
4110 RETURN
4120'*****
4130 ' *** routine to calculate sin and cos of angle
4140 S1=SIN (THETA)
4150 C1=COS (THETA)
4160 S2=SIN (PHI)
4170 C2=COS (PHI)
4180 RETURN
4190'*****
4270 ' setup of default values

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4280 PI=3.141592654#
4290 DECPLACE=4
4300 MULT=.001 : ' *** MULTIPLYER FOR INPUT OF CONTOUR
4310 G=9.810001: ' *** gravitational
acceleration
4320 SUBDUM=0: ' *** dummy to indicate level of
subroutine
4330 RETDUM=0: ' *** dummy flag to indicate exit
routine
4340 RHO=100: ' *** distance from eye to
object
4350 D= 20000: '5000: ' *** distance from eye
to screen
4360 THETAD=45:THETA=THETAD*PI/180: ' *** angle to x axis o n XY
plane
4370 PHID=45:PHI =PHID*PI/180: ' *** angle to z axis
4380 CX=320 ' *** centre of screen x axis
4390 CY=150 ' *** centre of screen y axis
4400 SC=2.4: '150/110 ' *** scaling factor for
screen
4405 SC=150/100
4410 FOR I=1 TO 4:T(I,I)=1:NEXT I
4420 A=1:B=1:C=1: ' *** scaling default values
4430 H=0:K=0:L=0: ' *** translation Default values
4440 PLFX= 5: ' *** plot x multiplier
4450 PLFY= 5: ' *** plot y multiplier
4460 PLOX=2500: ' *** plot x offset
4470 PLOY=1000: ' *** plot y offset
4480 '*****
4490 DISPXMIN=-1: ' *** picture x limit
4500 DISPMAX=13: ' *** picture x limit
4510 DISPYMIN=-1: ' *** picture y limit
4520 DISPYMAX=1 : ' *** picture y limit
4530 DISPZMIN=-1: ' *** picture z limit
4540 DISPZMAX= 1: ' *** picture z limit
4550 PLOTXMIN=0: ' *** picture x limit
4560 PLOTXMAX=13: ' *** picture x limit
4570 PLOTYMIN=-1 : ' *** picture y limit
4580 PLOTYMAX=1 : ' *** picture y limit
4590 PLOTZMIN=-1 ' *** picture z limit
4600 PLOTZMAX=1 : ' *** picture z limit
4680 RETURN
4690 '*****
4700 ' *** assign 1 and 0 values too transformation matrix T(i,j)
4710 FOR I1=1 TO 4:FOR J1=1 TO 4:T(I1,J1)=0:NEXT J1:NEXT I1
4720 T(1,1)=1:T(2,2)=1:T(3,3)=1:T(4,4)=1
4730 RETURN
4740 '*****
6390 '*** LEVEL 1 SUBROUTINE to save co-ordinate and line data
6400 CLS:LOCATE 1,1:INPUT "Name of file ";NAMEFILES$

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6410 OPEN NAMEFILE$ FOR OUTPUT AS #1
6420 PRINT#1,NONODE
6430 FOR I=1 TO NONODE
6450 PRINT#1,NODENO(I);
6455 PRINT#1,USING"###.###";X(I),Y(I),Z(I)
6460 NEXT I
6462 NOACTLIN=NOLIN
6464 FOR I= 1 TO NOLIN
6466 IF STPOINT(I)=0 AND ENDPOINT(I)=0 THEN LET NOACTLIN=NOACTLIN-1
6468 NEXT I
6470 PRINT#1,NOACTLIN
6480 FOR I=1 TO NOLIN
6490 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 6510
6500 PRINT#1,STPOINT(I),ENDPOINT(I)
6510 NEXT I
6520 CLOSE#1
6530 RETURN
6540 *****
6550 '*** LEVEL 1 SUBROUTINE to load co-ordinate and line data
6560 CLS:LOCATE 1,1:INPUT "Name of file ";NAMEFILE$
6570 OPEN NAMEFILE$ FOR INPUT AS #1
6580 INPUT#1,NONODE
6590 FOR I=1 TO NONODE
6600 INPUT#1,NODENO(I),X(I),Y(I),Z(I)
6610 NEXT I
6620 INPUT#1,NOACTLIN
6630 FOR I=1 TO NOACTLIN
6640 INPUT#1,STPOINT(I),ENDPOINT(I)
6650 NEXT I
6660 NOLIN=NOACTLIN
6670 CLOSE#1
6680 RETURN
6690 *****
6700 '*** LEVEL 1 SUBROUTINE to load ABAQUS file and plot data points
6710 CLS:LOCATE 1,1:INPUT "Name of file ";NAMEFILE$
6720 OPEN NAMEFILE$ FOR INPUT AS #1
6730 INPUT#1,NONODE
6740 FOR I=1 TO NONODE
6750 INPUT#1,NODENO(I),X(I),Y(I),Z(I)
6760 PRINT NODENO(I);X(I);Y(I);Z(I)
6770 NEXT I
6780 INPUT "Press return to continue";A$
6790 INPUT#1,NOLIN
6800 FOR I=1 TO NOLIN
6820 INPUT#1,STPOINT, ENDPOINT
6821 FOR J= 1 TO NONODE
6822 IF STPOINT=NODENO(J) THEN LET STPOINT(I)=J:GOTO 6825
6823 NEXT J
6825 FOR J= 1 TO NONODE
6826 IF ENDPOINT=NODENO(J) THEN LET ENDPOINT(I)=J:GOTO 6840

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6828     NEXT J
6840 NEXT I
6850 CLOSE#1
6860 RETURN
6870'*****
6880 'level ? subroutine to find nodenum from about
6890 FOR I1=1 TO NONODE
6900 IF STPOINT(I)=NODENO(I1) THEN RETURN
6910 NEXT I1
6920 RETURN
6930'*****
6940 'level ? subroutine to find nodenum from about
6950 FOR I2=1 TO NONODE
6960 IF ENDPOINT(I)=NODENO(I2) THEN RETURN
6970 NEXT I2
6980 RETURN
6990'*****
7000 'level 1 subroutine to calculate and plot co-ordinates
7010'*****
7020 SUBDUM=1:CLS
7030 KEY OFF:CLOSE#3
7040 OPEN "o",#3,"lpt1:":"** open output file to plotter
7050 PAPSIZ=4:INPUT "Size A4 or A3 (4/3)";A$
7060 IF A$<>" " THEN LET PAPSIZ=VAL(A$)
7070 IF PAPSIZ=3 THEN LET PXMAX=4000:PYMAX=2900
7080 IF PAPSIZ=4 THEN LET PXMAX=2900:PYMAX=2000
7090 '*** scale plotter
7100     PRINT "X factor <";PLFX;"> ";:INPUT A$
7110     IF A$<>" " THEN LET PLFX=VAL(A$)
7120     PRINT "Y factor <";PLFY;"> ";:INPUT A$
7130     IF A$<>" " THEN LET PLFY=VAL(A$)
7140     PRINT "X offset (mm) <";PLOX/10;"> ";:INPUT A$
7150     IF A$<>" " THEN LET PLOX=VAL(A$)*10
7160     PRINT "Y offset (mm) <";PLOY/10;"> ";:INPUT A$
7170     IF A$<>" " THEN LET PLOY=VAL(A$)*10
7180 CLS:INPUT "TYPE E TO EDIT PLOT LIMITS ";A$
7190 IF A$<>"E" THEN GOTO 7340
7200 CLS:INPUT "Same as display (Y/N) ";A$
7210 IF A$="Y" THEN LET
PLOTXMIN=DISPXMIN:PLOTXMAX=DISPXMAX:PLOTYMIN=DISPYMIN
:PLOTYMAX=DISPYMAX:PLOTZMIN=DISPZMIN:PLOTZMAX=DISPZMAX:GOTO
7340
7220 CLS:LOCATE 1,1:PRINT "X min <";PLOTXMIN;"> ";:INPUT A$
7230 IF A$<>" " THEN LET PLOTXMIN=VAL(A$)
7240 LOCATE 1,40:PRINT "X max <";PLOTXMAX;"> ";:INPUT A$
7250 IF A$<>" " THEN LET PLOTXMAX=VAL(A$)
7260 LOCATE 3,1:PRINT "Y min <";PLOTYMIN;"> ";:INPUT A$
7270 IF A$<>" " THEN LET PLOTYMIN=VAL(A$)
7280 LOCATE 3,40:PRINT "Y max <";PLOTYMAX;"> ";:INPUT A$
7290 IF A$<>" " THEN LET PLOTYMAX=VAL(A$)

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7300 LOCATE 5,1:PRINT "Z min <;PLOTZMIN;"> ";:INPUT A$
7310 IF A$<>" THEN LET PLOTZMIN=VAL(A$)
7320 LOCATE 5,40:PRINT "Z max <;PLOTZMAX;"> ";:INPUT A$
7330 IF A$<>" THEN LET PLOTZMAX=VAL(A$)
7340 GOSUB 4140: '*** assign sin and cos to variables for speed
7350 PRINT : INPUT "Choose drawing pen color ";PENCOLORD$
7360 PRINT : INPUT "Choose axis pen color ";PENCOLORA$
7370 IF VAL(PENCOLORD$)>6 THEN GOTO 7390
7380 '*** plot nodes option
7390 INPUT "Plot node numbers (Y/N)";PLNDDUM$
7400 IF PLNDDUM$="Y" THEN PRINT : INPUT "Choose node pen color
";PENCOLORN$
7410 INPUT "Plot element numbers (Y/N)";PLELDUM$
7420 IF PLELDUM$="Y" THEN PRINT : INPUT "Choose element pen color
";PENCOLORE$
7430 CLS:LOCATE 1,1:INPUT "Name of ABAQUS file ";NAMEFILES$
7440 CLS:LOCATE 12,40:PRINT "Busy"
7450 IF PENCOLORA$<>"0" THEN GOSUB 8650 : ' *** plot axis and limits
7460 PRINT#3,"M0,1200":PRINT#3,"JO"
7470 PRINT#3,"J"+PENCOLORD$
7480 FOR I= 1 TO NOLIN
7490 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 7790
7500 I1=STPOINT(I):IF PLOPT=2 OR PLOPT=3 THEN GOSUB 6890: ' *** find
node
7510 X1=X(I1):Y1=Y(I1):Z1=Z(I1)
7520 ' *** clip picture
7530 IF X1<PLOTXMIN OR X1>PLOTXMAX THEN 7790
7540 IF Y1<PLOTYMIN OR Y1>PLOTYMAX THEN 7790
7550 IF Z1<PLOTZMIN OR Z1>PLOTZMAX THEN 7790
7560 I2=ENDPOINT(I):IF PLOPT=2 OR PLOPT=3 THEN GOSUB 6950: ' ***
find node
7570 X2=X(I2):Y2=Y(I2):Z2=Z(I2)
7580 ' *** clip picture
7590 IF X2<PLOTXMIN OR X2>PLOTXMAX THEN 7790
7600 IF Y2<PLOTYMIN OR Y2>PLOTYMAX THEN 7790
7610 IF Z2<PLOTZMIN OR Z2>PLOTZMAX THEN 7790
7620 XE1=-X1*S1+Y1*C1
7630 YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
7640 ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
7650 PX1=INT((D*XE1/ZE1)*PLFX+PLOX)
7660 PY1=INT(((D*YE1/ZE1))*PLFY+PLOY)
7670 XE2=-X2*S1+Y2*C1
7680 YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
7690 ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
7700 PX2=INT((D*XE2/ZE2)*PLFX+PLOX)
7710 PY2=INT(((D*YE2/ZE2))*PLFY+PLOY)
7720 IF PX1<0 OR PX1>PXMAX GOTO 7850
7730 IF PX2<0 OR PX2>PXMAX GOTO 7850
7740 IF PY1<0 OR PY1>PYMAX GOTO 7850
7750 IF PY2<0 OR PY2>PYMAX GOTO 7850

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7760 '*** plot line
7770 PRINT#3,"M"+STR$(PX1)+" "+STR$(PY1)
7780 PRINT#3,"D"+STR$(PX2)+" "+STR$(PY2)
7790 NEXT I
7800 LOCATE 1,40:PRINT "      "
7810 IF PLNDDUM$="Y" THEN GOSUB 7880:'*** plot node numbers
7820 IF PLELDUM$="Y" THEN GOSUB 9520:'*** plot element numbers
7830 RETURN
7840 '*****
7850 CLS:INPUT "Picture outside of window";A$:GOTO 7100
7860 '*****
7870 '*** routine to plot node numbers *****
7880 IF VAL(PENCOLORN$)>6 THEN GOTO 7910
7890 PRINT#3,"M0,1000":PRINT#3,"J0"
7900 PRINT#3,"J"+PENCOLORN$
7910 PRINT#3,"S8,8"
7920 FOR I= 1 TO NONODE
7930 IF I<> NODENO(I) THEN 8070
7940     X1=X(I):Y1=Y(I):Z1=Z(I)
7950 ' *** clip picture
7960     IF X(I)<PLOTXMIN OR X(I)>PLOTXMAX THEN 8070
7970     IF Y(I)<PLOTYMIN OR Y(I)>PLOTYMAX THEN 8070
7980     IF Z(I)<PLOTZMIN OR Z(I)>PLOTZMAX THEN 8070
7990     XE1=-X1*S1+Y1*C1
8000     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
8010     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
8020     PX1= INT((D*XE1/ZE1)*PLFX+PLOX)
8030     PY1=INT((D*YE1/ZE1)*PLFY+PLOY)
8040 D1=-20:D2=-20 : ' *** dummy offset for node numbers
8050     PRINT#3,"M"+STR$(PX1+D1)+" "+STR$(PY1+D2)
8060     PRINT#3,"P"+STR$(NODENO(I))
8070 NEXT I
8080 RETURN
8090 '*****
8100 '*****
8110 '*** LEVEL 2 SUBROUTINE to input contours of 3d object or surface
8120 '*****
8130 CLS:X =0:Y1=0:Z1=0:STARTDUM$="Y":KEYDUM$="1":LINDUM$=""
8140 NODENUM=0:LINNO=0:      Y2=0:Z2=0
8150 KEY 1, "X-plane"
8160 KEY 2, "V-veiw "
8170 KEY 3, "D-del"
8180 KEY 4, "L-lines"
8190 KEY 5, "      "
8200 KEY 6, "      "
8210 KEY 7, "      "
8220 KEY 8, "      "
8230 KEY 9, "E-exit"
8240 KEY 10, "      "
8250 IF KEYDUM$="2" THEN LET KEYDUM$="1":GOTO 8380

```

```

8260 PRINT:INPUT "Y =";Y$
8270 IF Y$="E" THEN LET NOLIN=LINNO:GOSUB
10770:NONODE=NODENUM:RETURN
8280 IF Y$="X" THEN LET STARTDUM$="Y": LINDUM$="":GOSUB
8550:GOTO 8260
8290 IF Y$="V" THEN LET NOLIN=LINNO:NONODE=NODENUM:GOSUB
1200:GOTO 8150
8300 IF Y$="D" THEN LET LINNO=LINNO-1:NODENUM=NODENUM-1:GOTO
8260
8310 IF Y$="L" THEN GOSUB 8550:LINDUM$="L":GOTO 8260
8320 X1=X
8330 Y1=VAL(Y$)
8340 INPUT "Z =";Z1
8350 '*****
8360 X2=X: ** same x2 for contours
8370 IF LINDUM$="L" THEN GOSUB 8550:X2=X
8380 PRINT:INPUT "Y =";Y$
8390 IF Y$="V" THEN LET NOLIN=LINNO:NONODE=NODENUM:GOSUB
1200:KEYDUM$="2":GOTO 8150
8400 IF Y$="E" THEN LET NOLIN=LINNO:NONODE=NODENUM:RETURN
8410 IF Y$="X" THEN LET STARTDUM$="Y":LINDUM$="":GOSUB
8550:GOTO 8260
8420 IF Y$="D" THEN LET LINNO=LINNO-1:NODENUM=NODENUM-1:GOTO
8380
8430 IF Y$="L" THEN GOSUB 8550:LINDUM$="L":GOTO 8380
8440 Y2=VAL(Y$)
8450 INPUT "Z =";Z2
8460 IF STARTDUM$<>"Y" THEN GOTO 8500
8470
NODENUM=NODENUM+1:NODENO(NODENUM)=NODENUM:X(NODENUM)=X1*MULT
:Y(NODENUM)=Y1*MULT:Z(NODENUM)=Z1*MULT
8480
NODENUM=NODENUM+1:NODENO(NODENUM)=NODENUM:X(NODENUM)=X2*MULT
:Y(NODENUM)=Y2*MULT:Z(NODENUM)=Z2*MULT
8490 STARTDUM$="N":GOSUB 8520:GOTO 8360
8500
NODENUM=NODENUM+1:NODENO(NODENUM)=NODENUM:X(NODENUM)=X2*MULT
:Y(NODENUM)=Y2*MULT:Z(NODENUM)=Z2*MULT:GOSUB
8520:GOTO 8360
8510 '*****
8520 LINNO=LINNO+1:STPOINT(LINNO)-NODENUM-
1:ENDPOINT(LINNO)=NODENUM:RETURN
8530 '*****
8540 '***** ROUTINE TO CHANGE X PLANE
8550 PRINT:PRINT "X = <"X;">";:INPUT X$
8560 IF X$<>" " THEN LET X=VAL(X$)
8570 RETURN
8580 '*****
8590 '*** error trap
8600 CLS:INPUT "ERROR";A$:GOTO 70

```

```

8610 IF X(I1)<XPLOTMIN THEN 7790
8620 '*****
8630 ' *** routine to plot axis
8640 '*****
8650 IF VAL(PENCOLORA$)>6 THEN GOTO 8680
8660 PRINT#3,"M0,1200":PRINT#3,"J0"
8670 PRINT#3,"J"+PENCOLORA$
8680
X1=PLOTXMIN:X2=PLOTXMAX:A1=X1:A2=X2:Y1=0:Y2=0:Z1=0:Z2=0:AXISNAME$="X"
8690 '*** allow for 0 axis and avoid overprinting
8700 'IF PLOTXMAX=0 THEN LET A1=X2:A2=X1
8710 GOSUB 8830
8720
Y1=PLOTYMIN:Y2=PLOTYMAX:A1=Y1:A2=Y2:X1=0:X2=0:Z1=0:Z2=0:AXISNAME$="Y"
8730 '*** allow for 0 axis and avoid overprinting
8740 'IF PLOTYMAX=0 THEN LET A1=Y2:A2=Y1
8750 GOSUB 8830
8760
Z1=PLOTZMIN:Z2=PLOTZMAX:A1=Z1:A2=Z2:Y1=0:Y2=0:X1=0:X2=0:AXISNAME$="Z"
8770 '*** allow for 0 axis and avoid overprinting
8780 'IF PLOTZMAX=0 THEN LET A1=Z2:A2=Z1
8790 GOSUB 8830
8800 RETURN
8810 '*****
8820 ' *** routine to plot axis lines and names
8830 XE1=-X1*S1+Y1*C1
8840 YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
8850 ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
8860 PX1=INT((D*XE1/ZE1)*PLFX+PLOX)
8870 PY1=INT(((D*YE1/ZE1))*PLFY+PLOY)
8880 XE2=-X2*S1+Y2*C1
8890 YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
8900 ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
8910 PX2=INT((D*XE2/ZE2)*PLFX+PLOX)
8920 PY2=INT(((D*YE2/ZE2))*PLFY+PLOY)
8930 PRINT#3,"M"+STR$(PX1)+" "+STR$(PY1)
8940 PRINT#3,"D"+STR$(PX2)+" "+STR$(PY2)
8950 D1=0:D2=-40:
8960 PRINT#3,"M"+STR$(PX1+D1)+" "+STR$(PY1+D2)
8970 PRINT#3,"P"+STR$(A1)
8980 PRINT#3,"M"+STR$(PX2+D1)+" "+STR$(PY2+D2)
8990 PRINT#3,"P"+STR$(A2)
9000 PRINT#3,"M"+STR$(PX2+D1)+" "+STR$(PY2-D2)
9010 PRINT#3,"P"+AXISNAME$
9020 RETURN
9030 '*****
9040 ' *** routine to disp axis
9050 '*****
9060 DUM=DUM
9070 X1=0

```

```

: X2=DISPYMAX:A1=X1:A2=X2:Y1=0:Y2=0:Z1=0:Z2=0:AXISNAME$="X"
9080 '*** allow for 0 axis and avoid overprinting
9090 GOSUB 9190
9100 Y1=0
: Y2=DISPYMAX:A1=Y1:A2=Y2:X1=0:X2=0:Z1=0:Z2=0:AXISNAME$="Y"
9110 '*** allow for 0 axis and avoid overprinting
9120 GOSUB 9190
9130 Z1=0
: Z2=DISPYMAX:A1=Z1:A2=Z2:Y1=0:Y2=0:X1=0:X2=0:AXISNAME$="Z"
9140 '*** allow for 0 axis and avoid overprinting
9150 GOSUB 9190
9160 RETURN
9170 '*****
9180 ' *** routine to plot axis lines and names
9190     XE1=-X1*S1+Y1*C1
9200     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
9210     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
9220     SX1=      D*XE1/ZE1 +CX
9230     SY1=(CY-D*YE1/ZE1)/SC
9240     XE2=-X2*S1+Y2*C1
9250     YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
9260     ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
9270     SX2=      D*XE2/ZE2 +CX
9280     SY2=(CY-D*YE2/ZE2)/SC
9290     LINE (SX1,SY1)-(SX2,SY2)
9300 AXISX=INT(SX2/640*80+1):AXISY=INT(SY2/200*25+1):'*** screen co-
ords for text
9310 IF AXISX<0 OR AXISX>80 THEN GOTO 9340
9320 IF AXISY<0 OR AXISY>25 THEN GOTO 9340
9330 'LOCATE AXISY,AXISX:PRINT AXISNAME$
9340 RETURN
9350 '**** routine to merge two line files
9360 CLS:LOCATE 1,1:INPUT "Name of file ";NAMEFILE$
9370 OPEN NAMEFILE$ FOR INPUT AS #1
9375 NOFFSET=0
9380 INPUT#1,NONODE2
9390 NEWNODE=NONODE+1:NONODE =NONODE+NONODE2
9400 FOR I=NEWNODE TO NONODE
9410     INPUT#1,NODENO(I),X(I),Y(I),Z(I)
9515     NODENO(I)=NODENO(I)+NEWNODE-1
9420 NEXT I
9430 INPUT#1,NOLIN1
9440 NEWLEEM =NOLIN+1:NOLIN =NOLIN+NOLIN1:NOACTLIN=NOLIN
9450 FOR I=NEWLEEM TO NOLIN
9460     INPUT#1,STPOINT(I),ENDPOINT(I)
9470     STPOINT(I)=STPOINT(I)+NEWNODE-
1:ENDPOINT(I)=ENDPOINT(I)+NEWNODE-1
9480 NEXT I
9490 CLOSE#1
9500 RETURN

```

```

9510 ' *** ROUTINE TO LOAD ABAIN FOR PLOTTING ELEMENT NUMBERS
9520 OPEN NAMEFILE$ FOR INPUT AS #1
9530 LINE INPUT#1,A$
9540 IF LEFT$(A$,5)<>"*NODE" THEN GOTO 9530
9560 NONODE=0:NOELEM=0
9570 '*** LOAD ABAQUS FILE X,Y,Z INTO MATRICES
9580 INPUT#1,A$
9590 IF LEFT$(A$,8)="*ELEMENT" THEN GOTO 9670
9600 NODENUM=VAL(A$) :NONODE=NONODE+1
9610 NODENO(NODENUM)=NODENUM
9620 INPUT#1,A$:X(NODENUM)=VAL(A$)
9630 INPUT#1,A$:Y(NODENUM)=VAL(A$)
9640 INPUT#1,A$:Z(NODENUM)=VAL(A$)
9650 GOTO 9580
9660 '*** routine to element numbers *****
9670 INPUT#1,DUM1$,DUM2$:IF VAL(PENCOLORES$)>6 THEN GOTO 9700
9680 PRINT#3,"MO,1000":PRINT#3,"JO"
9690 PRINT#3,"J"+PENCOLORES$
9700 PRINT#3,"S8,8"
9710 INPUT#1,ELNOS$
9720 IF LEFT$(ELNOS$,1)="*" THEN CLOSE:RETURN
9730 INPUT#1,N1$,N2$,N3$,N4$,N5$,N6$,N7$,N8$
9740 X1 =(X(NODENO(VAL(N2$)))+X(NODENO(VAL(N3$))))/2
9750 Y1 =(Y(NODENO(VAL(N1$)))+Y(NODENO(VAL(N2$))))/2
9760 Z1 =(Z(NODENO(VAL(N1$)))+Z(NODENO(VAL(N2$))))/2
9770 ' *** clip picture
9780 IF X1 <PLOTXMIN OR X1 >PLOTXMAX THEN 9710
9790 IF Y1 <PLOTYMIN OR Y1 >PLOTYMAX THEN 9710
9800 IF Z1 <PLOTZMIN OR Z1 >PLOTZMAX THEN 9710
9810 XE1=-X1*S1+Y1*C1
9820 YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
9830 ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
9840 PX1=INT((D*XE1/ZE1)*PLFX+PLOX)
9850 PY1=INT((D*YE1/ZE1)*PLFY+PLOY)
9860 D1=-0:D2=-0 : ' *** dummy offset for element
9870 PRINT#3,"M"+STR$(PX1-D1)+" "+STR$(PY1-D2)
9880 PRINT#3,"P"+ELNOS$
9890 GOTO 9710
9900 '*****
9910 '*** LEVEL 1 routine to load abaqus input file and generate lin
file
9920 CLS:LOCATE 1,1:INPUT "Name of file ";NAMEFILE$
9945 CLOSE
9950 OPEN NAMEFILE$ FOR INPUT AS #1
9955 '*** load in all node numbers
9960 I=0
9970 LINE INPUT#1,A$
9975 IF EOF(1) THEN PRINT "Data not found":INPUT AAA:RETURN
9980 IF LEFT$(A$,5)<>"*NODE" THEN 9970
9990 INPUT#1,A$

```

```

9992         IF LEFT$(A$,8)="*ELEMENT" THEN PRINT "FOUND ELEMENT":GOTO
10040
9995         IF LEFT$(A$,5)="*NODE" THEN PRINT:INPUT#1,B$,A$
10000         I=VAL(A$): NODENO(I)=I
10010         INPUT#1,X(I),Y(I),Z(I)
10020 NONODE=I:GOTO 9990
10030 '*** load in all the elements
10040 INPUT#1,B$,C$: POINTNO=0:PRINT A$,B$
10042         IF B$="TYPE=S8R" THEN NOPEEL=8:SIGNODE=4:GOTO 10700
10044         IF B$="TYPE=STRI3" THEN NOPEEL=3:SIGNODE=3:GOTO 10700
10046         IF B$="TYPE=R32" THEN NOPEEL=3:SIGNODE=3:GOTO 10700
10050 INPUT#1,A$:PRINT A$
10052 IF LEFT$(A$,6) = "*ELSET" THEN CLOSE#1:GOTO 10172:'** REMOCE
DUPLICATE NUMBERS
10055 IF LEFT$(A$,8) = "*ELEMENT" THEN GOTO 10040
10070         FOR I=1 TO NOPEEL
10080             INPUT#1,NODE(I)
10090         NEXT I
10100         FOR I=1 TO SIGNODE-1
10110
POINTNO=POINTNO+1:STPOINT(POINTNO)=NODE(I):ENDPOINT(POINTNO)=NODE(I+1)
10120         NEXT I
10130 IF NOPEEL=8 AND SIGNODE=4 THEN
POINTNO=POINTNO+1:STPOINT(POINTNO)=NODE(4):ENDPOINT(POINTNO)=NODE(1)
10140 NOLIN=POINTNO
10150 NOACTLIN=NOLIN
10160 GOTO 10050
10172 INPUT "Do you want to eliminate duplicate lines (Y/N) ";DUP$
10174 IF DUP$<>"Y" THEN NOCASTLIN=NOLIN:RETURN
10176 GOSUB 10770:RETURN
10180 '*****
10190 'level ? subroutine to find nodenum from abacut
10200 FOR I1=1 TO NONODE
10210 IF STPOINT(I)= NODENO(I1) THEN RETURN
10220 NEXT I1
10230 RETURN
10240 '*****
10250 'level ? subroutine to find nodenum from abacut
10260 FOR I2=1 TO NONODE
10270 IF ENDPOINT(I)= NODENO(I2) THEN RETURN
10280 NEXT I2
10290 RETURN
10300 '*****
10310 '**** routine to truncate numbers
10320 TRUNC=TRUNC*10^DECPLACE
10330 TRUNC=INT(TRUNC)
10340 TRUNC=TRUNC/10^DECPLACE
10350 RETURN
10355 '*****
10360 '*** ROUTINE TO SAVE DATA AS NISA.NEU FILE *****

```

```

10370 CLS:LOCATE 1,1:INPUT "Name of file ":NAMEFILES$
10380 OPEN NAMEFILES$ FOR OUTPUT AS #1
10390 PRINT#1,NAMEFILES$
10400 FOR I=1 TO NONODE
10410 IF NODENO(I)=0 THEN GOTO 10500
10420 IF NODENO(I)<>I THEN GOTO 10500
10430 COUNTG=NODENO(I)
10440 SPAG$=CHR$(32)+CHR$(32)+CHR$(32)
10450 IF COUNTG>9 THEN SPAG$=CHR$(32)+CHR$(32)
10460 IF COUNTG>99 THEN SPAG$=CHR$(32)
10470 IF COUNTG>999 THEN SPAG$=""
10480 PRINT #1,1;SPAG$;COUNTG
10490 PRINT #1,USING "#.#####^"X(I),Y(I),Z(I)
10500 NEXT I
10510 '*** print lines to disc
10520 FOR I = 1 TO NOACTLIN
10530 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 10710
10540 COUNTL=I
10550 SPAL$=CHR$(32)+CHR$(32)+CHR$(32)
10560 IF COUNTL>9 THEN SPAL$=CHR$(32)+CHR$(32)
10570 IF COUNTL>99 THEN SPAL$=CHR$(32)
10580 IF COUNTL>999 THEN SPAL$=""
10590 PRINT #1,2;SPAL$;COUNTL
10600 X1=X(STPOINT(I)):Y1=Y(STPOINT(I)):Z1=Z(STPOINT(I))
10610 X4=X(ENDPOINT(I)):Y4=Y(ENDPOINT(I)):Z4=Z(ENDPOINT(I))
10620 DIVX=(X4-X1)/3
10630 DIVY=(Y4-Y1)/3
10640 DIVZ=(Z4-Z1)/3
10650 X2=X1+DIVX:Y2=Y1+DIVY:Z2=Z1+DIVZ
10660 X3=X1+2*DIVX:Y3=Y1+2*DIVY:Z3=Z1+2*DIVZ
10670 PRINT #1,USING "#.#####^"X1,Y1,Z1
10680 PRINT #1,USING "#.#####^"X2,Y2,Z2
10690 PRINT #1,USING "#.#####^"X3,Y3,Z3
10700 PRINT #1,USING "#.#####^"X4,Y4,Z4
10710 NEXT I
10720 CLOSE #1
10730 RETURN
10740 '*****
10750 '*** routine to eliminate similar lines
10760 '*****
10770 NOACTLIN= NOLIN
10780 '*** NOACTLIN - number of actual active lines
10790 FOR I= 1 TO NOLIN
10795 IF STPOINT(I)=0 AND ENDPOINT(I)=0 THEN 10850
10800 FOR J=1 TO NOLIN
10805 IF STPOINT(I)=0 AND ENDPOINT(I)=0 THEN 10840
10810 IF J=I THEN 10840
10820 IF STPOINT(I)=STPOINT(J) AND ENDPOINT(I)=ENDPOINT(J) THEN LET
STPOINT (I)=0:ENDPOINT(I)=0:NOACTLIN=NOACTLIN-1:GOTO 10840
10830 IF STPOINT(I)=ENDPOINT(J) AND ENDPOINT(I)=STPOINT(J) THEN LET

```



```
STPOINT (I)=0:ENDPOINT(I)=0:NOACTLIN=NOACTLIN-1  
10840 NEXT J  
10850 NEXT I  
10860 RETURN  
10870
```

**APPENDIX O**

**LISTING OF DATA TRANSFER PROGRAMS FOR FEM POST PROCESSING**

01 : ABASAS.WBA - WBASIC program to extract geometric, stress and stress resultant data from ABAQUS output file

```
00020 print 'ababas- extract stress resultants from abaqus output  
file'  
00030  
00040 dim el(3000),p(3000)  
00050 dim x(4000),y(4000),z(4000),r(4000),a(4000),b(4000)  
00060 dim c(4000),d(4000),e(4000)  
00070 dim f(4000),g(4000),h(4000)  
00080 print  
00090 print 'input abaqus filename'  
00100 input abafile$  
00110 abafile$=abafile$+' dat a1'  
00120 print 'min element number'  
00130 input elmin  
00140 print 'maximum element number'  
00150 input elmax  
00160 open #6,abafile$,input  
00170 print 'sas filename'  
00180 input sasfile$  
00190 sasfile1$=sasfile$+' data a1'  
00200 ! **** routine to fetch sigma1,sigma2,tau12  
00210 gosub 770  
00220 gosub 870  
00230  
00240 gosub 1240  
00250 gosub 1390  
00260 close #6  
00270 gosub 650  
00280 gosub 360  
00310 print 'total of ';total; ' sas entries'  
00320  
00330 stop  
00340  
00350 !*****  
00360 print '*** write sas data file'  
00370 open #6, sasfile1$,output  
00380 !print #6,total  
00390 for i=1 to total  
00400 if el(i)<elmin or el(i)>elmax then 450  
00410 f1$='#####.####.###.####.###.####.###.####,'  
00420 print #6,using f1$,el(i);x(i);y(i);z(i);r(i);  
00423 f2$='#####'#####'  
00425 print#6,using f2$,a(i);b(i)  
00427q$='#####,#####,#####,#####,#####,  
00430 print #6,using q$,c(i);d(i);e(i);f(i);g(i);h(i)  
00440  
00450 next i  
00460 close #6
```

```

00470 return
00480!*****
00640!*****
00650 print '***calculate arclength'
00660 for i= 1 to total
00670     r=sqr(z(i)*z(i)+y(i)*y(i))
00680     theta=atn(z(i)/y(i))
00690     if z(i)<=0 and y(i)<=0 then theta=theta-pi
00700     if z(i)>=0 and y(i)<=0 then theta=theta+pi
00710
00720
00730         r(i)=r*theta
00740     next i
00750 return
00760 !*****
00770 print'***searching for geometric data'
00780 loop
00790 lininput#6,a$
00800     l=len(a$)
00810         if str$(a$,1,21)=' ELEMENT PT SEC FOOT' then 850
00820     endloop
00830 print 'not found'
00840 print '*** found geometric data '
00850 return
00860 ! *****
00870 print '***loading goemetric data'
00880 l=1
00890 ! ***i= counter for matrix
00900 lininput#6,a$
00910     if a$="" then goto 900
00920     l=len(a$)
00930 if str$(a$,1,8)=' MAXIMUM' then return
00940
00950 !*** input element point and section
00960 b$=str$(a$,8,1)
00970 if b$='1' then 1080
00980 if b$='2' then 1080
00990 if b$='3' then 1080
01000 if b$='4' then 1080
01010 if b$='5' then 1080
01020 if b$='6' then 1080
01030 if b$='7' then 1080
01040 if b$='8' then 1080
01050 if b$='9' then 1080
01060 if b$='0' then 1080
01070 goto 900
01080 el(i)=value(str$(a$,1,9))
01090 !print a$
01100 p(i)=value(str$(a$,9,5))
01110

```

```

01120 se=value(str$(a$,13,5))
01130 if se<>1 then goto 900
01140 !*** input x,y,z co-ordinates
01150 x(i)=value(str$(a$,21,11))
01155 x(i)=x(i)-.054
01160 y(i)=value(str$(a$,33,11))
01165 y(i)=y(i)-.0631
01170 z(i)=value(str$(a$,45,11))
01180 total=i
01190 !print el(i);p(i);se(i);x(i);y(i);z(i)
01200 i=i+1
01210
01220 goto 900
01230 !*****
01240 print '***searching for stress resultants '
01250 loop
01260 linput#6,a$
01270
01280 l=len(a$)
01290
01300
01310 if str$(a$,1,17)=' ELEMENT PT FOOT' then goto 1340
01320 endloop
01330 print 'not found'
01340 print '*** found stress resultants
01350
01360 return
01370
01380 ! *****
01390 print '*** loading stress resultant data"
01400 i=1
01410 ! ***i= counter for matrix
01420 linput#6,a$
01430
01440 if a$="" then goto 1420
01450 l=len(a$)
01460 if str$(a$,1,8)=' MAXIMUM' then return
01470 !*** input element point and stress resultants
01480 b$=str$(a$,8,1)
01490 if b$='1' then 1600
01500 if b$='2' then 1600
01510 if b$='3' then 1600
01520 if b$='4' then 1600
01530 if b$='5' then 1600
01540 if b$='6' then 1600
01550 if b$='7' then 1600
01560 if b$='8' then 1600
01570 if b$='9' then 1600
01580 if b$='0' then 1600
01590 goto 1420

```

```

01600 el=value(str$(a$,1,8))
01610 !print a$
01620 !print
'12345678911234567892123456789312345678941234567895123456789'
01630
01640 p=value(str$(a$,9,5))
01650 if p<>p(i) or el<>el(i) then return
01660 !*** put x,y,z co-ordinates
01670 a(i)=value(str$(a$,17,12))
01680 b(i)=value(str$(a$,29,12))
01690 c(i)=value(str$(a$,41,12))
01700 d(i)=value(str$(a$,53,12))
01710 e(i)=value(str$(a$,65,12))
01720 f(i)=value(str$(a$,77,12))
01730 g(i)=value(str$(a$,89,12))
01740 h(i)=value(str$(a$,101,12))
01750 !print a(i);b(i);c(i);d(i);e(i);f(i);g(i);h(i)
01760 i=i+1
01770
01780 goto 1420
01790 !*****
01800 print 'sas smaller files'
01810 for j=1 to 8
01820 smalli$=sasfile$+value$(j)+' data a1'
01830 open #6,smalli$,output
01840 for i=1 to total
01850 if el(i)<elmin or el(i)>elmax then 1940
01860 if j=1 then print #6,x(i);r(i);a(i)
01870 if j=2 then print #6,x(i);r(i);b(i)
01880 if j=3 then print #6,x(i);r(i);c(i)
01890 if j=4 then print #6,x(i);r(i);d(i)
01900 if j=5 then print #6,x(i);r(i);e(i)
01910 if j=6 then print #6,x(i);r(i);f(i)
01920 if j=7 then print #6,x(i);r(i);g(i)
01930 if j=8 then print #6,x(i);r(i);h(i)
01940 next i
01950 close #6
01960 next j
01970
01980 return
01990 theta=theta+3.1425

```

02 : SOLIDVAL.WBA - WBASIC program for estimation of validation stresses using beam theory

```

00010 print '*** solidval : validation model stress estimation '
00020 print '          using strength of materials'
00040 fx=5000
00050 ! axial force in n
00060 ym=0.0631
00070 ! distance from cylinder centre-line to pipe
00080
00190 t=1.89e-3
00200 ! thickness of shell
00250 l=.224
00260 ! total length of model
00270
00280 ar=.020
00290 ! width of rib
00320 nr=2
00330 ! number of ribs
00340 ! print "pi;phi;ax;ay;az;p;gxy;t;xc;xd;l"
00350 ! print pi;phi;ax;ay;az;p;gxy;t;xc;xd;l
00360 !*****
00370 print 'abaqus basic input filename '
00380 input in$
00390 in$=in$+' data a1'
00400 open #4,in$,input
00410 print 'solids sas output filename '
00420 input out$
00430 out$=out$+' data a1'
00440 open #2,out$,output
00441 print 'abaqus sas output filename '
00442 input aba$
00443 aba$=aba$+' data a1'
00444 open #5,aba$,output
00450 print 'differences sas output filename '
00460 input dif$
00470 dif$=dif$+' data a1'
00480 open #3,dif$,output
00490 on eof goto 2480
00500 input#4,el,x,y,z,arc,sf1,sf2
00510 input#4,sf3,sf4,sf5,sm1,sm2,sm3
00511 print#5,el,x,y,z,arc,sf1,sf2
00512 print#5,sf3,sf4,sf5,sm1,sm2,sm3
00520 !*** calculate section properties
00530 lrs=(y**2+z**2)**.5
00540 ! shell radius
00550 ri=.050
00560 ! internal radius
00570 ro=.05189
00580 ! external radius

```

```

00630 dou=ro*2
00640 ! outer diameter
00650 di=ri*2
00660 ! inside diameter
00740 !*** sectional geometric properties
00750 q=2/3*(ro**3-ri**3)
00760 ! first moment of area
00770 a=pi*(ro**2-ri**2)
00780 ! cross sectional area
00790 i=pi/4*(ro**4-ri**4)
00800 ! bending moment of area
00810 j=i*2
00840 !print "rs;ri;ro;dbo;dbi;dou;di;l"
00850 !print rs;ri;ro;dbo;dbi;dou;di;l
00860 !print "rhoc;rhos;cz;cy;q;a;i;j;ap"
00870 !print rhoc;rhos;cz;cy;q;a;i;j;ap
00880 ! torsional moment of area
00890 b=2*(ro-ri)
00900 ! shear width
01160
01500 !*** loads due to offset force
01530     mz=fx*ym
01540     !bending moment due to offset load
01550     nxb=mz*-y/i*t
01560     ! nxx due to bending
01570     nxa=fx/a*t
01575     !print fx;ym;mz;y;i;t;a;nxb;nxa
01580 ! nxx due to axial force
02150 !*** find totals of sectional forces
02160     nx=nxb+nxa
02165 if x<.090 then nx=0
02190     qx=0
02200     qt=0
02210     mx=0
02220     mt=0
02230     mxt=0
02240 !*** write theoretical calculations to file
02250     print#2,el;x;y;z;arc;nx;nt
02255     !print,el;x;y;z;arc;nx;nt
02260     print#2,n,rc;qx;qt;mx;mt;mxt
02270 !*** calculate differences
02280     da=0
02290     if nx<>0 then da=(sf1-nx)/nx*100
02300     db=0
02310     if nt<>0 then db=(sf2-nt)/nt*100
02320     dc=0
02330     if nxt<>0 then dc=(sf3-nxt)/nxt*100
02340     dd=0
02350     if qx<>0 then dd=(sf4-qx)/qx*100
02360     de=0

```



```

02370     if qt<>0 then de=(sf5-qt)/qt*100
02380     df=0
02390     if mx<>0 then df=(sm1-mx)/mx*100
02400     dg=0
02410     if mt<>0 then dg=(sm2-mt)/mt*100
02420     dh=0
02430     if mxt<>0 then dh=(sm3-mxt)/mxt*100
02440     !*** write differences to file
02450     print#3,el;x;y;z;arc;da;db
02460     print#3,dc;dd;de;df;dg;dh
02470     goto 490
02480     close #2
02490     close #4
02500     close #3
02505     close #5
02510     stop
02520     end

```

03 : PLOT.SAS - SAS program for plotting of contour maps

```
OPTIONS LEAVE=20K;
CMS FILEDEF EXAMPLE DISK ABVALIDI DATA A (LRECL 80;
DATA DATAI;
INFILE EXAMPLE;
INPUT E X Y Z ARC SF1 SF2/SF3 SF4 SF5 SM1 SM2 SM3;
*GOPTIONS DEVICE=TEK4010;
*GOPTIONS DEVICE=IBM3279;
*GOPTIONS DEVICE=IBM3179;
**** FOR PLOTTER C:FIBRE TIP A4 MATT;
GOPTIONS HANDSHAKE=NONE AUTOFEED NOPROMPT;
GOPTIONS GACCESS=GSASFILA;
CMS FILEDEF GSASFILE DISK STATA4AB HPGL O;
GOPTIONS DEVICE=HP7550A PENMOUNTS=8;
GOPTIONS COLORS=(BLACK,RED,GREEN,BLUE,ORANGE,BROWN,VIOLET,YELLOW);

*TITLE1 'TANKER STRESS RESULTANTS (N/M WIDTH)';
*TITLE2 'NXT VS X VS ARC FOR AX,AY,AZ=2G';
*TITLE2 'NXX VS X VS ARC FOR P=84000 KPA';
*TITLE2 'NXT VS X VS ARC FOR AZ=2G,THETA=3';
TITLE1 'VALIDATION STRESS RESULTANTS (N/M WIDTH)';
TITLE2 'NXT VS X VS ARC FOR FX=5KN';

* PROC G3GRID DATA=DATAI OUT=DATAG;
* GRID ARC * X = SF3 / ;
*                               AXIS1=.2113 TO 7.789 BY .03789
*                               AXIS2=0      TO 4.3982 BY .2199;

PROC GCONTOUR DATA = DATAI;
  PLOT ARC * X = SF3 / CTEXT=BLACK
                CAXIS=BLACK
                VM=0
                HM=0
                HREF=1 TO 11 BY 1
                VREF=0
LEVELS=-1E4 -8E3 -6E3 -4E3 -2E3 0 2E3 4E3 6E3 8E3 1E4
CLEVELS=BLUE BLACK BROWN BLACK BROWN BLUE VIOLET GREEN YELLOW ORANGE
RED
LLEVELS=2 2 2 1 1 1 1 1 1 1 1;
RUN;

**** FOR PLOTTER A:ROLLERBALL A4 MATT;
GOPTIONS HANDSHAKE=NONE AUTOFEED NOPROMPT;
GOPTIONS GACCESS=GSASFILA;
CMS FILEDEF GSASFILE DISK STATA4AA HPGL O;
GOPTIONS DEVICE=HP7550A PENMOUNTS=4;
GOPTIONS COLORS=(BLACK,RED,GREEN,BLUE);
```

```

PROC G3D DATA = DATA1;
PLOT ARC* X = SF3 / SIDE
      TILT = 45
      ROTATE =45
      CTEXT=BLACK
      CAXIS=BLACK
      CTOP=BLACK
      CBOTTOM=BLACK
      XYTYPE=2
      XTICKNUM=8
      YTICKNUM=8
      ZTICKNUM=10;

```

```

PROC G3D DATA = DATA1;
PLOT ARC* X = SF3 / SIDE
      TILT = 45
      ROTATE =45
      CTEXT=BLACK
      CAXIS=BLACK
      CTOP=BLACK
      CBOTTOM=BLACK
      XYTYPE=1
      XTICKNUM=8
      YTICKNUM=8
      ZTICKNUM=10;

```

RUN;

```

**   PROC G3D DATA = DATA1;
**   PLOT ARC * X = SF1 / SIDE
      TILT = 90
      ROTATE =0;

**   PROC G3D DATA = DATA1;
**   PLOT ARC * X = SM3 / SIDE
      TILT = 90
      ROTATE =90;

**   PROC G3D DATA = DATA1;
**   SCATTER ARC * X = SF1 /
      TILT=90
      ROTATE=0;

**   PROC G3D DATA = DATA1;
**   SCATTER ARC * X = SF1 /
      TILT = 90
      ROTATE =90;

```

\*RT27AA

SF1

LEVELS=-1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6

SF2  
 LEVELS=-1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6  
 SF3  
 LEVELS=-3E5 -2.4E5 -1.8E5 -1.2E5 -6E5 0 6E4 1.2E5 1.8E5 2.5E5 3E5  
 RT27P  
 SF1  
 LEVELS=2.7E5 2.72E5 2.74E5 2.76E5 2.78E5 2.80E5 2.82E5 2.84E5 2.86E5  
 2.88E5 2.90E5  
 SF2  
 LEVELS=1E5 1.6E5 2.2E5 2.8E5 3.4E5 4E5 4.6E5 5.2E5 5.8E5 6.4E5 7.0E5  
 SF3  
 LEVELS=-3E3 -2.3E3 -1.6E3 -9E2 -2E2 5E2 1.2E3 1.9E3 2.6E3 3.3E3 4.0E3  
 F XT  
 (-1E6 -3E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6  
 SF2  
 LEVELS=-3E6 -2.4E6 -1.8E6 -1.2E6 -6E5 0 6E5 1.2E6 1.8E6 2.4E6 3E6  
 SF3  
 LEVELS=-1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6  
 VALIDATION  
 SF1  
 LEVELS=-2E4 -1.2E4 -3.99E3 4E3 1.2E4 2E4 2.8E4 3.6E4 4.4E4 5.2E4 6E4  
 SF2  
 LEVELS=-1E4 -7E3 -4E3 -1E3 2E3 5E3 8E3 1.1E4 1.4E4 1.7E4 2.0E4  
 SF3  
 LEVELS=-1E4 -8E3 -6E3 -4E3 -2E3 0 2E3 4E3 6E3 8E3 1E4  
 END OF FILE

APPENDIX P  
LISTING OF THE MATHEORY PROGRAM

```

3 '*** matheor7.bas 28/11/1991
   on error goto 25010
4 CLS
5 PRINT "*** MATHEOR7.BAS: road tanker stress estimation "
7 'print "using strength of materials for overhanging ends"
10 '*****
20 DEF FNHS(X)=(EXP(Y)-EXP(-X))/2
25 DEF FNHC(X)=(EXP(X)+EXP(-X))/2
27 ' *** functions for localized stresses
30 GOSUB 1010
50 ' *** define loading conditions
70 GOSUB 1950
90 ' *** define geometrical properties
110 GOSUB 3950
130 ' *** define shell properties and densities
140 GOSUB 4490
150 ' *** calculate sectional properties
190 GOSUB 4870
210 ' *** calculate volumes
230 GOSUB 5210
250 ' *** calculate masses
   PRINT:INPUT "ABAQUS OUTPUT, CO-ORDINATES OR RANGE (A/C/R)";DTA$
   IF DTA$="C" THEN RESTORE 312:GOTO 341
   IF DTA$="R" THEN GOSUB 26000:END
   ' *** for range of x values
270 GOSUB 2780
290 ' *** specify files
295 DUM$="L":INPUT "Input tanker model size - (Large/Small)";DUM1$
   IF DUM1$<>" " THEN DUM$=DUM1$
300 IF DUM$="L" or DUM$="l" THEN GOSUB 3470
310 IF DUM$="S" or DUM$="s" THEN GOSUB 23470
   NON$="R"
INPUT "Resultant, Non-Dimensional Data or Max Principal Stresses
(R/N/M)";NON1$
   IF NON1$<>" " THEN NON$=NON1$
311 ' *** define range defaults
312 DATA 781, -.025, -.528, .389
313 DATA 2, .053, -.529, .390
314 DATA 38, .947, -.529, .390
315 DATA 50, 1.053, -.529, .390
316 DATA 314, 6.553, -.529, .390
317 DATA 518, 10.95, -.529, .390
318 DATA 530, 11.05, -.529, .390
337 DATA 556, 11.95, -.529, .390
338 DATA 865, 12.02, -.528, .389
339 DATA 9999, 9, 9, 9
340 IF DTA$<>"C" THEN 350
341 'FOR DTA=1 TO 9: READ EL(DTA),X(DTA),Y(DTA),Z(DTA):NEXT DTA
342 ' FOR DTA=1 TO 9: EL=EL(DTA):X=X(DTA):Y=Y(DTA):Z=Z(DTA)

```

```

343 ' INPUT A$:CLS
344 ' PRINT EL;X;Y;Z:
346 ' GOTO 510
350 WHILE NOT EOF(1)
360 ' INPUT#1,EL,X,Y,Z,ARC,SF1,SF2,SF3
370 INPUT#1,EL,X,Y,Z,ARC,SF1,SF2
390 INPUT#1,SF3,SF4,SF5,SM1,SM2,SM3
410 IF X<XMIN OR X>XMAX THEN 870
430 IF Y<YMIN OR Y>YMAX THEN 870
450 IF Z<ZMIN OR Z>ZMAX THEN 870
500 GOSUB 13840
510 ' *** define local variables for dome
550 IF AX<>0 THEN GOSUB 5710
570 ' *** loads due to ax acceleration
590 IF AZ<>0 THEN GOSUB 7110
610 ' *** loads due to az acceleration
630 IF AY<>0 THEN GOSUB 8110
650 ' *** loads due to ay acceleration
670 IF TWIST<>0 THEN GOSUB 9470
690 ' *** loads due to twisting
710 IF PP<>0 OR AX<>0 THEN GOSUB 9630
730 ' *** membrane loads due to internal pressure
750 IF AX<>0 OR PP<>0 THEN GOSUB 13858
770 ' ** localized stresses due to domes/cylinder connection
790 IF AX<>0 OR PP<>0 THEN GOSUB 10990
810 ' ** localized stresses due to ribs
    GOSUB 3810
    ' *** write abaqus data file
830 IF DTA$<>"C" THEN GOSUB 10090
850 ' *** find totals and errors and write to file
855 'NEXT DTA
865 'STOP
870 WEND
890 CLOSE #1
910 CLOSE #2
930 CLOSE #3
950 ' CLOSE #4
970 STOP
990 ' *****
1010 'print "*** loading conditions ***"
1030 PI=3.141592654#
1050 TWIST=0:'6
1070 PHI=TWIST*PI/180
1090 ' *** angle of twist
1110 AZ=-2*9.810001
1130 ' *** accel in z direction (must be -ve)
1150 AY=-2*9.810001
1170 ' *** accel in y direction (must be -ve)
1190 AX=2*9.810001
1210 ' *** accel in x dirn

```

```

1230 PP=0: '***8.4E5
1250 ' *** internal pressure
      RHOC=1850
      ' *** density of sulphuric acid
1260 '*****
1265 ' print "**** material properties ****"
1270 NUS=.1287
1290 ' *** equivalent poissions ratio for the shell
1310 GXTS=4.91E+09
1330 ' *** equivalent shear modulus of the shell
1350 EXS=2.262E+10
1370 ' *** equivalent axial modulus of the shell
1390 ETS=2.262E+10
1410 ' *** equivalent transverse modulus of the shell
1430 ES=(EXS+ETS)/2
1450 ' *** equivalent average modulus of the shell
1470 NUD=.2695
1490 ' *** equivalent poissions ratio for the dome
1510 GXTD=7.469E+09
1530 ' *** equivalent shear modulus of the dome
1550 EXD=1.896E+10
1570 ' *** equivalent axial modulus of the dome
1590 ETD=1.896E+10
1610 ' *** equivalent transverse modulus of the dome
1630 ED=(EXD+ETD)/2
1650 ' *** equivalent average modulus of the dome
1670 NUR=.26
1690 ' *** equivalent poissions ratio for the rib
1710 GXTR=4.14E+09
1730 ' *** equivalent shear modulus of the rib
1750 EXR=3.86E+10
1770 ' *** equivalent axial modulus of the rib
1790 ETR=8.27E+09
1810 ' *** equivalent transverse modulus of the rib
1830 ER=(EXR+ETR)/2
1850 ' *** equivalent average modulus of the rib
1870 'PRINT "pi;phi;az;ay;ax;p;;nus;gxts;exs;ets;es"
1890 'PRINT PI;PHI;AZ;AY;AX;P;NUS;GXTS;EXS;ETS;ES"
1892 'PRINT "nud;gxtd;exd;etd;ed"
1894 'PRINT NUD;GXTD;EXD;ETD;ED"
1896 'PRINT "nur;gxtr;exr;etr;er"
1898 'PRINT NUR;GXTR;EXR;ETR;ER"
1910 RETURN:STOP
1930 ' *****
1950 'print "**** geometrical dimensions ****"
1970 T=.015
1990 ' *** thickness of shell
2010 RI=.65
2030 ' *** shell inside radius
2050 RS=RI+T/2

```



```

2070 ' *** shell centreline radius
2090 RO=RI+T
2110 ' *** shell outside radius
2130 ADOME=RS
2150 ' *** dome major axis
2170 BDOME=RS/2
2190 XC=1
2210 ' *** overhang at back or lhs
2230 XD=1
2250 ' *** overhang at front or rhs
2270 XCYL=12:XT=XCYL
2290 ' *** cylinder length of tanker
      L=1
      ' *** spacing between ribs
2310 ARS=.05
2330 ' *** width of small rib
2350 BRS=.05
2370 ' *** height of small rib
2390 ARL=.05
2410 ' *** width of large rib
2430 BRL=.1
2450 ' *** height of large rib
2455 COFFSET=RO+BRL/2
2460 ' *** distance from tank centreline to back axial restraint
      ROFFSET=0
2465 ' *** offset of reaction for equivalent moment
2470 NRS=5
2490 ' *** number of small ribs
2510 NRL=8
2530 ' *** number of large ribs
2550 NRIBS=NRS+NRL
2570 ' *** total number of ribs
2590 DATA 0,1,2,3,4,5,6,7,8,9,10,11,12
2610 ' *** define rib x position
2630 DATA .05,.05,.05,.05,.05,.05,.05,.05,.05,.05,.05,.05,.05
2650 ' *** define rib widths
2670 DATA .10,.10,.10,.10,.05,.05,.05,.05,.10,.10,.10,.10
2690 ' *** define rib heights
2710 'PRINT "T;RI;RS;RO;ADOME;BDOME;XC;XD;XCYL"
2715 'PRINT T;RI;RS;RO;ADOME;BDOME;XC;XD;XCYL
2720 'PRINT "ARS;BRS;ARL;BRL;COFFSET;NRS;NRL;NRIBS"
2725 'PRINT ARS;BRS;ARL;BRL;COFFSET;NRS;NRL;NRIBS
2750 RETURN
2770 ' *****
2780 PRINT "ABAQUS output filename (excl.ext)"
2810 INPUT IN$
2830 IN$="F:\MIKE\MATHESIS\RT27\"+IN$+".ABA"
      PRINT "Opening file ";IN$
2870 OPEN IN$ FOR INPUT AS #1
2910 PRINT:PRINT "New ABAQUS reduced filename. "

```

```

2930 INPUT ABA$
2970 ABA$="F:\MIKE\MATHESIS\RT27\"+ABA$+".DAT"
PRINT "Opening file ";ABA$
3010 OPEN ABA$ FOR OUTPUT AS #2
3030 PRINT:PRINT "New THEORY reduced filename. "
3050 INPUT SOL$
3090 SOL$="F:\MIKE\MATHESIS\RT27\"+SOL$+".DAT"
PRINT "Opening file ";SOL$
3110 OPEN SOL$ FOR OUTPUT AS #3
3150 'PRINT:PRINT "Differences sas filename "
3170 'INPUT DIF$
3210 'DIF$="F:\BIRGIT\MATHESIS\RT27\DAT\"+DIF$+".DAT"
PRINT "Opening file ;DIF$
3250 'OPEN DIF$ FOR OUTPUT AS #4
3270 RETURN
3290 '*****
3310 'print "specify range extraction values RT27"
3321 XMIN=0
3322 XMAX=12
3323 YMIN=.070
3324 YMAX=.075
3325 ZMIN=.650
3326 ZMAX=.655
3327 RETURN
3328 ' *** extract positions for top

3331 XMIN=0
3332 XMAX=12
3333 YMIN=.07
3334 YMAX=.075
3335 ZMIN=-.655
3336 ZMAX=-.65
3337 RETURN
3338 ' *** extract positions for bottom

3341 XMIN=0
3342 XMAX=12
3343 YMIN=.65
3344 YMAX=.655
3345 ZMIN=.070
3346 ZMAX=.0755
3347 RETURN
3348 ' *** extract positions for left (+Y)

3351 XMIN=0
3352 XMAX=12
3353 YMIN=-.655
3354 YMAX=-.65
3355 ZMIN=.070
3356 ZMAX=.0755

```

```

3357 RETURN
3358 ' *** extract positions for right (-Y)

3361 XMIN=-1
3362 XMAX=0
3363 YMIN=.024
3364 YMAX=.075
3365 ZMIN=.0
3366 ZMAX=.655
3367 RETURN
3368 ' *** extract positions for back dome

3450 '*****
3470 PRINT "Specify position (Top/Bottom/Left/Right/Dome/New) "
3490 INPUT RANGE$
3500 IF RANGE$="T" THEN GOSUB 3321:RETURN
3510 IF RANGE$="B" THEN GOSUB 3331:RETURN
3520 IF RANGE$="L" THEN GOSUB 3341:RETURN
3530 IF RANGE$="R" THEN GOSUB 3351:RETURN
3525 IF RANGE$="D" THEN GOSUB 3361:RETURN
3540 IF RANGE$<>"N" THEN RETURN
3545 PRINT "xmin"
3550 INPUT XMIN
3570 PRINT "xmax"
3590 INPUT XMAX
3610 PRINT "ymin"
3630 INPUT YMIN
3650 PRINT "ymax"
3670 INPUT YMAX
3690 PRINT "zmin"
3710 INPUT ZMIN
3730 PRINT "zmax"
3750 INPUT ZMAX
3770 RETURN
3790 ' *****
3810 'print "writing ab file"
3830 PRINT#2,USING " ###.### ";X;
3850 IF NON$="R" THEN
    PRINT#2,USING " ###.##^ ^ ^ ^ ^ ";SF1;SF2;SF3;SF4;SF5;SM1;SM2;SM3
    END IF

    IF NON$="N" THEN
        PE=PP+P2;DN=PE*RI;DM=PE*RI*T
        '** DUMMIES FOR NON DIMENSIONAL
        PRINT#2,USING " ###.##^ ^ ^ ^ ^
";SF1/DN;SF2/DN;SF3/DN;SF4/DN;SF5/DN;SM1/DM;SM2/DM;SM3/DM
        EN:) IF
3870 ' PRINT#2,EL;X;Y;Z;ARC;SF1;SF2;SF3
3890 ' print#2,sf3;sf4;sf5;sm1;sm2;sm3
3910 RETURN

```

```

3930 ' *****
3950 'input "*** shell properties ***",a$
3970 XBI=RI/2
3990 ' *** depth of elliptical dome inside
4010 XBO=RO/2
4030 ' *** depth of elliptical dome outside
4050 XB=RS/2
4070 XF=XB
4090 ' *** depth of elliptical dome middle
4110 DOU=RO*2
4130 ' *** outer diameter
4150 DI=RI*2
4170 ' *** inside diameter
4190 XL=XCYL-XC-XD
4210 ' *** unsupported span of the tanker
4230 'PRINT "XBI;XBO;XB;XF;DOU;DI;XL"
4250 'PRINT XBI;XBO;XB;XF;DOU;DI;XL
4270 ' *****
4290 'input "*** densities of shell and contents ***",a$

4350 RHOR=1900
4370 ' *** density of the ribs
4390 RHOS=1900
4410 ' *** density of the shell
4430 'PRINT "RHOC;RHOR;RHOS"
4450 'PRINT RHOC;RHOR;RHOS
4470 ' *****

4490 'input "*** sectional geometric properties ***",a$

4550 A=PI*(RO^2-RI^2):ACROSS=A
4570 ' ** cross sectional area
4590 J=PI/4*(RO^4-RI^4)
4610 ' *** bending moment of area
4630 JJ=II*2
4650 ' *** torsional moment of area
4670 AP=PI*RI^2
4690 ' *** internal projected area
4750 ' ** DS=ES*T^3/(12*(1-NUS^2))
DS=7.473E3:'D11 FROM STIFFNESS MATRIX
4770 ' *** average flexural rigidity of shell
4775 ' ** DDOME=ED*T^3/(12*(1-NUD^2))
DDOME=6.428E3:'D11 FROM STIFFNESS MATRIX
4780 ' *** average flexural rigidity of shell
4790 'PRINT "Q;A;I;J;AP;B;DS;DDOME"
4800 'PRINT Q;A;I;J;AP;B;DS;DDOME
4830 RETURN
4850 ' *****

4870 'input "*** calculate volumes ***",a$

```

```

4890 VCC=PI/4*DI^2*XCYL
4910 ' *** volume of cyl contents
4930 VCS=PI/4*(DOU^2-DI^2)*XCYL
4950 ' *** volume of cyl shell
4970 VDS=PI*4/6*(RO^2*XBO-RI^2*XBI)
4990 ' *** volume of dome shell
5010 VDC=PI*4/6*(RI^2*XBI)
5030 ' *** volume of dome contents
5050 VRS= PI*((RO+BRS)^2-(RO^2))*ARS
5070 ' *** volume of small rib
5090 VRL= PI*((RO+BRL)^2-(RO^2))*ARL
5110 ' *** volume of large rib
5130 'print "vcc;vcs;vds;vdc;vrs;vrl"
5150 'print vcc;vcs;vds;vdc;vrs;vrl
5170 RETUR
5190 ' *****

5210 'input "*** calculate masses ***",a$

5230 MRG=6000
5250 ' *** mass of running gear,fifth wheel and landing legs
5270 MCC=VCC*RHOC
5290 ' *** mass cylidrical contents
5310 MCS=VCS*RHOS
5330 ' *** mass cylidrical shell
5350 MDC=VDC*RHOC
5370 ' *** mass dome contents
5390 MDS=VDS*RHOS
5410 ' *** mass dome shell
5430 MRS=VRS*RHOR
5450 ' *** mass per small rib
5470 MRL=VRL*RHOR
5490 ' *** mass per large rib
5510 MRT=MRL*NRL+MRS*NRS
5530 ' *** total mass of rings
5540 MSHELL=MCS+2*MDS+MRT
5550 ' *** total mass of shell only
5570 MT=MCC+MCS+2*(MDC+MDS)+MRT
5590 ' *** total mass of shell and contents
5590 MTRG=MT+MRG
5610 ' *** total mass of tanker
5630 'PRINT "mrg;mcc;mcs;mdc;mds;mrs;mrl;mrt;mt;mtrg"
5650 'PRINT MRG,MCC,MCS,MDC,MDS,MRS,MRL,MRT,MT,MTRG
5670 RETURN
5690 ' *****

5710 'input "*** loads due to ax acceleration ***",a$

5730 'print "*** forces due to content's average pressure in front head

```

```

(1) ***
5750 HAVE=RI/2+XC+XL+XD+3/8*RI/2
5770 ' *** average head in front dome
5790 P1=RHOC*HAVE*AX
5810 ' *** average pressure in front dome
5830 FX=P1*AP
5850 ' ***axial force in shell from pressure of contents
5855 RX1=-FX
5856 ' ***axial reaction at back support
5857 MYB=RX1*(ROFFSET)
5858 ' *** moment due to offset of force from support using offset
assumption
5870 RZF1=-MYB/XL
5890 ' *** vertical reaction as back support (+ve upwards)
5910 RZB1=MYB/XL
5930 ' *** vertical reaction as front support (+ve upwards)

5990 IF X>=XC THEN FX1=-RX1
6010 IF X<XC THEN FX1=0
6030 ' *** Fx1 axial force in x direction

6050 IF X >= XC AND X <= (XC+XL) THEN VZ1=RZB1
6070 IF X < XC OR X > (XC+XL) THEN VZ1=0
6090 ' *** vz1 shearing force in z direction

6110 IF X >= XC AND X <= (XC+XL) THEN MY1=RZB1*(X-XC)-MYB
6130 IF X>(XC+XL) AND X<=XCYL THEN MY1=0
6150 IF X>XCYL OR X<XC THEN MY1=0
' *** MY1 bending moment

6170 'print "x;have;p1;fx/rzbl;rzf1;myb;fx1;vz1;my1"
6190 'print x;have;p1;fx/rzbl;rzf1;myb;fx1;vz1;my1

6195 ' *****
6210 'print "*** forces due to ax :pressure along length (2) ***"
6220 P2=RHOC*AX*(X+RI/2)
6225 ' *** pressure as a function of x
6227 'PRINT "p2"
6229 'PRINT P2

6391 ' *****
6392 'print "*** forces due to ribs and shells (3)***"
6394 ' *** routine to establish number of ribs after x
6396 MRAX=0:MAX3=0
6398 ' *** MRAX - total mass of ribs after x
6402 ' *** find ribs after x
6404 RESTORE 2590
6406 FOR I=1 TO NRIBS
6408 READ XRIB
6410 ' *** x rib back and x rib front

```

```

6411 IF XRIB>X THEN 6413
6412 NEXT I
6413 RESTORE 2670
6414 FOR J=1 TO I-1:READ HB:NEXT J
6415 ' read rib thickness values which are not needed
6418 FOR J = I TO NRIBS
6420 READ HB
6422 IF HB=BRS THEN MRAX=MRAX+MRS
6424 IF HB=BRL THEN MRAX=MRAX+MRL
6426 NEXT J
      WTOTAL=AX*MSHELL
      ' *** equivalent weight for 2G acceleration
      WFRONT=RHOS*(XCYL-X)*ACROSS+MRAX+MDS)*AX
      ' *** weight of shell and ribs to front of x
      WBACK=WTOTAL-WFRONT
      ' *** weight of shell and ribs behind x
6429 RX3=-WTOTAL
      ' *** support reaction axial force due to wax
      MYB=RX3*ROFFSET
      ' *** moment due to offset of force from support uses smaller
offset
6340 RZF3 = -MYB/XL
6342 ' *** vertical reaction as back support (+ve upwards)
6344 RZB3 = MYB/XL
6346 ' *** vertical reaction as front support (+ve upwards)

6334 IF X>=0 AND X<XC THEN FX3=-(MRL+RHOS*ACROSS*X+MDS)*AX
6435 IF X>=XC AND X<=XCYL THEN FX3=WFRONT
6337 ' *** fx3 axial reaction force due to shell deceleration

6360 IF X>=XC AND X<=XC+XL THEN VZ3=RZB3
6362 IF X<0 OR X>XC+XL THEN VZ3=0
6364 ' *** vz3 shearing force in z direction

6366 IF X>=XC AND X<=(XC+XL) THEN MY3=RZB3*(X-XC)-MYB
6370 IF X>(XC+XL) OR X<XC THEN MY3=0
      ' *** MY3 bending moment

6372 'print "X;max3;fx;fx3t;rx3;rzb3;rzf3;my;fx3;vz3;my3"
6374 'print X;max3;fx;fx3t;rx3;rzb3;rzf3;my;fx3;vz3;my3

6377 '
*****

6381 ' *** sectional properties for shear
6382 Q=2/3*(RO^2-Z^2)^(3/2)-2/3*(RI^2-Z^2)^(3/2)
6383 ' *** first moment of area
6384 B=2*(RO^2-Z^2)^.5 - 2*(RI^2-Z^2)^.5
6385 ' *** shear width

```

```

6464 'input "*** stress resultants for ax **",a$
6465 NXXAX=(FX1+FX3)/A*T-(MY1+MY3)*Z/II*T
6466 ' *** from beam theory definition z is positive downwards
6467 NTTAX=P2*RI
6470 NXTAX=(VZ1+VZ3)*Q/II/B*T
6490 'print "nxxax;nttax;nxtax"
6510 'print nxxax;nttax;nxtax
6530 RETURN

7090 ' *****

7110 'input "*** loads due az accelaration **",a$

7130 'print " ** uniformly ditributed load (4) **"
7150 WZ=(MT*ABS(AZ))/(XCYL+4*XB/3)
7170 ' *** ud load per unit lenght on the beam (+ve down)
7190 RBZ=(MT*ABS(AZ))/2
7210 ' *** reaction at back support for xc=xd (+ve up)
7230 RFZ=(MT*ABS(AZ))/2
7250 ' *** reaction at fron support for xc=xd (+ve up)
7270 FPZ=WZ*RS
7290 '*** hydrostatic force due to presssure of the ends
7300 MTZ=1/4*WZ*(RS^2-XB^2)
7310 ' *** moment due to mass of domes and offset of Fp
7330 FDZ=2*XB/3*WZ
7350 ' *** vertical force due to mass of domes and contents
7355 'print "X,wz;rbz;rfz;fpz;mtz;fdz"
7357 'print X,wz;rbz;rfz;fpz;mtz;fdz
7370 IF X<0 OR X>12 THEN RETURN
7380 IF X>=11 THEN 7450
7390 ' *** axial force, shearing force and bending moment as f(x)
7400 FX=FPZ
7410 VZ=-FDZ-WZ*X
7420 MZ=-WZ/2*X^2+MTZ-FDZ*X
7430 GOTO 7560
7450 IF X>=11 THEN 7510
7470 FX=FPZ
7480 VZ=RBZ-FDZ-WZ*X
7490 MZ=-WZ/2*X^2+RBZ*(X-XC)-FDZ*X+MTZ
7500 GOTO 7560
7510 FX=FPZ
7520 VZ=WZ*(XCYL-X)+FDZ
7530 MZ=-WZ/2*(XCYL^2-2*XCYL*X+X^2)-FDZ*(XCYL-X)+MTZ
7560 PZ=RHOC*ABS(AZ)*ABS(Z-RI)
7570 ' *** pressure due to z accel
7580 'print " *** axial force, shearing force and bending moment as f(x)"
7590 'print "x;fx;vz;mz;pz"
7600 'print x;fx;vz;mz;pz

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7601 'print " *** sectional properties for shear"
7602 Q=2/3*(RO^2-Z^2)^(3/2)-2/3*(RI^2-Z^2)^(3/2)
7603 'print " *** first moment of area"
7604 B=2*((RO^2-Z^2)^.5 - (RI^2-Z^2)^.5)
7605 ' *** shear width

7610 'print " *** stress resultants for az ***"
7660 NXXAZ=FX/A*T-MZ*Z/II*T
7670 NTTAZ=PZ*RI
7680 NXTAZ=VZ*Q/II/B*T
7690 'print "nxxaz;nttaz;nxtaz"
7700 'print nxxaz;nttaz;nxtaz
7710 RETURN
7720 ' *****

8110 'input " *** loads due ay accelaration ***",a$
8130 'print " ** uniformly ditributed load (5) ***"
      IF X<0 OR X>12 THEN RETURN
8150 WY=(MT*ABS(AY))/(XCYL+4*XB/3)
8170 ' *** ud load per unit lenght on the beam (+ve down)
8190 RBY=(MT*ABS(AY))/2
8210 ' *** reaction at back support for xc=xd (+ve up)
8230 RFY=(MT*ABS(AY))/2
8250 ' *** reaction at front support for xc=xd (+ve up)
8270 FPY=WY*RS
8290 ' *** hydrostatic force due to presssure of the ends
8300 MTY=1/4*WY*(RS^2-XB^2)
8310 ' *** moment due to mass of domes and offset of yp
8330 FDY=2*XB/3*WY
8350 ' *** vertical force due to mass of domes and contents
8355 'print "wy;rby;rfy;fpy;mty;fdy"
8357 'print wy;rby;rfy;fpy;mty;fdy

8380 IF X>=1 THEN 8450
8390 ' *** axial force, shearing force and bending moment as f(x)
8400 FX=FPY
8410 VY=-FDY-WY*X
8420 MY=-WY/2*X^2+MTY-FDY*X
8430 GOTO 8560
8450 IF X>=11 THEN 8510
8470 FX=FPY
8480 VY=RBY-FDY-WY*X
      ' *** possible problems with this equation for rhoc=0
8490 MY=-WY/2*X^2+RBY*(X-XC)-FDY*X+MTY
8500 GOTO 8560
8510 FX=FPY
8520 VY=WY*(XCYL-X)+FDY
8530 MY=-WY/2*(XCYL^2-2*XCYL*X+X^2)-FDY*(XCYL-X)+MTY
8560 PY=RHOC*ABS(AY)*ABS(Y-RI)
8570 ' *** pressure due to y accel

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8580 'print " *** axial force, shearing force and bending moment at
f(x)"
8590 'print "x;fx;vy;my;py"
8600 'print x;fx;vy;my;py

8601 ' *** sectional properties for shear
8602 Q=2/3*(RO^2-Y^2)^(3/2)-2/3*(RI^2-Y^2)^(3/2)
8603 ' *** first moment of area
8604 B=2*((RO^2-Y^2)^.5 - (RI^2-Y^2)^.5)
8605 ' *** shear width

8610 'print "*** stress resultant: for ay ***"
8660 NXXAY=FX/A*T-MY*Y/II*T
8670 NTTAY=PY*RI
8680 NXTAY=-VY*Q/II/B*T
8690 'print "nxxay;nttay;nxtay"
8700 'print nxxay;nttay;nxtay
8710 RETURN
9450 ' *****

9470 'input "***** loads due to twisting *****",a$

9490 NXTT=PHI*GXTS*RS/XL/2*T
9510 IF X<XC OR X>(XC+XL) THEN NXTT=0
9530 ' ***** shear sectional force due to twisting
9550 'print "x;phi;gxts;rs;xl;t;nxtt"
9570 'print x;phi;gxts;rs;xl;t;nxtt
9590 RETURN
9610 ' *****
9630 'input "*** loads due to internal pressure ***" a$
9650 IF X >= 0 AND X <= XC+XL THEN 9930
9670 ' *** consider membrane stresses in domes only
9690 R2DOME=((ADOME^4*YDOME^2+BDOME^4*XDOME^2)^.5)/BDOME^2
9710 ' *** tangential or circumferential radius of curvature
9730 R1DOME=(R2DOME^3*BDOME^2/ADOME^4)
9750 ' *** axial or meridional radius of curvature
9770 NXXP=(PP+P2)*R2DOME/2
9790 ' *** meridional stress resultant
9810 NTTTP=(PP+P2)*R2DOME*(1-R2DOME/2/R1DOME)
9830 ' *** circumferential stress resultant
9850 ' print "x;y;z;adome;bdome;xdome;ydome;r2dome;r1dome;nxxp;nttp"
9870 ' print x;y;z;adome;bdome;xdome;ydome;r2dome;r1dome;nxxp;nttp
9890 RETURN
9905 ' *****

9910 ' *** stresses considering membrane stresses on cylinder only

9930 NXXP=PP*RI/2
9950 ' *** longitudinal or axial stress resultant
9970 NTTTP=(PP)*RI

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9990 ' *** hoop or tangential stress resultant
10010 'print "nxxp;nttp"
10030 'print nxxp;nttp
10050 RETURN
10070 ' *****

10090 'input "find totals of sectional forces",a$

10110     NXX=NXXAX+NXXAZ+NXXAY+NXXP
10130     NTT=NTTAX+NTTAZ+NTTAY+NTTP+NTD+NTR
10150     NXT=NXTAX+NXTAZ+NXTAY+NXTT
10170     QXX=QXD+QXR
10190     QTT=QTD+QTR
10210     MXX=MXD+MXR
10230     MTT=MTD+MTR
10250     MXT=0
10270 'print "nxx;ntt;nxt;qxx;qtt;mxx;mtt;mxt"
10290 'print "solids-";nxx;ntt;nxt;qxx;qtt;mxx;mtt;mxt
10310 'print "abaqus-";sf1;sf2;sf3;sf4;sf5;sm1;sm2;sm3
10330 'input " ***** write theoretical calculations to file",a$
      IF DTA$="C" THEN
        PRINT USING "####.### ";EL;X;Y;Z
        PRINT NXX;NTT;NXT;QXX;QTT;MXX;MTT;MXT
        RETURN
      END IF

10370 IF NON$="R" THEN
      PRINT#3,USING " ###.### ";X;
      PRINT#3,USING " ###.###~",NXX;NTT;NXT;QXX;QTT;MXX;MTT;MXT
      RETURN
    END IF

      IF NON$="N" THEN
        PE=PP+P2;DN=PE*RI;DM=PE*RI*T
        '** DUMMIES FOR NON DIMENSIONAL
        PRINT#3,USING " ###.### ";X;
        PRINT#3,USING " ###.###~",
";NXX/DN;NTT/DN;NXT/DN;QXX/DN;QTT/DN;MXX/DM;MTT/DM;MXT/DM
        RETURN
      END IF

      '*** CALCULATE MAX PRINCIPAL STRESSES
      IF NON$="M" then
        '** stresses as a sum of membrane and bending
        SXXT= NXX/T+6*MXX/T^2
        SXXC= NXX/T-6*MXX/T^2
        STTT= NTT/T+6*MTT/T^2
        STTC= NTT/T-6*MTT/T^2
        ' find maximums for axial or circumferential
        IF ABS(SXXT)>=ABS(SXXC) THEN SX=SXXT

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```

IF ABS(SXXC)>=ABS(SXXT) THEN SX=SXXC
IF ABS(STTT)>=ABS(STTC) THEN ST=STTT
IF ABS(STTC)>=ABS(STTT) THEN ST=STTC
' determine maximums for Mohrs circle
IF SX>=ST THEN MAX=SX:MIN=ST
IF ST>=SX THEN MAX=ST:MIN=SX
' determine principals
IF MIN<=0 THEN S1=MAX:S2=MIN:SHEAR=(MAX-MIN)/2
IF MIN>0 THEN S1=MAX:S2=MIN:SHEAR=MAX/2
PRINT#3,USING " ###.### ";X;
PRINT#3,USING " ###.###^~~~~ ";S1;S2;0;SHEAR
RETURN
END IF

```

```

10390 ' PRINT#3,EL;X;Y;Z;ARC;NXX;NTT;NXT
10410 ' print#3,nxt;qxx;qtt;mxx;mtt;mxt
10430 ' ***** calculate differences
10450 DA=0
10470 IF NXX<>0 THEN DA=(SF1-NXX)/NXX*100
10490 DB=0
10510 IF NTT<>0 THEN DB=(SF2-NTT)/NTT*100
10530 DC=0
10550 IF NXT<>0 THEN DC=(SF3-NXT)/NXT*100
10570 DD=0
10590 IF QXX<>0 THEN DD=(SF4-QXX)/QXX*100
10610 DE=0
10630 IF QTT<>0 THEN DE=(SF5-QTT)/QTT*100
10650 DF=0
10670 IF MXX<>0 THEN DF=(SM1-MXX)/MXX*100
10690 DG=0
10710 IF MTT<>0 THEN DG=(SM2-MTT)/MTT*100
10730 DH=0
10750 IF MXT<>0 THEN DH=(SM3-MXT)/MXT*100
10770 ' *** write differences to file
10790 'PRINT#4,EL;X;Y;Z;ARC;DA;DB;DC;DD;DE;DF;DG;DH
10810 'PRINT#4,USING " ###.## ";X;
10830 'PRINT#4,DA;DB;DC;DD;DE;DF;DG;DH
10850 'print "el;x;y;z;arc;da;db"
10870 'print el;x;y;z;arc;da;db
10890 'print "dc%;dd%;de%;df%;dg%;dh%"
10910 'print dc%;dd%;de%;df%;dg%;dh%
10930 RETURN
10950 '***
10970 ' *****

10990 'input " ** stresses from rib constraints";a$
10991 IF X<0 OR X>XCYL THEN RETURN
10992 ' *** rib approximation not accurate beyond cylindrical shell
10995 IF X<0 THEN
XR=ABS(X):ARIB=ARL*BRL:L=1:RR=(Z^2+Y^2)^.5

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```

AB=ARIB:AF=ARIB:GOTO 11480
END IF
10997 IF X>XCYL THEN
XR=X-XCYL:ARIB=ARL*BRL:L=1:RR=(Z^2+Y^2)^.5
AB=ARIB:AF=ARIB:GOTO 11480
END IF

11000 ' *** routine to establish x co-ordinate relative to existing
rib
11150 RESTORE 2590:READ XRB
11170 FOR I=1 TO NRIBS-1
11190 READ XRF
11210 ' *** x rib back and x rib front
11230 IF X>=XRB AND X<=XRF THEN 11290
11250 XRB=XRF
11270 NEXT I
11290 XR=X-XRB
11310 ' *** local co-ordinate for distance to back rib
11320 RR=RS
11330 ' *** local radius for rib calcs
11340 L=(XRF-XRB)
11345 ' *** distance between rings
11350 'PRINT "X;XRB;XRF;XR;NRIBS;L"
11370 'PRINT X;XRB;XRF;XR;NRIBS;L
11420 ' ***** define plate rigidity paramaters
*****
11480 BETAD=(ED*T/4/RR^2/DDOME)^.25
11490 BETAS=(ES*T/4/RR^2/DS)^.25
11540 IF X<0 OR X>XCYL THEN BETA=BETAD:D=DDOME:E=ED:NU=NUD
11545 ' *** consider dome properties
11546 IF X>=0 OR X<=XCYL THEN BETA=BETAS:D=DS:E=ES:NU=NUS
11547 ' *** consider shell properties
11550 ALPHA=BETA*L/2
11610
CHI1=(FNHC(2*ALPHA)+COS(2*ALPHA))/(FNHS(2*ALPHA)+SIN(2*ALPHA))
11630 CHI2=(FNHS(2*ALPHA)-
SIN(2*ALPHA))/(FNHS(2*ALPHA)+SIN(2*ALPHA))
11650 CHI3=(FNHC(2*ALPHA)-
COS(2*ALPHA))/(FNHS(2*ALPHA)+SIN(2*ALPHA))
11670 ' *** numerical functions of alpha
11690 ' print "x;pe;l;beta;alpha;chi1;chi2;chi3"
11710 ' print x;pe;l;beta;alpha;chi1;chi2;chi3
11720 ' ***** find rib cross-sectional areas for back and front
*****
11725 IF X<0 OR X>XCYL THEN 12070
11730 RESTORE 2630
11750 FOR J = 1 TO I
11770 READ WB
11790 NEXT J
11810 READ WF

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```

11830 ' *** find current front and back rib widths
11850 RESTORE 2670
11870 FOR J = 1 TO I
11890 READ HB
11910 NEXT J
11930 READ HF
11950 ' *** find current front and back rib heights
11970 AB=WB*HB
11990 ' *** back rib cross sectional area
12010 AF=WF*HF
12030 ' *** front rib cross sectional area
12035 IF (XRF-X)>(X-XRB) THEN XR=X-XRB:ELSE XR=XRF-X
12037 ' *** local x for rib calcs
12040 IF (XRF-X)>(X-XRB) THEN ARIB=AB:ELSE ARIB=AF
12050 ' ** select rib x-area ARIB depending on which is closer
12065 ' ***** determine constants and equivalent pressures
*****
12070 PE=(PP+P2)*(1-1/2*NU)
12075 ' ** equivalent pressure due to poissions effect of axial force
on dome
12080 PCIRCUMB=PE/(BETA*(CHI1-1/2*CHI2^2/CHI3)+T/ARIB)
12420 ' *** force per unit length of circumference for back rib
12422 ' *** use shell or dome beta
12425 PEB=PE-PCIRCUMB*T/ARIB
12430 ' *** equivalent pressure for back ring incl pe and ring
extension
12432 MO=PEB/(2*BETA^2)*CHI2
12434 ' ** local moment at edge of shell section under ring
12437 ' ** use shell beta as analysis first assumes infinite stiff
ring
12439 Q0=-1/2*PCIRCUMB
12583 '*** METHOD INCORPORATING EQN 281 AND 282 FROM TIMO FOR ALPHA
LARGE

12590 PHI=EXP(-BETA*XR)*(COS(BETA*XR)+SIN(BETA*XR))
12600 PSI=EXP(-BETA*XR)*(COS(BETA*XR)-SIN(BETA*XR))
12610 THETA=EXP(-BETA*XR)*COS(BETA*XR)
12620 ZETA=EXP(-BETA*XR)*SIN(BETA*XR)
' *** EQN 281 OF PG 470
12630 W=-1/(2*BETA^3*D)*(BETA*MO*PSI+Q0*THETA)
12640 DWDX=1/(2*BETA^2*D)*(2*BETA*MO*THETA+Q0*PHI)
12650 D2WDX2=-1/(2*BETA*D)*(2*BETA*MO*PHI+2*Q0*ZETA)
12655 D3WDX3=1/D*(2*BETA*MO*ZETA-Q0*PSI)
12660 ' *** differentials of displacement w for local variable xr

12670 NTR=-E*T*W/RR
' *** tangential force resultant
12710 MXR=-1*(-D*D2WDX2)
' *** axial moment resultant, -1 to account for w inwards for
theory

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12810 MTR=NU*MXR
      ' *** tangential moment resultant
12850 QXR=-1*(-D*LJWDX3)
      ' *** axial transverse shear, -1 to account for w inwards for
theory
12890 QTR=0
      ' *** tangential transverse shear force resultant (=0 due to
symmetry)

13750 ' PRINT "x;ntr;mxr;mtr;qxr;qtr"
13770 ' PRINT x;ntr;mxr;mtr;qxr;qtr
13790 RETURN
13838 '
*****
13840 'input " *** definition of local variables **",a$
13842 IF X<0 OR X>XCYL THEN XDOME=(Y^2+Z^2)^.5
13843 IF X<0 THEN YDOME=ABS(X)
13845 ' *** define local dome co-ordinates for back dome
13846 IF X>XCYL THEN YDOME=X-XCYL
13849 ' *** define local dome co-ordinates for front dome
13850 IF X=>0 AND X<=XCYL/2 THEN YDOME=X
13851 IF X>XCYL/2 AND X<=XCYL THEN YDOME=XCYL-X
13852 IF X=>0 AND X<=XCYL THEN XDOME=RS
13853 ' *** define local co-ordinates for cylinder
13854 'print "x;y;z;ydome;xdome"
13855 'print x;y;z;ydome;xdome

13856 RETURN
13857 ' *****

13858 ' input "** localized stresses due to domes/cylinder
connection",a$
13859 PE=PP+P2
13860 ' *** instantaneous pressure due to pp and ax
13990 BETAD=(ED*T/4/XDOME^2/DDOME)^.25
14010 BETAS=(ES*T/4/XDOME^2/DS)^.25
14020 ' *** use nu and beta for dome or shell respectively
14030 IF X<0 OR X>XCYL THEN NU=NUD:BETA=BETAD:E=ED:D=DDOME
14050 IF X=>0 AND X<=XCYL THEN NU=NUS:BETA=BETAS:E=ES:D=DS
14110 QO=PE/8/BETA*ADOME^2/BDOME^2
14130 ' *** axial transverse shearing force
ON ERROR GOTO 15000
14150 PHI=EX*(-BETA*YDOME)*(COS(BETA*YDOME)+SIN(BETA*YDOME))
14170 PSI=EX*(-BETA*YDOME)*(COS(BETA*YDOME)-SIN(BETA*YDOME))
14190 THETA=EXP(-BETA*YDOME)*COS(BETA*YDOME)
14210 ZETA=EXP(-BETA*YDOME)*SIN(BETA*YDOME)
14230 ' *** functions of bx
14250 W=-1/(2*BETA^3*D)*(QO*THETA)
14270 DWDX=1/(2*BETA^2*D)*(QO*PHI)

```

```

14290 D2WDX2=-1/(2*BETA*D)*(2*Q0*ZETA)
14310 D3WDX3=1/D*(-Q0*PSI)
14330 ' *** differentials of displacement w

      NTD=-E*T*W/XDOME
      ' *** tangential force resultant
      MXD=-1*(-D*D2WDX2)
      ' *** axial moment resultant, -1 to account for w inwards for
theory
      MTD=NU*MXD
      ' *** tangential moment resultant
      QXD=-D*D3WDX3
      ' *** axial transverse shear
      QTD=0
      ' *** tangential transverse shear force resultant (=0 due to
symmetry)

14550 'PRINT "X;YDOME;BETA;Q0;PHI;PSI;THETA;ZETA"
14570 'PRINT X;YDOME;BETA;Q0;PHI;PSI;THETA;ZETA
14590 'PRINT "W;DWDX;D2WDX2;D3WDX3;MXD;MTD;QXD;QTD;NTD"
14610 'PRINT W;DWDX;D2WDX2;D3WDX3;MXD;MTD;QXD;QTD;NTD
14630 'INPUT AA$
14650 RETURN

15000 ' ERROR TRAP FOR DOMES/CYLINDER
      PHI=0;PSI=0;THETA=0;ZETA=0
      PRINT "ERROR FOR X=";X
      PRINT "X;YDOME;XDOME;BETA;Q0;PHI;PSI;THETA;ZETA"
      PRINT X;YDOME;XDOME;BETA;Q0;PHI;PSI;THETA;ZETA
      INPUT A$
      on error goto 25010
      GOTO 14250

23320 'print "specify range extraction values RT23"
23321 XMIN=0
23322 XMAX=12
23323 YMIN=.1
23324 YMAX=.12
23325 ZMIN=.640
23326 ZMAX=.65
23327 RETURN
23328 ' *** extract positions for top

23331 XMIN=0
23332 XMAX=12
23333 YMIN=.1
23334 YMAX=.12
23335 ZMIN=-.65
23336 ZMAX=-.64

```



```

23337 RETURN
23338 ' *** extract positions for bottom

23341 XMIN=0
23342 XMAX=12
23343 YMIN=.64
23344 YMAX=.65
23345 ZMIN=.1
23346 ZMAX=.12
23347 RETURN
23348 ' *** extract positions for left (+Y)

23351 XMIN=0
23352 XMAX=12
23353 YMIN=-.67
23354 YMAX=-.63
23355 ZMIN=.1
23356 ZMAX=.12
23357 RETURN
23358 ' *** extract positions for right (-Y)

23361 XMIN=-1
23362 XMAX=0
23363 YMIN=.024
23364 YMAX=.1005
23365 ZMIN=.0
23366 ZMAX=.65
23367 RETURN
23368 ' *** extract positions for back dome

23450 '*****
23470 PRINT "Specify position (Top/Bottom/Left/Right/Dome/New) "
23490 INPUT RANGE$
23500 IF RANGE$="T" THEN GOSUB 23321:RETURN
23510 IF RANGE$="B" THEN GOSUB 23331:RETURN
23520 IF RANGE$="L" THEN GOSUB 23341:RETURN
23530 IF RANGE$="R" THEN GOSUB 23351:RETURN
23525 IF RANGE$="D" THEN GOSUB 23361:RETURN
23540 IF RANGE$<>"N" THEN RETURN
23545 PRINT "xmin"
23550 INPUT XMIN
23570 PRINT "xmax"
23590 INPUT XMAX
23610 PRINT "ymin"
23630 INPUT YMIN
23650 PRINT "ymax"
23670 INPUT YMAX
23690 PRINT "zmin"
23710 INPUT ZMIN
23730 PRINT "zmax"

```

```

23750 INPUT ZMAX
23770 RETURN

```

```

25000' *** ERROR TRAP

```

```

25010 PRINT "NON RECOVERABLE ERROR ";ERN;" AT LINE ";ERL
STOP

```

```

'*****
26000 PRINT "*** DETERMINE FORCE AND MOMENT RESULTANTS FOR RANGE ***"
PRINT:PRINT "New THEORY reduced filename. "
INPUT SOL$
SOL$="F:\MIKE\MATHESIS\RT27\"+SOL$+".DAT"
PRINT "Opening file ";SOL$
OPEN SOL$ FOR OUTPUT AS #3
INPUT "Resultant, Non-Dimensional Data or Max Principal Stresses
(R/N/M)";NON1$
IF NON1$<>" " THEN NON$=NON1$
PRINT "Specify position (Top/Bottom/Left/Right/Dome/New) "
INPUT RANGES$
XMIN=0:PRINT "XMIN= <";XMIN;"> ";:INPUT A$
IF A$<>" " THEN XMIN=VAL(A$)
XMAX=12:PRINT "XMAX= <";XMAX;"> ";:INPUT A$
IF A$<>" " THEN XMAX=VAL(A$)
XINC=.01:PRINT "XINCREMENT= <";XINC;"> ";:INPUT A$
IF A$<>" " THEN XINC=VAL(A$)
EL=0
FOR X = XMIN TO XMAX STEP XINC
IF X<0 OR X>XCYL THEN
IF X<0 THEN XDOME=ABS(X)
IF X>XCYL THEN XDOME=ABS(X-XCYL)
IF RANGES$="T" THEN Y=0:Z=SQR((1-(XDOME/(RS/2))^2)*RS^2)
IF RANGES$="B" THEN Y=0:Z=-SQR((1-(XDOME/(RS/2))^2)*RS^2)
IF RANGES$="L" THEN Z=0:Y=SQR((1-(XDOME/(RS/2))^2)*RS^2)
IF RANGES$="R" THEN Z=0:Y=-SQR((1-(XDOME/(RS/2))^2)*RS^2)
END IF
IF X>=0 AND X<=XCYL THEN
IF RANGES$="T" THEN Y=.07:Z=.650
IF RANGES$="B" THEN Y=.07:Z=-.650
IF RANGES$="L" THEN Y=.650:Z=.070
IF RANGES$="R" THEN Y=-.650:Z=.070
END IF
GOSUB 13840
' *** define local variables for dome
IF AX<>0 THEN GOSUB 5710
' *** loads due to ax acceleration
IF AZ<>0 THEN GOSUB 7110
' *** loads due to az acceleration

```

```

IF AX<>0 THEN GOSUB 8110
  ' *** loads due to ay acceleration
IF TWIST<>0 THEN GOSUB 9470
  ' *** loads due to twisting
IF PP<>0 OR AX<>0 THEN GOSUB 9630
  ' *** membrane loads due to internal pressure
IF AX<>0 OR PP<>0 THEN GOSUB 13858
  ' ** localized stresses due to domes/cylinder connection
IF AX<>0 OR PP<>0 THEN GOSUB 10990
  ' ** localized stresses due to ribs
EL=EL+1
GOSUB 10090
  ' *** find totals and errors and write to file
NEXT X
CLOSE #3
RETURN

```

APPENDIX Q  
SUMMARISED FEM OUTPUT FOR INTERNAL PRESSURE

ABAQUS FEM OUTPUT

X	N <sub>x</sub>	N <sub>φ</sub>	N <sub>xφ</sub>	Q <sub>x</sub>	Q <sub>φ</sub>	M <sub>x</sub>	M <sub>φ</sub>	M <sub>xφ</sub>
-0.33	1.05	0.99	2.71E-3	6.85E-4	8.26E-4	2.44E-4	0.00	0.00
-0.32	1.05	0.99	-1.58E-3	2.75E-5	3.66E-4	-6.11E-4	0.00	0.00
-0.30	0.94	0.80	-1.55E-3	2.06E-3	-5.26E-3	1.73E-2	1.58E-2	1.22E-4
-0.28	0.90	0.67	-1.47E-3	-7.82E-4	7.92E-3	2.05E-2	1.70E-2	6.11E-4
-0.26	0.86	0.51	-2.48E-3	6.01E-4	-1.50E-3	2.08E-2	1.75E-2	2.44E-4
-0.22	0.78	0.21	-2.44E-3	-2.13E-3	-1.34E-2	1.62E-2	1.61E-2	-4.88E-4
-0.19	0.70	-0.08	-4.55E-3	-6.92E-3	1.60E-2	-1.83E-3	9.89E-3	6.11E-4
-0.14	0.61	-0.40	-6.57E-3	-1.68E-2	-2.87E-2	-5.91E-2	-1.09E-2	3.17E-3
-0.09	0.56	-0.46	9.77E-3	-8.27E-3	-6.92E-3	-0.12	-3.36E-2	2.81E-3
-0.03	0.52	-0.11	5.84E-3	4.50E-2	8.75E-2	-3.59E-2	-1.12E-2	6.11E-4
0.05	0.50	0.52	1.64E-3	0.37	-4.03E-2	3.06E-2	4.88E-3	3.66E-4
0.20	0.50	1.13	2.12E-3	0.18	-4.27E-2	3.97E-2	6.72E-3	4.88E-4
0.30	0.50	1.04	-1.02E-3	-0.29	5.07E-2	-1.68E-2	-1.59E-3	-1.22E-4
0.45	0.50	1.00	-9.36E-4	4.90E-2	-7.35E-3	5.62E-3	1.95E-3	1.22E-4
0.55	0.50	0.98	1.96E-3	5.88E-2	-1.02E-2	-2.08E-3	7.33E-4	-1.22E-4
0.70	0.50	1.06	2.79E-3	-0.11	1.49E-2	-1.68E-2	-1.71E-3	-1.22E-4
0.80	0.50	1.04	2.58E-3	7.21E-2	2.83E-3	5.80E-2	9.52E-3	3.66E-4
0.95	0.50	0.53	1.35E-3	8.18E-2	-4.65E-2	-4.11E-2	-6.11E-3	-7.33E-4
1.05	0.50	0.53	-1.11E-3	8.74E-2	1.81E-2	-4.07E-2	-6.11E-3	-1.22E-4
1.20	0.50	1.04	-2.44E-3	7.32E-2	-2.48E-2	5.76E-2	9.40E-3	8.55E-4
1.30	0.50	1.07	-2.79E-3	-0.10	1.66E-2	-1.75E-2	-1.83E-3	-2.44E-4
1.45	0.50	0.98	-1.75E-3	2.84E-2	-1.71E-3	7.33E-4	1.10E-3	0.00
1.55	0.50	0.98	8.57E-4	2.95E-2	-6.80E-3	8.55E-4	9.77E-4	0.00
1.70	0.50	1.07	1.40E-3	-0.11	1.51E-2	-1.76E-2	-1.95E-3	-2.44E-4
1.80	0.50	1.04	1.19E-3	7.93E-2	9.93E-4	5.76E-2	9.28E-3	3.66E-4
1.95	0.50	0.53	6.90E-4	8.00E-2	-4.52E-2	-4.07E-2	-6.11E-3	-7.33E-4
2.05	0.50	0.53	-1.26E-3	8.59E-2	1.87E-2	-4.07E-2	-6.23E-3	-1.22E-4
2.20	0.50	1.04	-2.16E-3	32E-2	-2.44E-2	5.76E-2	9.16E-3	8.55E-4
2.30	0.50	1.07	-2.48E-3		1.63E-2	-1.76E-2	-2.08E-3	-2.44E-4
2.45	0.51	0.98	-1.67E-3	2.00E-2	-1.05E-3	8.55E-4	8.55E-4	0.00
2.55	0.51	0.98	9.18E-4	3.00E-2	-7.47E-3	8.55E-4	8.55E-4	0.00
2.70	0.51	1.07	1.70E-3	-0.11	1.54E-2	-1.75E-2	-1.95E-3	-1.22E-4
2.80	0.51	1.04	1.40E-3	7.97E-2	1.29E-3	5.76E-2	9.28E-3	3.66E-4
2.95	0.50	0.53	7.60E-4	8.14E-2	-4.66E-2	-4.07E-2	-6.11E-3	-7.33E-4
3.05	0.50	0.53	-1.23E-3	8.63E-2	1.71E-2	-4.09E-2	-6.11E-3	-1.22E-4
3.20	0.51	1.04	-1.86E-3	7.69E-2	-2.45E-2	5.79E-2	9.52E-3	8.55E-4
3.30	0.51	1.07	-2.04E-3	-0.10	1.65E-2	-1.75E-2	-1.83E-3	-2.44E-4
3.45	0.51	0.98	-1.35E-3	1.56E-2	1.58E-4	7.33E-4	1.10E-3	0.00
3.55	0.51	0.99	1.00E-3	3.77E-2	-7.73E-3	8.55E-4	1.22E-3	0.00
3.70	0.51	1.06	1.68E-3	-8.90E-2	1.23E-2	-1.45E-2	-1.10E-3	-1.22E-4
3.80	0.51	1.03	1.55E-3	6.29E-2	1.91E-3	4.80E-2	8.30E-3	2.44E-4
3.95	0.51	0.61	3.01E-4	6.87E-2	-3.88E-2	-3.38E-2	-4.64E-3	-6.11E-4
4.05	0.51	0.61	-1.03E-3	7.37E-2	1.42E-2	-3.39E-2	-4.76E-3	-1.22E-4
4.20	0.51	1.03	-1.60E-3	6.07E-2	-2.05E-2	4.81E-2	8.30E-3	7.33E-4
4.30	0.51	1.06	-1.65E-3	-8.50E-2	1.42E-2	-1.44E-2	-2.77E-4	-2.44E-4
4.45	0.51	0.99	-1.02E-3	2.33E-2	-1.88E-3	7.33E-4	1.34E-3	0.00
4.55	0.51	0.99	1.06E-3	2.52E-2	-5.29E-3	7.33E-4	1.34E-3	0.00

$\kappa$	$N_{\kappa}$	$N_{\phi}$	$N_{\kappa\phi}$	$Q_{\kappa}$	$Q_{\phi}$	$M_{\kappa}$	$M_{\phi}$	$M_{\kappa\phi}$
4.70	0.51	1.06	1.69E-3	-8.85E-2	1.21E-2	-1.43E-2	-9.77E-4	-1.22E-4
4.80	0.51	1.03	1.66E-3	6.57E-2	1.29E-3	4.81E-2	8.42E-3	2.44E-4
4.95	0.50	0.61	1.03E-3	6.89E-2	-3.83E-2	-3.39E-2	-4.64E-3	-6.11E-4
5.05	0.50	0.61	-1.00E-3	7.39E-2	1.37E-2	-3.39E-2	-4.64E-3	-1.22E-4
5.20	0.51	1.03	-1.64E-3	6.10E-2	-2.02E-2	4.81E-2	8.42E-3	7.33E-4
5.30	0.51	1.06	-1.67E-3	-8.54E-2	1.40E-2	-1.44E-2	-8.55E-4	-2.44E-4
5.45	0.51	0.99	-1.03E-3	2.35E-2	-1.75E-3	7.33E-4	1.47E-3	0.00
5.55	0.51	0.99	1.06E-3	2.51E-2	-5.40E-3	7.33E-4	1.47E-3	0.00
5.70	0.51	1.06	1.66E-3	-8.85E-2	1.22E-2	-1.44E-2	-8.55E-4	-1.22E-4
5.80	0.51	1.03	1.65E-3	6.59E-2	1.20E-3	4.81E-2	8.42E-3	2.44E-4
5.95	0.50	0.61	1.03E-3	6.86E-2	-3.81E-2	-3.41E-2	-4.64E-3	-7.33E-4

# MATHEORY THEORETICAL OUTPUT

$\mu$	$N_x$	$N_\phi$	$N_{x\phi}$	$Q_x$	$Q_\phi$	$M_x$	$M_\phi$	$M_{x\phi}$
-0.329	1.01	1.01	0	0	0	0	-6.45E-26	0
-0.319	0.99	0.94	0	-1.09E-5	0	-2.18E-5	-5.87E-6	0
-0.309	0.97	0.87	0	2.75E-5	0	-5.21E-5	-1.40E-5	0
-0.299	0.94	0.80	0	1.51E-4	0	1.63E-4	4.39E-5	0
-0.289	0.92	0.73	0	2.95E-4	0	6.57E-4	1.77E-4	0
-0.279	0.90	0.66	0	3.92E-4	0	1.33E-3	3.59E-4	0
-0.269	0.88	0.58	0	3.88E-4	0	2.04E-3	5.50E-4	0
-0.259	0.86	0.51	0	2.48E-4	0	2.62E-3	7.06E-4	0
-0.249	0.83	0.43	0	-5.18E-5	0	2.92E-3	7.86E-4	0
-0.239	0.81	0.35	0	-5.26E-4	0	2.77E-3	7.46E-4	0
-0.229	0.79	0.27	0	-1.18E-3	0	2.04E-3	5.49E-4	0
-0.219	0.77	0.19	0	-2.01E-3	0	5.87E-4	1.58E-4	0
-0.209	0.75	0.10	0	-2.99E-3	0	-1.69E-3	-4.55E-4	0
-0.199	0.73	2.17E-2	0	-4.12E-3	0	-4.88E-3	-1.32E-3	0
-0.189	0.71	-5.99E-2	0	-5.35E-3	0	-9.06E-3	-2.44E-3	0
-0.179	0.69	-0.14	0	-6.64E-3	0	-1.42E-2	-3.84E-3	0
-0.169	0.68	-0.22	0	-7.95E-3	0	-2.04E-2	-5.51E-3	0
-0.159	0.66	-0.29	0	-9.21E-3	0	-2.76E-2	-7.43E-3	0
-0.149	0.64	-0.36	0	-1.04E-2	0	-3.56E-2	-9.59E-3	0
-0.139	0.63	-0.42	0	-1.13E-2	0	-4.43E-2	-1.19E-2	0
-0.129	0.61	-0.47	0	-1.19E-2	0	-5.36E-2	-1.44E-2	0
-0.119	0.60	-0.52	0	-1.22E-2	0	-6.31E-2	-1.70E-2	0
-0.109	0.58	-0.55	0	-1.20E-2	0	-7.26E-2	-1.96E-2	0
-0.099	0.57	-0.58	0	-1.11E-2	0	-8.15E-2	-2.20E-2	0
-0.089	0.56	-0.59	0	-9.43E-3	0	-8.95E-2	-2.41E-2	0
-0.079	0.55	-0.58	0	-6.89E-3	0	-9.60E-2	-2.59E-2	0
-0.069	0.54	-0.56	0	-3.31E-3	0	-0.10	-2.70E-2	0
-0.059	0.53	-0.53	0	1.47E-3	0	-0.10	-2.74E-2	0
-0.049	0.52	-0.48	0	7.58E-3	0	-9.91E-2	-2.67E-2	0
-0.039	0.52	-0.41	0	1.52E-2	0	-9.19E-2	-2.48E-2	0
-0.029	0.51	-0.32	0	2.44E-2	0	-7.90E-2	-2.13E-2	0
-0.019	0.51	-0.22	0	3.53E-2	0	-5.93E-2	-1.60E-2	0
-0.009	0.51	-0.11	0	4.81E-2	0	-3.17E-2	-8.53E-3	0
0.001	0.50	1.35	0	0.13	0	-0.20	-2.57E-2	0
0.011	0.50	1.24	0	0.11	0	-0.19	-2.40E-2	0
0.021	0.50	1.14	0	8.86E-2	0	-0.17	-2.21E-2	0
0.031	0.50	1.06	0	6.93E-2	0	-0.15	-1.99E-2	0
0.041	0.50	1.00	0	5.23E-2	0	-0.14	-1.77E-2	0
0.051	0.50	0.95	0	3.77E-2	0	-0.12	-1.54E-2	0
0.061	0.50	0.91	0	2.53E-2	0	-0.10	-1.32E-2	0
0.071	0.50	0.89	0	1.49E-2	0	-8.67E-2	-1.12E-2	0
0.081	0.50	0.87	0	6.48E-3	0	-7.18E-2	-9.24E-3	0
0.091	0.50	0.86	0	-2.60E-4	0	-5.81E-2	-7.48E-3	0
0.101	0.50	0.86	0	-5.47E-3	0	-4.59E-2	-5.91E-3	0
0.111	0.50	0.86	0	-9.36E-3	0	-3.51E-2	-4.52E-3	0
0.121	0.50	0.86	0	-1.21E-2	0	-2.58E-2	-3.32E-3	0
0.131	0.50	0.87	0	-1.39E-2	0	-1.78E-2	-2.29E-3	0

$x$	$N_x$	$N_\phi$	$N_{x\phi}$	$Q_x$	$Q_\phi$	$M_x$	$M_\phi$	$M_{x\phi}$
0.141	0.50	0.88	0	-1.49E-2	0	-1.11E-2	-1.43E-3	0
0.151	0.50	0.89	0	-1.52E-2	0	-5.57E-3	-7.16E-4	0
0.161	0.50	0.90	0	-1.50E-2	0	-1.13E-3	-1.46E-4	0
0.171	0.50	0.92	0	-1.45E-2	0	2.34E-3	3.01E-4	0
0.181	0.50	0.93	0	-1.36E-2	0	4.96E-3	6.38E-4	0
0.191	0.50	0.94	0	-1.26E-2	0	6.85E-3	8.82E-4	0
0.201	0.50	0.95	0	-1.14E-2	0	8.12E-3	1.05E-3	0
0.211	0.50	0.96	0	-1.02E-2	0	8.88E-3	1.14E-3	0
0.221	0.50	0.97	0	-8.94E-3	0	9.21E-3	1.18E-3	0
0.231	0.50	0.97	0	-7.71E-3	0	9.20E-3	1.18E-3	0
0.241	0.50	0.98	0	-6.55E-3	0	8.93E-3	1.15E-3	0
0.251	0.50	0.99	0	-5.46E-3	0	8.47E-3	1.09E-3	0
0.261	0.50	0.99	0	-4.45E-3	0	7.87E-3	1.01E-3	0
0.271	0.50	1.00	0	-3.55E-3	0	7.18E-3	9.24E-4	0
0.281	0.50	1.00	0	-2.75E-3	0	6.44E-3	8.29E-4	0
0.291	0.50	1.00	0	-2.05E-3	0	5.68E-3	7.32E-4	0
0.301	0.50	1.00	0	-1.45E-3	0	4.94E-3	6.35E-4	0
0.311	0.50	1.00	0	-9.40E-4	0	4.21E-3	5.42E-4	0
0.321	0.50	1.01	0	-5.19E-4	0	3.53E-3	4.55E-4	0
0.331	0.50	1.01	0	-1.79E-4	0	2.91E-3	3.74E-4	0
0.341	0.50	1.01	0	9.02E-5	0	2.34E-3	3.01E-4	0
0.351	0.50	1.01	0	2.96E-4	0	1.83E-3	2.35E-4	0
0.361	0.50	1.01	0	4.47E-4	0	1.38E-3	1.78E-4	0
0.371	0.50	1.01	0	5.52E-4	0	9.97E-4	1.28E-4	0
0.381	0.50	1.01	0	6.17E-4	0	6.70E-4	8.62E-5	0
0.391	0.50	1.00	0	6.50E-4	0	3.97E-4	5.11E-5	0
0.401	0.50	1.00	0	6.57E-4	0	1.74E-4	2.24E-5	0
0.411	0.50	1.00	0	6.44E-4	0	-3.37E-6	-4.34E-7	0
0.421	0.50	1.00	0	6.15E-4	0	-1.41E-4	-1.81E-5	0
0.431	0.50	1.00	0	5.75E-4	0	-2.44E-4	-3.14E-5	0
0.441	0.50	1.00	0	5.28E-4	0	-3.16E-4	-4.07E-5	0
0.451	0.50	1.00	0	4.76E-4	0	-3.64E-4	-4.68E-5	0
0.461	0.50	1.00	0	4.23E-4	0	-3.90E-4	-5.02E-5	0
0.471	0.50	1.00	0	3.69E-4	0	-3.99E-4	-5.14E-5	0
0.481	0.50	1.00	0	3.17E-4	0	-3.95E-4	-5.08E-5	0
0.491	0.50	1.00	0	2.67E-4	0	-3.80E-4	-4.90E-5	0
0.501	0.50	1.00	0	2.26E-4	0	-3.80E-4	-4.90E-5	0
0.511	0.50	1.00	0	2.20E-4	0	-5.29E-4	-6.81E-5	0
0.521	0.50	1.00	0	2.17E-4	0	-6.75E-4	-8.68E-5	0
0.531	0.50	1.00	0	1.17E-4	0	-8.19E-4	-1.05E-4	0
0.541	0.50	1.00	0	1.17E-4	0	-9.64E-4	-1.24E-4	0
0.551	0.50	1.00	0	2.18E-4	0	-1.11E-3	-1.43E-4	0
0.561	0.50	1.00	0	2.16E-4	0	-1.25E-3	-1.61E-4	0
0.571	0.50	1.00	0	2.10E-4	0	-1.40E-3	-1.80E-4	0
0.581	0.50	1.00	0	1.99E-4	0	-1.53E-3	-1.97E-4	0
0.591	0.50	1.00	0	1.79E-4	0	-1.66E-3	-2.14E-4	0
0.601	0.50	1.00	0	1.48E-4	0	-1.77E-3	-2.28E-4	0
0.611	0.50	1.00	0	1.04E-4	0	-1.85E-3	-2.39E-4	0



$x$	$N_x$	$N_\phi$	$N_{x\phi}$	$Q_x$	$Q_\phi$	$M_x$	$M_\phi$	$M_{x\phi}$
0.621	0.50	1.00	0	4.38E-5	0	-1.90E-3	-2.45E-4	0
0.631	0.50	1.01	0	-3.58E-5	0	-1.91E-3	-2.46E-4	0
0.641	0.50	1.01	0	-1.38E-4	0	-1.85E-3	-2.38E-4	0
0.651	0.50	1.01	0	-2.65E-4	0	-1.72E-3	-2.21E-4	0
0.661	0.50	1.01	0	-4.20E-4	0	-1.49E-3	-1.92E-4	0
0.671	0.50	1.01	0	-6.06E-4	0	-1.15E-3	-1.48E-4	0
0.681	0.50	1.02	0	-8.24E-4	0	-6.77E-4	-8.7'E-5	0
0.691	0.50	1.02	0	-1.08E-3	0	-4.53E-5	-5.4E-6	0
0.701	0.50	1.02	0	-1.36E-3	0	7.66E-4	9.86E-5	0
0.711	0.50	1.02	0	-1.69E-3	0	1.78E-3	2.29E-4	0
0.721	0.50	1.02	0	-2.04E-3	0	3.02E-3	3.89E-4	0
0.731	0.50	1.03	0	-2.42E-3	0	4.51E-3	5.80E-4	0
0.741	0.50	1.03	0	-2.82E-3	0	6.25E-3	8.05E-4	0
0.751	0.50	1.03	0	-3.24E-3	0	8.28E-3	1.07E-3	0
0.761	0.50	1.03	0	-3.66E-3	0	1.06E-2	1.36E-3	0
0.771	0.50	1.03	0	-4.07E-3	0	1.32E-2	1.69E-3	0
0.781	0.50	1.02	0	-4.45E-3	0	1.60E-2	2.06E-3	0
0.791	0.50	1.02	0	-4.77E-3	0	1.91E-2	2.46E-3	0
0.801	0.50	1.01	0	-5.01E-3	0	2.23E-2	2.88E-3	0
0.811	0.50	1.00	0	-5.14E-3	0	2.57E-2	3.31E-3	0
0.821	0.50	0.99	0	-5.11E-3	0	2.92E-2	3.75E-3	0
0.831	0.50	0.98	0	-4.89E-3	0	3.25E-2	4.18E-3	0
0.841	0.50	0.96	0	-4.43E-3	0	3.56E-2	4.59E-3	0
0.851	0.50	0.94	0	-3.67E-3	0	3.84E-2	4.94E-3	0
0.861	0.50	0.91	0	-2.55E-3	0	4.04E-2	5.21E-3	0
0.871	0.50	0.88	0	-1.01E-3	0	4.17E-2	5.36E-3	0
0.881	0.50	0.85	0	1.01E-3	0	4.17E-2	5.37E-3	0
0.891	0.50	0.81	0	3.57E-3	0	4.02E-2	5.17E-3	0
0.901	0.50	0.77	0	6.75E-3	0	3.68E-2	4.73E-3	0
0.911	0.50	0.72	0	1.06E-2	0	3.10E-2	3.99E-3	0
0.921	0.50	0.67	0	1.52E-2	0	2.25E-2	2.89E-3	0
0.931	0.50	0.62	0	2.05E-2	0	1.06E-2	1.37E-3	0
0.941	0.50	0.57	0	2.67E-2	0	-5.07E-3	-6.53E-4	0
0.951	0.50	0.52	0	3.36E-2	0	-2.51E-2	-3.23E-3	0
0.961	0.50	0.47	0	4.13E-2	0	-5.01E-2	-6.45E-3	0
0.971	0.50	0.42	0	4.98E-2	0	-8.04E-2	-1.03E-2	0
0.981	0.50	0.39	0	5.88E-2	0	-0.12	-1.50E-2	0
0.991	0.50	0.36	0	6.83E-2	0	-0.16	-2.05E-2	0
1.001	0.50	0.36	0	7.56E-2	0	-0.19	-2.51E-2	0
1.011	0.50	0.37	0	6.59E-2	0	-0.15	-1.90E-2	0
1.021	0.50	0.40	0	5.65E-2	0	-0.11	-1.38E-2	0
1.031	0.50	0.43	0	4.76E-2	0	-7.22E-2	-9.30E-3	0
1.041	0.50	0.48	0	3.93E-2	0	-4.33E-2	-5.57E-3	0
1.051	0.50	0.53	0	3.18E-2	0	-1.96E-2	-2.53E-3	0
1.061	0.50	0.58	0	2.51E-2	0	-7.32E-4	-9.42E-5	0
1.071	0.50	0.64	0	1.91E-2	0	1.39E-2	1.79E-3	0
1.081	0.50	0.69	0	1.40E-2	0	2.49E-2	3.21E-3	0
1.091	0.50	0.74	0	9.57E-3	0	3.27E-2	4.21E-3	0

$x$	$N_x$	$N_\phi$	$N_{x\phi}$	$\Omega_x$	$\Omega_\phi$	$M_x$	$M_\phi$	$M_{x\phi}$
1.101	0.50	0.78	0	5.89E-3	0	3.78E-2	4.87E-3	0
1.111	0.50	0.82	0	2.87E-3	0	4.07E-2	5.24E-3	0
1.121	0.50	0.86	0	4.47E-4	0	4.18E-2	5.38E-3	0
1.131	0.50	0.89	0	-1.44E-3	0	4.14E-2	5.33E-3	0
1.141	0.50	0.92	0	-2.87E-3	0	4.00E-2	5.15E-3	0
1.151	0.50	0.94	0	-3.89E-3	0	3.77E-2	4.85E-3	0
1.161	0.50	0.97	0	-4.57E-3	0	3.49E-2	4.49E-3	0
1.171	0.50	0.98	0	-4.97E-3	0	3.17E-2	4.08E-3	0
1.181	0.50	1.00	0	-5.14E-3	0	2.83E-2	3.64E-3	0
1.191	0.50	1.01	0	-5.12E-3	0	2.49E-2	3.20E-3	0
1.201	0.50	1.01	0	-4.96E-3	0	2.15E-2	2.77E-3	0
1.211	0.50	1.02	0	-4.70E-3	0	1.83E-2	2.35E-3	0
1.221	0.50	1.02	0	-4.36E-3	0	1.53E-2	1.96E-3	0
1.231	0.50	1.03	0	-3.97E-3	0	1.25E-2	1.61E-3	0
1.241	0.50	1.03	0	-3.55E-3	0	9.97E-3	1.28E-3	0
1.251	0.50	1.03	0	-3.13E-3	0	7.74E-3	9.96E-4	0
1.261	0.50	1.03	0	-2.72E-3	0	5.79E-3	7.45E-4	0
1.271	0.50	1.03	0	-2.32E-3	0	4.11E-3	5.29E-4	0
1.281	0.50	1.02	0	-1.94E-3	0	2.70E-3	3.47E-4	0
1.291	0.50	1.02	0	-1.59E-3	0	1.52E-3	1.96E-4	0
1.301	0.50	1.02	0	-1.28E-3	0	5.66E-4	7.28E-5	0
1.311	0.50	1.02	0	-9.97E-4	0	-1.90E-4	-2.45E-5	0
1.321	0.50	1.02	0	-7.51E-4	0	-7.71E-4	-9.92E-5	0
1.331	0.50	1.01	0	-5.39E-4	0	-1.20E-3	-1.54E-4	0
1.341	0.50	1.01	0	-3.59E-4	0	-1.50E-3	-1.93E-4	0
1.351	0.50	1.01	0	-2.10E-4	0	-1.68E-3	-2.17E-4	0
1.361	0.50	1.01	0	-8.78E-5	0	-1.78E-3	-2.29E-4	0
1.371	0.50	1.01	0	9.21E-6	0	-1.81E-3	-2.33E-4	0
1.381	0.50	1.00	0	8.42E-5	0	-1.78E-3	-2.28E-4	0
1.391	0.50	1.00	0	1.40E-4	0	-1.70E-3	-2.19E-4	0
1.401	0.50	1.00	0	1.79E-4	0	-1.59E-3	-2.05E-4	0
1.411	0.50	1.00	0	2.04E-4	0	-1.46E-3	-1.88E-4	0
1.421	0.50	1.00	0	2.18E-4	0	-1.32E-3	-1.70E-4	0
1.431	0.50	1.00	0	2.23E-4	0	-1.18E-3	-1.51E-4	0
1.441	0.50	1.00	0	2.20E-4	0	-1.03E-3	-1.32E-4	0
1.451	0.50	1.00	0	2.11E-4	0	-8.84E-4	-1.14E-4	0
1.461	0.50	1.00	0	1.99E-4	0	-7.47E-4	-9.61E-5	0
1.471	0.50	1.00	0	1.83E-4	0	-6.19E-4	-7.97E-5	0
1.481	0.50	1.00	0	1.66E-4	0	-5.03E-4	-6.47E-5	0
1.491	0.50	1.00	0	1.48E-4	0	-3.99E-4	-5.13E-5	0
1.501	0.50	1.00	0	1.34E-4	0	-3.28E-4	-4.22E-5	0
1.511	0.50	1.00	0	1.52E-4	0	-4.24E-4	-5.45E-5	0
1.521	0.50	1.00	0	1.70E-4	0	-5.31E-4	-6.84E-5	0
1.531	0.50	1.00	0	1.87E-4	0	-6.51E-4	-8.37E-5	0
1.541	0.50	1.00	0	2.02E-4	0	-7.80E-4	-1.00E-4	0
1.551	0.50	1.00	0	2.14E-4	0	-9.19E-4	-1.18E-4	0
1.561	0.50	1.00	0	2.21E-4	0	-1.06E-3	-1.37E-4	0
1.571	0.50	1.00	0	2.22E-4	0	-1.21E-3	-1.56E-4	0

x	N <sub>x</sub> '	N <sub>φ</sub> '	N <sub>xφ</sub> '	Q <sub>x</sub> '	Q <sub>φ</sub> '	M <sub>x</sub> '	M <sub>φ</sub> '	M <sub>xφ</sub> '
1.581	0.50	1.00	0	2.16E-4	0	-1.36E-3	-1.75E-4	0
1.591	0.50	1.00	0	1.99E-4	0	-1.50E-3	-1.93E-4	0
1.601	0.50	1.00	0	1.71E-4	0	-1.62E-3	-2.09E-4	0
1.611	0.50	1.00	0	1.28E-4	0	-1.72E-3	-2.22E-4	0
1.621	0.50	1.00	0	6.72E-5	0	-1.79E-3	-2.30E-4	0
1.631	0.50	1.01	0	-1.30E-5	0	-1.81E-3	-2.33E-4	0
1.641	0.50	1.01	0	-1.16E-4	0	-1.77E-3	-2.27E-4	0
1.651	0.50	1.01	0	-2.45E-4	0	-1.65E-3	-2.12E-4	0
1.661	0.50	1.01	0	-4.02E-4	0	-1.43E-3	-1.84E-4	0
1.671	0.50	1.01	0	-5.89E-4	0	-1.10E-3	-1.42E-4	0
1.681	0.50	1.02	0	-8.10E-4	0	-6.40E-4	-8.24E-5	0
1.691	0.50	1.02	0	-1.06E-3	0	-1.74E-5	-2.24E-6	0
1.701	0.50	1.02	0	-1.35E-3	0	7.86E-4	1.01E-4	0
1.711	0.50	1.02	0	-1.68E-3	0	1.79E-3	2.31E-4	0
1.721	0.50	1.02	0	-2.03E-3	0	3.03E-3	3.90E-4	0
1.731	0.50	1.03	0	-2.41E-3	0	4.51E-3	5.80E-4	0
1.741	0.50	1.03	0	-2.82E-3	0	6.25E-3	8.08E-4	0
1.751	0.50	1.03	0	-3.24E-3	0	8.27E-3	1.06E-3	0
1.761	0.50	1.03	0	-3.66E-3	0	1.06E-2	1.36E-3	0
1.771	0.50	1.03	0	-4.07E-3	0	1.31E-2	1.69E-3	0
1.781	0.50	1.02	0	-4.45E-3	0	1.60E-2	2.06E-3	0
1.791	0.50	1.02	0	-4.77E-3	0	1.91E-2	2.45E-3	0
1.801	0.50	1.01	0	-5.01E-3	0	2.23E-2	2.87E-3	0
1.811	0.50	1.00	0	-5.14E-3	0	2.57E-2	3.31E-3	0
1.821	0.50	0.99	0	-5.12E-3	0	2.92E-2	3.75E-3	0
1.831	0.50	0.98	0	-4.89E-3	0	3.25E-2	4.18E-3	0
1.841	0.50	0.96	0	-4.43E-3	0	3.56E-2	4.59E-3	0
1.851	0.50	0.94	0	-3.67E-3	0	3.83E-2	4.93E-3	0
1.861	0.50	0.91	0	-2.55E-3	0	4.04E-2	5.20E-3	0
1.871	0.50	0.88	0	-1.01E-3	0	4.17E-2	5.36E-3	0
1.881	0.50	0.85	0	1.00E-3	0	4.17E-2	5.36E-3	0
1.891	0.50	0.81	0	3.57E-3	0	4.02E-2	5.17E-3	0
1.901	0.50	0.77	0	6.75E-3	0	3.68E-2	4.73E-3	0
1.911	0.50	0.72	0	1.06E-2	0	3.10E-2	3.99E-3	0
1.921	0.50	0.67	0	1.52E-2	0	2.25E-2	2.89E-3	0
1.931	0.50	0.62	0	2.05E-2	0	1.06E-2	1.37E-3	0
1.941	0.50	0.57	0	2.67E-2	0	-5.07E-3	-6.53E-4	0
1.951	0.50	0.52	0	3.36E-2	0	-2.51E-2	-3.23E-3	0
1.961	0.50	0.47	0	4.13E-2	0	-5.01E-2	-6.44E-3	0
1.971	0.50	0.42	0	4.98E-2	0	-8.04E-2	-1.03E-2	0
1.981	0.50	0.39	0	5.88E-2	0	-0.12	-1.50E-2	0
1.991	0.50	0.36	0	6.83E-2	0	-0.16	-2.05E-2	0
2.001	0.50	0.36	0	7.56E-2	0	-0.19	-2.51E-2	0
2.011	0.50	0.37	0	6.59E-2	0	-0.15	-1.90E-2	0
2.021	0.50	0.40	0	5.65E-2	0	-0.11	-1.38E-2	0
2.031	0.50	0.43	0	4.76E-2	0	-7.22E-2	-9.30E-3	0
2.041	0.50	0.48	0	3.93E-2	0	-4.33E-2	-5.57E-3	0
2.051	0.50	0.53	0	3.18E-2	0	-1.96E-2	-2.53E-3	0

x	N <sub>x</sub> '	N <sub>φ</sub> '	N <sub>xφ</sub> '	Q <sub>x</sub> '	Q <sub>φ</sub> '	M <sub>x</sub> '	M <sub>φ</sub> '	M <sub>xφ</sub> '
2.061	0.50	0.58	0	2.51E-2	0	-7.33E-4	-9.44E-5	0
2.071	0.50	0.64	0	1.91E-2	0	1.39E-2	1.79E-3	0
2.081	0.50	0.69	0	1.40E-2	0	2.49E-2	3.21E-3	0
2.091	0.50	0.74	0	9.57E-3	0	3.27E-2	4.21E-3	0
2.101	0.50	0.78	0	5.89E-3	0	3.78E-2	4.87E-3	0
2.111	0.50	0.82	0	2.87E-3	0	4.07E-2	5.24E-3	0
2.121	0.50	0.86	0	4.47E-4	0	4.18E-2	5.38E-3	0
2.131	0.50	0.89	0	-1.44E-3	0	4.14E-2	5.33E-3	0
2.141	0.50	0.92	0	-2.87E-3	0	4.00E-2	5.15E-3	0
2.151	0.50	0.94	0	-3.89E-3	0	3.77E-2	4.85E-3	0
2.161	0.50	0.97	0	-4.57E-3	0	3.49E-2	4.49E-3	0
2.171	0.50	0.98	0	-4.97E-3	0	3.17E-2	4.08E-3	0
2.181	0.50	1.00	0	-5.14E-3	0	2.83E-2	3.64E-3	0
2.191	0.50	1.01	0	-5.12E-3	0	2.49E-2	3.20E-3	0
2.201	0.50	1.01	0	-4.96E-3	0	2.15E-2	2.77E-3	0
2.211	0.50	1.02	0	-4.70E-3	0	1.83E-2	2.35E-3	0
2.221	0.50	1.02	0	-4.36E-3	0	1.53E-2	1.96E-3	0
2.231	0.50	1.03	0	-3.97E-3	0	1.25E-2	1.61E-3	0
2.241	0.50	1.03	0	-3.55E-3	0	9.97E-3	1.28E-3	0
2.251	0.50	1.03	0	-3.13E-3	0	7.74E-3	9.96E-4	0
2.261	0.50	1.03	0	-2.72E-3	0	5.79E-3	7.45E-4	0
2.271	0.50	1.03	0	-2.32E-3	0	4.11E-3	5.29E-4	0
2.281	0.50	1.02	0	-1.94E-3	0	2.70E-3	3.47E-4	0
2.291	0.50	1.02	0	-1.59E-3	0	1.52E-3	1.96E-4	0
2.301	0.50	1.02	0	-1.28E-3	0	5.66E-4	7.28E-5	0
2.311	0.50	1.02	0	-9.97E-4	0	-1.90E-4	-2.45E-5	0
2.321	0.50	1.02	0	-7.51E-4	0	-7.71E-4	-9.92E-5	0
2.331	0.50	1.01	0	-5.39E-4	0	-1.20E-3	-1.54E-4	0
2.341	0.50	1.01	0	-3.59E-4	0	-1.50E-3	-1.93E-4	0
2.351	0.50	1.01	0	-2.10E-4	0	-1.68E-3	-2.17E-4	0
2.361	0.50	1.01	0	-8.78E-5	0	-1.78E-3	-2.29E-4	0
2.371	0.50	1.01	0	9.20E-6	0	-1.81E-3	-2.33E-4	0
2.381	0.50	1.00	0	8.42E-5	0	-1.78E-3	-2.28E-4	0
2.391	0.50	1.00	0	1.40E-4	0	-1.70E-3	-2.19E-4	0
2.401	0.50	1.00	0	1.79E-4	0	-1.59E-3	-2.05E-4	0
2.411	0.50	1.00	0	2.04E-4	0	-1.46E-3	-1.88E-4	0
2.421	0.50	1.00	0	2.18E-4	0	-1.32E-3	-1.70E-4	0
2.431	0.50	1.00	0	2.23E-4	0	-1.18E-3	-1.51E-4	0
2.441	0.50	1.00	0	2.20E-4	0	-1.03E-3	-1.32E-4	0
2.451	0.50	1.00	0	2.11E-4	0	-8.84E-4	-1.14E-4	0
2.461	0.50	1.00	0	1.99E-4	0	-7.47E-4	-9.61E-5	0
2.471	0.50	1.00	0	1.83E-4	0	-6.19E-4	-7.97E-5	0
2.481	0.50	1.00	0	1.66E-4	0	-5.03E-4	-6.47E-5	0
2.491	0.50	1.00	0	1.48E-4	0	-3.99E-4	-5.13E-5	0
2.501	0.50	1.00	0	1.34E-4	0	-3.28E-4	-4.22E-5	0
2.511	0.50	1.00	0	1.52E-4	0	-4.24E-4	-5.45E-5	0
2.521	0.50	1.00	0	1.70E-4	0	-5.31E-4	-6.84E-5	0
2.531	0.50	1.00	0	1.87E-4	0	-6.51E-4	-8.37E-5	0

$x$	$N_x'$	$N_\phi'$	$N_{x\phi}'$	$Q_x'$	$Q_\phi'$	$M_x'$	$M_\phi'$	$M_{x\phi}'$
2.541	0.50	1.00	0	2.02E-4	0	-7.80E-4	-1.00E-4	0
2.551	0.50	1.00	0	2.14E-4	0	-9.19E-4	-1.18E-4	0
2.561	0.50	1.00	0	2.21E-4	0	-1.06E-3	-1.37E-4	0
2.571	0.50	1.00	0	2.22E-4	0	-1.21E-3	-1.56E-4	0
2.581	0.50	1.00	0	2.16E-4	0	-1.36E-3	-1.75E-4	0
2.591	0.50	1.00	0	1.99E-4	0	-1.50E-3	-1.93E-4	0
2.601	0.50	1.00	0	1.71E-4	0	-1.62E-3	-2.09E-4	0
2.611	0.50	1.00	0	1.28E-4	0	-1.72E-3	-2.22E-4	0
2.621	0.50	1.00	0	6.72E-5	0	-1.79E-3	-2.30E-4	0
2.631	0.50	1.01	0	-1.30E-5	0	-1.81E-3	-2.33E-4	0
2.641	0.50	1.01	0	-1.16E-4	0	-1.77E-3	-2.27E-4	0
2.651	0.50	1.01	0	-2.45E-4	0	-1.65E-3	-2.12E-4	0
2.661	0.50	1.01	0	-4.02E-4	0	-1.43E-3	-1.84E-4	0
2.671	0.50	1.01	0	-5.89E-4	0	-1.10E-3	-1.42E-4	0
2.681	0.50	1.02	0	-8.10E-4	0	-6.40E-4	-8.24E-5	0
2.691	0.50	1.02	0	-1.06E-3	0	-1.74E-5	-2.25E-6	0
2.701	0.50	1.02	0	-1.35E-3	0	7.86E-4	1.01E-4	0
2.711	0.50	1.02	0	-1.68E-3	0	1.79E-3	2.31E-4	0
2.721	0.50	1.02	0	-2.03E-3	0	3.03E-3	3.90E-4	0
2.731	0.50	1.03	0	-2.41E-3	0	4.51E-3	5.80E-4	0
2.741	0.50	1.03	0	-2.82E-3	0	6.25E-3	8.05E-4	0
2.751	0.50	1.03	0	-3.24E-3	0	8.27E-3	1.06E-3	0
2.761	0.50	1.03	0	-3.66E-3	0	1.06E-2	1.36E-3	0
2.771	0.50	1.03	0	-4.07E-3	0	1.31E-2	1.69E-3	0
2.781	0.50	1.02	0	-4.45E-3	0	1.60E-2	2.06E-3	0
2.791	0.50	1.02	0	-4.77E-3	0	1.91E-2	2.45E-3	0
2.801	0.50	1.01	0	-5.01E-3	0	2.23E-2	2.87E-3	0
2.811	0.50	1.00	0	-5.14E-3	0	2.57E-2	3.31E-3	0
2.821	0.50	0.99	0	-5.12E-3	0	2.92E-2	3.75E-3	0
2.831	0.50	0.98	0	-4.89E-3	0	3.25E-2	4.18E-3	0
2.841	0.50	0.96	0	-4.43E-3	0	3.56E-2	4.59E-3	0
2.851	0.50	0.94	0	-3.67E-3	0	3.83E-2	4.93E-3	0
2.861	0.50	0.91	0	-2.55E-3	0	4.04E-2	5.20E-3	0
2.871	0.50	0.88	0	-1.01E-3	0	4.17E-2	5.26E-3	0
2.881	0.50	0.85	0	1.00E-3	0	4.17E-2	5.36E-3	0
2.891	0.50	0.81	0	3.57E-3	0	4.02E-2	5.17E-3	0
2.901	0.50	0.77	0	6.75E-3	0	3.68E-2	4.73E-3	0
2.911	0.50	0.72	0	1.06E-2	0	3.10E-2	3.99E-3	0
2.921	0.50	0.67	0	1.52E-2	0	2.25E-2	2.89E-3	0
2.931	0.50	0.62	0	2.05E-2	0	1.06E-2	1.37E-3	0
2.941	0.50	0.57	0	2.67E-2	0	-5.07E-3	-6.53E-4	0
2.951	0.50	0.52	0	3.36E-2	0	-2.51E-2	-3.23E-3	0
2.961	0.50	0.47	0	4.13E-2	0	-5.01E-2	-6.44E-3	0
2.971	0.50	0.42	0	4.98E-2	0	-8.04E-2	-1.03E-2	0
2.981	0.50	0.39	0	5.88E-2	0	-0.12	-1.50E-2	0
2.991	0.50	0.36	0	6.83E-2	0	-0.16	-2.05E-2	0
3.001	0.50	0.36	0	7.56E-2	0	-0.19	-2.51E-2	0
3.011	0.50	0.37	0	6.59E-2	0	-0.15	-1.90E-2	0

x	N <sub>x</sub> '	N <sub>φ</sub> '	N <sub>xφ</sub> '	Q <sub>x</sub> '	Q <sub>φ</sub> '	M <sub>x</sub> '	M <sub>φ</sub> '	M <sub>xφ</sub> '
3.021	0.50	0.40	0	5.65E-2	0	-0.11	-1.38E-2	0
3.031	0.50	0.43	0	4.76E-2	0	-7.22E-2	-9.30E-3	0
3.041	0.50	0.48	0	3.93E-2	0	-4.33E-2	-5.57E-3	0
3.051	0.50	0.53	0	3.18E-2	0	-1.96E-2	-2.53E-3	0
3.061	0.50	0.58	0	2.51E-2	0	-7.35E-4	-9.46E-5	0
3.071	0.50	0.64	0	1.91E-2	0	1.39E-2	1.79E-3	0
3.081	0.50	0.69	0	1.40E-2	0	2.49E-2	3.21E-3	0
3.091	0.50	0.74	0	9.57E-3	0	3.27E-2	4.21E-3	0
3.101	0.50	0.78	0	5.89E-3	0	3.78E-2	4.87E-3	0
3.111	0.50	0.82	0	2.87E-3	0	4.07E-2	5.24E-3	0
3.121	0.50	0.86	0	4.48E-4	0	4.18E-2	5.38E-3	0
3.131	0.50	0.89	0	-1.44E-3	0	4.14E-2	5.33E-3	0
3.141	0.50	0.92	0	-2.87E-3	0	4.00E-2	5.15E-3	0
3.151	0.50	0.94	0	-3.89E-3	0	3.77E-2	4.85E-3	0
3.161	0.50	0.97	0	-4.57E-3	0	3.49E-2	4.49E-3	0
3.171	0.50	0.98	0	-4.97E-3	0	3.17E-2	4.08E-3	0
3.181	0.50	1.00	0	-5.14E-3	0	2.83E-2	3.64E-3	0
3.191	0.50	1.01	0	-5.12E-3	0	2.49E-2	3.20E-3	0
3.201	0.50	1.01	0	-4.96E-3	0	2.15E-2	2.77E-3	0
3.211	0.50	1.02	0	-4.70E-3	0	1.83E-2	2.35E-3	0
3.221	0.50	1.02	0	-4.36E-3	0	1.53E-2	1.96E-3	0
3.231	0.50	1.03	0	-3.97E-3	0	1.25E-2	1.61E-3	0
3.241	0.50	1.03	0	-3.56E-3	0	9.97E-3	1.28E-3	0
3.251	0.50	1.03	0	-3.13E-3	0	7.74E-3	9.96E-4	0
3.261	0.50	1.03	0	-2.72E-3	0	5.79E-3	7.45E-4	0
3.271	0.50	1.03	0	-2.32E-3	0	4.11E-3	5.29E-4	0
3.281	0.50	1.02	0	-1.94E-3	0	2.70E-3	3.47E-4	0
3.291	0.50	1.02	0	-1.59E-3	0	1.52E-3	1.96E-4	0
3.301	0.50	1.02	0	-1.28E-3	0	5.66E-4	7.28E-5	0
3.311	0.50	1.02	0	-9.97E-4	0	-1.90E-4	-2.45E-5	0
3.321	0.50	1.02	0	-7.51E-4	0	-7.71E-4	-9.92E-5	0
3.331	0.50	1.01	0	-5.39E-4	0	-1.20E-3	-1.54E-4	0
3.341	0.50	1.01	0	-3.59E-4	0	-1.50E-3	-1.93E-4	0
3.351	0.50	1.01	0	-2.10E-4	0	-1.68E-3	-2.17E-4	0
3.361	0.50	1.01	0	-8.78E-5	0	-1.78E-3	-2.29E-4	0
3.371	0.50	1.01	0	9.20E-6	0	-1.81E-3	-2.33E-4	0
3.381	0.50	1.00	0	8.42E-5	0	-1.78E-3	-2.28E-4	0
3.391	0.50	1.00	0	1.40E-4	0	-1.70E-3	-2.19E-4	0
3.401	0.50	1.00	0	1.79E-4	0	-1.59E-3	-2.05E-4	0
3.411	0.50	1.00	0	2.04E-4	0	-1.46E-3	-1.88E-4	0
3.421	0.50	1.00	0	2.18E-4	0	-1.32E-3	-1.70E-4	0
3.431	0.50	1.00	0	2.23E-4	0	-1.18E-3	-1.51E-4	0
3.441	0.50	1.00	0	2.20E-4	0	-1.03E-3	-1.32E-4	0
3.451	0.50	1.00	0	2.11E-4	0	-8.84E-4	-1.14E-4	0
3.461	0.50	1.00	0	1.99E-4	0	-7.47E-4	-9.61E-5	0
3.471	0.50	1.00	0	1.83E-4	0	-6.19E-4	-7.97E-5	0
3.481	0.50	1.00	0	1.66E-4	0	-5.03E-4	-6.48E-5	0
3.491	0.50	1.00	0	1.48E-4	0	-3.99E-4	-5.13E-5	0

x	N <sub>x</sub> '	N <sub>φ</sub> '	N <sub>xφ</sub> '	Q <sub>x</sub> '	Q <sub>φ</sub> '	M <sub>x</sub> '	M <sub>φ</sub> '	M <sub>xφ</sub> '
3.501	0.50	1.00	0	1.02E-4	0	-2.49E-4	-3.20E-5	0
3.511	0.50	1.00	0	1.15E-4	0	-3.21E-4	-4.13E-5	0
3.521	0.50	1.00	0	1.29E-4	0	-4.02E-4	-5.18E-5	0
3.531	0.50	1.00	0	1.42E-4	0	-4.93E-4	-6.34E-5	0
3.541	0.50	1.00	0	1.53E-4	0	-5.91E-4	-7.61E-5	0
3.551	0.50	1.00	0	1.62E-4	0	-6.96E-4	-8.96E-5	0
3.561	0.50	1.00	0	1.67E-4	0	-8.06E-4	-1.04E-4	0
3.571	0.50	1.00	0	1.68E-4	0	-9.18E-4	-1.18E-4	0
3.581	0.50	1.00	0	1.63E-4	0	-1.03E-3	-1.32E-4	0
3.591	0.50	1.00	0	1.51E-4	0	-1.13E-3	-1.46E-4	0
3.601	0.50	1.00	0	1.29E-4	0	-1.23E-3	-1.58E-4	0
3.611	0.50	1.00	0	9.66E-5	0	-1.30E-3	-1.68E-4	0
3.621	0.50	1.00	0	5.09E-5	0	-1.35E-3	-1.74E-4	0
3.631	0.50	1.00	0	-9.85E-6	0	-1.37E-3	-1.76E-4	0
3.641	0.50	1.01	0	-8.79E-5	0	-1.34E-3	-1.72E-4	0
3.651	0.50	1.01	0	-1.85E-4	0	-1.25E-3	-1.61E-4	0
3.661	0.50	1.01	0	-3.04E-4	0	-1.09E-3	-1.40E-4	0
3.671	0.50	1.01	0	-4.46E-4	0	-8.37E-4	-1.08E-4	0
3.681	0.50	1.01	0	-6.13E-4	0	-4.85E-4	-6.24E-5	0
3.691	0.50	1.01	0	-8.06E-4	0	-1.33E-3	-1.71E-4	0
3.701	0.50	1.02	0	-1.02E-3	0	5.96E-4	7.65E-5	0
3.711	0.50	1.02	0	-1.27E-3	0	1.36E-3	1.75E-4	0
3.721	0.50	1.02	0	-1.54E-3	0	2.29E-3	2.95E-4	0
3.731	0.50	1.02	0	-1.83E-3	0	3.41E-3	4.39E-4	0
3.741	0.50	1.02	0	-2.14E-3	0	4.74E-3	6.09E-4	0
3.751	0.50	1.02	0	-2.45E-3	0	6.26E-3	8.06E-4	0
3.761	0.50	1.02	0	-2.77E-3	0	8.01E-3	1.03E-3	0
3.771	0.50	1.02	0	-3.08E-3	0	9.96E-3	1.28E-3	0
3.781	0.50	1.02	0	-3.37E-3	0	1.21E-2	1.56E-3	0
3.791	0.50	1.01	0	-3.61E-3	0	1.44E-2	1.86E-3	0
3.801	0.50	1.01	0	-3.80E-3	0	1.69E-2	2.18E-3	0
3.811	0.50	1.00	0	-3.89E-3	0	1.93E-2	2.51E-3	0
3.821	0.50	0.99	0	-3.87E-3	0	2.21E-2	2.84E-3	0
3.831	0.50	0.98	0	-3.71E-3	0	2.46E-2	3.17E-3	0
3.841	0.50	0.97	0	-3.36E-3	0	2.70E-2	3.47E-3	0
3.851	0.50	0.95	0	-2.78E-3	0	2.90E-2	3.74E-3	0
3.861	0.50	0.93	0	-1.93E-3	0	3.06E-2	3.94E-3	0
3.871	0.50	0.91	0	-7.68E-4	0	3.15E-2	4.06E-3	0
3.881	0.50	0.89	0	7.60E-4	0	3.16E-2	4.06E-3	0
3.891	0.50	0.86	0	2.70E-3	0	3.04E-2	3.92E-3	0
3.901	0.50	0.83	0	5.11E-3	0	2.79E-2	3.59E-3	0
3.911	0.50	0.79	0	8.03E-3	0	2.35E-2	3.03E-3	0
3.921	0.50	0.75	0	1.15E-2	0	1.70E-2	2.19E-3	0
3.931	0.50	0.71	0	1.56E-2	0	3.05E-3	1.04E-3	0
3.941	0.50	0.67	0	2.02E-2	0	-3.84E-3	-4.94E-4	0
3.951	0.50	0.63	0	2.55E-2	0	-1.90E-2	-2.45E-3	0
3.961	0.50	0.60	0	3.13E-2	0	-3.79E-2	-4.88E-3	0
3.971	0.50	0.56	0	3.77E-2	0	-6.09E-2	-7.81E-3	0

$x$	$N_x$	$N_\phi$	$N_{x\phi}$	$\Omega_x$	$\Omega_\phi$	$M_x$	$M_\phi$	$M_{x\phi}$
3.981	0.50	0.54	0	4.46E-2	0	-8.83E-2	-1.14E-2	0
3.991	0.50	0.52	0	5.18E-2	0	-0.12	-1.55E-2	0
4.001	0.50	0.51	0	5.73E-2	0	-0.15	-1.90E-2	0
4.011	0.50	0.52	0	4.99E-2	0	-0.11	-1.44E-2	0
4.021	0.50	0.54	0	4.28E-2	0	-8.10E-2	-1.04E-2	0
4.031	0.50	0.57	0	3.60E-2	0	-5.47E-2	-7.04E-3	0
4.041	0.50	0.61	0	2.98E-2	0	-3.28E-2	-4.22E-3	0
4.051	0.50	0.64	0	2.41E-2	0	-1.49E-2	-1.91E-3	0
4.061	0.50	0.68	0	1.90E-2	0	-5.56E-4	-7.16E-5	0
4.071	0.50	0.72	0	1.45E-2	0	1.06E-2	1.36E-3	0
4.081	0.50	0.76	0	1.06E-2	0	1.89E-2	2.43E-3	0
4.091	0.50	0.80	0	7.25E-3	0	2.48E-2	3.19E-3	0
4.101	0.50	0.83	0	4.46E-3	0	2.87E-2	3.69E-3	0
4.111	0.50	0.87	0	2.17E-3	0	3.08E-2	3.97E-3	0
4.121	0.50	0.89	0	3.39E-4	0	3.17E-2	4.07E-3	0
4.131	0.50	0.92	0	-1.09E-3	0	3.14E-2	4.04E-3	0
4.141	0.50	0.94	0	-2.17E-3	0	3.03E-2	3.90E-3	0
4.151	0.50	0.96	0	-2.95E-3	0	2.86E-2	3.68E-3	0
4.161	0.50	0.97	0	-3.46E-3	0	2.64E-2	3.40E-3	0
4.171	0.50	0.99	0	-3.77E-3	0	2.40E-2	3.09E-3	0
4.181	0.50	1.00	0	-3.89E-3	0	2.14E-2	2.76E-3	0
4.191	0.50	1.00	0	-3.88E-3	0	1.88E-2	2.42E-3	0
4.201	0.50	1.01	0	-3.76E-3	0	1.63E-2	2.10E-3	0
4.211	0.50	1.02	0	-3.56E-3	0	1.38E-2	1.78E-3	0
4.221	0.50	1.02	0	-3.30E-3	0	1.16E-2	1.49E-3	0
4.231	0.50	1.02	0	-3.01E-3	0	9.45E-3	1.22E-3	0
4.241	0.50	1.02	0	-2.69E-3	0	7.55E-3	9.71E-4	0
4.251	0.50	1.02	0	-2.37E-3	0	5.86E-3	7.54E-4	0
4.261	0.50	1.02	0	-2.06E-3	0	4.38E-3	5.64E-4	0
4.271	0.50	1.02	0	-1.75E-3	0	3.11E-3	4.01E-4	0
4.281	0.50	1.02	0	-1.47E-3	0	2.04E-3	2.63E-4	0
4.291	0.50	1.02	0	-1.21E-3	0	1.15E-3	1.48E-4	0
4.301	0.50	1.01	0	-9.67E-4	0	4.28E-4	5.51E-5	0
4.311	0.50	1.01	0	-7.55E-4	0	-1.44E-4	-1.86E-5	0
4.321	0.50	1.01	0	-5.69E-4	0	-5.84E-4	-7.52E-5	0
4.331	0.50	1.01	0	-4.08E-4	0	-9.08E-4	-1.17E-4	0
4.341	0.50	1.01	0	-2.72E-4	0	-1.13E-3	-1.46E-4	0
4.351	0.50	1.01	0	-1.59E-4	0	-1.28E-3	-1.64E-4	0
4.361	0.50	1.01	0	-6.65E-5	0	-1.35E-3	-1.74E-4	0
4.371	0.50	1.00	0	7.02E-6	0	-1.37E-3	-1.76E-4	0
4.381	0.50	1.00	0	6.38E-5	0	-1.34E-3	-1.73E-4	0
4.391	0.50	1.00	0	1.06E-4	0	-1.29E-3	-1.66E-4	0
4.401	0.50	1.00	0	1.36E-4	0	-1.21E-3	-1.55E-4	0
4.411	0.50	1.00	0	1.55E-4	0	-1.11E-3	-1.43E-4	0
4.421	0.50	1.00	0	1.65E-4	0	-1.00E-3	-1.29E-4	0
4.431	0.50	1.00	0	1.69E-4	0	-8.90E-4	-1.15E-4	0
4.441	0.50	1.00	0	1.66E-4	0	-7.78E-4	-1.00E-4	0
4.451	0.50	1.00	0	1.60E-4	0	-6.69E-4	-8.61E-5	0



X	N <sub>X</sub> '	N <sub>φ</sub> '	N <sub>Xφ</sub> '	Q <sub>X</sub> '	Q <sub>φ</sub> '	M <sub>X</sub> '	M <sub>φ</sub> '	M <sub>Xφ</sub> '
4.461	0.50	1.00	0	1.50E-4	0	-5.66E-4	-7.28E-5	0
4.471	0.50	1.00	0	1.39E-4	0	-4.69E-4	-6.04E-5	0
4.481	0.50	1.00	0	1.26E-4	0	-3.81E-4	-4.90E-5	0
4.491	0.50	1.00	0	1.12E-4	0	-3.02E-4	-3.88E-5	0
4.501	0.50	1.00	0	1.02E-4	0	-2.49E-4	-3.20E-5	0
4.511	0.50	1.00	0	1.15E-4	0	-3.21E-4	-4.13E-5	0
4.521	0.50	1.00	0	1.29E-4	0	-4.02E-4	-5.18E-5	0
4.531	0.50	1.00	0	1.42E-4	0	-4.93E-4	-6.34E-5	0
4.541	0.50	1.00	0	1.53E-4	0	-5.91E-4	-7.61E-5	0
4.551	0.50	1.00	0	1.62E-4	0	-6.96E-4	-8.96E-5	0
4.561	0.50	1.00	0	1.67E-4	0	-8.06E-4	-1.04E-4	0
4.571	0.50	1.00	0	1.68E-4	0	-9.18E-4	-1.18E-4	0
4.581	0.50	1.00	0	1.63E-4	0	-1.03E-3	-1.32E-4	0
4.591	0.50	1.00	0	1.51E-4	0	-1.13E-3	-1.46E-4	0
4.601	0.50	1.00	0	1.29E-4	0	-1.23E-3	-1.58E-4	0
4.611	0.50	1.00	0	9.65E-5	0	1.30E-3	-1.68E-4	0
4.621	0.50	1.00	0	5.09E-5	0	-1.35E-3	-1.74E-4	0
4.631	0.50	1.00	0	-9.95E-6	0	-1.37E-3	-1.76E-4	0
4.641	0.50	1.01	0	-8.80E-5	0	-1.34E-3	-1.72E-4	0
4.651	0.50	1.01	0	-1.85E-4	0	-1.25E-3	-1.61E-4	0
4.661	0.50	1.01	0	-3.04E-4	0	-1.09E-3	-1.40E-4	0
4.671	0.50	1.01	0	-4.47E-4	0	-8.36E-4	-1.08E-4	0
4.681	0.50	1.01	0	-6.13E-4	0	-4.84E-4	-6.23E-5	0
4.691	0.50	1.01	0	-8.06E-4	0	-1.24E-5	-1.60E-6	0
4.701	0.50	1.02	0	-1.03E-3	0	5.97E-4	7.68E-5	0
4.711	0.50	1.02	0	-1.27E-3	0	1.36E-3	1.75E-4	0
4.721	0.50	1.02	0	-1.54E-3	0	2.30E-3	2.95E-4	0
4.731	0.50	1.02	0	-1.83E-3	0	3.42E-3	4.40E-4	0
4.741	0.50	1.02	0	-2.14E-3	0	4.74E-3	6.10E-4	0
4.751	0.50	1.02	0	-2.45E-3	0	6.27E-3	8.07E-4	0
4.761	0.50	1.02	0	-2.77E-3	0	8.01E-3	1.03E-3	0
4.771	0.50	1.02	0	-3.08E-3	0	9.96E-3	1.28E-3	0
4.781	0.50	1.02	0	-3.37E-3	0	1.21E-2	1.56E-3	0
4.791	0.50	1.01	0	-3.61E-3	0	1.44E-2	1.86E-3	0
4.801	0.50	1.01	0	-3.80E-3	0	1.69E-2	2.18E-3	0
4.811	0.50	1.00	0	-3.89E-3	0	1.95E-2	2.51E-3	0
4.821	0.50	0.99	0	-3.87E-3	0	2.21E-2	2.84E-3	0
4.831	0.50	0.98	0	-3.71E-3	0	2.46E-2	3.17E-3	0
4.841	0.50	0.97	0	-3.35E-3	0	2.70E-2	3.47E-3	0
4.851	0.50	0.95	0	-2.78E-3	0	2.90E-2	3.74E-3	0
4.861	0.50	0.93	0	-1.93E-3	0	3.06E-2	3.94E-3	0
4.871	0.50	0.91	0	-7.66E-4	0	3.15E-2	4.06E-3	0
4.881	0.50	0.89	0	7.64E-4	0	3.16E-2	4.06E-3	0
4.891	0.50	0.86	0	2.71E-3	0	3.04E-2	3.92E-3	0
4.901	0.50	0.83	0	5.12E-3	0	2.79E-2	3.58E-3	0
4.911	0.50	0.79	0	8.04E-3	0	2.35E-2	3.02E-3	0
4.921	0.50	0.75	0	1.15E-2	0	1.70E-2	2.19E-3	0
4.931	0.50	0.71	0	1.56E-2	0	8.02E-3	1.03E-3	0

x	N <sub>x</sub> '	N <sub>φ</sub> '	N <sub>xφ</sub> '	Q <sub>x</sub> '	Q <sub>φ</sub> '	M <sub>x</sub> '	M <sub>φ</sub> '	M <sub>xφ</sub> '
4.941	0.50	0.67	0	2.02E-2	0	-3.87E-3	-4.98E-4	0
4.951	0.50	0.63	0	2.55E-2	0	-1.91E-2	-2.45E-3	0
4.961	0.50	0.60	0	3.13E-2	0	-3.80E-2	-4.89E-3	0
4.971	0.50	0.56	0	3.77E-2	0	-6.10E-2	-7.84E-3	0
4.981	0.50	0.54	0	4.46E-2	0	-8.84E-2	-1.14E-2	0
4.991	0.50	0.52	0	5.18E-2	0	-0.12	-1.55E-2	0
5.001	0.50	0.51	0	5.73E-2	0	-0.15	-1.90E-2	0
5.011	0.50	0.52	0	4.99E-2	0	-0.11	-1.44E-2	0
5.021	0.50	0.54	0	4.28E-2	0	-8.09E-2	-1.04E-2	0
5.031	0.50	0.57	0	3.60E-2	0	-5.47E-2	-7.04E-3	0
5.041	0.50	0.61	0	2.98E-2	0	-3.28E-2	-4.22E-3	0
5.051	0.50	0.64	0	2.41E-2	0	-1.48E-2	-1.91E-3	0
5.061	0.50	0.68	0	1.90E-2	0	-5.27E-4	-6.78E-5	0
5.071	0.50	0.72	0	1.45E-2	0	1.06E-2	1.36E-3	0
5.081	0.50	0.76	0	1.06E-2	0	1.89E-2	2.43E-3	0
5.091	0.50	0.80	0	7.24E-3	0	2.48E-2	3.19E-3	0
5.101	0.50	0.83	0	4.46E-3	0	2.87E-2	3.69E-3	0
5.111	0.50	0.87	0	2.17E-3	0	3.09E-2	3.97E-3	0
5.121	0.50	0.89	0	3.35E-4	0	3.17E-2	4.07E-3	0
5.131	0.50	0.92	0	-1.10E-3	0	3.14E-2	4.04E-3	0
5.141	0.50	0.94	0	-2.17E-3	0	3.03E-2	3.90E-3	0
5.151	0.50	0.96	0	-2.95E-3	0	2.86E-2	3.68E-3	0
5.161	0.50	0.97	0	-3.46E-3	0	2.64E-2	3.40E-3	0
5.171	0.50	0.99	0	-3.77E-3	0	2.40E-2	3.09E-3	0
5.181	0.50	1.00	0	-3.89E-3	0	2.14E-2	2.76E-3	0
5.191	0.50	1.00	0	-3.88E-3	0	1.88E-2	2.42E-3	0
5.201	0.50	1.01	0	-3.76E-3	0	1.63E-2	2.09E-3	0
5.211	0.50	1.02	0	-3.56E-3	0	1.38E-2	1.78E-3	0
5.221	0.50	1.02	0	-3.30E-3	0	1.15E-2	1.49E-3	0
5.231	0.50	1.02	0	-3.00E-3	0	9.44E-3	1.22E-3	0
5.241	0.50	1.02	0	-2.69E-3	0	7.54E-3	9.71E-4	0
5.251	0.50	1.02	0	-2.37E-3	0	5.86E-3	7.54E-4	0
5.261	0.50	1.02	0	-2.06E-3	0	4.38E-3	5.64E-4	0
5.271	0.50	1.02	0	-1.75E-3	0	3.11E-3	4.00E-4	0
5.281	0.50	1.02	0	-1.47E-3	0	2.04E-3	2.62E-4	0
5.291	0.50	1.02	0	-1.20E-3	0	1.15E-3	1.48E-4	0
5.301	0.50	1.01	0	-9.67E-4	0	4.27E-4	5.49E-5	0
5.311	0.50	1.01	0	-7.54E-4	0	-1.46E-4	-1.87E-5	0
5.321	0.50	1.01	0	-5.68E-4	0	-5.85E-4	-7.53E-5	0
5.331	0.50	1.01	0	-4.08E-4	0	-9.09E-4	-1.17E-4	0
5.341	0.50	1.01	0	-2.72E-4	0	-1.13E-3	-1.46E-4	0
5.351	0.50	1.01	0	-1.59E-4	0	-1.28E-3	-1.64E-4	0
5.361	0.50	1.01	0	-6.63E-5	0	-1.35E-3	-1.74E-4	0
5.371	0.50	1.00	0	7.16E-6	0	-1.37E-3	-1.76E-4	0
5.381	0.50	1.00	0	6.39E-5	0	-1.34E-3	-1.73E-4	0
5.391	0.50	1.00	0	1.06E-4	0	-1.29E-3	-1.66E-4	0
5.401	0.50	1.00	0	1.36E-4	0	-1.21E-3	-1.55E-4	0
5.411	0.50	1.00	0	1.55E-4	0	-1.11E-3	-1.43E-4	0

$x$	$N_x'$	$N_\phi'$	$N_{x\phi}'$	$Q_x'$	$Q_\phi'$	$M_x'$	$M_\phi'$	$M_{x\phi}'$
5.421	0.50	1.00	0	1.65E-4	0	-1.00E-3	-1.29E-4	0
5.431	0.50	1.00	0	1.69E-4	0	-8.90E-4	-1.15E-4	0
5.441	0.50	1.00	0	1.66E-4	0	-7.78E-4	-1.00E-4	0
5.451	0.50	1.00	0	1.60E-4	0	-6.69E-4	-8.61E-5	0
5.461	0.50	1.00	0	1.50E-4	0	-5.65E-4	-7.28E-5	0
5.471	0.50	1.00	0	1.39E-4	0	-4.69E-4	-6.03E-5	0
5.481	0.50	1.00	0	1.26E-4	0	-3.81E-4	-4.90E-5	0
5.491	0.50	1.00	0	1.12E-4	0	-3.02E-4	-3.86E-5	0
5.501	0.50	1.00	0	1.02E-4	0	-2.49E-4	-3.20E-5	0
5.511	0.50	1.00	0	1.15E-4	0	-3.21E-4	-4.13E-5	0
5.521	0.50	1.00	0	1.29E-4	0	-4.03E-4	-5.18E-5	0
5.531	0.50	1.00	0	1.42E-4	0	-4.93E-4	-6.35E-5	0
5.541	0.50	1.00	0	1.53E-4	0	-5.91E-4	-7.61E-5	0
5.551	0.50	1.00	0	1.62E-4	0	-6.97E-4	-8.96E-5	0
5.561	0.50	1.00	0	1.67E-4	0	-8.07E-4	-1.04E-4	0
5.571	0.50	1.00	0	1.68E-4	0	-9.19E-4	-1.18E-4	0
5.581	0.50	1.00	0	1.63E-4	0	-1.03E-3	-1.33E-4	0
5.591	0.50	1.00	0	1.51E-4	0	-1.13E-3	-1.46E-4	0
5.601	0.50	1.00	0	1.29E-4	0	-1.23E-3	-1.58E-4	0
5.611	0.50	1.00	0	9.64E-5	0	-1.30E-3	-1.68E-4	0
5.621	0.50	1.00	0	5.07E-5	0	-1.35E-3	-1.74E-4	0
5.631	0.50	1.00	0	-1.01E-5	0	-1.37E-3	-1.76E-4	0
5.641	0.50	1.01	0	-8.82E-5	0	-1.34E-3	-1.72E-4	0
5.651	0.50	1.01	0	-1.86E-4	0	-1.25E-3	-1.60E-4	0
5.661	0.50	1.01	0	-3.08E-4	0	-1.08E-3	-1.40E-4	0
5.671	0.50	1.01	0	-4.47E-4	0	-8.35E-4	-1.08E-4	0
5.681	0.50	1.01	0	-6.14E-4	0	-4.83E-4	-6.22E-5	0
5.691	0.50	1.01	0	-8.07E-4	0	-1.12E-5	-1.44E-6	0
5.701	0.50	1.02	0	-1.03E-3	0	5.98E-4	7.70E-5	0
5.711	0.50	1.02	0	-1.27E-3	0	1.36E-3	1.75E-4	0
5.721	0.50	1.02	0	-1.54E-3	0	2.30E-3	2.96E-4	0
5.731	0.50	1.02	0	-1.83E-3	0	3.42E-3	4.40E-4	0
5.741	0.50	1.02	0	-2.14E-3	0	4.74E-3	6.10E-4	0
5.751	0.50	1.02	0	-2.45E-3	0	6.27E-3	8.07E-4	0
5.761	0.50	1.02	0	-2.77E-3	0	8.01E-3	1.03E-3	0
5.771	0.50	1.02	0	-3.08E-3	0	9.97E-3	1.28E-3	0
5.781	0.50	1.02	0	-3.37E-3	0	1.21E-2	1.56E-3	0
5.791	0.50	1.01	0	-3.61E-3	0	1.45E-2	1.86E-3	0
5.801	0.50	1.01	0	-3.80E-3	0	1.69E-2	2.18E-3	0
5.811	0.50	1.00	0	-3.89E-3	0	1.95E-2	2.51E-3	0
5.821	0.50	0.99	0	-3.87E-3	0	2.21E-2	2.84E-3	0
5.831	0.50	0.98	0	-3.71E-3	0	2.46E-2	3.17E-3	0
5.841	0.50	0.97	0	-3.35E-3	0	2.70E-2	3.47E-3	0
5.851	0.50	0.95	0	-2.78E-3	0	2.90E-2	3.74E-3	0
5.861	0.50	0.93	0	-1.93E-3	0	3.06E-2	3.94E-3	0
5.871	0.50	0.91	0	-7.63E-4	0	3.15E-2	4.06E-3	0
5.881	0.50	0.89	0	7.68E-4	0	3.16E-2	4.06E-3	0
5.891	0.50	0.86	0	2.71E-3	0	3.04E-2	3.92E-3	0

x	$N_x'$	$N_\phi'$	$N_{x\phi}'$	$Q_x'$	$Q_\phi'$	$M_x'$	$M_\phi'$	$M_{x\phi}'$
5.901	0.50	0.83	0	5.12E-3	0	2.78E-2	3.58E-3	0
5.911	0.50	0.79	0	8.05E-3	0	2.35E-2	3.02E-3	0
5.921	0.50	0.75	0	1.15E-2	0	1.70E-2	2.19E-3	0
5.931	0.50	0.71	0	1.53E-2	0	8.00E-3	1.03E-3	0
5.941	0.50	0.67	0	2.02E-2	0	-3.90E-3	-5.02E-4	0
5.951	0.50	0.63	0	2.55E-2	0	-1.91E-2	-2.46E-3	0
5.961	0.50	0.60	0	3.13E-2	0	-3.80E-2	-4.89E-3	0
5.971	0.50	0.56	0	3.77E-2	0	-6.10E-2	-7.85E-3	0
5.981	0.50	0.54	0	4.46E-2	0	-8.84E-2	-1.14E-2	0
5.991	0.50	0.52	0	5.18E-2	0	-0.12	-1.55E-2	0

**APPENDIX R**

**SUMMARISED FEM AND THEORY OUTPUT FOR 2g COMBINED  
ACCELERATION LOAD CASE**

Nx	No	Nao	Qx	Qo	Mr	Mo	Mao	THE x	Nx	No	Nao	Qx	Qo	Mr	Mo	Mao
7261	26620	-22620	93690	-114300	315	11	23	0.05	13044	22128	61953	34172	0	-1618	-204	0
-8139	44091	-24150	7824	26210	-236	-65	26	0.2	15091	25424	10115	-1453	0	1.64	0.19	0
-24734	33939	-22350	-43144	6500	53	-19	23	0.3	14972	28467	12528	-2238	0	1.11	0.14	0
-34240	36000	-27470	-344	929	31	-131	24	0.45	29543	32007	16144	8.83	0	-0.0944	-0.0127	0
-35150	18921	-26190	-75470	14375	-127	-17	40	0.55	23441	34324	18561	4.49	0	-0.3	-0.0435	0
-57040	18632	-34330	260450	-60950	-113	-114	33	0.7	21623	34344	22131	-3247	0	0.24	0.0305	0
-62970	-21990	-26630	-154390	95643	333	-50	4	0.8	32570	40532	24394	-1324	0	4.79	1.12	0
-60630	110250	61741	-130990	-145700	-1163	-331	-26	0.95	37262	29445	26214	903.33	0	-10.08	-1.3	0
-62870	463450	54115	82859	-464800	1553	111	32	1.03	143510	36432	-119500	1601	0	-10.07	-1.4	0
-41530	144370	-37030	30942	37570	-433	-127	1	1.2	153270	50147	-115040	-179.5	0	11.43	1.52	0
-61290	-75340	-51134	-57659	162200	17	17	4	1.3	135600	52740	-113400	-30.41	0	0.39	0.0499	0
-40420	47217	-23134	-35070	-193190	123	-44	12	1.45	106340	55333	-109940	6.3	0	-0.57	-0.0729	0
-70280	72715	-4464	46195	162420	-43	-102	-19	1.55	44243	37491	-147400	9.4	0	-4.6	-0.077	0
-32450	20191	-4403	-15340	-139700	-10	20	-20	1.7	61063	62044	-101400	-62.42	0	0.41	0.0622	0
-44730	72141	-454	-34590	-12340	-216	-5	-44	1.8	43463	64435	-101400	-250.1	0	16.44	2.12	0
-62940	247640	-9185	72502	262910	229	-54	-44	1.95	17434	41407	-97730	1755.4	0	-17.39	-2.32	0
-47430	227430	-31820	92370	7836	41	-100	13	2.03	10011	43043	-55320	1812.6	0	-16.31	-2.42	0
-96440	75776	-65950	-31650	-8060	-114	-43	1	2.2	-22020	70053	-91700	-297.1	0	19.50	2.52	0
-49200	32217	-72440	71404	-17820	-51	-9	-21	2.3	-34560	76445	-49220	-31.43	0	4.63	0.0406	0
-111400	30066	-54960	-92540	-72390	2	-27	-19	2.45	-61090	79110	-45670	13.21	0	-4.08	-0.11	0
-114090	96477	-31630	3043	45419	11	-4	-21	2.53	-75000	81444	-43250	14.41	0	-4.92	-0.12	0
-122140	77333	-57090	-28140	-40460	-4	61	-19	2.7	-94340	16470	-79640	-93.84	0	0.72	0.0929	0
-124400	103760	-35550	-21650	-40470	-104	34	-31	2.8	-110100	84404	-77220	-467.7	0	24.31	3.12	0
-127200	174350	-42090	49140	221610	149	-17	-17	2.95	-125500	54167	-75400	233.11	0	-25.8	-3.33	0
-140300	141710	-30370	-40620	113450	-64	-90	3	3.03	-140100	55405	-71130	2004.2	0	-26.49	-3.44	0
-152200	92112	-70310	-72990	-17230	13	-43	-3	3.2	-160000	97968	-47570	-41.48	0	27.34	3.52	0
-162440	90299	-82520	44075	-25920	-67	-91	-11	3.3	-171400	100910	-63160	-112.5	0	0.67	0.11	0
-177100	100540	-67130	-13020	-13250	-12	-62	-11	3.45	-167800	102090	-41540	18.92	0	-1.2	-0.15	0
-183300	112330	-63450	2009	-4562	2	-34	-10	3.53	-194100	105060	-59120	14.71	0	-4.91	-0.12	0
-197500	113340	-71650	-33100	-22310	-21	0	-4	3.7	-212900	110070	-55500	-84.57	0	0.73	0.0977	0
-205700	127950	-42640	7401	-40460	17	11	-11	3.8	-222300	112000	-57090	-367.6	0	24.25	3.12	0
-213700	36363	-36610	75776	56120	12	-23	-4	3.95	-233500	78140	-49470	2096.3	0	-25.03	-3.3	0
-227400	64318	-35145	-12270	56621	-139	-68	-3	4.03	-240900	79640	-47040	2536.8	0	-26.2	-3.37	0
-235900	113259	-50190	-10190	-57300	110	-33	-3	4.2	-256600	121330	-34440	-403.3	0	26.38	3.42	0
-243100	127260	-40134	11820	-72920	-66	-73	-4	4.3	-262900	124440	-41020	-104.7	0	0.84	0.11	0
-252000	123740	-46650	-1860	-4054	-14	-31	-6	4.45	-271100	126440	-37400	18.13	0	-1.15	-0.15	0
-256500	130620	-45010	2147	-30420	-7	-9	-3	4.53	-279300	128640	-34090	18.51	0	-1.11	-0.13	0
-264500	142640	-43710	-32540	-13140	-34	4	-3	4.7	-287500	134020	-31370	-114.1	0	0.91	0.12	0
-271700	146210	-40210	7254	-34940	44	30	-3	4.8	-293100	135430	-28940	-456.8	0	30.1	3.87	0
-276700	76945	-23310	31459	47643	-60	-4	-1	4.95	-300200	93267	-25340	342.7	0	-31.6	-4.07	0
-284000	62085	-20450	1143	69314	-143	-34	-2	5.03	-304300	94776	-22940	3141.2	0	-32.33	-4.14	0
-284400	140540	-35660	1914	-33400	138	-15	-2	5.2	-314000	145600	-19910	-192.4	0	32.45	-4.18	0
-291600	150390	-34130	-1603	-26210	-63	-43	-3	5.3	-313100	146390	-16490	-132.2	0	1.02	0.13	0
-295500	147400	-27810	1135	-4333	-12	-5	-2	5.45	-317100	149400	-13270	21.93	0	-1.4	-0.18	0
-297500	131240	-24730	1314	-23710	-14	4	-1	5.53	-319300	152220	-10460	22.31	0	-1.47	-0.18	0
-300000	144530	-23710	-20540	-10730	-32	7	-1	5.7	-326600	157970	-7240	-141.6	0	1.00	0.14	0
-301100	164460	-19430	12541	-26190	142	34	2	5.8	-322700	159400	-4826	-541.9	0	35.91	4.63	0
-301900	71781	-12259	27942	6900	-114	-7	-1	5.95	-323500	160350	-1207	3667.1	0	-37.58	-4.64	0

TOP OF TANKER (+Z)

FEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
6.85	-360000	71347	-9524	23134	32416	-134	-16	-2	6.05	-323709	109149	12946	37254	0	-3414	-431	0
6.2	-361600	172344	-10410	11756	-24394	150	13	2	6.2	-325009	163200	44264	-341.5	0	34.53	4.33	0
6.3	-360100	183614	-4466	-23280	-22749	-60	-14	1	6.3	-322090	172340	7239.5	-155.7	0	1.2	0.15	0
6.43	-297600	171709	-4622	429	-4444	-4	9	1	6.45	-319400	174450	10459	25.72	0	-1.64	-4.21	0
6.50	-293500	172460	-2599	394	-24640	-12	13	3	6.53	-317800	175000	15773	26.1	0	-1.64	-4.21	0
6.7	-291700	192890	2234	-17016	-16520	-64	-2	3	6.7	-314000	141920	14492	-165.1	0	1.27	0.16	0
6.8	-244100	143010	3442	12232	-17410	142	34	5	6.8	-311000	143500	15103	-613	0	41.45	3.39	0
6.95	-244000	79241	1474	3974	-25790	-162	-15	0	6.95	-305600	123444	22925	4251.6	0	-40.57	-5.61	0
7.05	-277700	92403	3944	54187	-10410	-113	-7	0	7.05	-301600	124950	25774	4310	0	-441.7	-3.69	0
7.2	-271300	282314	13027	14131	-14720	144	29	6	7.2	-294400	195030	28954	-676.7	0	44.2	5.69	0
7.3	-265100	249270	16440	-34450	-14379	-56	-1	-4	7.3	-289700	156290	51371	-179.2	0	1.34	0.11	0
7.45	-250000	196430	17044	5745	-9744	-9	12	5	7.45	-281200	107036	34091	29.52	0	-1.44	-0.24	0
7.55	-249700	192140	19374	-1473	-22920	-13	7	7	7.55	-273100	199340	37404	49.5	0	-1.9	-0.24	0
7.7	-239500	215720	22423	-4344	-12220	-73	-19	7	7.7	-265100	205470	41024	-144.5	0	1.45	0.19	0
7.8	-231000	201420	24956	3625	-16520	204	20	9	7.8	-257900	207330	45417	724.1	0	47.72	6.14	0
7.95	-221400	99221	14275	-21140	-51740	-195	-15	0	7.95	-246400	134530	47057	4836	0	-49.56	-6.54	0
8.05	-204100	126810	15477	42469	-40060	-74	-10	4	8.05	-243000	140040	49476	4844.4	0	-50.16	-4.46	0
8.2	-197400	231030	33049	20792	-11460	131	34	11	8.2	-232300	216160	53090	-739.1	0	50.07	6.44	0
8.3	-187800	233200	39540	-17470	-9449	-52	6	9	8.3	-216400	228230	55503	-202.6	0	1.56	6.2	0
8.45	-171400	223630	34119	9330	-20150	-4	2	11	8.45	-201400	223410	59123	33.52	0	-2.12	-0.27	0
8.55	-161600	216750	39330	-3504	-12730	-4	-9	12	8.55	-191100	222330	61536	44.49	0	-2.83	-4.36	0
8.7	-145100	235930	51224	6310	-21300	-36	-35	12	8.7	-174900	230440	65156	-240	0	2.15	0.24	0
8.8	-132000	226050	48545	7494	994	226	18	9	8.8	-163000	231870	67569	-1474	0	74.77	9.11	0
8.95	-117400	140710	24426	-43970	-71950	-204	-42	-4	8.95	-145000	124340	71140	7156.4	0	-77.35	-9.44	0
9.05	-100200	175370	23593	34477	-161200	-24	-17	13	9.05	-139400	120540	75602	7233.9	0	-74.14	-9.54	0
9.2	-49440	240520	37150	16230	5442	114	37	22	9.2	-114500	241430	77222	-1121	0	73.47	9.51	0
9.3	-78940	254630	42041	-45470	14430	-44	35	14	9.3	-101200	245240	79635	-294.6	0	2.3	4.3	0
9.45	-43440	252400	37142	1376	-53970	10	-9	17	9.45	-40450	244150	83235	49	0	-3.12	-4.4	0
9.55	-34510	241790	42434	-4455	21744	7	-14	14	9.55	-69940	246310	15644	49.5	0	-3.15	-0.41	0
9.7	-37570	247540	53140	35444	-42900	-111	-26	17	9.7	-43500	251900	49744	-311	0	2.39	0.31	0
9.8	-23340	255340	50243	-15140	-1159	160	0	6	9.8	-24160	255740	51781	-1191	0	74.52	10.11	0
9.85	-11740	251250	25446	-74400	-11120	-157	-46	-4	9.85	-4231	140700	55521	7924.4	0	-41.26	-10.46	0
10.05	-34720	245500	12444	21310	-190100	37	-49	24	10.05	12005	141940	57744	8045.6	0	-42.65	-10.56	0
10.2	-3113	243430	15765	-1476	-13400	-4	6	31	10.2	37465	263540	101354	-1239	0	41.43	10.51	0
10.3	-1720	267540	11005	-24430	41919	-33	-9	14	10.3	54957	269340	103770	-329.6	0	2.54	0.35	0
10.45	2430	240410	14021	-18900	-94940	11	-34	20	10.45	81946	267730	107390	5401	0	-3.44	-4.44	0
10.55	6454	264970	24413	-1499	64441	-10	-12	12	10.55	100490	270090	104490	54.52	0	-3.47	-4.45	0
10.7	13574	257430	33740	47944	-73140	-140	-73	12	10.7	129650	274960	113720	-342	0	2.63	6.34	0
10.8	16746	297540	33402	-12450	-1335	-4	-42	-3	10.8	144000	279690	115430	-1349	0	44.24	11.1	0
10.95	25259	335610	34424	-64390	63942	7	-114	-16	10.95	174710	133060	119450	4700	0	-49.17	-11.44	0
11.05	37243	334900	36666	-145000	-44540	-14	-111	4	11.05	146250	144300	-24210	4777.3	0	-48.85	-11.38	0
11.2	43249	310140	34422	-42490	-6100	14	-19	-2	11.2	179290	249240	-24390	-1156	0	19.42	11.51	0
11.3	56144	271630	32243	61461	-47294	-104	-29	-14	11.3	175340	293370	-22140	-363.7	0	2.69	0.35	0
11.45	70745	240510	34954	-22270	-59640	-12	-43	-14	11.45	170420	291500	-14560	60.44	0	-4.55	-0.39	0
11.55	82402	310500	44091	41242	-49296	10	-49	-21	11.55	167004	294450	-14150	135.35	0	-1.51	-0.19	0
11.7	99551	301450	47346	-121700	-9027	-42	-54	-20	11.7	163200	294110	-12530	-134.5	0	21.4	2.75	0
11.8	114520	344760	50540	54379	-4140	4	-24	-29	11.8	161240	244420	-10120	-3309	0	34.29	4.41	0
11.95	134200	214260	46014	30540	30410	567	33	-19	11.95	159004	*30000	-4495	11415	0	-529.5	-44.14	0

BOTTOM OF TANKER (-Z)

FEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo		THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
0.05	92591	-11446	-44570	21710	117134	-130	-4	30		0.05	14176	52799	64853	344.7		-14.11	-2.04		
0.2	147730	65634	-47550	-12490	-30430	177	44	41		0.2	14375	50995	10115	-4.93	0	1.46	0.19		
0.3	192370	73434	-55420	-24730	12723	-41	40	17		0.3	14739	59134	12524	-12.34	0	1.11	0.14		
0.45	243440	33672	-79720	69751	99370	144	144	27		0.45	11711	62674	14148	1.13	0	-0.094	-0.0127		
0.53	297120	1420	-79110	-27490	-130500	-144	95	17		0.53	92653	64999	14562	4.49	0	-0.34	-0.0435		
0.7	377210	263460	-79470	-150400	159990	-39	-24	15		0.7	49412	69013	22141	-5.47	0	0.26	0.0505		
0.8	353440	-5240	-63400	73020	-75610	1230	135	8		0.8	146	71253	24594	-1324	0	4.79	1.12		
0.95	310230	-94400	-57110	160290	-179400	-1945	-904	-32		0.95	-1453	60116	28214	945.43	0	-10.04	-1.5		
1.05	-113400	-909	59313	413340	442400	1443	233	3		1.05	136329	61352	-119900	1641	0	-10.87	-1.4		
1.2	-35330	30947	267440	-224500	-196400	-671	-100	-43		1.2	161759	40111	-113400	-179.5	0	11.43	1.52		
1.3	-79650	-14640	271400	164440	104420	201	-19	37		1.3	196590	43435	-113400	-54.41	0	0.39	0.099		
1.45	-14460	137460	219440	-74910	5236	-55	-144	37		1.45	219440	44294	-109199	1.9	0	-0.57	-0.0729		
1.55	43007	146220	237330	-11440	-30774	-105	-202	-7		1.55	234300	44562	-107490	34	0	-0.6	-0.077		
1.7	112420	45711	263310	-244	144340	-23	-174	-2		1.7	254140	93079	-141400	-62.42	0	4.44	0.0622		
1.8	173260	104590	247240	-23470	-174400	-94	-161	-36		1.8	270210	95164	-101400	-2341	0	14.44	2.12		
1.95	219440	203170	149960	153240	310140	66	-94	-29		1.95	294710	72471	-97740	17334	0	-17.99	-2.32		
2.05	241070	225160	146600	300420	-15340	153	-161	35		2.05	301759	73714	-35324	14326	0	-14.74	-2.42		
2.2	314390	114550	164134	21639	-13130	-219	-471	31		2.2	323000	147470	-91700	-2971	0	19.54	2.52		
2.3	336470	44016	176490	-25170	-70450	-76	-445	-33		2.3	355420	107520	-49220	-41.43	0	0.63	0.0404		
2.45	371290	122550	161130	45094	121150	13	-249	-32		2.45	351420	109740	-45471	1391	0	-1.89	-0.11		
2.55	391250	122740	161440	-21040	-75940	-17	-179	-21		2.55	365000	112144	-43250	14.41	0	-0.92	-0.12		
2.7	421910	111000	161490	-5103	57540	-10	-141	-16		2.7	341759	117140	-79640	-91.44	0	0.72	0.0929		
2.8	442950	125490	156390	15315	-11340	-64	-119	-12		2.8	392510	119070	77220	-147.7	0	24.24	3.12		
2.95	464540	161250	114930	14401	64746	79	-44	-37		2.95	404014	14440	77490	23271	0	-25.9	-3.39		
3.05	484220	171870	94184	252240	-14130	40	-43	4		3.05	417730	40976	-71190	24042	0	-24.41	-3.44		
3.2	495670	140270	102240	7396	-32510	-44	-222	3		3.2	431990	124440	-67570	-8.43	0	21.34	3.52		
3.3	504940	122740	104050	-4446	-2722	-41	-223	-19		3.3	441440	131540	-63140	-41.23	0	6.47	0.11		
3.45	517730	135100	94020	17392	41514	14	-102	-14		3.45	454090	137340	-61540	11.92	0	-1.2	-0.15		
3.55	526504	137750	95774	-4403	-4409	6	-46	-13		3.55	462550	135720	-59120	14.71	0	-4.9	-0.12		
3.7	534450	149930	95420	-3410	15902	-4	-14	-11		3.7	474110	140740	-55560	-94.57	0	0.75	0.0957		
3.8	547410	144450	14364	5976	547	21	4	-14		3.8	481540	142470	-53490	-547.4	0	24.23	3.12		
3.95	555720	131140	66094	12244	94444	-15	-21	-13		3.95	492090	104450	-49470	24042	0	-25.61	-3.3		
4.05	561270	136760	35746	135330	2910	-9	-42	-4		4.05	491530	110340	-70460	23564	0	-26.2	-3.37		
4.2	564150	134930	73672	-7274	-6236	35	-79	-5		4.2	507420	152200	-43440	-4013	0	24.54	3.42		
4.3	574120	132614	76440	4446	6960	-21	-43	-9		4.3	513390	153110	-41420	-104.7	0	0.44	0.11		
4.45	581230	137720	44650	6372	21674	14	-29	-9		4.45	521610	156950	-57460	14.13	0	-1.45	-0.15		
4.55	585610	149520	64419	-2403	15017	10	-3	-7		4.55	526590	159310	-49990	14.31	0	-1.14	-0.15		
4.7	591140	109540	63901	3516	14713	-4	13	-6		4.7	533320	164690	-31270	-114.1	0	0.91	0.12		
4.8	594550	172420	57947	147	14702	79	27	-3		4.8	537420	166590	-21940	-456.1	0	30.1	3.87		
4.95	594650	134200	34093	6723	45443	-36	-7	-5		4.95	542950	125940	-25140	3402.7	0	-31.6	-4.07		
5.05	600150	139540	33164	14610	2942	-37	-22	-4		5.05	546120	125450	-22940	3141.2	0	-32.19	-4.14		
5.2	602460	177790	47794	-3361	2474	77	-24	-2		5.2	550400	170020	-19214	-492.4	0	32.45	4.14		
5.3	604450	140420	49041	9197	12570	-15	-15	-4		5.3	552440	170600	-16490	-1372	0	1.02	0.13		
5.45	606320	140190	44644	1243	14316	17	-1	-3		5.45	553870	144540	-13270	21.93	0	-1.4	-0.14		
5.55	607120	143210	37223	-144	14134	15	13	-2		5.55	557440	142350	-10460	22.31	0	-1.42	-0.14		
5.7	607410	144940	34321	1497	11272	-12	17	-1		5.7	559270	144640	-7240	-141.5	0	1.89	0.14		
5.8	607290	197460	31794	-4.75	14397	22	33	1		5.8	560040	190330	-4426	-545.5	0	35.91	4.63		
5.95	606620	144190	14555	-7040	17945	-40	-2	-1		5.95	564540	139020	-1287	3467.1	0	-37.54	-4.44		



Nx	No	Nao	Qx	Qo	Mx	Mo	Mao	THE	Nx	No	Nao	Qx	Qo	Mx	Mo	Mao
32591	-11460	-11570	51710	117130	-130	-4	30	0.85	14176	52799	64955	34472	0	-1411	-204	0
147150	45458	-54750	-12190	-94130	177	44	41	0.7	14375	56955	14115	-1413	0	1.41	0.19	0
192570	73434	-55520	-34790	127725	-41	40	17	0.4	14759	59138	12528	-2234	0	1.11	0.14	0
245440	23472	-79720	64761	93370	184	160	27	0.45	11211	62674	14144	1.43	0	-0.9944	-0.9127	0
297120	1420	-79110	-27420	-134500	-164	93	17	0.55	92613	64999	12561	4.49	0	-4.54	-0.4435	0
377210	203460	-79470	-134400	159990	-39	-24	15	0.7	49442	69015	22167	-12.87	0	0.24	0.8305	0
353440	-5240	-45940	79420	-75610	1720	133	1	0.4	1643	71253	2457	-132.4	0	3.79	1.12	0
310220	-144440	-57110	164290	-179400	-1985	-444	-92	0.85	-9453	50116	24254	985.85	0	-16.04	-1.5	0
-115600	-4009	90513	415340	464640	1443	231	5	1.05	156320	61352	-119590	1061	0	-10.47	-1.4	0
-53550	90947	267440	-221500	-156400	-571	-104	-45	1.2	140750	64418	-115400	-179.5	0	11.43	1.52	0
-79650	-14440	271400	34444	144470	201	-19	37	1.3	196500	43455	-112400	-58.4	0	9.39	0.409	0
-14460	157460	219440	-74310	5236	-33	-144	37	1.45	219440	46294	-109000	1.9	0	-0.57	-0.9729	0
45047	160220	237130	-11040	-44770	-105	-202	-7	1.55	234300	44562	-107400	9.4	0	-0.6	-0.977	0
112420	65791	263510	-7044	144440	-35	-176	-2	1.7	254140	93477	-104400	-62.42	0	0.44	0.9622	0
173260	194540	247440	-34730	-174400	-94	-161	-36	1.8	279210	95164	-101400	-250.1	0	16.41	2.12	0
218440	285170	109500	155240	310140	64	-91	-29	1.95	299710	72474	-97750	1755.4	0	-17.39	-1.52	0
241070	225160	140400	344420	-15364	151	-141	35	2.05	303750	73714	-95720	1892.6	0	-14.71	-2.42	0
310390	114550	164430	21630	-15130	-215	-471	21	2.2	325040	104720	-91740	-79.71	0	12.54	2.52	0
336470	44416	174500	-23170	-79450	-76	-445	-35	2.3	335420	107520	-89290	-61.43	0	6.65	0.9404	0
371290	122550	161130	45094	123130	13	-249	-32	2.45	351420	109780	-85070	13.91	0	-4.49	-0.11	0
391390	122740	161440	-21040	-15940	-17	-174	-21	2.55	369040	112140	-82550	14.41	0	-4.92	-0.12	0
421940	111040	162090	-5105	57340	-19	-141	-16	2.7	341750	117140	-79440	-93.44	0	0.72	0.9729	0
442950	125490	156940	15313	-11140	-64	-419	-42	2.8	392510	119070	-77220	-347.7	0	24.24	3.12	0
466560	141250	114930	14401	64786	79	-44	-37	2.95	404010	44440	-73400	2527.1	0	-25.9	-5.33	0
484720	171470	94144	252240	-14150	40	-45	1	3.05	417730	46076	-71130	2644.2	0	-26.09	-3.44	0
495670	340270	102140	7396	-32510	-44	-922	3	3.2	431990	126440	-67570	-414.3	0	27.54	3.32	0
504910	122740	104840	-3444	-2772	-41	-223	-19	3.3	441940	131540	-63160	-112.5	0	0.47	0.11	0
517740	133100	94830	17592	41514	14	-102	-14	3.45	454690	133300	-61540	14.92	0	-1.2	-0.15	0
526500	137750	95774	-4403	-4409	6	-44	-13	3.55	462250	135720	-59120	14.71	0	-4.91	-0.12	0
534430	143950	95404	-3410	15962	-4	-14	-11	3.7	474110	140740	-55500	-34.57	0	0.73	0.9937	0
547410	144430	44264	5976	547	31	4	-14	3.8	481540	142670	-53994	-567.6	0	24.23	3.12	0
553720	131110	44404	11246	90444	-15	-21	-12	3.95	492040	104450	-49470	2494.3	0	-25.61	-3.3	0
561270	130700	53794	113530	2910	-9	-42	-4	4.05	494350	110404	-47040	2556.4	0	-26.2	-3.37	0
568130	134930	73479	-4174	-6236	35	-79	-3	4.2	507820	152200	-43440	-403.3	0	26.38	3.42	0
574120	152640	76440	1446	4960	-21	-45	-9	4.3	513590	153110	-40200	-104.7	0	0.44	0.11	0
581230	137720	64590	6172	21676	14	-29	-9	4.45	521410	156930	-37440	14.13	0	-1.15	-0.15	0
585610	160320	65419	-2405	15013	14	-3	-7	4.55	528540	159310	-34990	14.51	0	-1.14	-0.15	0
591140	169500	63901	5312	10793	-4	13	-6	4.7	537320	164690	-31570	-114.1	0	0.31	0.12	0
595050	172420	37917	147	10702	79	27	-3	4.8	547420	166590	-28600	-456.4	0	30.1	3.47	0
591650	134200	34405	6723	65683	-94	-7	-3	4.95	542550	172940	-25340	2442.7	0	-24.6	-4.67	0
600150	159510	35365	46410	2964	-97	-22	-4	5.05	546170	125450	-22330	3141.2	0	-31.53	-3.4	0
602460	177390	47724	-1341	2474	77	-24	-2	5.2	550400	176030	-19510	-492.4	0	72.45	4.14	0
604430	110420	49443	5177	12370	-12	-15	-4	5.3	552440	179060	-16490	-132.2	0	1.92	0.13	0
606320	140130	46434	1240	14516	17	-1	-3	5.45	555470	164540	-13270	21.91	0	-1.4	-0.14	0
607130	143210	37224	-144	14134	15	15	-2	5.55	557490	142490	-10440	22.31	0	-1.42	-0.14	0
607410	150440	36321	14522	11272	-42	17	-1	5.7	559270	141440	-7240	-141.6	0	1.09	0.14	0
607260	337460	31704	-1273	16377	39	33	1	5.8	560040	190330	-4126	-545.9	0	35.94	4.43	0
606620	144130	14555	-7094	37345	-40	-2	-1	5.95	560500	190020	-1207	3657.1	0	-37.54	-4.44	0

Nx	No	Nco	Qc	Qo	Mr	Mo	Mco	THE #	Nx	No	Nco	Qc	Qo	Mr	Mo	Mco
-5373	22582	5617	-77560	-23360	-43	-1	-23	6.05	13044	22124	-4495	344.72	0	-1614	-2.04	0
-21610	24434	-53220	36433	191020	45	2	-30	0.2	15991	25424	-10120	-145.3	0	1.43	0.19	0
-19270	3495	-82220	-137100	7161	-94	-61	-25	0.3	16972	26467	-12350	-22.34	0	1.11	0.14	0
-26294	51334	-17410	-16190	54309	71	-134	-35	0.45	26564	32007	-16150	1.43	0	-4.094	-0.0127	0
6842	59185	-51460	60176	-1314	-51	-171	-19	0.56	23481	34124	-14560	4.49	0	-0.24	-0.0435	0
-22400	26485	-141500	-194500	-77739	-264	-141	-21	0.7	24623	34344	-22144	-32.07	0	0.24	0.0305	0
71174	-539490	-140000	41165	124110	747	69	-52	0.8	32578	44542	-24530	-172.4	0	4.73	1.12	0
119640	-335500	60193	242654	-145000	-1744	-253	-54	0.95	33082	25445	-24210	343.43	0	-10.04	-1.3	0
472510	425270	72844	-242500	338140	1644	304	-121	1.05	143340	34642	119450	1001	0	-0.47	-1.4	0
514960	491790	-140490	-116500	-39000	-353	740	-117	1.2	133270	50147	115430	-179.5	0	11.43	1.52	0
514230	122540	-223500	263100	255200	344	921	71	1.3	135040	32244	113420	-50.41	0	0.39	0.0499	0
546294	2334	-37440	-140000	-245600	44	820	66	1.45	146340	15513	109440	1.9	0	-0.57	-0.0729	0
545750	19049	-22550	113330	265750	-15	430	22	1.54	14243	57491	147390	9.4	0	-4.6	-0.077	0
459920	112240	-33460	19330	-206000	94	546	22	1.7	61445	6244	143770	-42.42	0	9.41	0.0622	0
434140	14611	-37150	-42120	77424	243	493	99	1.4	43443	6409	141350	-25.11	0	16.41	2.12	0
347470	-52570	-53440	24444	307440	-119	144	47	1.95	17344	41447	17354	-17.99	0	-17.99	-3.92	0
335400	-54910	-5412	-140400	6772	-147	102	-34	2.05	16611	43043	35321	1432.6	0	-14.74	-2.42	0
314460	51746	37212	-107	124470	254	354	-13	2.2	-23024	74450	31741	-29.71	0	19.54	2.52	0
234910	53472	62453	100	-22950	26	353	39	2.3	-14544	74445	19244	-41.43	0	0.63	0.0406	0
234310	70344	27210	-24020	-14050	11	241	38	2.45	-61040	77110	85644	13.01	0	-0.49	-0.11	0
232220	70440	21123	12337	46797	35	244	28	2.58	-75090	31443	10255	14.41	0	-0.92	-0.12	0
177100	146020	31194	-40524	-34020	-1	272	21	2.7	-66540	14470	79045	-33.44	0	0.72	0.0929	0
173400	25322	24144	-33560	1525	174	254	46	2.8	-110100	44404	77222	-34.77	0	24.21	3.12	0
146020	24229	17473	11145	180900	-102	74	33	2.95	-125940	34169	73402	2327.1	0	-25.9	-3.95	0
121640	24340	13125	42256	8150	-155	29	-12	3.05	-142100	55403	71149	20442	0	-24.60	-3.44	0
59461	44426	62160	-47740	-2744	140	115	4	3.2	-140040	97964	67569	-11.43	0	27.34	3.52	0
15613	113440	47816	13423	25472	-16	44	22	3.3	-171404	140910	63156	-112.3	0	0.47	0.11	0
72044	37752	50747	-14350	1311	-41	71	21	3.45	-147840	102094	61536	14.92	0	-1.2	-0.15	0
47111	103760	-47444	4354	33517	1	73	16	3.55	-131440	103404	50123	14.71	0	-0.34	-0.12	0
26503	120930	55715	37411	995	-21	40	12	3.7	-212940	114470	33503	-34.57	0	0.23	0.0777	0
12413	127240	47154	-21540	1150	34	49	11	3.8	-222940	112940	50990	-347.4	0	34.23	3.12	0
-3407	61343	22513	-14440	41572	-52	34	9	3.92	-233940	70140	49476	2401.3	0	-15.61	-4.3	0
-47440	36703	23370	73357	-4376	-125	1	1	4.05	-243900	70403	47057	2356.4	0	-24.2	-3.57	0
-47440	110240	42456	-3027	4422	131	27	11	4.2	-253940	121540	43437	-401.3	0	26.51	3.42	0
-47440	130490	45941	-1341	7623	-34	4	12	4.3	-263940	124440	41024	-144.7	0	0.44	0.11	0
-46340	123860	24514	-6496	24050	-15	24	11	4.45	-273940	126240	37404	14.13	0	-1.13	-0.15	0
-70470	124640	32144	4164	9464	3	32	9	4.55	-283940	126440	34091	14.51	0	-1.14	-0.15	0
-43520	144040	54620	33194	14472	-37	22	4	4.7	-247900	134020	31371	-11.61	0	4.31	0.12	0
-22750	147240	20060	-14150	14453	144	39	9	4.8	-257900	132430	24954	-452.1	0	50.1	3.47	0
-113500	73976	13562	-14650	24256	-73	3	2	4.95	-260200	13207	25534	3042.7	0	-31.6	-4.07	0
-113500	60750	14094	33420	643	-122	-13	2	5.05	-264500	14704	22925	3141.2	0	-32.19	-4.14	0
-121340	140430	24543	-5429	17064	129	10	6	5.2	-314000	145140	19505	-492.4	0	32.43	4.11	0
-121340	135425	21401	6362	4443	-46	-16	6	5.3	-317100	146390	16492	-1322	0	1.42	0.13	0
-134000	147490	13577	-771	26459	-13	8	5	5.45	-317100	146404	13273	21.39	0	-1.1	-0.14	0
-141700	131400	11499	999	5551	-4	4	4	5.55	-319200	152220	10439	22.31	0	-1.42	-0.14	0
-144400	167420	9672	76574	21325	-51	-17	4	5.7	-321600	147970	7239.5	-141.6	0	1.07	0.14	0
-153500	147170	6793	-13744	15424	121	4	3	5.8	-322700	159640	4456.4	-345.9	0	53.01	4.63	0
-154600	65764	344	-21560	-1970	-160	-16	-2	5.95	-323300	160350	1204.6	3467.1	0	-37.36	-4.14	0

PEM #	Nx	No	Nro	Qx	Qo	Mx	Mo	Mao	THE #	Nx	No	Nro	Qx	Qo	Mx	Mo	Mao
4.05	-167600	13911	-2399	19583	1525	-120	14	1	6.05	-321700	18960	-1207	2725.6	0	-34.14	-421	0
4.2	-165600	170730	-3029	-7191	25263	133	14	5	6.2	-323000	169200	-4226	-381.5	0	34.33	439	0
4.3	-164100	180610	-5269	14544	1434	-31	-14	1	6.3	-322000	172340	-7240	-185.7	0	1.2	415	0
4.45	-170300	172220	-4752	-1627	26296	-10	2	1	6.45	-319140	179450	-16460	25.72	0	-1.64	-421	0
4.55	-171500	174120	-16600	-1701	4763	-3	-3	0	6.55	-317600	175400	-17270	26.1	0	-1.66	-421	0
6.7	-172600	191760	-16620	23596	23779	-40	-37	0	6.7	-316000	181320	-16390	-163.1	0	1.37	616	0
6.1	-173200	186700	-16620	-10234	27211	143	-7	-1	6.1	-311000	183500	-19310	-635	0	41.43	319	0
6.35	-173200	95926	-12540	-23999	-44714	-126	-27	-3	6.35	-309000	123440	-22090	4231.6	0	-41.37	-561	0
7.05	-171200	103160	-15640	-22650	17543	-119	-13	-1	7.05	-301600	124950	-23340	4316	0	-34.17	-569	0
7.2	-169300	200050	-34350	-18440	34994	146	34	6	7.2	-294400	197390	-28360	-670.7	0	44.2	569	0
7.3	-167700	206170	-31050	23451	9526	-56	3	-3	7.3	-289700	196290	-31370	-179.2	0	1.34	614	0
7.45	-164000	196430	-30440	-774	23217	-3	11	-4	7.45	-281200	197010	-34990	29.32	0	-1.44	-624	0
7.53	-161200	196460	-32780	-4817	6496	-13	-2	-3	7.53	-275100	199740	-37400	29.9	0	-1.9	-624	0
7.7	-165000	216140	-27550	11971	26990	-63	-39	0	7.7	-265100	205470	-41020	-144.3	0	1.43	619	0
7.8	-153100	205460	-19760	-7709	32444	110	-5	-3	7.8	-257900	207340	-43440	-724.1	0	43.72	614	0
7.95	-144000	104000	-25160	-24400	-71310	-132	-31	-4	7.95	-246400	194520	-47060	4636	0	-49.56	-634	0
8.05	-137900	123010	-63920	-72250	25497	-118	-3	-6	8.05	-231300	140440	-49470	4894.4	0	-50.16	-646	0
8.2	-137200	129250	-63250	-14220	37667	162	69	-3	8.2	-225200	216660	-53990	-789.1	0	50.07	644	0
8.3	-127500	237480	-50190	35961	14344	-37	40	-4	8.3	-216000	226230	-55500	-262.6	0	1.56	62	0
8.45	-117900	219190	-39070	-7564	9993	0	29	-9	8.45	-201400	224610	-59120	31.32	0	-2.12	-627	0
8.55	-110400	217130	-53220	-2649	22905	-14	14	-13	8.55	-191100	222930	-61500	44.49	0	-2.43	-636	0
8.7	-92940	246370	-49370	24144	11597	-75	-39	-13	8.7	-174900	214440	-65160	-250	0	2.15	628	0
8.8	-92840	228420	-41160	-12550	51711	2.3	34	-1	8.8	-161600	231470	-67570	-1074	0	70.77	311	0
8.95	-40430	16551	-42390	-104400	-199	-23	2	0	8.95	-145900	128340	-71150	7136.1	0	-13.33	-644	0
9.05	-63990	106540	-35450	-171700	28500	-172	19	-21	9.05	-133400	129500	-75400	7239.9	0	-74.14	-654	0
9.2	-56040	25770	-43320	-21110	54576	248	111	-27	9.2	-114300	241430	-77220	-1121	0	73.47	321	0
9.3	-44340	239700	-53130	50972	30000	-41	130	-16	9.3	-101200	243240	-79640	-294.6	0	2.3	63	0
9.45	-26500	341340	-16190	-10000	-12550	9	112	-19	9.45	-80350	244150	-83250	49	0	-3.32	-63	0
9.55	-14240	240520	-31690	-7067	35391	-5	101	-30	9.55	-63900	246510	-85670	48.3	0	-3.15	-640	0
9.7	3992	276940	-64440	21654	31494	-45	116	-26	9.7	-43890	254900	-89290	-311	0	2.39	631	0
9.8	14142	245700	-64490	-29243	-1603	300	136	3	9.8	-28160	255700	-91700	-1191	0	74.52	1011	0
9.95	23315	77766	-50390	-22620	15239	-374	7	11	9.95	-251	14700	-9330	7924.4	0	-41.26	-1046	0
10.05	39607	104510	-3740	-314000	21972	-19	48	-50	10.05	12043	141940	-97710	8005.6	0	-42.43	-1056	0
10.2	14220	279110	-11300	-30160	18679	-323	214	34	10.2	37460	243340	-101400	-1229	0	11.63	1051	0
10.3	163970	249210	-17940	63457	54541	-60	219	-25	10.3	50357	289240	-103400	-329.6	0	2.94	633	0
10.45	137690	235410	-15640	-14410	-50920	24	131	-27	10.45	81950	267730	-107400	54.01	0	-3.44	-644	0
10.55	135540	252910	-22110	163	160350	-11	139	-30	10.55	104900	276990	-109400	54.32	0	-3.47	-645	0
10.7	171120	317140	-22450	12852	-140304	-42	244	-45	10.7	129050	278960	-113400	-342	0	2.43	634	0
10.8	217250	312570	-27940	-14093	144230	400	344	32	10.8	144600	278090	-113400	-1309	0	40.23	11.1	0
10.95	222610	148440	-37450	-44740	-1431	-220	60	47	10.95	178720	156600	-119500	8700	0	-49.17	-1146	0
11.05	229730	156520	-35550	-60400	75315	-139	63	-37	11.05	164250	154900	-28214	8777.3	0	-49.93	-1154	0
11.2	246180	227010	-33160	-59920	-119200	346	304	-17	11.2	179790	249200	-24994	-1356	0	19.42	1151	0
11.3	210470	329510	-82310	102530	161960	-14	269	-42	11.3	175310	243370	-22141	-145.7	0	2.69	635	0
11.45	204920	277550	-59770	-35010	-125700	-17	112	-45	11.45	170920	241300	-14341	64.44	0	-4.53	-639	0
11.55	203110	265110	-65140	23233	91040	44	82	37	11.55	167900	204450	16141	13533	0	-1.51	-619	0
11.7	194000	308140	-57730	12641	-34230	-94	72	29	11.7	163210	201110	12381	-430.3	0	21.4	273	0
11.8	146150	249010	-63160	-29060	-24440	240	116	56	11.8	161200	204620	10115	-3949	0	34.29	441	0
11.95	173510	160270	-67110	-47190	133030	77	33	47	11.95	159490	200090	61953	11415	0	-529.3	-6411	0

FEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
0.03	-7714	-77440	8925	-91938	189400	-346	-10	-43	0.03	18176	52299	-6435	34872	-1618	-284	-	-
0.2	13143	39497	99739	97919	-27640	340	109	-44	0.2	16375	56093	-10120	-533	-	1.48	0.19	-
0.3	16617	76345	183860	44669	-39338	-135	69	-43	0.3	14759	39134	-12590	-234	-	1.11	0.14	-
0.45	26223	22335	120500	-45594	84993	91	174	-43	0.45	11711	62674	-16150	819	-	-0.094	-0.0127	-
0.55	41811	28446	115460	-49327	-94499	-122	146	-13	0.55	9265.3	64999	-14564	449	-	-0.34	-0.0435	-
0.7	73310	194230	145040	-13910	81944	204	961	3	0.7	4964.2	69613	-22140	-3287	-	0.24	0.0345	-
0.8	91437	-99890	140000	1999	-64959	1319	589	-53	0.8	1649	71283	-24590	-132.4	-	1.75	1.12	-
0.95	137310	-723690	107	37725	29049	-1711	44	-44	0.95	3633	60114	-28210	914.31	-	-10.04	-1.3	-
1.05	140720	-402640	-166700	412920	197970	691	363	7	1.05	151920	61352	119450	1061	-	-10.47	-1.4	-
1.2	96939	111079	-183200	191340	-34990	138	115	13	1.2	18479	80814	115430	-179.5	-	11.3	1.52	-
1.3	163470	196910	-149940	-306400	-49490	179	92	9	1.3	196500	65453	115420	-30.41	-	0.39	0.0499	-
1.45	142770	64223	-172940	97224	169890	-70	160	6	1.45	218440	16284	109400	49	-	-0.57	-0.0729	-
1.55	96666	63994	-142200	-1794	-134590	-4	193	27	1.55	244590	11562	197390	9.4	-	-0.6	-0.077	-
1.7	15793	128340	-181600	-30810	36259	-53	170	27	1.7	256140	93079	189720	-62.42	-	0.48	0.0622	-
1.8	12841	41246	-176500	49911	-37640	455	215	41	1.8	270210	92164	161350	-290.1	-	16.48	2.12	-
1.95	76643	-1784	-135600	-14259	-17820	-113	34	30	1.95	290710	72474	27724	1755.4	-	-17.99	-2.32	-
2.05	17444	-133900	-113300	171100	295340	-163	64	-1	2.05	303750	73714	95321	1832.6	-	-18.78	-2.42	-
2.2	94271	116550	-169500	46292	-92640	342	-28	11	2.2	323600	164730	91761	-297.1	-	19.56	2.52	-
2.3	144200	145390	-146240	-110200	-57510	-13	-41	21	2.3	335020	197520	49244	-41.43	-	0.63	0.0666	-
2.45	114140	101540	-144340	37163	32175	-2	49	19	2.45	354420	169740	65663	1391	-	-0.49	-0.11	-
2.55	119650	94913	-146200	-4035	-61644	-4	93	14	2.55	365900	112140	13253	14.91	-	-0.92	-0.12	-
2.7	126260	197650	-163700	-12600	-2442	-42	94	17	2.7	381750	117140	79435	-93.44	-	0.72	0.0929	-
2.8	111699	110640	-95770	21153	-24420	313	144	25	2.8	392510	119470	77222	-167.1	-	24.24	3.12	-
2.95	115940	-66750	-75640	-20000	26046	-290	34	12	2.95	404410	14440	73602	2571.1	-	-2.53	-3.33	-
3.05	146570	-54370	-43350	114630	147670	-91	96	1	3.05	417750	16074	71169	2684.2	-	-26.69	-4.44	-
3.2	160470	157090	-63440	73467	-36670	154	-1	10	3.2	431990	126600	67509	-114.3	-	27.34	3.52	-
3.3	175310	157190	-62440	-40440	-91710	-1	-29	14	3.3	441040	171540	65156	-119.5	-	0.47	0.11	-
3.45	189320	131890	-51670	1748	5816	3	46	12	3.45	454090	133140	61516	18.92	-	-1.2	-0.13	-
3.55	131914	125770	-57290	-2143	-12190	-4	73	12	3.55	462350	135790	59123	14.71	-	-0.94	-0.12	-
3.7	213340	150100	-54750	6140	-18290	-29	77	31	3.7	474110	140740	55943	-94.57	-	0.73	0.0937	-
3.8	224759	137910	-48410	2633	-25850	190	104	12	3.8	481540	142670	53090	-167.6	-	24.23	3.12	-
3.95	254250	56973	-36350	-27500	34683	-163	24	3	3.95	492040	104450	49470	2493.3	-	-25.61	-3.3	-
4.05	266910	41913	-31210	71543	67551	-6	27	4	4.05	491350	100360	47657	2556.1	-	-25.52	-3.37	-
4.2	213470	161480	-36100	16497	-36340	62	2	8	4.2	503200	152200	45487	-105.3	-	28.54	3.42	-
4.3	243440	163490	-37110	-50010	-20000	-7	-10	10	4.3	513590	135110	41024	-104.7	-	0.84	0.11	-
4.45	211390	157600	-36140	9175	-11660	9	23	3	4.45	521610	150950	37441	141.3	-	-1.15	-0.13	-
4.55	219100	135010	-24060	-3271	-17500	2	15	4	4.55	526340	159310	14021	14.31	-	-1.14	-0.13	-
4.7	349230	-24400	-24400	1767	-21244	-33	29	7	4.7	533320	164090	31371	-114.1	-	0.91	0.12	-
4.8	344400	11	-26420	2119	-19420	154	31	7	4.8	537420	164590	24954	-152.1	-	30.1	3.87	-
4.95	316540	181900	-15270	-20010	11311	-122	-5	1	4.95	542950	123940	25334	3443.7	-	-31.6	-4.07	-
5.05	215950	119950	-13240	42046	24764	-21	0	2	5.05	548120	125450	22923	3141.2	-	-32.19	-4.14	-
5.2	313110	143320	-11210	10451	-26750	71	-1	6	5.2	550460	170030	19345	-492.4	-	32.45	4.18	-
5.3	340310	145750	-9935	-34240	-17660	-16	-13	4	5.3	552840	179040	16072	-137.2	-	1.93	0.13	-
5.45	344790	181230	-3359	5772	-15390	10	9	5	5.45	553870	140540	15873	21.53	-	-1.4	-0.18	-
5.55	313440	146470	-2374	-1211	-15690	5	11	4	5.55	557440	142490	16459	22.31	-	-1.42	-0.18	-
5.7	340270	193590	2404	-6247	-17444	-33	-4	3	5.7	559270	144440	7259.3	-141.4	-	1.99	0.14	-
5.8	345190	150400	4442	4220	-14910	124	16	3	5.8	560040	194034	4428.4	-545.9	-	35.84	4.63	-
5.95	349630	135010	2963	-3564	-20520	-92	-20	-1	5.95	560544	139429	1264.6	3461.1	-	-37.36	-4.34	-

Nx	No	Nno	Qx	Qo	Me	Mo	Mno	THE x	Nx	No	Nno	Qx	Qo	Me	Mo	Mno
37448	143870	5254	17955	-10290	-44	-15	0	6.05	500040	146514	-1297	37254	0	-53.14	-4.91	0
37729	201299	15254	7344	-20610	96	10	5	6.2	559720	199470	-4826	-531.5	0	34.33	4.93	0
310660	209710	16351	-22440	-15220	-26	-6	2	6.3	534440	203810	-7240	-155.7	0	1.2	0.15	0
313120	204329	11184	2747	-16780	10	6	1	6.45	556480	204120	-10400	25.72	0	-1.64	-0.21	0
315310	205140	22137	845	-14520	7	0	0	6.55	555160	204470	-13270	2.61	0	-1.66	-0.21	0
246590	217440	27219	-16810	-11650	-35	-27	-1	6.7	551940	212590	-16890	-1.651	0	1.27	0.18	0
347950	217140	29294	9128	-10350	121	-6	1	6.8	549410	214170	-17910	-4.53	0	4.45	5.39	0
317710	152040	21345	641	-57820	-75	-24	-3	6.95	545680	154110	-22910	6251.6	0	-0.57	-5.61	0
317680	155660	21741	-2739	-40650	-46	-15	-1	7.05	541440	155620	-23340	4210	0	-46.17	-5.69	0
317890	234770	34450	6468	-14710	133	33	0	7.2	535790	225790	-20760	-470.7	0	44.2	5.69	0
315550	215300	41157	-14090	-13180	-55	10	-3	7.3	531570	226940	-31370	-179.2	0	1.34	0.11	0
343150	226750	63729	1665	-16140	9	13	-3	7.45	526630	227760	-34990	29.32	0	-1.44	-0.20	0
311280	228440	46925	3481	-20120	7	-1	-1	7.55	519510	230060	-37490	29.9	0	-1.9	-0.20	0
317250	242540	55947	-30940	-4369	-34	-11	-5	7.7	511390	236540	-10920	-164.5	0	1.45	0.19	0
319270	249260	54135	17749	-1985	127	-17	-2	7.8	505320	234000	-13440	-724.1	0	47.72	6.14	0
349560	159120	40573	12621	-102040	-70	-16	-1	7.95	496080	169200	-17860	4636	0	-0.56	-6.34	0
345070	155140	43611	-20420	-44990	-137	-6	-7	8.05	488270	170710	-19470	4654.4	0	-50.16	-6.46	0
341220	233420	64584	7873	-16680	189	78	-5	8.2	478590	243530	-35090	-759.4	0	50.07	6.44	0
345570	207470	71422	-1854	-14370	-44	39	-4	8.3	471050	250000	-55560	-262.6	0	3.56	1.2	0
344210	246260	71424	5821	-1246	5	33	-4	8.45	459120	251280	-59120	33.32	0	-2.12	-0.27	0
345240	250150	73729	4722	-12910	4	4	-9	8.55	450750	255000	-63540	44.9	0	-2.43	-0.34	0
344270	279340	8041	-35120	11570	-49	-49	-10	8.7	437570	261510	-65140	-210	0	2.15	0.28	0
356740	272760	79453	35742	3929	206	-29	-1	8.8	428570	262540	-67570	-1074	0	70.77	9.11	0
318460	184934	73645	29649	-161200	-126	-12	-3	8.95	413940	150010	-11190	71563	0	-73.55	-9.44	0
310170	346434	84475	-28160	-56180	-260	-3	-14	9.05	403710	160250	-75400	7218.9	0	-74.14	-9.54	0
346290	271574	107340	25917	-13650	317	102	-16	9.2	388830	272160	-77220	-1125	0	78.87	9.51	0
346920	294490	115350	-24120	-21670	-77	-11	-15	9.3	377170	275950	-79640	-294.6	0	2.3	0.3	0
294280	262460	116450	10720	20002	0	39	-16	9.45	360250	274320	-82350	49	0	-3.12	-4.4	0
290020	270250	116750	15535	-47070	-4	-4	-17	9.55	348350	277140	-85670	49.5	0	-3.15	-4.41	0
291490	316740	121740	-14670	35945	-59	-129	-17	9.7	330340	283570	-89290	-311	0	2.39	0.31	0
269170	341390	122510	63590	21429	293	-62	-1	9.8	317460	286450	-91790	-1191	0	78.52	10.11	0
264950	21065	119460	4428	-314760	-107	12	-5	8.95	298440	171370	-95320	7924.4	0	-81.26	-10.46	0
350150	-7253	140150	-81050	-54730	-71	36	-37	10.05	284440	172410	-97730	1005.6	0	-82.85	-10.56	0
266010	294290	116810	50411	6947	541	219	-32	10.2	264220	296010	-101400	-1219	0	81.43	10.51	0
272174	316570	201610	-33370	-57920	-121	134	-27	10.3	250020	300010	-103400	-329.6	0	2.54	0.33	0
315440	264090	191410	9757	70129	-43	180	-24	10.45	238120	291460	-107400	34.01	0	-3.44	-4.44	0
215810	279140	192430	41144	-13040	-162	152	-2	10.55	213100	300760	-109400	56.52	0	-3.47	-4.45	0
213550	345630	221330	-14690	49484	102	144	3	10.7	149940	309630	-113400	-242	0	2.63	0.34	0
316240	244440	211430	104090	-36270	453	322	-14	10.8	174090	310340	-115400	-1309	0	46.28	11.1	0
354720	-157100	90782	145750	-255700	-607	167	-23	10.95	149040	143740	-118500	8700	0	-49.17	-11.48	0
333720	-144090	-13770	199740	-64140	-509	194	11	11.05	143140	144970	-121400	1777.3	0	-49.95	-11.54	0
344110	266660	-101800	113440	34593	443	402	37	11.2	143510	319910	-125940	-1356	0	49.42	11.51	0
201170	381470	-101400	-174500	-40210	129	263	-3	11.3	151440	320440	-126400	-145.7	0	2.69	0.35	0
364540	343720	-46220	104690	59615	-180	153	-1	11.45	135810	322170	-128400	14541	0	-4.55	-4.59	0
211640	295340	-49910	-32370	-57500	79	144	31	11.55	154140	379120	-14140	13333	0	-1.51	-0.19	0
217450	349940	-76160	-42710	27639	-157	54	26	11.7	161020	328740	-128240	-450.5	0	2.4	2.73	0
344810	334630	-75270	79410	22013	491	119	42	11.8	162540	315490	-10115	-3949	0	34.29	4.41	0
175130	91646	-69050	-7592	-121300	-117	16	28	11.95	164140	320760	-6495.5	11419	0	-529.5	-48.14	0
13510	140270	-67110	-47190	153654	77	33	47	11.95	150650	290060	-6495.5	11415	0	-529.5	-48.14	0

## APPENDIX S

### FEM MAPS OF INTERNAL PRESSURE FORCE RESULTANTS

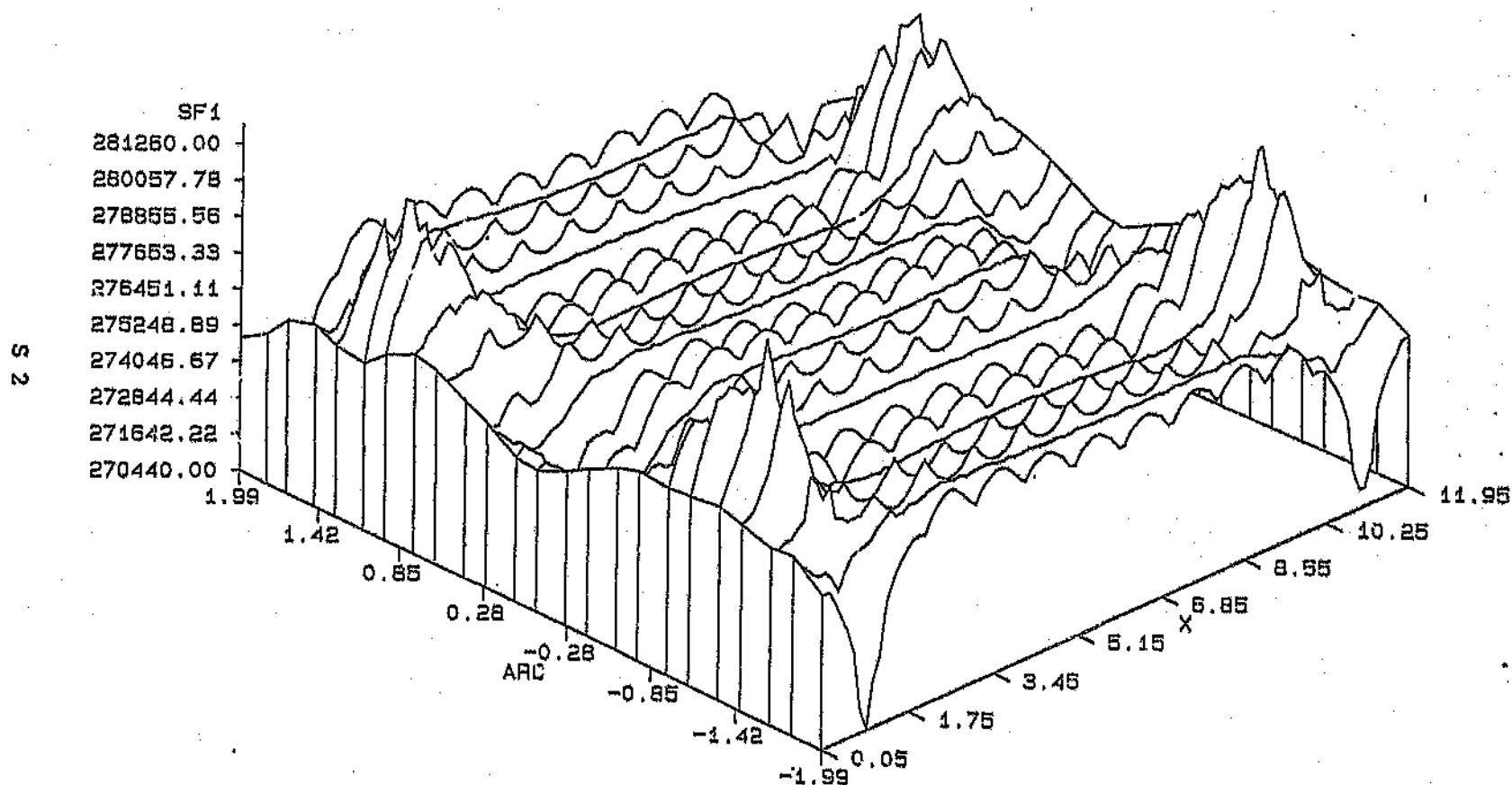


Figure S1 FEM axial force resultants  $N_x$  superimposed on the "unrolled" tube.

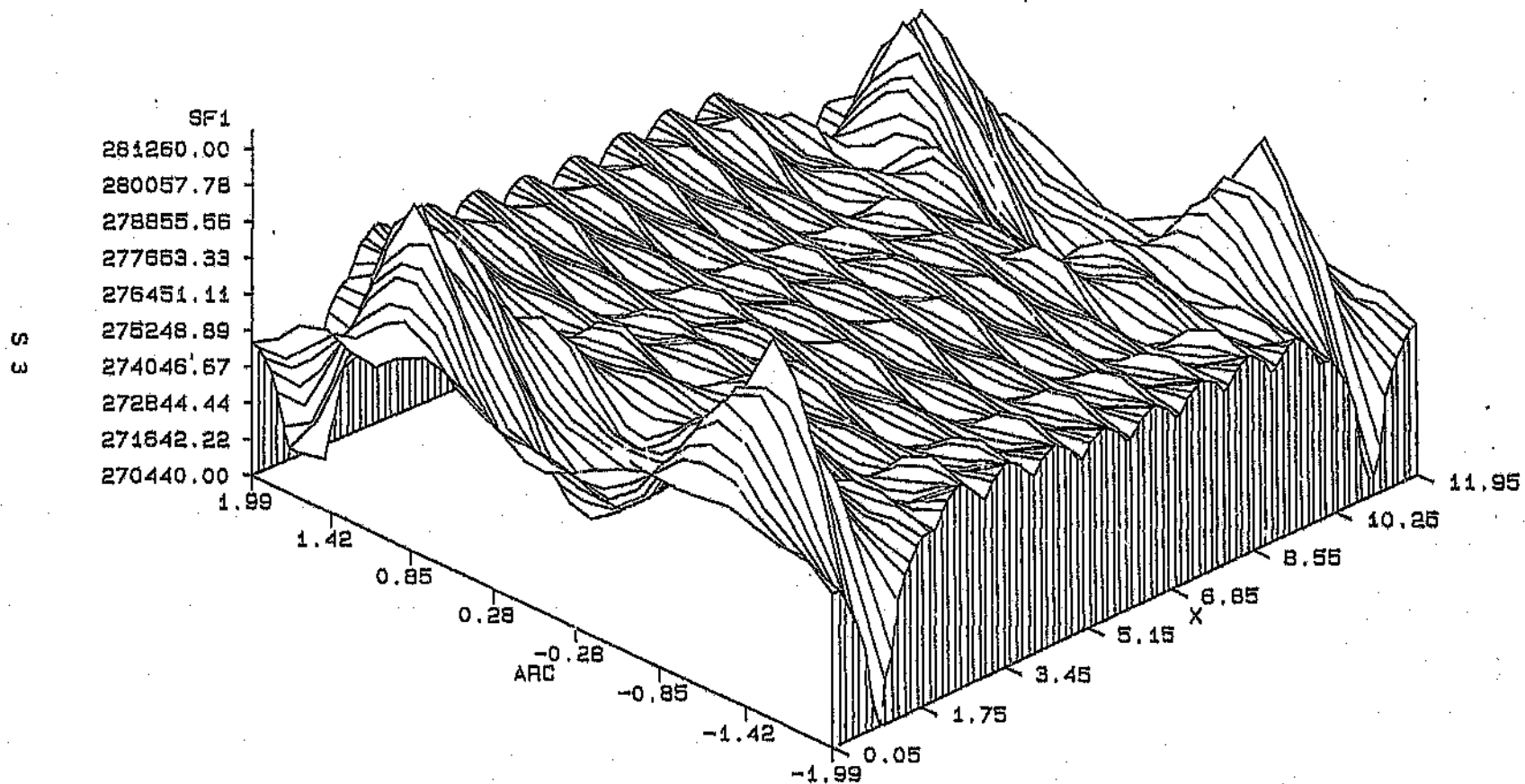


Figure S2 FEM axial force resultants  $N_x$  superimposed on the "unrolled" tube.



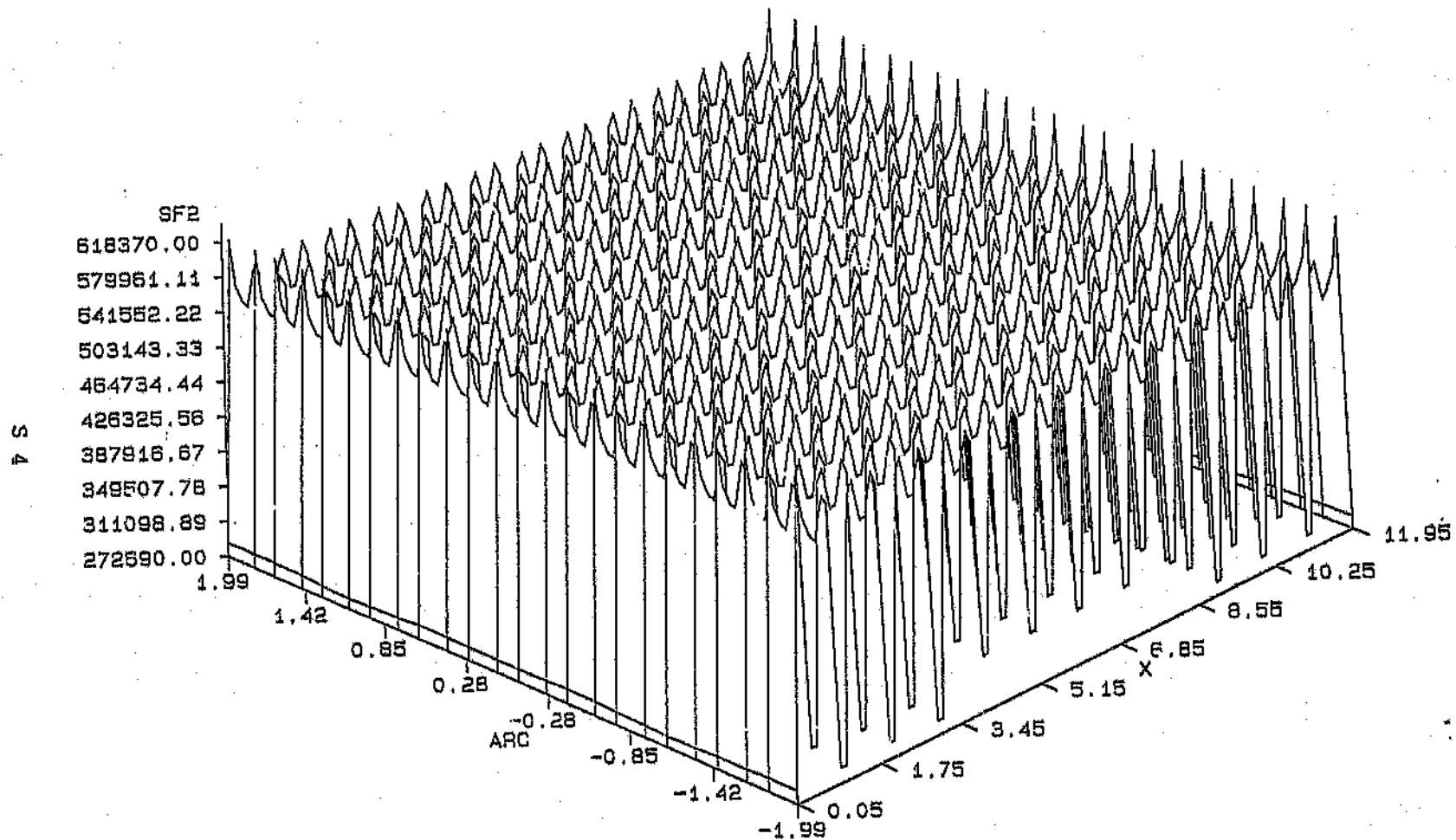


Figure S3 FEM circumferential force resultants  $N_\phi$  superimposed on the "unrolled" tube.

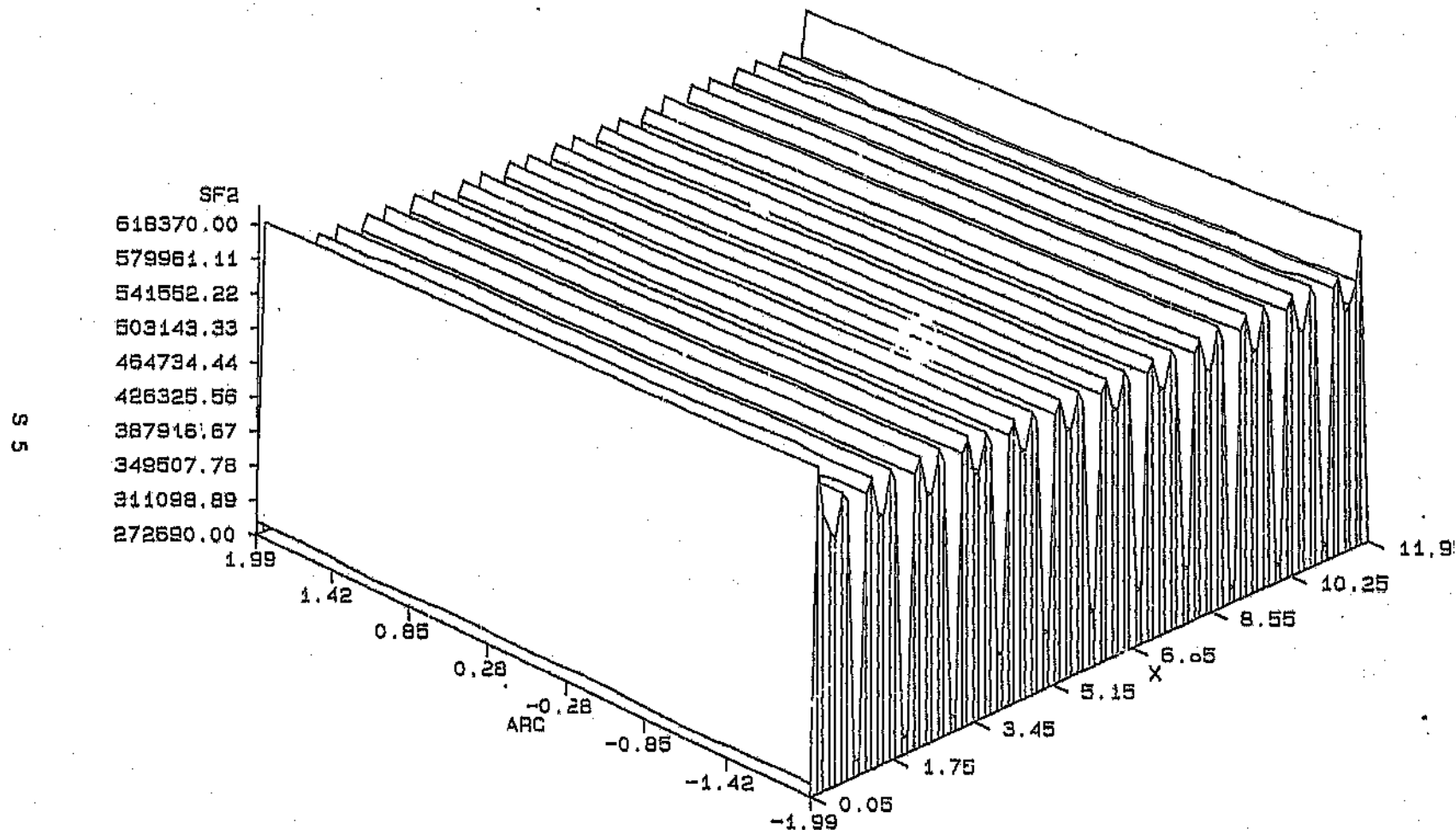


Figure S4 FEM circumferential force resultants  $N_\phi$  superimposed on the "unrolled" tube.

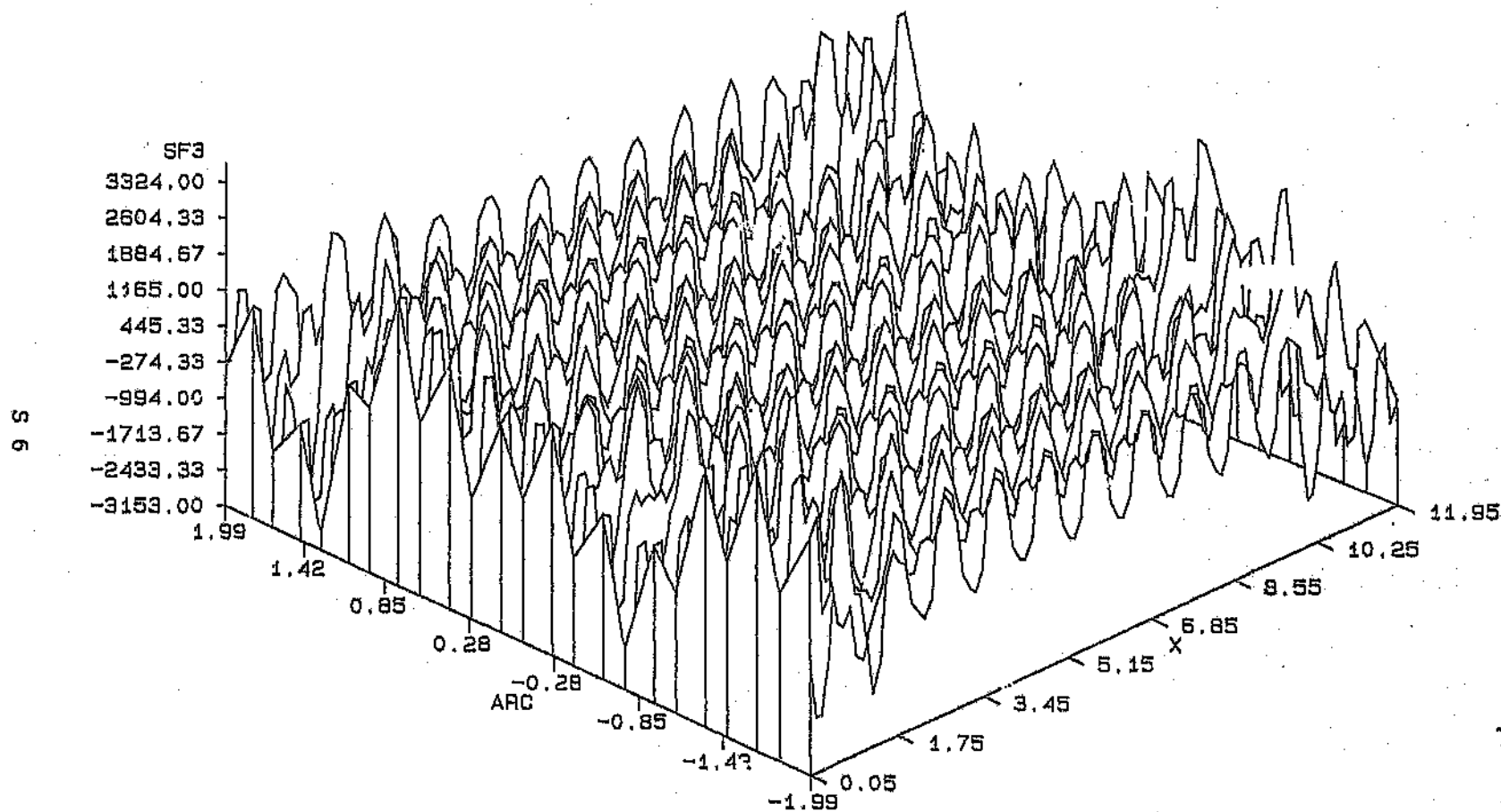


Figure S5 FEM inplane shear force resultants  $Nx_\phi$  superimposed on the "unrolled" tube.

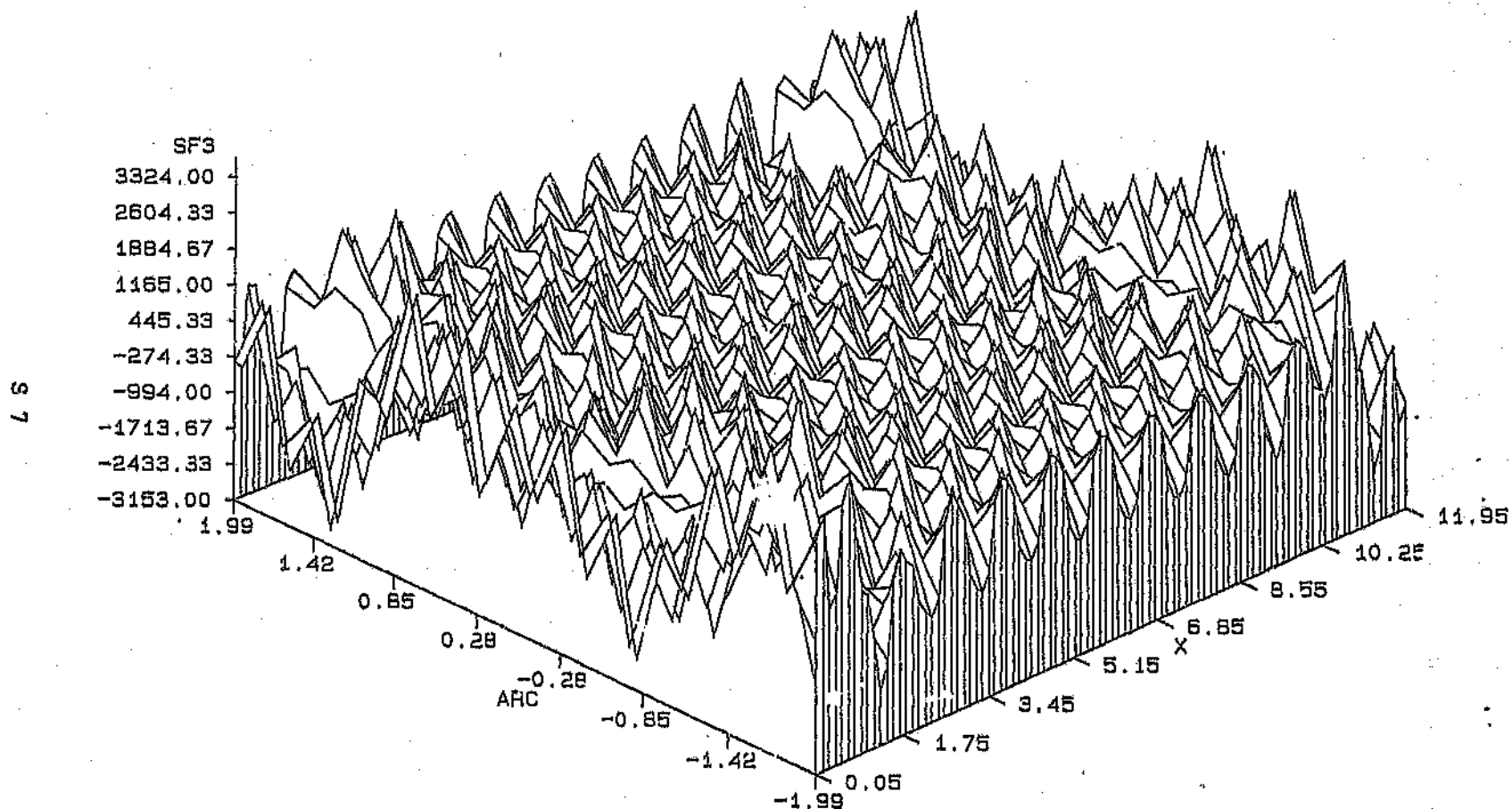


Figure S6. FEM inplane shear force resultants  $Nx_\phi$  superimposed on the "unrolled" tube.

APPENDIX T

FEM MAPS OF COMBINED ACCELERATIONS FORCE RESULTANTS

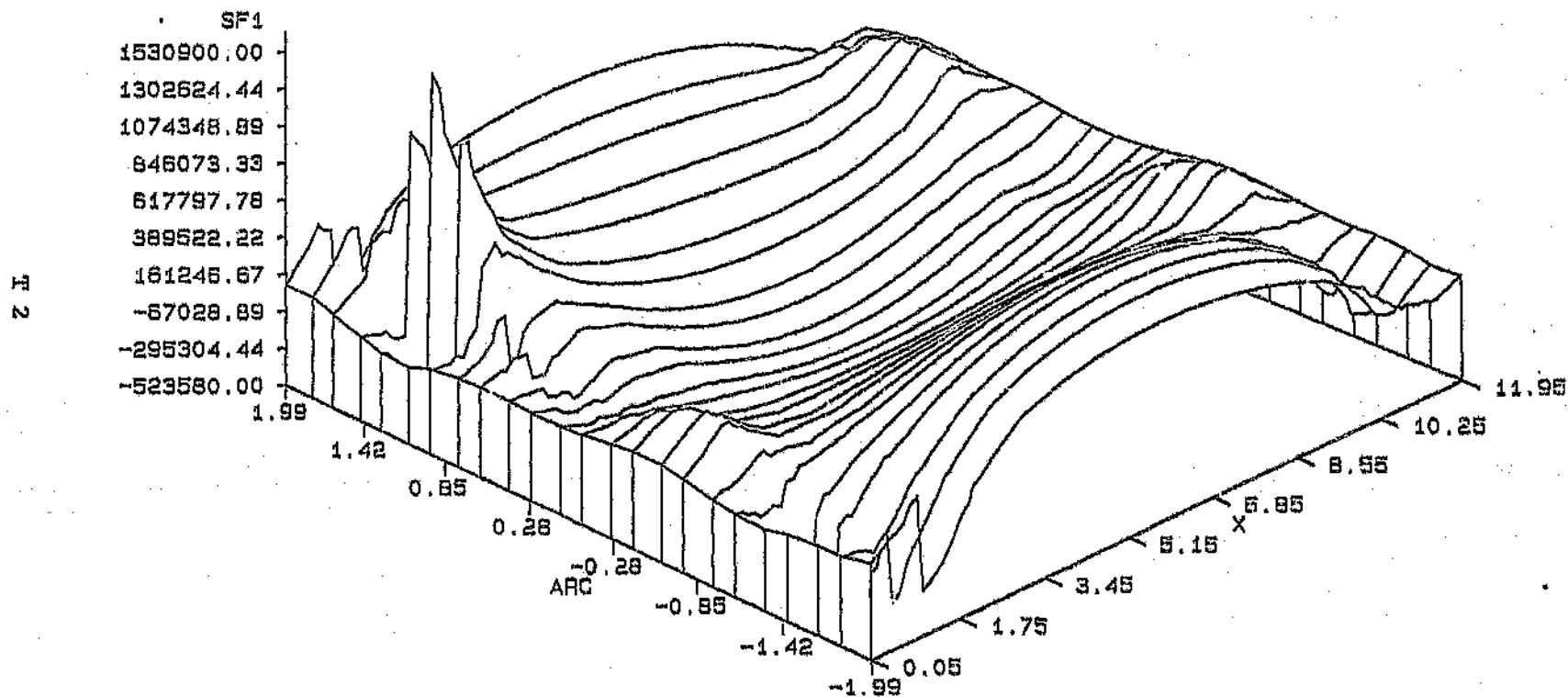


Figure T1 FEM axial force resultants  $N_x$  superimposed on the  
"unrolled" tube.

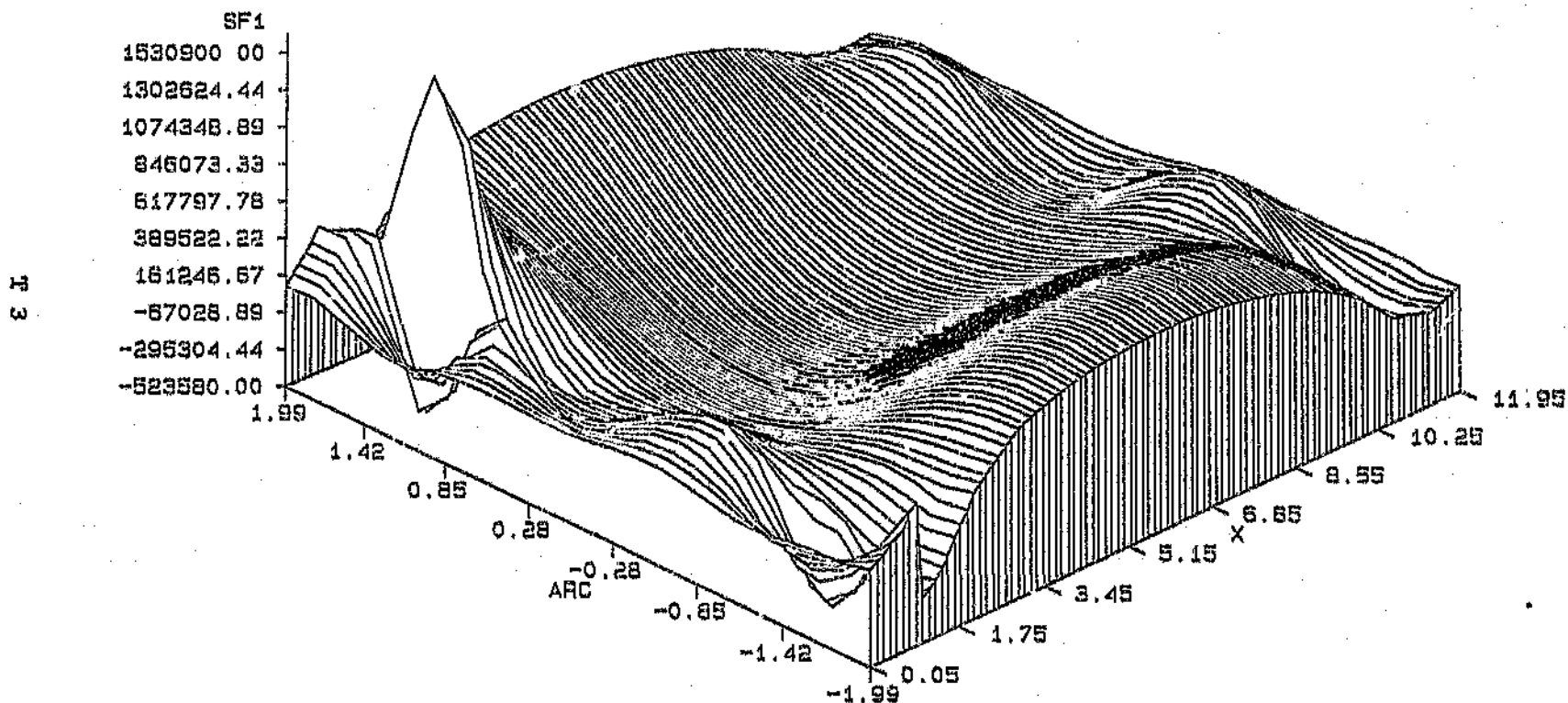


Figure T2 FEM axial force resultants  $N_x$  superimposed on the "unrolled" tube.

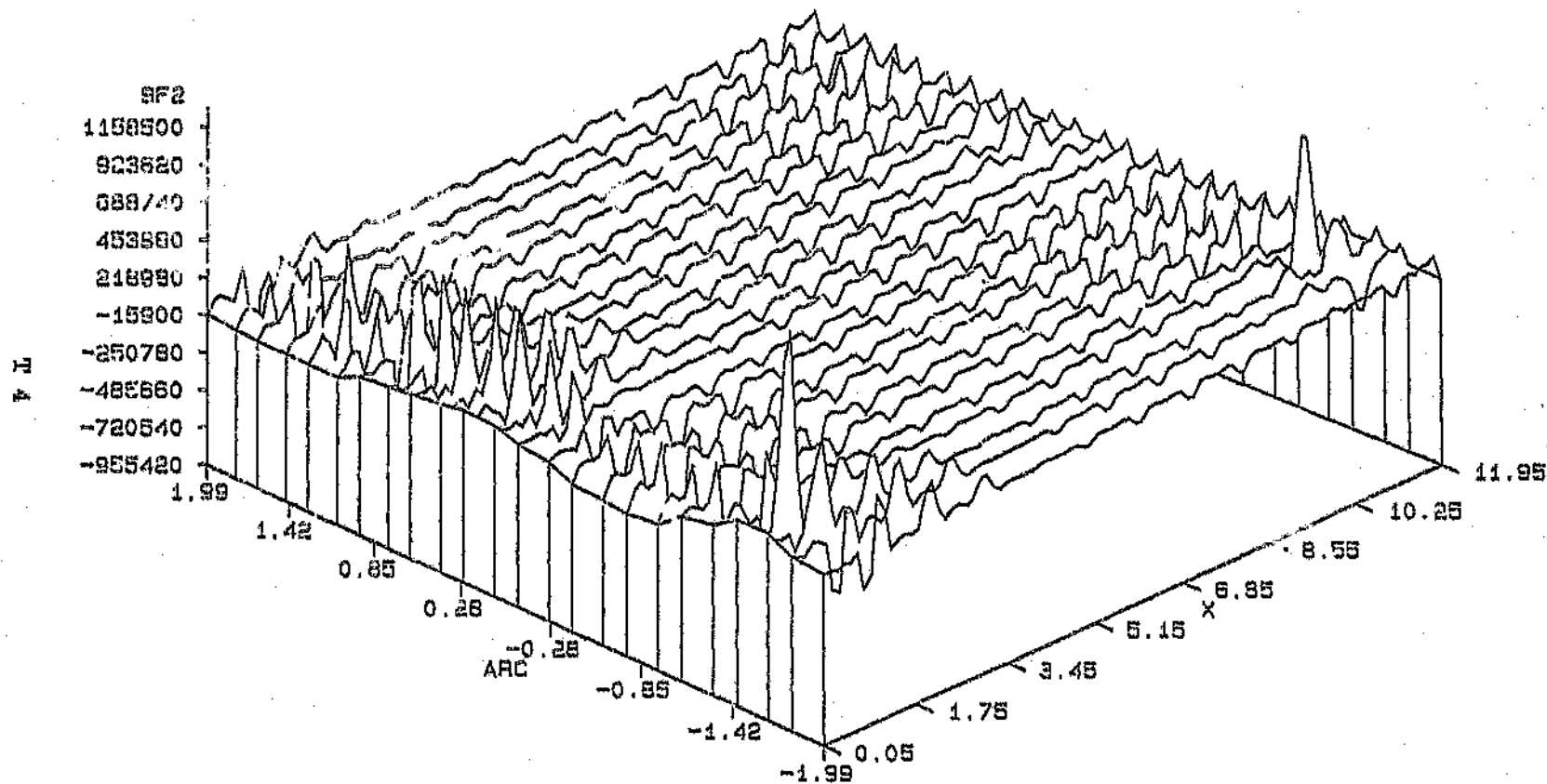


Figure T3 FEM circumferential force resultants  $N_\phi$  superimposed on the "unrolled" tube.



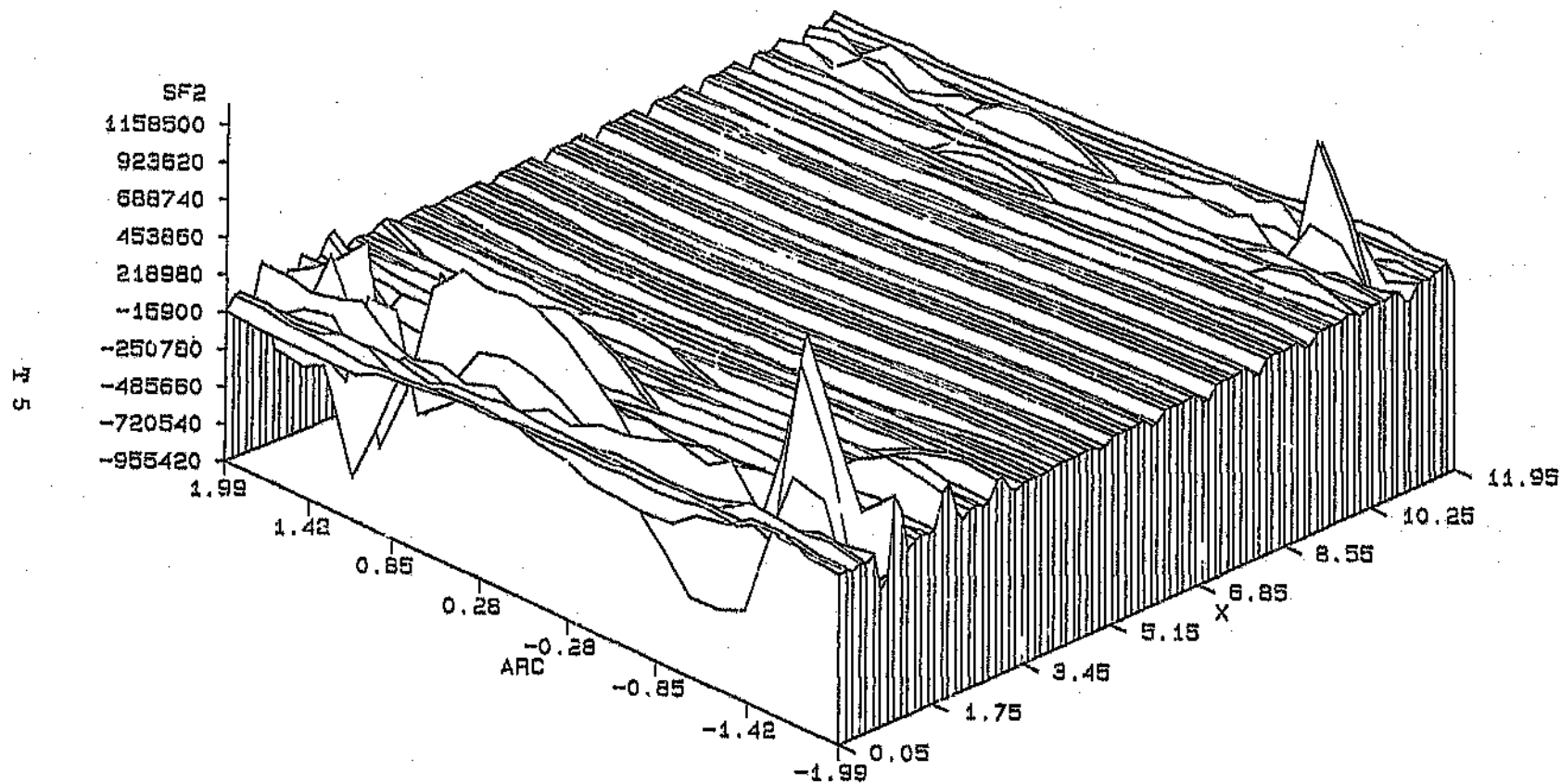


Figure T4 FEM circumferential force resultant's  $N_\phi$  superimposed on the "unrolled" tube.

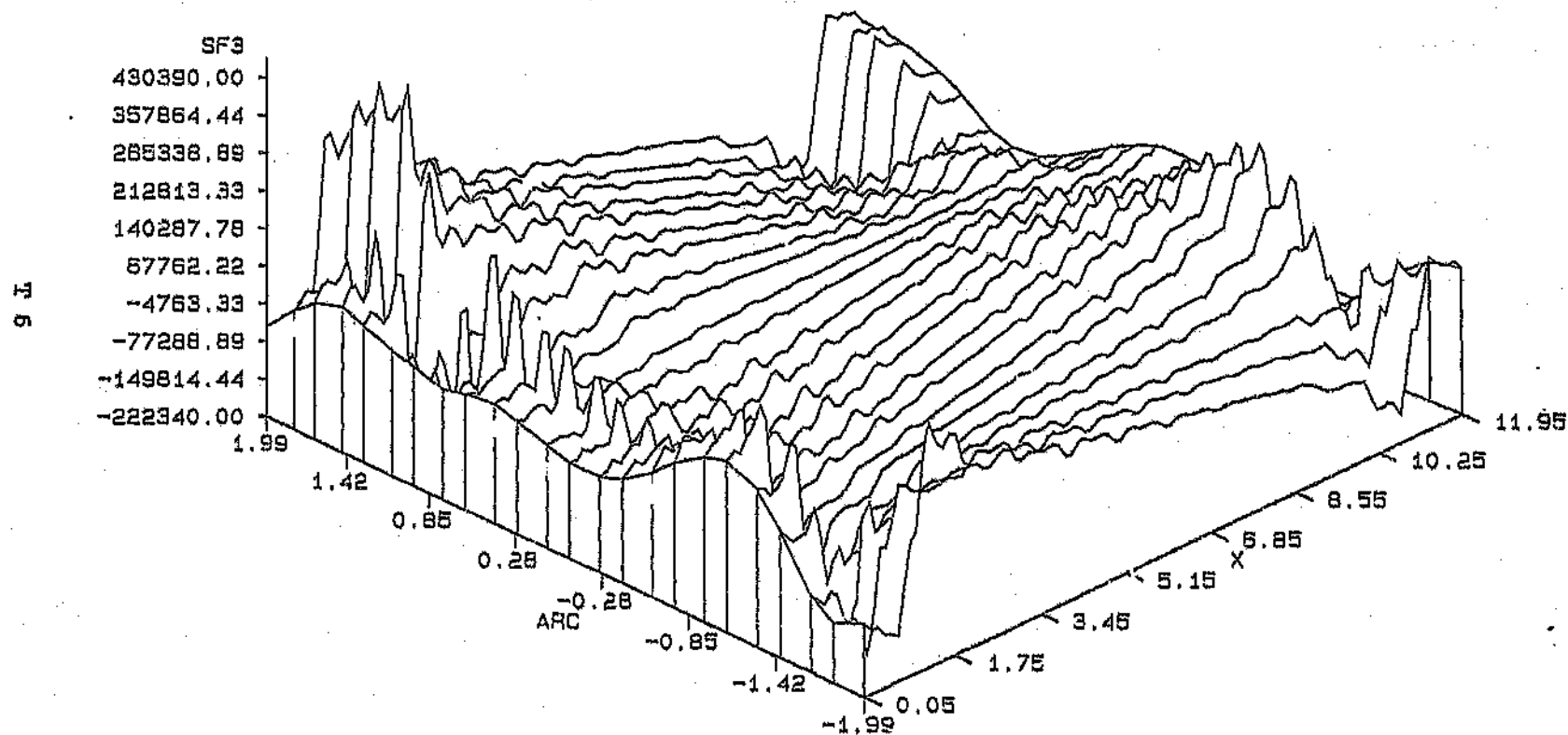


Figure T5 FEM inplane shear force resultants  $N_{x0}$  superimposed on the "unrolled" tube.

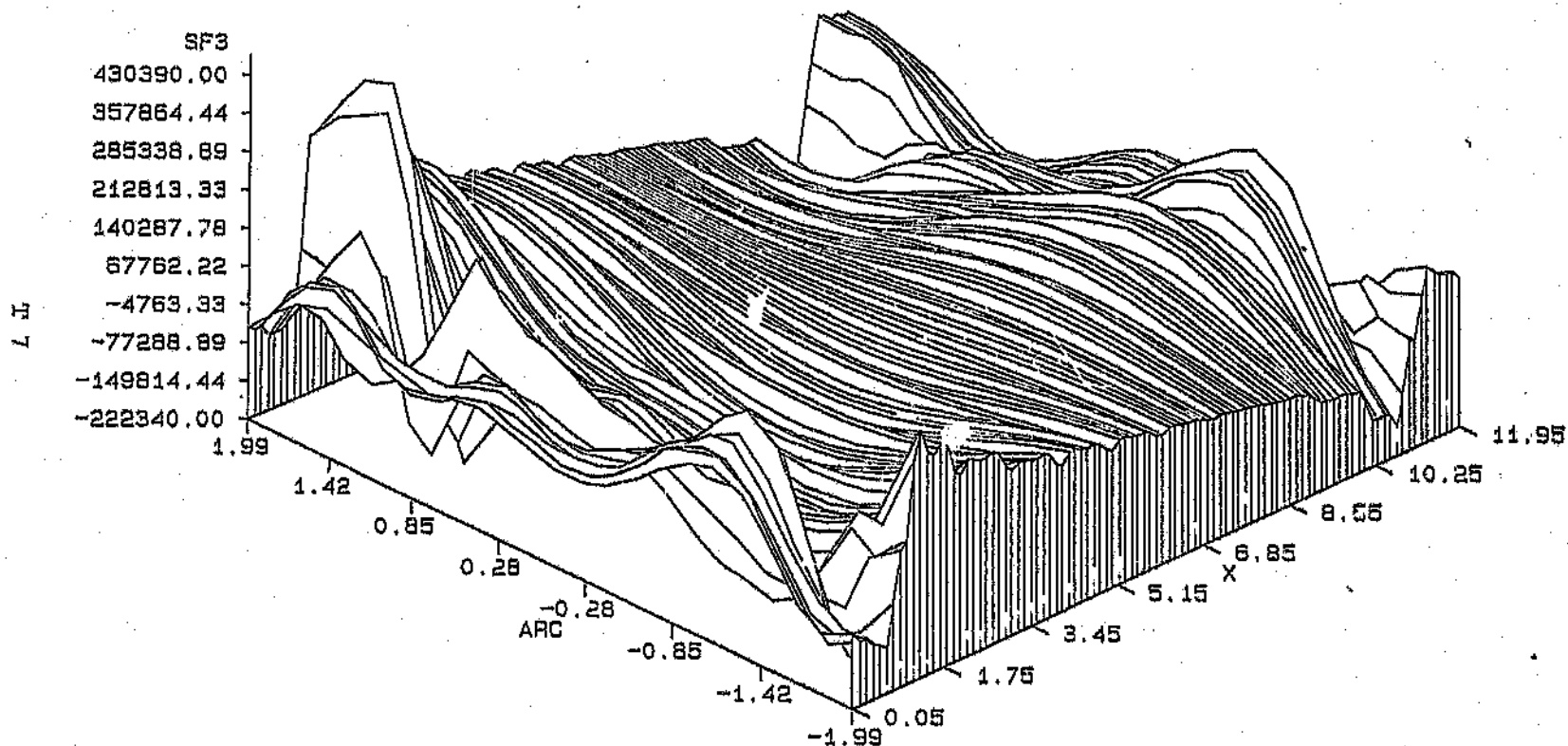


Figure T6 FEM inplane shear force resultants  $Nx_\phi$  superimposed on the "unrolled" tube.

**APPENDIX B**

**FEM MAPS OF VALIDATION MODEL FORCE RESULTS**

## APPENDIX U

### FEM MAPS OF VALIDATION MODEL FORCE RESULTANTS

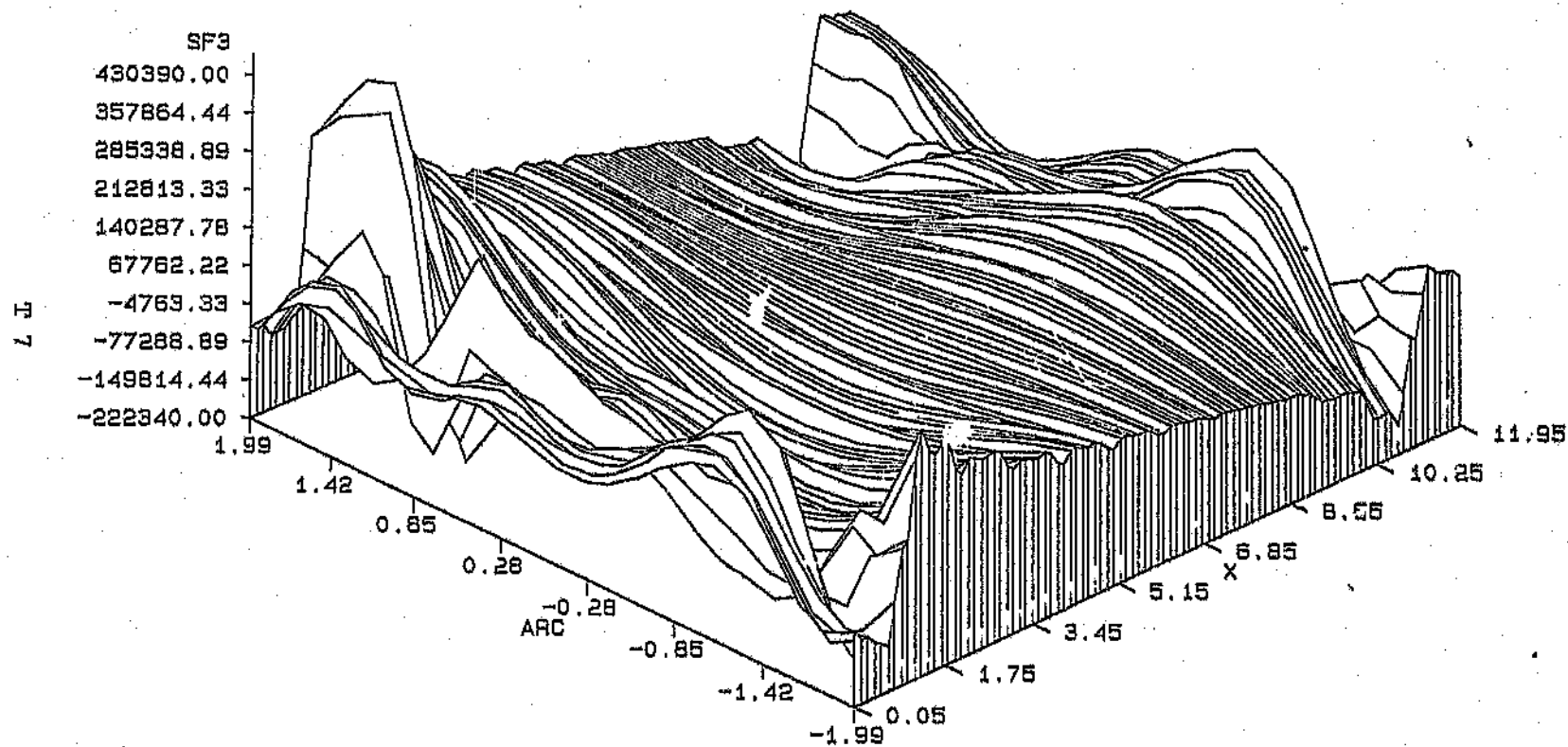


Figure T6 FEM inplane shear force resultants  $Nx_\phi$  superimposed on the "unrolled" tube.

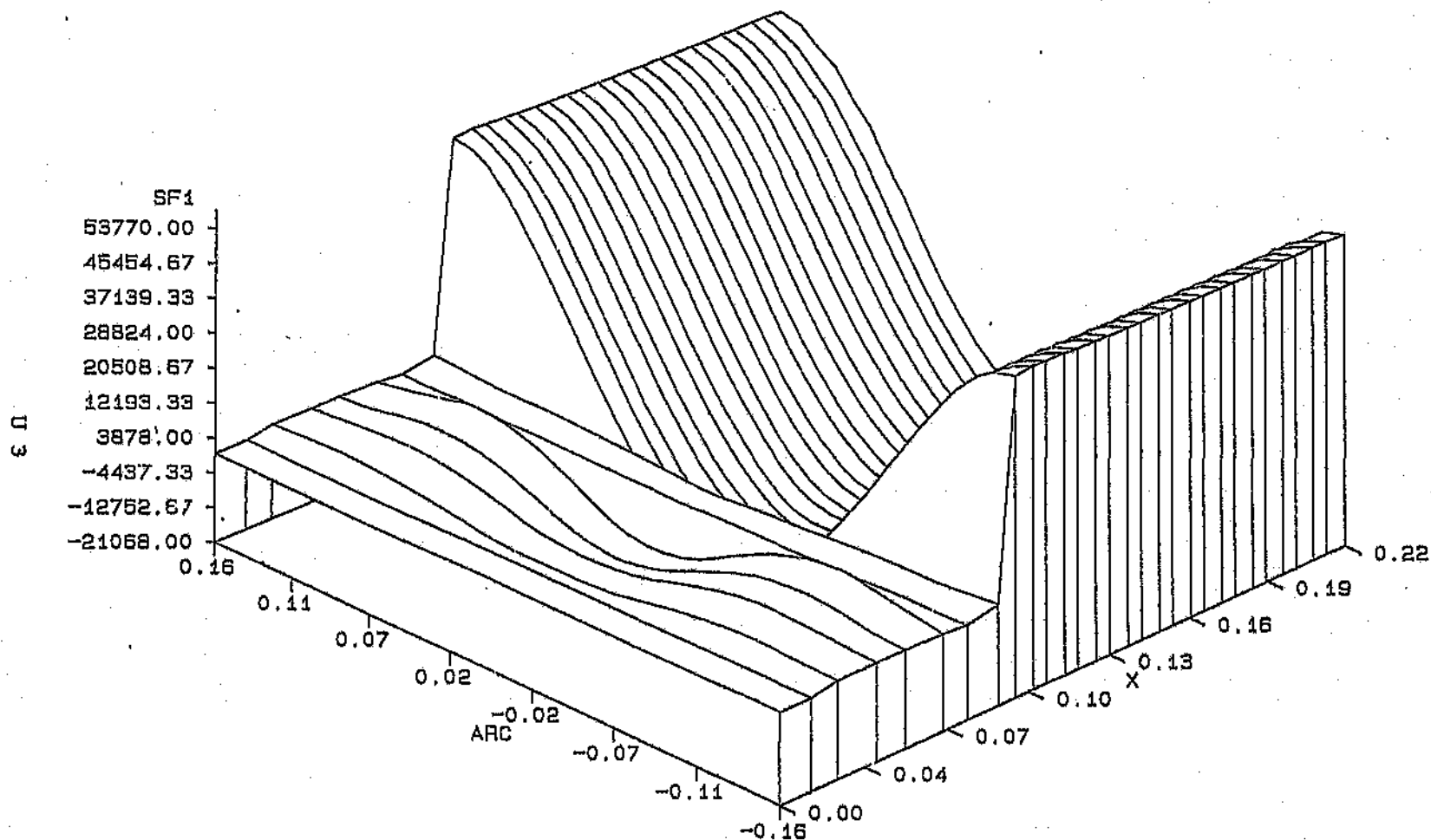


Figure U2 FEM axial force resultants  $N_x$  superimposed on the "unrolled" tube.

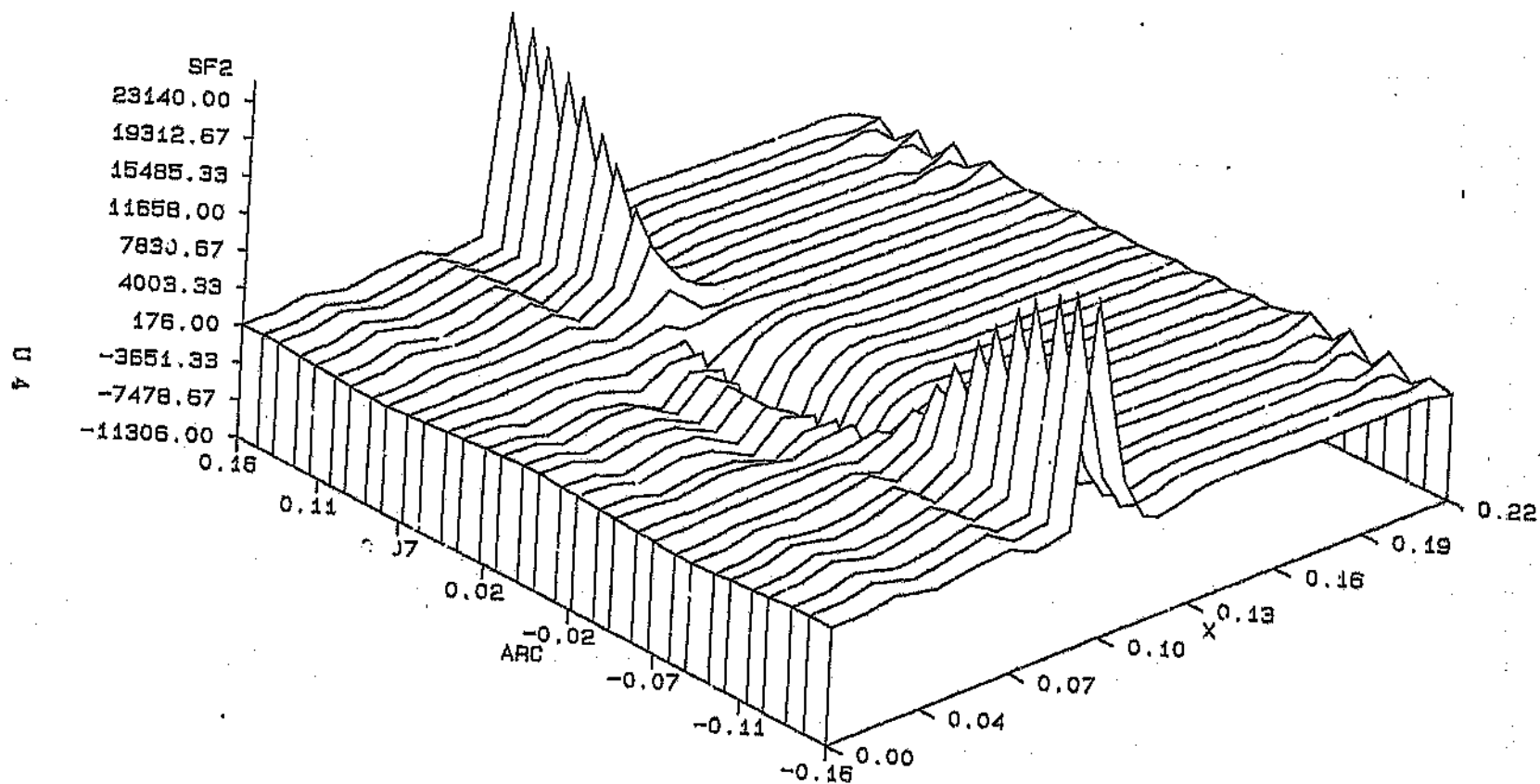


Figure U3 FEM circumferential force resultants,  $N_\phi$  superimposed on the "unrolled" tube.



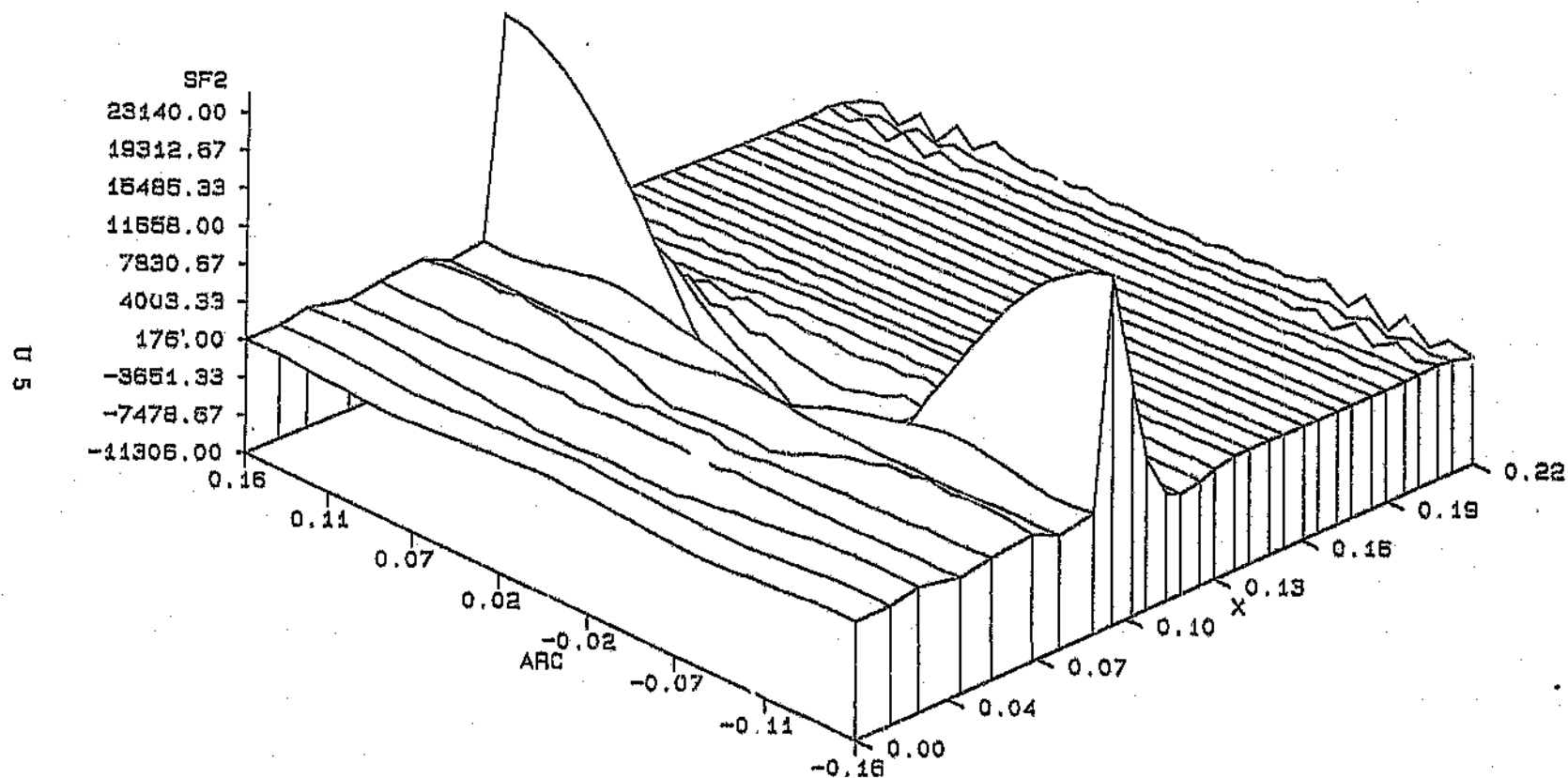


Figure U4 FEM circumferential force resultants  $N_\phi$  superimposed on the "unrolled" tube.

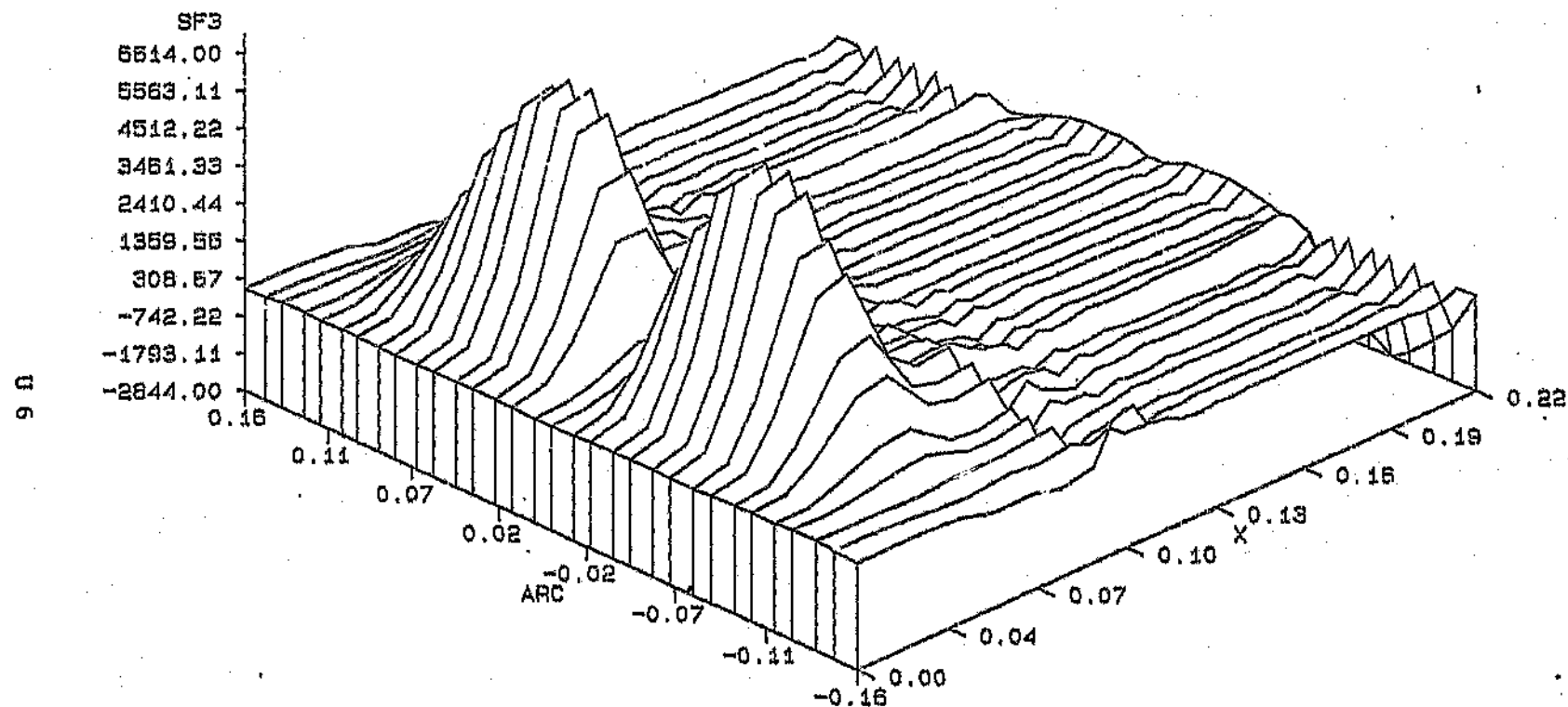


Figure U5 FEM inplane shear force resultants  $Nx_\phi$  superimposed on the "unrolled" tube.

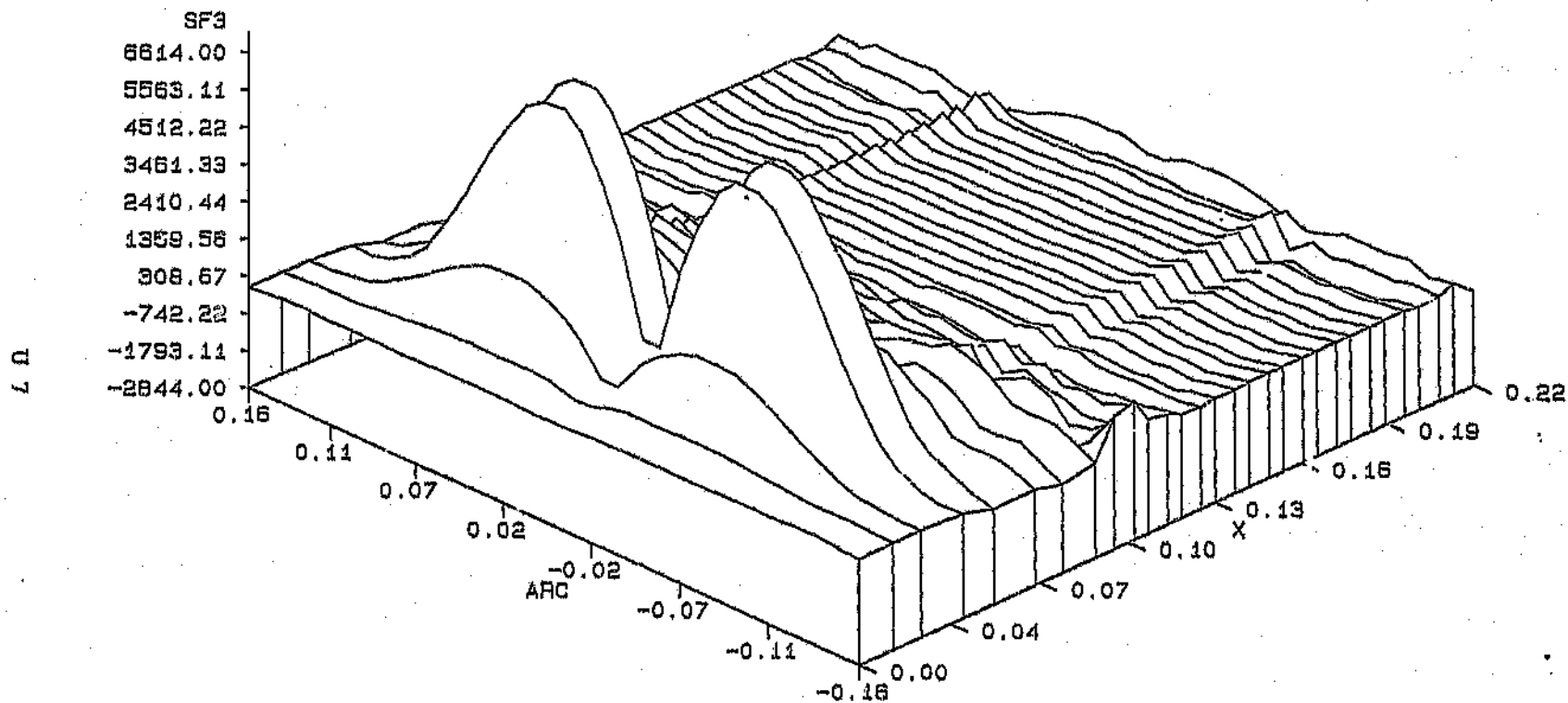


Figure U6 FEM inplane shear force resultants  $N_{x\phi}$  superimposed on the "unrolled" tube.

**APPENDIX V**  
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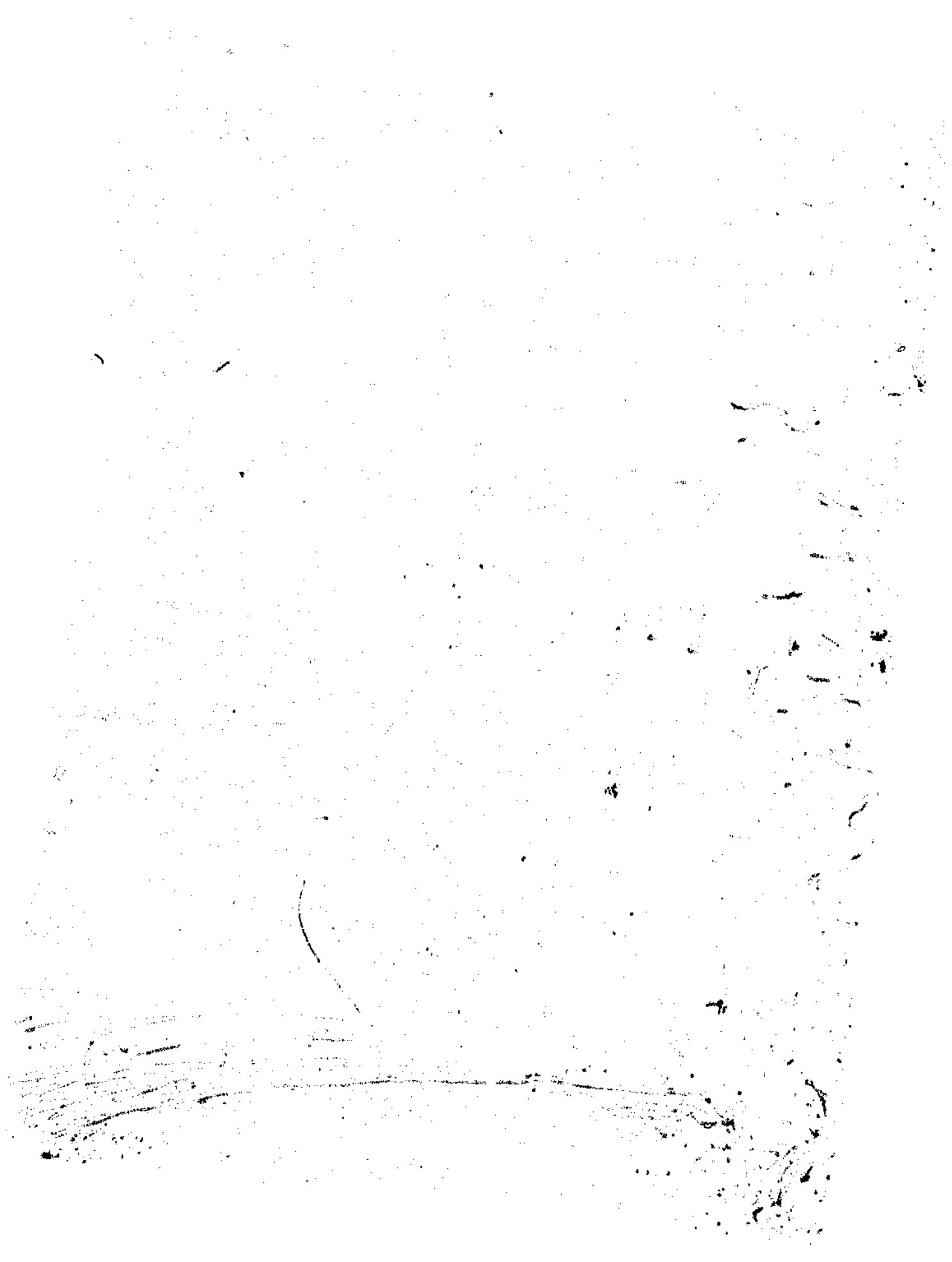
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