S. Levy Incorporated

CALCULATION OF SHROUD LOADS DURING A RECIRCULATION LINE BREAK

SLI-94-029

Prepared by

J. C. Gillis
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INTRODUCTION

The reactor core in Boiling Water Reactors (BWRs) is surrounded by a shroud, as shown in Figure 1. The shroud is made of stainless steel and is two inches thick. Recently, routine inspections have spotted surface cracks in the core shrouds of several BWR's. This has led to the concern that the damaged shrouds would not be able to withstand the loads encountered during loss-of-coolant-accidents (LOCAs). A few milliseconds after a line break occurs fluid dynamic loads develop on the shroud as contents of the vessel discharge. The nature of these loads depends on what kind of break has taken place. The two types of LOCAs which would cause the highest loads on the shroud are the main steam line (MSL) break and the recirculation line (RL) break. In this report we will consider the RL break.

The RL is attached near the bottom of the vessel, and so the break flow during an RL LOCA is all liquid. (Flashing will occur as the coolant leaves the vessel, but the flow over the shroud is liquid.) After a recirculation line break, liquid in the annulus between the shroud and vessel wall accelerates toward the recirculation line attachment. High velocities are reached close to the nozzle that is the attachment point, and the low pressures which then occur produce asymmetric loads on the shroud. These loads are shown schematically in Figure 2. Numerical evaluation of the asymmetric load is our goal in this calculation.

Calculations of the shroud loads have also been done at General Electric (GE) using the computer code TRACG. Our calculations were undertaken as an independent verification of the GE results. Our calculation methods and results are presented below; the last section of this report compares our results to the GE results.

BWR GEOMETRY

It was assumed that the recirculation line break was a double-ended guillotine break with the upstream end of the break at the end of the RPV nozzle.

At the direction of the Technical Assessment Committee of the Vessel Internals Program (VIP), dimensions from the BWR at Dresden, Illinois were used. The geometry of the annulus region of Dresden Station was obtained from Reference 1. The dimensions which affect the asymmetric load and the thermodynamic operating conditions of the reactor are shown in Table 1.

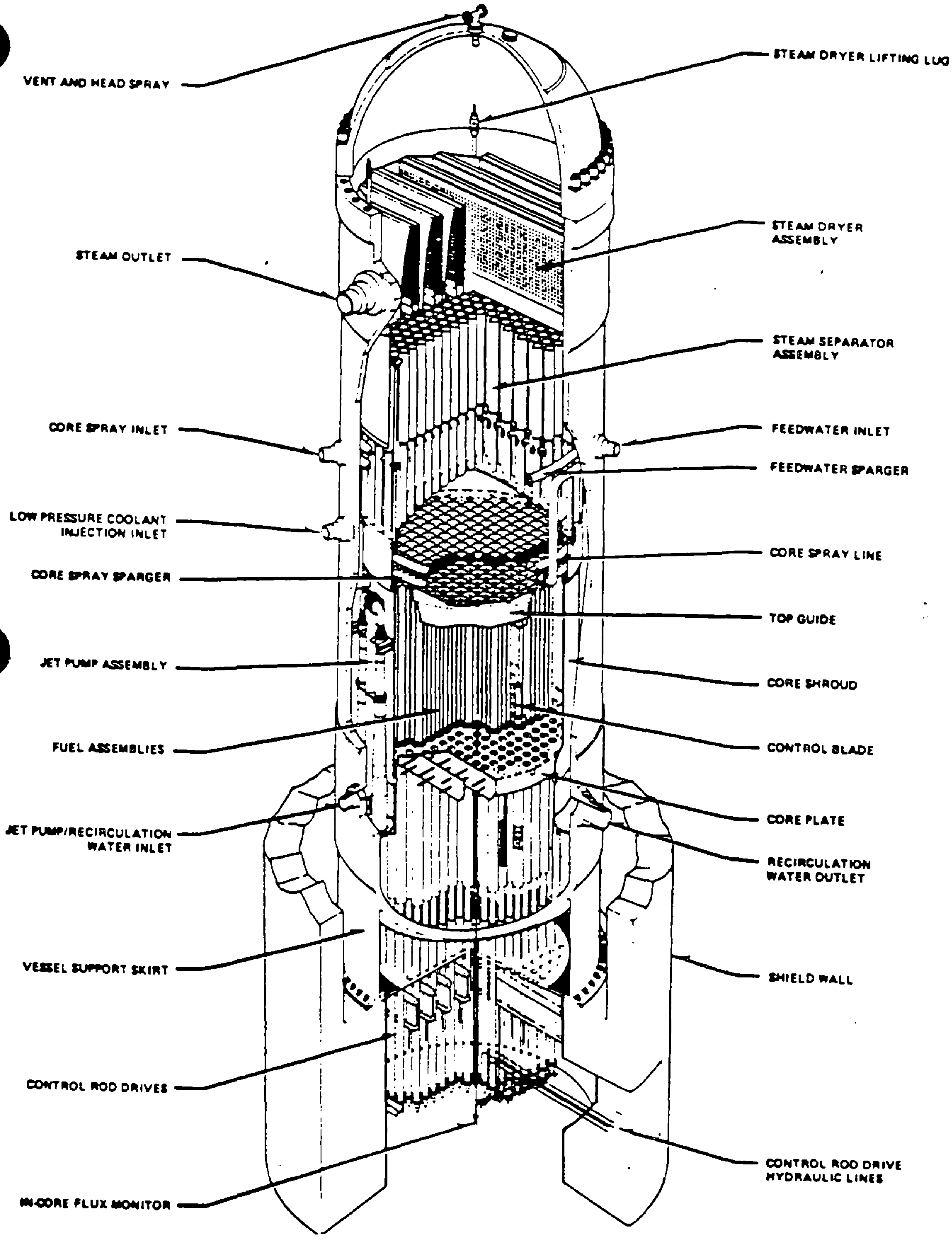

Figure 1. BWR Reactor and Core Shroud Geometry

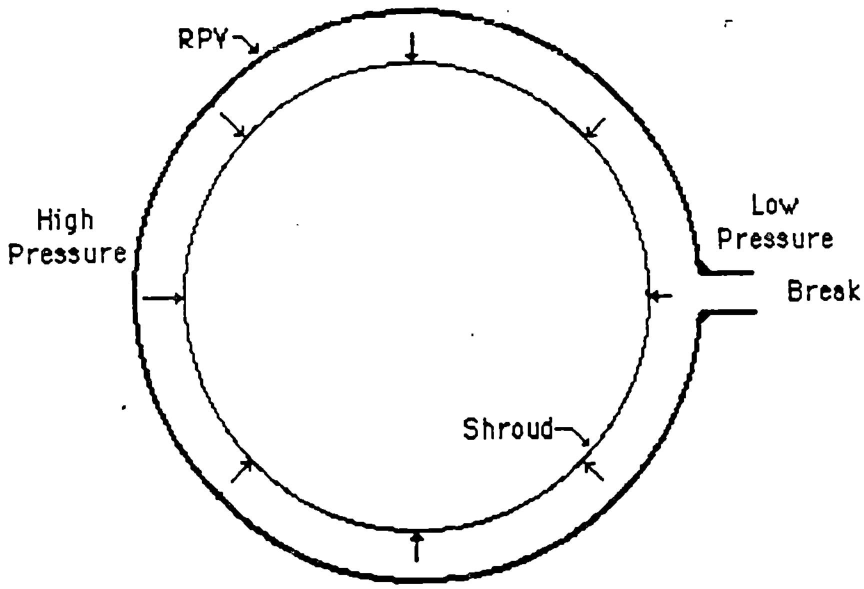

Figure 2. Asymmetric Loads on the Shroud

METHODS OF ATTACK

The asymmetric load on the shroud is calculated from the pressure distribution on the outside of the shroud by integrating the pressure over the shroud area.

The discharge flow through the break is a function of time. As the vessel depressurizes, the flow rate decreases. Rather than do a time-dependent calculation, we have made a conservative quasi-steady state calculation. In this approach, we calculate the load which corresponds to the initial flow rate and make the observation that the load will decrease with time as the flow rate decreases. Thus, the load calculated from the initial flow rate should be the bounding load.

There is no reason for the inside pressure distribution to change dramatically or become asymmetric, so the pressure forces on the inside wall of the shroud cancel each other. To know the pressure distribution on the outside of the shroud, one must somehow find the coupled velocity and pressure fields in the annulus.

The Best Estimate Calculation

To compute the velocity and pressure field we used the Computational Fluid Dynamics (CFD) code COMPACT 3-D. This code is capable of solving the full Navier-Stokes equations in three dimensions. This method of attack has the advantage that the flow field is computed from first principles, using as inputs only the geometry of the annulus as specified above along with the density and viscosity of the fluid. In other thermal-hydraulic analysis codes often used in the nuclear industry, many friction factors, flow inertia factors, area factors and other factors have to be specified in the input. The long list of factors in the input may lead to questions about how the factors are chosen.

Table 1

CRITICAL DIMENSIONS USED IN CALCULATION OF THE ASYMMETRIC SHROUD LOAD DURING A RECIRCULATION LINE BLOWDOWN AT DRESDEN

I. RAW DIMENSIONS	VALUE	UNITS	REF
A. RPV Inside Diameter	251.000	in	1,2
B. Shroud Outside Diameter (opposite nozzle)	201.000	in	1,2
C. Shroud Outside Diameter (above H5)	207.125	in	2
D. Shroud Outside Diameter (above H3)	220.000	in	2
E. Baffle Plate Elevation	118.000	in	1
F. Nozzle Centerline Elevation	158.625	in	2
G. H5 Elevation	191.125	in	2
H. Top of Shroud Elevation	404.650	in	1
I. Nozzle Diameter at RPV inside surface	36.000	in	1
J. Nozzle Half-Angle	15.000	deg	1
K. Nozzle Outlet Diameter	25.15	in	2
L. Nozzle 1 Angular Location	0.00	deg	-
M. Jet Pump Pair 1 Angular Location	30.00	deg	1
N. Jet Pump Pair 2 Angular Location	60.00	deg	1
O. Jet Pump Pair 3 Angular Location	90.00	deg	1
P. Jet Pump Pair 4 Angular Location	120.00	deg	1
Q. Jet Pump Pair 5 Angular Location	150.00	deg	1
II. THERMODYNAMIC CONDITIONS	**VALUE**	**UNITS**	**REF**
1. Pressure	1034.7	psia	1
2. Temperature	527.0	°F	1
3. Density	46.0	lbm/ft^3	2
4. Viscosity	0.0000705	$lbm\text{-}s/ft^2$	3

In the cylindrical coordinates best suited to the flow in the RPV annulus, the Navier-Stokes equations are:

$$\frac{\partial \rho}{\partial t}+\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta\right)+\frac{\partial}{\partial z}\left(\rho u_z\right)=0 \tag{1}$$

$$\begin{aligned}&\frac{\partial}{\partial t}\left(\rho u_r\right)+\frac{\partial}{\partial z}\left(\rho u_z u_r\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r u_r\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta u_r\right)=\\ &-\frac{\partial P}{\partial r}+\frac{\partial}{\partial z}\left(\mu\frac{\partial u_r}{\partial z}\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(r\mu\frac{\partial u_r}{\partial r}\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\frac{\mu}{r}\frac{\partial u_r}{\partial \theta}\right)\end{aligned} \tag{2}$$

$$\begin{aligned}&\frac{\partial}{\partial t}\left(\rho u_\theta\right)+\frac{\partial}{\partial z}\left(\rho u_z u_\theta\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r u_\theta\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta u_\theta\right)=\\ &-\frac{1}{r}\frac{\partial P}{\partial \theta}+\partial z\left(\mu\frac{\partial u_\theta}{\partial z}\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(r\mu\frac{\partial u_\theta}{\partial r}\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\frac{\mu}{r}\frac{\partial u_\theta}{\partial \theta}\right)\end{aligned} \tag{3}$$

$$\begin{aligned}&\frac{\partial}{\partial t}\left(\rho u_z\right)+\frac{\partial}{\partial z}\left(\rho u_z u_z\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r u_z\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta u_z\right)=\\ &-\frac{\partial P}{\partial z}+\frac{\partial}{\partial z}\left(\mu\frac{\partial u_z}{\partial z}\right)+\frac{1}{r}\frac{\partial}{\partial r}\left(\mu\frac{\partial u_z}{\partial r}\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\frac{\mu}{r}\frac{\partial u_z}{\partial \theta}\right)\end{aligned} \tag{4}$$

A complete solution for the velocity and pressure fields using the form of the Navier-Stokes equations above would require an extremely fine mesh. The required mesh size can be made much coarser if a turbulence model is used. In our calculations, we used a two-equation model of the turbulence which solved one equation for the turbulent kinetic energy and one for the dissipation of turbulence. This model is sometimes referred to as the k-epsilon model. The turbulence model computes an effective supplemental viscosity due to the turbulence. With this "eddy viscosity," μ_t, included, and with simplification for steady flow, the Navier-Stokes equations become:

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta\right)+\frac{\partial}{\partial z}\left(\rho u_z\right)=0 \tag{5}$$

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r u_r\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta u_r\right)+\frac{\partial}{\partial z}\left(\rho u_z u_r\right) =$$

$$-\frac{\partial P}{\partial r}+\frac{1}{r}\frac{\partial}{\partial r}\left[r\left(\mu+\mu_t\right)\frac{\partial u_r}{\partial r}\right]+\frac{1}{r}\frac{\partial}{\partial \theta}\left[\frac{\left(\mu+\mu_t\right)}{r}\frac{\partial u_r}{\partial \theta}\right] \tag{6}$$

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r u_\theta\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta u_\theta\right)+\frac{\partial}{\partial z}\left(\rho u_z u_\theta\right) = -\frac{1}{r}\frac{\partial P}{\partial \theta}$$

$$+\frac{1}{r}\frac{\partial}{\partial r}\left[r\left(\mu+\mu_t\right)\frac{\partial u_\theta}{\partial r}\right]+\frac{1}{r}\frac{\partial}{\partial \theta}\left[\frac{\left(\mu+\mu_t\right)}{r}\frac{\partial u_\theta}{\partial \theta}\right]+\frac{\partial}{\partial z}\left[\left(\mu+\mu_t\right)\frac{\partial u_\theta}{\partial z}\right] \tag{7}$$

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho u_r u_z\right)+\frac{1}{r}\frac{\partial}{\partial \theta}\left(\rho u_\theta u_z\right)+\frac{\partial}{\partial z}\left(\rho u_z u_z\right) = -\frac{\partial P}{\partial z}$$

$$+\frac{1}{r}\frac{\partial}{\partial r}\left[\left(\mu+\mu_t\right)\frac{\partial u_z}{\partial r}\right]+\frac{1}{r}\frac{\partial}{\partial \theta}\left[\frac{\left(\mu+\mu_t\right)}{r}\frac{\partial u_z}{\partial \theta}\right]+\frac{\partial}{\partial z}\left[\left(\mu+\mu_t\right)\frac{\partial u_z}{\partial z}\right] \tag{8}$$

The solution domain is shown in Figure 3. The boundary conditions are: zero velocity on all solid surfaces, constant pressure at the top of the annulus, and a proscribed flow rate out of the nozzle. Inside the solution domain, a solution grid is laid out. This computational grid is discussed in more detail in the subsection on the solution grid below.

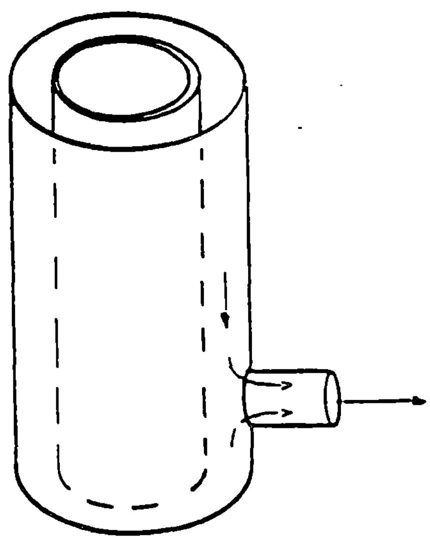

Figure 3. The Annular Solution Domain

The outflow boundary condition (the flow out of the vessel) is calculated by a critical flow model and then used as a boundary condition for the CFD solution. Determination of the choked or critical flow rate of two-phase mixtures is not yet an exact calculation. Several models are used, each based on slightly different thermodynamic assumptions. We calculated the critical flow rate predicted by three models: Moody's, Henry-Fauske, and the Homogeneous Equilibrium Model (HEM). It was assumed that the stagnation pressure of the break flow was 1020 psia, and that the stagnation temperature was 527 °F. The highest flow rates will occur if the line break at the end of the nozzle where the diameter at Dresden is 25.1 in. For these parameters, the results of the flow rate calculation are shown in Table 2.

Table 2

BREAK FLOW RATES

Model	Mass Flux Lbm/sec-ft2	Mass Flow Rate lbm/sec
Moody	8,653	29,733
Henry-Fauske	11,359	39,031
HEM	8,120	27,902

A series of large scale critical flow tests was conducted between 1977 and 1979 at the Marviken Power Station. The test results are documented in Reference 2. A review of the test results showed that one of the tests had approximately the same length/diameter ratio as the postulated flow. Under subcooled stagnation conditions the measured flow rates were predicted well by the HEM model. For stagnation conditions of 638 psi, 455°F and a length/diameter ratio of 1.5, the measured flow rate was 20,940 lbm/sec vs. an HEM model prediction of 19,980 lbm/sec. Because the HEM model seemed to perform well, we used its results for the remainder of this study.

With the boundary conditions specified, the CFD solution computes the shroud wall pressures directly. Once the pressures on the shroud wall are known, loads on the shroud can be computed by integrating over the shroud area.

$$F = 2\int_o^h \int_o^\pi P(z,\theta) \cdot r\, d\theta dz \qquad (9)$$

Moments about both the shroud base and the H5 weld were also computed. Using z_{ref} for the reference elevations, the moments were computed by:

$$M = 2\int_{o\ z_{ref}}^h \int_o^\pi P(z,\theta) \cdot r(z - z_{ref})\, d\theta dz \qquad (10)$$

Solution Grid for the Navier-Stokes Equations

To take advantage of symmetry, the solution grid was laid out on a 180 degree section of the annulus space as shown in Figure 4. Radial lines of grid points were laid out roughly every 5 degrees, with more reduced spacing between lines of points in the vicinity of the break. On Figure 4, the nozzle entrance is on the right edge of the boundary, occupying the first 8.162 degrees of the 180 degree arc. There were 16 grid points on each radial line of points, allowing for good resolution of the boundary layers on the shroud and RPV walls.

In the vertical direction, there were 26 planes of grid points. For the first eight feet above the baffle plate, there was a plane of grid points every six inches. Above eight feet there was a plane of grid points every 19.075 inches.

Figure 5 shows a pictorial representation of how the actual jet pump geometry is represented in the CFD solution. The jet pumps are represented by volumes which are blocked off to flow. The edges of these flow blocks must correspond to locations where there are grid points. As a result, it is not possible to represent the complicated jet pump geometry exactly. In Figure 5 the flow block representation of the jet pumps show up as the quasi-rectangular objects. Figure 6 shows the solution grid in the r-z plane: the plane in which a jet pump representation is shown in cross section.

To summarize the grid, there were sixteen grid points in the r direction, 42 grid lines in the theta direction and 28 planes in the z direction. The total number of grid points was 18,816.

CONFIRMATION CALCULATION

Before computing the shroud load, we made a check of our methods against a trusted result. A simple method for estimating the asymmetric shroud load neglecting the jet pumps has been developed by F. J. Moody and others at General Electric (GE).

The GE method uses a superposition of 2-D flow sinks, as shown in Figure 7 to specify the flow. With the baffle plate located at distance b below the break, the complex potential is:

$$\phi = \frac{Q}{2\pi w}\left\{ln\ sin\left[\frac{\pi}{L}(z - ib)\right] + ln\ sin\left[\frac{\pi}{L}(z - ib)\right]\right\} \tag{11}$$

where Q is the volumetric flow rate, w is the annulus width, and z is the complex variable $x + iy$.

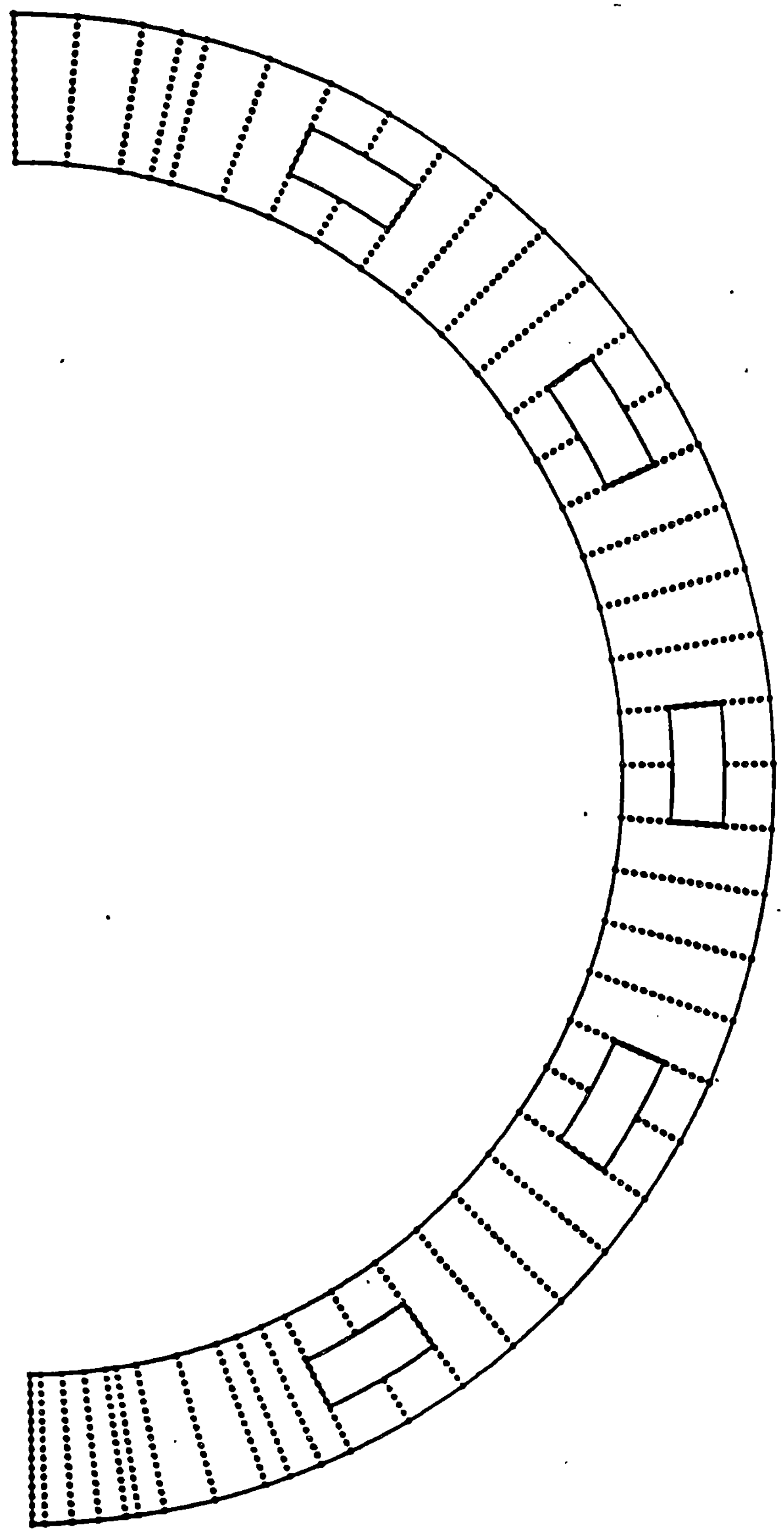

Figure 4. Solution Grid in the r-θ Direction

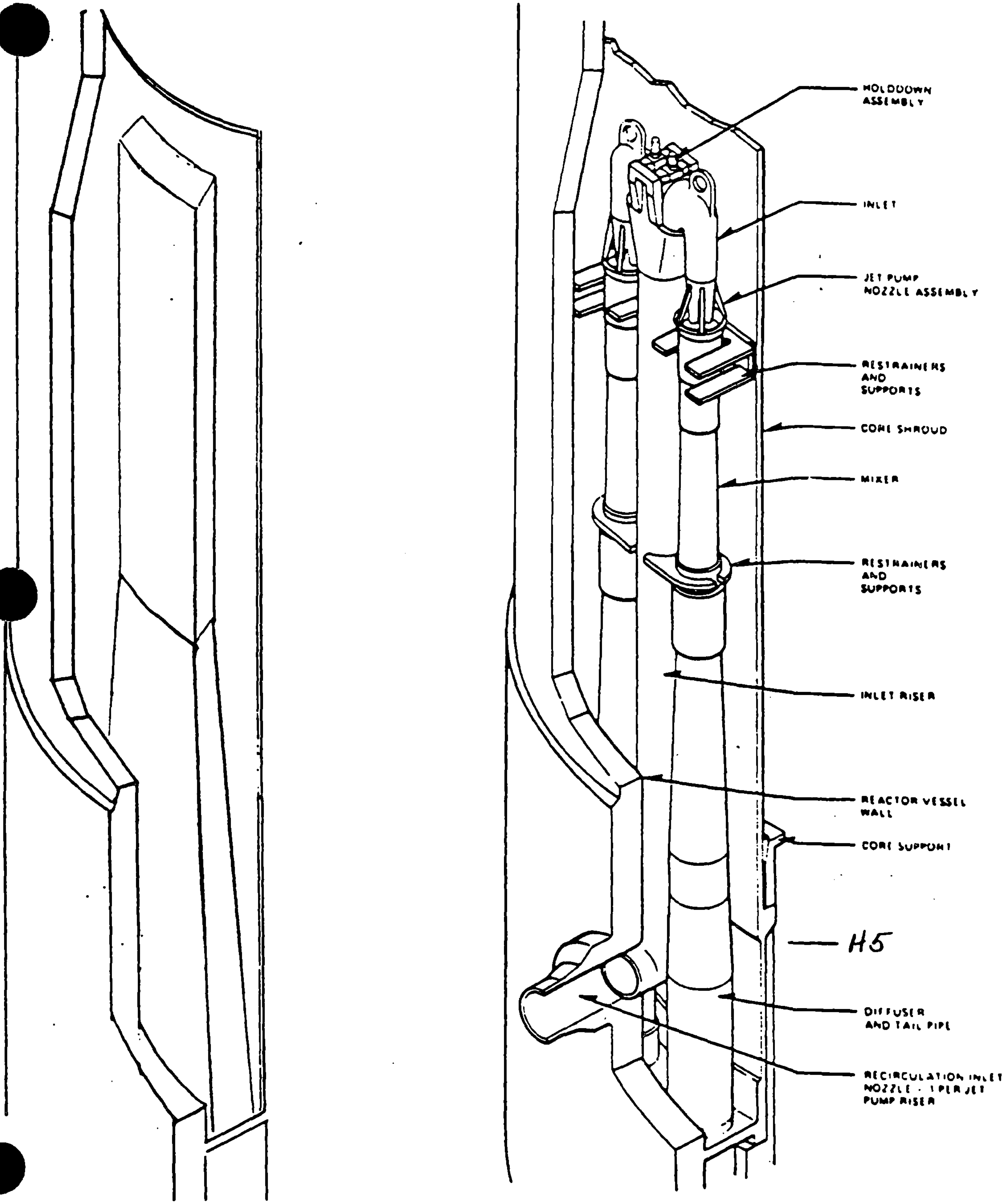

Figure 5. Jet Pump Assembly

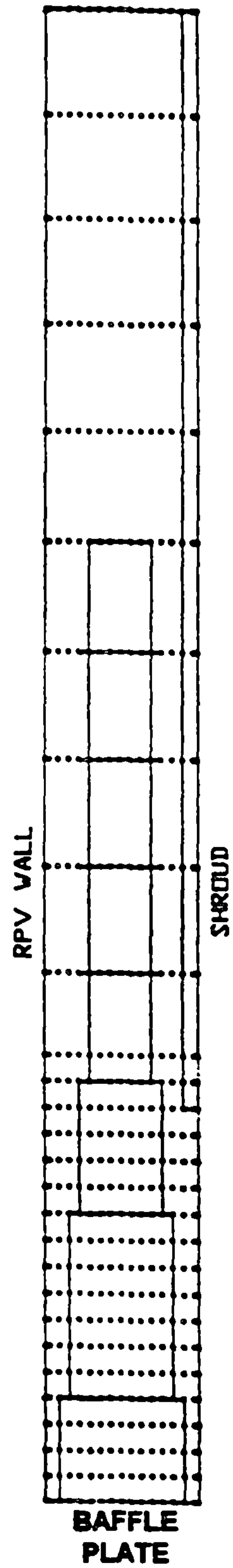

Figure 6. Solution Grid in the r-z Direction

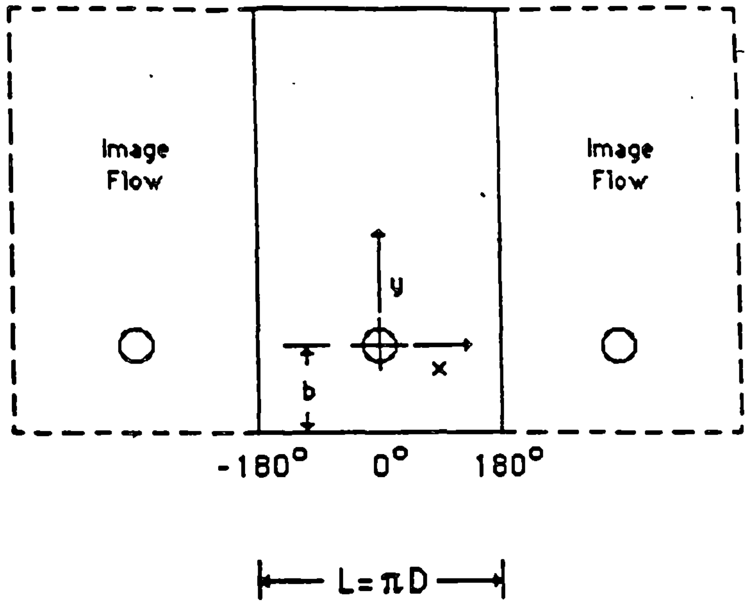

Figure 7. Potential Flow Field

The potential can be differentiated to find the velocity field:

$$\bar{V} = \frac{-Q}{4\pi Dw}\left\{\frac{\sin\left(\frac{2x}{D}\right) - i\,\sinh\left[\frac{2(y-b)}{D}\right]}{\sin^2\left(\frac{x}{D}\right) + \sinh^2\left(\frac{y-b}{D}\right)} + \frac{\sin\left(\frac{2x}{D}\right) - i\,\sinh\left[\frac{2(y+b)}{D}\right]}{\sin^2\left(\frac{x}{D}\right) + \sinh^2\left(\frac{y+b}{D}\right)}\right\} \qquad (12)$$

where D is the diameter of the annulus midpoint.

This formulation more accurately simulates the effect of the baffle plate on the far field flow in the annulus. However, for the near field flow (distances of a few feet from the nozzle centerline) it predicts velocities which are unrealistically high, tending toward infinity. These high velocities would correspond to unrealistically high local shroud loads. For this region, it is argued at GE that the flow will separate from the annulus wall and that therefore the pressure on the annulus wall will be constant distances less than about 30 inches from the nozzle centerline. Separate and very detailed computations of the flow field in this small area using the CFD code show that no such separation takes place. However, the pressure field one obtains by following the GE argument is actually close, on average, to the pressure field computed with the CFD code. Therefore, we felt comfortable in using the GE methodology as a check of our CFD results for the flow in the annulus.

Using the GE methodology, with the HEM break flow and the Dresden dimensions shown above, the asymmetric load calculated was 16,075 lbs. Using the CFD code (with the jet pump blockages removed), we calculated 20,013 lbs. The CFD input models the reduction in the annulus width above H3, so it is to be expected that the computed load will be a bit higher than the potential flow.

RESULTS

After integrating the pressure distribution shown, the total load on the shroud was found to be 119,955 lbs. The total moment was calculated as 878,862 ft-lbs. Of particular interest is the load above the height of the H5 weld. This was found to be 56,527 lbs; the moment above H5 was calculated as 336,800 ft-lbs. Table 3 shows how our results compare to those calculated by GE.

Table 3

COMPARISON OF SLI AND GE RESULTS

		SLI	GE (Max)	Units
Total Load		120,000	165,000	lbs
Moment		878,862	1,083,000	ft-lbs
Load	Above H5	56,500	65,000	lbs
Moment	Above H5	336,800	375,000	ft-lbs

REFERENCES

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4. *Principles of Heat Transfer*, 4th Edition, F. W. Krieth and M. S. Bohn, Harper & Row, New York, 1986.

5. *Critical Flow Calculation*, Davood Abdollahian, S. Levy Incorporated, September 22, 1994.

6. *Critical Flow Data Review and Analysis*, D. Abdollahian, J. Healzer, E. Jansen and C. Amos, EPRI Report NP-2192, 1982.

APPENDIX A - CALCULATED PRESSURE DISTRIBUTION

For Weld Elevation (in. above baffle plate) = .000

NZ = 28 NTH = 42 RI = 8.630

	J	Z	THETA	AREA	PAVE	dF
1	1	.00	.005	.018	1029.10	13.35
1	2	.00	.030	.072	1029.02	54.15
1	3	.00	.065	.054	1028.92	41.36
1	4	.00	.100	.072	1028.82	56.00
1	5	.00	.140	.072	1028.74	56.48
1	6	.00	.180	.072	1028.72	56.41
1	7	.00	.220	.072	1028.75	55.57
1	8	.00	.260	.072	1028.87	53.86
1	9	.00	.300	.072	1029.08	51.18
1	10	.00	.355	.126	1029.45	81.67
1	11	.00	.435	.162	1029.62	97.97
1	12	.00	.520	.144	1029.33	88.46
1	13	.00	.605	.162	1031.05	61.44
1	14	.00	.695	.162	1033.02	22.22
1	15	.00	.780	.144	1032.99	18.63
1	16	.00	.865	.162	1032.95	19.76
1	17	.00	.955	.162	1032.96	17.47
1	18	.00	1.045	.162	1032.93	15.56
1	19	.00	1.130	.144	1033.50	6.69
1	20	.00	1.215	.162	1034.10	1.30
1	21	.00	1.305	.162	1034.07	1.19
1	22	.00	1.395	.162	1034.04	.89
1	23	.00	1.480	.144	1034.03	.43
[illegible]	24	.00	1.565	.162	1033.99	.04
[illegible]	25	.00	1.655	.162	1034.20	-.13
1	26	.00	1.740	.144	1034.43	.58
1	27	.00	1.825	.162	1034.40	.83
1	28	.00	1.915	.162	1034.38	.92
1	29	.00	2.005	.162	1034.36	1.01
1	30	.00	2.090	.144	1034.34	.81
1	31	.00	2.175	.162	1034.43	2.20
1	32	.00	2.265	.162	1034.54	4.11
1	33	.00	2.355	.162	1034.54	4.59
1	34	.00	2.440	.144	1034.54	4.40
1	35	.00	2.525	.162	1034.54	5.21
1	36	.00	2.615	.162	1034.53	5.43
1	37	.00	2.700	.144	1034.53	5.10
1	38	.00	2.795	.197	1034.54	7.43
1	39	.00	2.905	.197	1034.54	7.71
1	40	.00	3.020	.215	1034.54	8.65
1	41	.00	3.110	.108	1034.55	4.41
2	1	.21	.005	.036	1029.12	26.62
2	2	.21	.030	.144	1029.04	108.28
2	3	.21	.065	.108	1028.91	83.05
2	4	.21	.100	.144	1028.79	112.82
2	5	.21	.140	.144	1028.70	114.06
2	6	.21	.180	.144	1028.66	114.27
2	7	.21	.220	.144	1028.67	113.17
2	8	.21	.260	.144	1028.73	110.75
[illegible]	9	.21	.300	.144	1028.86	106.89
2	10	.21	.355	.252	1029.11	175.29
2	11	.21	.435	.324	1029.31	209.51
2	12	.21	.520	.288	1029.18	182.89
2	13	.21	.605	.324	1030.99	125.45
2	14	.21	.695	.324	1033.00	45.07

2	15	.21	.780	.288	1032.99	37.47
2	16	.21	.865	.324	1032.95	39.54
2	17	.21	.955	.324	1032.96	35.08
2	18	.21	1.045	.324	1032.93	31.22
[illegible]	19	.21	1.130	.288	1033.50	13.45
2	20	.21	1.215	.324	1034.10	2.65
2	21	.21	1.305	.324	1034.07	2.40
2	22	.21	1.395	.324	1034.04	1.80
2	23	.21	1.480	.288	1034.03	.86
2	24	.21	1.565	.324	1033.99	.07
2	25	.21	1.655	.324	1034.20	-.25
2	26	.21	1.740	.288	1034.42	1.14
2	27	.21	1.825	.324	1034.40	1.64
2	28	.21	1.915	.324	1034.38	1.84
2	29	.21	2.005	.324	1034.37	2.06
2	30	.21	2.090	.288	1034.34	1.72
2	31	.21	2.175	.324	1034.43	4.49
2	32	.21	2.265	.324	1034.54	8.20
2	33	.21	2.355	.324	1034.54	9.19
2	34	.21	2.440	.288	1034.54	8.76
2	35	.21	2.525	.324	1034.53	10.36
2	36	.21	2.615	.324	1034.53	10.82
2	37	.21	2.700	.288	1034.53	10.15
2	38	.21	2.795	.396	1034.54	14.83
2	39	.21	2.905	.396	1034.54	15.35
2	40	.21	3.020	.432	1034.54	17.17
2	41	.21	3.110	.216	1034.54	8.77
3	1	.63	.005	.036	1029.09	26.82
3	2	.63	.030	.144	1028.98	109.51
[illegible]	3	.63	.065	.108	1028.81	84.51
[illegible]	4	.63	.100	.144	1028.67	115.39
3	5	.63	.140	.144	1028.56	116.94
3	6	.63	.180	.144	1028.51	117.30
3	7	.63	.220	.144	1028.51	116.44
3	8	.63	.260	.144	1028.53	114.79
3	9	.63	.300	.144	1028.58	112.51
3	10	.63	.355	.252	1028.67	190.33
3	11	.63	.435	.324	1028.88	227.63
3	12	.63	.520	.288	1028.93	191.77
3	13	.63	.605	.324	1030.88	129.52
3	14	.63	.695	.324	1032.98	45.90
3	15	.63	.780	.288	1032.98	37.65
3	16	.63	.865	.324	1032.95	39.53
3	17	.63	.955	.324	1032.95	35.23
3	18	.63	1.045	.324	1032.92	31.31
3	19	.63	1.130	.288	1033.49	13.55
3	20	.63	1.215	.324	1034.09	2.78
3	21	.63	1.305	.324	1034.06	2.45
3	22	.63	1.395	.324	1034.04	1.82
3	23	.63	1.480	.288	1034.03	.87
3	24	.63	1.565	.324	1034.00	.07
3	25	.63	1.655	.324	1034.20	-.26
3	26	.63	1.740	.288	1034.42	1.09
3	27	.63	1.825	.324	1034.40	1.58
[illegible]	28	.63	1.915	.324	1034.38	1.80
[illegible]	29	.63	2.005	.324	1034.37	2.08
3	30	.63	2.090	.288	1034.35	1.85
3	31	.63	2.175	.324	1034.43	4.57
3	32	.63	2.265	.324	1034.53	8.08
3	33	.63	2.355	.324	1034.54	9.04

3	34	.63	2.440	.288	1034.53	8.58
3	35	.63	2.525	.324	1034.53	10.16
3	36	.63	2.615	.324	1034.52	10.62
3	37	.63	2.700	.288	1034.53	10.00
3	38	.63	2.795	.396	1034.54	14.72
3	39	.63	2.905	.396	1034.53	15.05
3	40	.63	3.020	.432	1034.53	16.51
3	41	.63	3.110	.216	1034.53	8.35
4	1	1.04	.005	.036	1028.99	27.27
4	2	1.04	.030	.144	1028.84	112.01
4	3	1.04	.065	.108	1028.62	87.24
4	4	1.04	.100	.144	1028.43	119.96
4	5	1.04	.140	.144	1028.32	121.73
4	6	1.04	.180	.144	1028.28	121.61
4	7	1.04	.220	.144	1028.32	120.00
4	8	1.04	.260	.144	1028.36	118.01
4	9	1.04	.300	.144	1028.38	116.27
4	10	1.04	.355	.251	1028.36	200.22
4	11	1.04	.435	.323	1028.53	241.71
4	12	1.04	.520	.287	1028.66	200.92
4	13	1.04	.605	.323	1030.76	134.14
4	14	1.04	.695	.323	1032.96	46.67
4	15	1.04	.780	.287	1032.98	37.71
4	16	1.04	.865	.323	1032.95	39.55
4	17	1.04	.955	.323	1032.95	35.35
4	18	1.04	1.045	.323	1032.92	31.35
4	19	1.04	1.130	.287	1033.49	13.68
4	20	1.04	1.215	.323	1034.08	2.98
4	21	1.04	1.305	.323	1034.05	2.52
4	22	1.04	1.395	.323	1034.03	1.84
4	23	1.04	1.480	.287	1034.03	.88
4	24	1.04	1.565	.323	1034.00	.07
4	25	1.04	1.655	.323	1034.19	-.27
4	26	1.04	1.740	.287	1034.41	1.00
4	27	1.04	1.825	.323	1034.39	1.48
4	28	1.04	1.915	.323	1034.37	1.74
4	29	1.04	2.005	.323	1034.37	2.07
4	30	1.04	2.090	.287	1034.36	1.95
4	31	1.04	2.175	.323	1034.44	4.59
4	32	1.04	2.265	.323	1034.53	7.88
4	33	1.04	2.355	.323	1034.53	8.79
4	34	1.04	2.440	.287	1034.52	8.33
4	35	1.04	2.525	.323	1034.52	9.83
4	36	1.04	2.615	.323	1034.51	10.19
4	37	1.04	2.700	.287	1034.52	9.75
4	38	1.04	2.795	.395	1034.53	14.50
4	39	1.04	2.905	.395	1034.52	14.36
4	40	1.04	3.020	.431	1034.51	15.09
4	41	1.04	3.110	.215	1034.50	7.41
5	1	1.46	.005	.036	1028.94	27.59
5	2	1.46	.030	.144	1028.73	114.53
5	3	1.46	.065	.108	1028.42	90.69
5	4	1.46	.100	.144	1028.13	126.47
5	5	1.46	.140	.144	1027.98	128.94
5	6	1.46	.180	.144	1027.97	128.28
5	7	1.46	.220	.144	1028.07	125.32
5	8	1.46	.260	.144	1028.17	122.09
5	9	1.46	.300	.144	1028.22	119.68
5	10	1.46	.355	.252	1028.19	206.46
5	11	1.46	.435	.324	1028.30	252.22

5	12	1.46	.520	.288	1028.51	207.07
5	13	1.46	.605	.324	1030.69	136.82
5	14	1.46	.695	.324	1032.91	48.57
[illegible]	15	1.46	.780	.288	1032.97	38.03
[illegible]	16	1.46	.865	.324	1032.94	39.94
5	17	1.46	.955	.324	1032.93	35.77
5	18	1.46	1.045	.324	1032.94	31.01
5	19	1.46	1.130	.288	1033.49	13.57
5	20	1.46	1.215	.324	1034.06	3.31
5	21	1.46	1.305	.324	1034.05	2.59
5	22	1.46	1.395	.324	1034.03	1.87
5	23	1.46	1.480	.288	1034.03	.89
5	24	1.46	1.565	.324	1034.01	.07
5	25	1.46	1,655	.324	1034.19	-.27
5	26	1.46	1.740	.288	1034.39	.90
5	27	1.46	1.825	.324	1034.38	1.39
5	28	1.46	1.915	.324	1034.37	1.70
5	29	1.46	2.005	.324	1034.37	2.07
5	30	1.46	2.090	.288	1034.36	2.09
5	31	1.46	2.175	.324	1034.44	4.69
5	32	1.46	2.265	.324	1034.52	7.74
5	33	1.46	2.355	.324	1034.52	8.64
5	34	1.46	2.440	.288	1034.52	8.15
5	35	1.46	2.525	.324	1034.51	9.46
5	36	1.46	2.615	.324	1034.50	9.60
5	37	1.46	2.700	.288	1034.51	9.35
5	38	1.46	2.795	.396	1034.52	14.03
5	39	1.46	2.905	.396	1034.50	13.28
5	40	1.46	3.020	.432	1034.47	13.17
[illegible]	41	1.46	3.110	.216	1034.46	6.24
6	1	1.88	.005	.036	1029.03	27.11
6	2	1.88	.030	.144	1028.73	114.60
6	3	1.88	.065	.108	1028.25	93.29
6	4	1.88	.100	.144	1027.79	133.48
6	5	1.88	.140	.144	1027.53	138.10
6	6	1.88	.180	.144	1027.50	137.90
6	7	1.88	.220	.144	1027.64	133.93
6	8	1.88	.260	.144	1027.81	129.13
6	9	1.88	.300	.144	1027.93	125.29
6	10	1.88	.355	.252	1027.96	214.31
6	11	1.88	.435	.324	1028.07	261.78
6	12	1.88	.520	.288	1028.38	211.71
6	13	1.88	.605	.324	1030.64	139.09
6	14	1.88	.695	.324	1032.85	50.68
6	15	1.88	.780	.288	1032.96	38.35
6	16	1.88	.865	.324	1032.93	40.41
6	17	1.88	.955	.324	1032.92	36.26
6	18	1.88	1.045	.324	1032.95	30.72
6	19	1.88	1.130	.288	1033.50	13.51
6	20	1.88	1.215	.324	1034.04	3.62
6	21	1.88	1.305	.324	1034.05	2.63
6	22	1.88	1.395	.324	1034.03	1.89
6	23	1.88	1.480	.288	1034.02	.90
6	24	1.88	1.565	.324	1034.02	.07
[illegible]	25	1.88	1.655	.324	1034.19	-.26
6	26	1.88	1.740	.288	1034.37	.79
6	27	1.88	1.825	.324	1034.37	1.31
6	28	1.88	1.915	.324	1034.37	1.64
6	29	1.88	2.005	.324	1034.36	2.02
6	30	1.88	2.090	.288	1034.37	2.20

6	31	1.88	2.175	.324	1034.44	4.77
6	32	1.88	2.265	.324	1034.52	7.61
6	33	1.88	2.355	.324	1034.52	8.48
[illegible]	34	1.88	2.440	.288	1034.51	7.98
[illegible]	35	1.88	2.525	.324	1034.50	9.11
6	36	1.88	2.615	.324	1034.48	8.94
6	37	1.88	2.700	.288	1034.49	8.67
6	38	1.88	2.795	.396	1034.50	12.93
6	39	1.88	2.905	.396	1034.47	11.66
6	40	1.88	3.020	.432	1034.44	10.85
6	41	1.88	3.110	.216	1034.42	4.92
7	1	2.29	.005	.036	1029.37	25.30
7	2	2.29	.030	.144	1028.95	109.70
7	3	2.29	.065	.108	1028.27	92.71
7	4	2.29	.100	.144	1027.58	137.37
7	5	2.29	.140	.144	1027.15	145.62
7	6	2.29	.180	.144	1027.01	147.59
7	7	2.29	.220	.144	1027.12	144.10
7	8	2.29	.260	.144	1027.33	138.55
7	9	2.29	.300	.144	1027.51	133.45
7	10	2.29	.355	.251	1027.62	225.47
7	11	2.29	.435	.323	1027.82	271.73
7	12	2.29	.520	.287	1028.18	218.20
7	13	2.29	.605	.323	1030.52	143.23
7	14	2.29	.695	.323	1032.81	51.72
7	15	2.29	.780	.287	1032.95	38.57
7	16	2.29	.865	.323	1032.91	40.75
7	17	2.29	.955	.323	1032.90	36.64
7	18	2.29	1.045	.323	1032.93	31.03
[illegible]	19	2.29	1.130	.287	1033.48	13.79
7	20	2.29	1.215	.323	1034.03	3.82
7	21	2.29	1.305	.323	1034.04	2.66
7	22	2.29	1.395	.323	1034.02	1.92
7	23	2.29	1.480	.287	1034.02	.92
7	24	2.29	1.565	.323	1034.02	.06
7	25	2.29	1.655	.323	1034.19	-.27
7	26	2.29	1.740	.287	1034.36	.71
7	27	2.29	1.825	.323	1034.37	1.24
7	28	2.29	1.915	.323	1034.36	1.55
7	29	2.29	2.005	.323	1034.36	1.92
7	30	2.29	2.090	.287	1034.37	2.20
7	31	2.29	2.175	.323	1034.44	4.75
7	32	2.29	2.265	.323	1034.51	7.47
7	33	2.29	2.355	.323	1034.51	8.31
7	34	2.29	2.440	.287	1034.51	7.79
7	35	2.29	2.525	.323	1034.49	8.76
7	36	2.29	2.615	.323	1034.47	8.28
7	37	2.29	2.700	.287	1034.47	7.72
7	38	2.29	2.795	.395	1034.47	11.21
7	39	2.29	2.905	.395	1034.44	9.72
7	40	2.29	3.020	.431	1034.40	8.55
7	41	2.29	3.110	.215	1034.38	3.71
8	1	2.71	.005	.036	1029.93	22.44
8	2	2.71	.030	.144	1029.41	100.51
8	3	2.71	.065	.108	1028.55	88.59
8	4	2.71	.100	.144	1027.67	136.02
8	5	2.71	.140	.144	1027.05	147.94
8	6	2.71	.180	.144	1026.76	152.96
8	7	2.71	.220	.144	1026.76	151.66
8	8	2.71	.260	.144	1026.91	147.24

8	9	2.71	.300	.144	1027.07	142.34
8	10	2.71	.355	.252	1027.23	239.31
8	11	2.71	.435	.324	1027.54	284.33
[illegible]	12	2.71	.520	.288	1027.99	225.72
[illegible]	13	2.71	.605	.324	1030.41	147.65
8	14	2.71	.695	.324	1032.79	52.82
8	15	2.71	.780	.288	1032.93	39.16
8	16	2.71	.865	.324	1032.89	41.39
8	17	2.71	.955	.324	1032.88	37.26
8	18	2.71	1.045	.324	1032.91	31.59
8	19	2.71	1.130	.288	1033.46	14.16
8	20	2.71	1.215	.324	1034.02	4.00
8	21	2.71	1.305	.324	1034.04	2.72
8	22	2.71	1.395	.324	1034.02	1.96
8	23	2.71	1.480	.288	1034.01	.93
8	24	2.71	1.565	.324	1034.02	.06
8	25	2.71	1.655	.324	1034.19	-.29
8	26	2.71	1.740	.288	1034.35	.65
8	27	2.71	1.825	.324	1034.36	1.18
8	28	2.71	1.915	.324	1034.36	1.48
8	29	2.71	2.005	.324	1034.36	1.84
8	30	2.71	2.090	.288	1034.37	2.17
8	31	2.71	2.175	.324	1034.44	4.70
8	32	2.71	2.265	.324	1034.51	7.36
8	33	2.71	2.355	.324	1034.51	8.16
8	34	2.71	2.440	.288	1034.50	7.64
8	35	2.71	2.525	.324	1034.48	8.37
8	36	2.71	2.615	.324	1034.45	7.59
[illegible]	37	2.71	2.700	.288	1034.44	6.60
[illegible]	38	2.71	2.795	.396	1034.43	9.11
8	39	2.71	2.905	.396	1034.40	7.84
8	40	2.71	3.020	.432	1034.37	6.71
8	41	2.71	3.110	.216	1034.35	2.82
9	1	3.13	.005	.036	1030.50	19.48
9	2	3.13	.030	.144	1029.89	90.66
9	3	3.13	.065	.108	1028.90	83.23
9	4	3.13	.100	.144	1027.90	131.11
9	5	3.13	.140	.144	1027.22	144.58
9	6	3.13	.180	.144	1026.85	151.19
9	7	3.13	.220	.144	1026.75	151.91
9	8	3.13	.260	.144	1026.78	149.80
9	9	3.13	.300	.144	1026.84	146.98
9	10	3.13	.355	.252	1026.92	249.84
9	11	3.13	.435	.324	1027.27	295.53
9	12	3.13	.520	.288	1027.82	231.72
9	13	3.13	.605	.324	1030.32	151.02
9	14	3.13	.695	.324	1032.76	53.88
9	15	3.13	.780	.288	1032.91	39.90
9	16	3.13	.865	.324	1032.87	42.20
9	17	3.13	.955	.324	1032.85	37.95
9	18	3.13	1.045	.324	1032.89	32.15
9	19	3.13	1.130	.288	1033.44	14.48
9	20	3.13	1.215	.324	1034.01	4.12
9	21	3.13	1.305	.324	1034.04	2.77
[illegible]	22	3.13	1.395	.324	1034.02	1.99
9	23	3.13	1.480	.288	1034.01	.93
9	24	3.13	1.565	.324	1034.03	.06
9	25	3.13	1.655	.324	1034.19	-.30
9	26	3.13	1.740	.288	1034.35	.60
9	27	3.13	1.825	.324	1034.36	1.13

9	28	3.13	1.915	.324	1034.35	1.41
9	29	3.13	2.005	.324	1034.35	1.79
9	30	3.13	2.090	.288	1034.37	2.14
9	31	3.13	2.175	.324	1034.44	4.62
[illegible]	32	3.13	2.265	.324	1034.50	7.21
[illegible]	33	3.13	2.355	.324	1034.50	7.97
9	34	3.13	2.440	.288	1034.50	7.45
9	35	3.13	2.525	.324	1034.47	7.95
9	36	3.13	2.615	.324	1034.43	6.93
9	37	3.13	2.700	.288	1034.40	5.38
9	38	3.13	2.795	.396	1034.39	6.81
9	39	3.13	2.905	.396	1034.37	6.10
9	40	3.13	3.020	.432	1034.35	5.41
9	41	3.13	3.110	.216	1034.34	2.36
10	1	3.54	.005	.036	1030.80	17.88
10	2	3.54	.030	.144	1030.07	86.72
10	3	3.54	.065	.108	1028.96	82.08
10	4	3.54	.100	.144	1027.94	130.00
10	5	3.54	.140	.144	1027.31	142.26
10	6	3.54	.180	.144	1027.01	147.60
10	7	3.54	.220	.144	1026.92	148.13
10	8	3.54	.260	.144	1026.90	147.19
10	9	3.54	.300	.144	1026.85	146.50
10	10	3.54	.355	.251	1026.76	254.63
10	11	3.54	.435	.323	1027.08	303.13
10	12	3.54	.520	.287	1027.72	234.80
10	13	3.54	.605	.323	1030.28	152.49
10	14	3.54	.695	.323	1032.73	54.68
10	15	3.54	.780	.287	1032.88	40.64
[illegible]	16	3.54	.865	.323	1032.84	43.01
[illegible]	17	3.54	.955	.323	1032.83	38.59
10	18	3.54	1.045	.323	1032.86	32.63
10	19	3.54	1.130	.287	1033.43	14.71
10	20	3.54	1.215	.323	1034.00	4.16
10	21	3.54	1.305	.323	1034.03	2.78
10	22	3.54	1.395	.323	1034.02	1.99
10	23	3.54	1.480	.287	1034.01	.93
10	24	3.54	1.565	.323	1034.03	.06
10	25	3.54	1.655	.323	1034.18	-.30
10	26	3.54	1.740	.287	1034.34	.55
10	27	3.54	1.825	.323	1034.35	1.08
10	28	3.54	1.915	.323	1034.35	1.37
10	29	3.54	2.005	.323	1034.35	1.76
10	30	3.54	2.090	.287	1034.36	2.12
10	31	3.54	2.175	.323	1034.43	4.53
10	32	3.54	2.265	.323	1034.50	7.02
10	33	3.54	2.355	.323	1034.50	7.74
10	34	3.54	2.440	.287	1034.49	7.21
10	35	3.54	2.525	.323	1034.46	7.54
10	36	3.54	2.615	.323	1034.42	6.38
10	37	3.54	2.700	.287	1034.38	4.45
10	38	3.54	2.795	.395	1034.36	5.07
10	39	3.54	2.905	.395	1034.35	4.83
10	40	3.54	3.020	.431	1034.34	4.82
10	41	3.54	3.110	.215	1034.34	2.39
[illegible]	1	3.96	.005	.036	1030.77	18.11
11	2	3.96	.030	.144	1029.92	89.96
11	3	3.96	.065	.108	1028.73	85.78
11	4	3.96	.100	.144	1027.77	133.85
11	5	3.96	.140	.144	1027.28	143.36

11	6	3.96	.180	.144	1027.10	146.04
11	7	3.96	.220	.144	1027.09	145.07
11	8	3.96	.260	.144	1027.07	143.96
11	9	3.96	.300	.144	1026.97	144.30
11	10	3.96	.355	.252	1026.72	256.62
11	11	3.96	.435	.324	1026.98	307.76
11	12	3.96	.520	.288	1027.76	234.07
11	13	3.96	.605	.324	1030.30	151.86
11	14	3.96	.695	.324	1032.70	55.96
11	15	3.96	.780	.288	1032.85	41.55
11	16	3.96	.865	.324	1032.81	43.83
11	17	3.96	.955	.324	1032.81	39.22
11	18	3.96	1.045	.324	1032.85	33.04
11	19	3.96	1.130	.288	1033.42	14.92
11	20	3.96	1.215	.324	1034.00	4.25
11	21	3.96	1.305	.324	1034.03	2.78
11	22	3.96	1.395	.324	1034.02	1.98
11	23	3.96	1.480	.288	1034.02	.92
11	24	3.96	1.565	.324	1034.04	.06
11	25	3.96	1.655	.324	1034.18	-.31
11	26	3.96	1.740	.288	1034.33	.50
11	27	3.96	1.825	.324	1034.35	1.03
11	28	3.96	1.915	.324	1034.35	1.36
11	29	3.96	2.005	.324	1034.35	1.78
11	30	3.96	2.090	.288	1034.37	2.14
11	31	3.96	2.175	.324	1034.43	4.48
11	32	3.96	2.265	.324	1034.49	6.85
11	33	3.96	2.355	.324	1034.49	7.50
11	34	3.96	2.440	.288	1034.48	6.97
[illegible]	35	3.96	2.525	.324	1034.45	7.22
11	36	3.96	2.615	.324	1034.41	6.09
11	37	3.96	2.700	.288	1034.37	4.24
11	38	3.96	2.795	.396	1034.35	4.75
11	39	3.96	2.905	.396	1034.35	4.72
11	40	3.96	3.020	.432	1034.35	5.29
11	41	3.96	3.110	.216	1034.35	2.90
12	1	4.38	.005	.036	1030.59	19.00
12	2	4.38	.030	.144	1029.71	94.37
12	3	4.38	.065	.108	1028.54	88.82
12	4	4.38	.100	.144	1027.70	135.38
12	5	4.38	.140	.144	1027.35	141.94
12	6	4.38	.180	.144	1027.27	142.55
12	7	4.38	.220	.144	1027.31	140.67
12	8	4.38	.260	.144	1027.30	139.50
12	9	4.38	.300	.144	1027.18	140.32
12	10	4.38	.355	.252	1026.85	252.14
12	11	4.38	.435	.324	1027.15	300.99
12	12	4.38	.520	.288	1028.11	221.26
12	13	4.38	.605	.324	1030.47	145.56
12	14	4.38	.695	.324	1032.60	59.49
12	15	4.38	.780	.288	1032.81	42.72
12	16	4.38	.865	.324	1032.79	44.60
12	17	4.38	.955	.324	1032.78	39.81
12	18	4.38	1.045	.324	1032.85	32.92
[illegible]	19	4.38	1.130	.288	1033.41	15.00
[illegible]	20	4.38	1.215	.324	1033.98	4.64
12	21	4.38	1.305	.324	1034.03	2.84
12	22	4.38	1.395	.324	1034.02	1.97
12	23	4.38	1.480	.288	1034.02	.90
12	24	4.38	1.565	.324	1034.04	.06

12	25	4.38	1.655	.324	1034.18	-.31
12	26	4.38	1.740	.288	1034.32	.43
12	27	4.38	1.825	.324	1034.34	.98
12	28	4.38	1.915	.324	1034.35	1.35
[illegible]	29	4.38	2.005	.324	1034.35	1.81
[illegible]	30	4.38	2.090	.288	1034.37	2.21
12	31	4.38	2.175	.324	1034.43	4.48
12	32	4.38	2.265	.324	1034.48	6.61
12	33	4.38	2.355	.324	1034.48	7.17
12	34	4.38	2.440	.288	1034.47	6.65
12	35	4.38	2.525	.324	1034.44	6.96
12	36	4.38	2.615	.324	1034.41	6.09
12	37	4.38	2.700	.288	1034.39	4.68
12	38	4.38	2.795	.396	1034.37	5.72
12	39	4.38	2.905	.396	1034.36	5.69
12	40	4.38	3.020	.432	1034.37	6.56
12	41	4.38	3.110	.216	1034.38	3.64
13	1	4.79	.005	.036	1030.50	19.42
13	2	4.79	.030	.144	1029.64	95.48
13	3	4.79	.065	.108	1028.56	88.26
13	4	4.79	.100	.144	1027.86	131.80
13	5	4.79	.140	.144	1027.61	136.23
13	6	4.79	.180	.144	1027.58	135.89
13	7	4.79	.220	.144	1027.63	133.91
13	8	4.79	.260	.144	1027.61	132.92
13	9	4.79	.300	.144	1027.48	133.88
13	10	4.79	.355	.251	1027.18	240.43
13	11	4.79	.435	.323	1027.45	287.56
13	12	4.79	.520	.287	1028.44	208.85
[illegible]	13	4.79	.605	.323	1030.58	140.89
[illegible]	14	4.79	.695	.323	1032.48	63.56
13	15	4.79	.780	.287	1032.77	43.80
13	16	4.79	.865	.323	1032.76	45.33
13	17	4.79	.955	.323	1032.76	40.44
13	18	4.79	1.045	.323	1032.86	32.75
13	19	4.79	1.130	.287	1033.41	15.10
13	20	4.79	1.215	.323	1033.95	5.10
13	21	4.79	1.305	.323	1034.02	2.92
13	22	4.79	1.395	.323	1034.02	1.96
13	23	4.79	1.480	.287	1034.02	.89
13	24	4.79	1.565	.323	1034.05	.06
13	25	4.79	1.655	.323	1034.18	-.30
13	26	4.79	1.740	.287	1034.31	.37
13	27	4.79	1.825	.323	1034.34	.92
13	28	4.79	1.915	.323	1034.35	1.32
13	29	4.79	2.005	.323	1034.35	1.79
13	30	4.79	2.090	.287	1034.37	2.22
13	31	4.79	2.175	.323	1034.43	4.35
13	32	4.79	2.265	.323	1034.47	6.26
13	33	4.79	2.355	.323	1034.47	6.75
13	34	4.79	2.440	.287	1034.46	6.29
13	35	4.79	2.525	.323	1034.44	6.86
13	36	4.79	2.615	.323	1034.42	6.40
13	37	4.79	2.700	.287	1034.40	5.36
13	38	4.79	2.795	.395	1034.39	6.94
[illegible]	39	4.79	2.905	.395	1034.38	6.72
13	40	4.79	3.020	.431	1034.39	7.71
13	41	4.79	3.110	.215	1034.40	4.25
14	1	5.21	.005	.036	1030.64	18.75
14	2	5.21	.030	.144	1029.80	92.35

14	3	5.21	.065	.108	1028.76	85.39
14	4	5.21	.100	.144	1028.09	127.29
14	5	5.21	.140	.144	1027.85	131.50
14	6	5.21	.180	.144	1027.83	131.23
14	7	5.21	.220	.144	1027.87	129.27
14	8	5.21	.260	.144	1027.87	128.02
14	9	5.21	.300	.144	1027.77	128.50
14	10	5.21	.355	.252	1027.49	230.29
14	11	5.21	.435	.324	1027.64	279.85
14	12	5.21	.520	.288	1028.48	207.98
14	13	5.21	.605	.324	1030.52	143.66
14	14	5.21	.695	.324	1032.40	66.85
14	15	5.21	.780	.288	1032.74	44.70
14	16	5.21	.865	.324	1032.74	46.02
14	17	5.21	.955	.324	1032.73	41.12
14	18	5.21	1.045	.324	1032.85	33.12
14	19	5.21	1.130	.288	1033.39	15.45
14	20	5.21	1.215	.324	1033.93	5.44
14	21	5.21	1.305	.324	1034.01	3.02
14	22	5.21	1.395	.324	1034.02	1.98
14	23	5.21	1.480	.288	1034.02	.89
14	24	5.21	1.565	.324	1034.06	.05
14	25	5.21	1.655	.324	1034.19	-.29
14	26	5.21	1.740	.288	1034.31	.32
14	27	5.21	1.825	.324	1034.33	.86
14	28	5.21	1.915	.324	1034.34	1.26
14	29	5.21	2.005	.324	1034.35	1.70
14	30	5.21	2.090	.288	1034.36	2.09
14	31	5.21	2.175	.324	1034.41	4.05
14	32	5.21	2.265	.324	1034.46	5.80
14	33	5.21	2.355	.324	1034.45	6.32
14	34	5.21	2.440	.288	1034.45	6.02
14	35	5.21	2.525	.324	1034.44	6.98
14	36	5.21	2.615	.324	1034.43	6.95
14	37	5.21	2.700	.288	1034.42	6.01
14	38	5.21	2.795	.396	1034.41	7.76
14	39	5.21	2.905	.396	1034.39	7.29
14	40	5.21	3.020	.432	1034.40	8.34
14	41	5.21	3.110	.216	1034.41	4.64
15	1	5.63	.005	.036	1031.22	15.78
15	2	5.63	.030	.144	1030.29	82.36
15	3	5.63	.065	.108	1029.10	80.10
15	4	5.63	.100	.144	1028.28	123.45
15	5	5.63	.140	.144	1027.92	130.23
15	6	5.63	.180	.144	1027.82	131.35
15	7	5.63	.220	.144	1027.86	129.52
15	8	5.63	.260	.144	1027.90	127.51
15	9	5.63	.300	.144	1027.85	126.88
15	10	5.63	.355	.252	1027.62	225.79
15	11	5.63	.435	.324	1027.72	276.50
15	12	5.63	.520	.288	1028.45	209.13
15	13	5.63	.605	.324	1030.39	148.51
15	14	5.63	.695	.324	1032.28	70.95
15	15	5.63	.780	.288	1032.72	45.45
15	16	5.63	.865	.324	1032.73	46.37
15	17	5.63	.955	.324	1032.72	41.51
15	18	5.63	1.045	.324	1032.83	33.41
15	19	5.63	1.130	.288	1033.36	15.86
15	20	5.63	1.215	.324	1033.90	5.81
15	21	5.63	1.305	.324	1034.01	3.12

15	22	5.63	1.395	.324	1034.02	2.01
15	23	5.63	1.480	.288	1034.02	.89
15	24	5.63	1.565	.324	1034.06	.05
[illegible]	25	5.63	1.655	.324	1034.18	-.31
15	26	5.63	1.740	.288	1034.30	.27
15	27	5.63	1.825	.324	1034.33	.81
15	28	5.63	1.915	.324	1034.34	1.22
15	29	5.63	2.005	.324	1034.35	1.65
15	30	5.63	2.090	.288	1034.36	2.00
15	31	5.63	2.175	.324	1034.40	3.76
15	32	5.63	2.265	.324	1034.45	5.49
15	33	5.63	2.355	.324	1034.45	6.32
15	34	5.63	2.440	.288	1034.46	6.20
15	35	5.63	2.525	.324	1034.46	7.42
15	36	5.63	2.615	.324	1034.45	7.62
15	37	5.63	2.700	.288	1034.44	6.60
15	38	5.63	2.795	.396	1034.42	8.29
15	39	5.63	2.905	.396	1034.40	7.55
15	40	5.63	3.020	.432	1034.40	8.69
15	41	5.63	3.110	.216	1034.42	4.88
16	1	6.04	.005	.036	1031.13	16.18
16	2	6.04	.030	.144	1030.40	79.79
16	3	6.04	.065	.108	1029.43	74.76
16	4	6.04	.100	.144	1028.69	114.70
16	5	6.04	.140	.144	1028.30	122.03
16	6	6.04	.180	.144	1028.17	123.93
16	7	6.04	.220	.144	1028.19	122.53
16	8	6.04	.260	.144	1028.23	120.51
16	9	6.04	.300	.144	1028.20	119.73
16	10	6.04	.355	.251	1027.98	213.16
16	11	6.04	.435	.323	1028.07	261.24
16	12	6.04	.520	.287	1028.73	198.46
16	13	6.04	.605	.323	1030.54	142.26
16	14	6.04	.695	.323	1032.34	68.48
16	15	6.04	.780	.287	1032.77	43.71
16	16	6.04	.865	.323	1032.77	44.94
16	17	6.04	.955	.323	1032.76	40.31
16	18	6.04	1.045	.323	1032.87	32.46
16	19	6.04	1.130	.287	1033.38	15.51
16	20	6.04	1.215	.323	1033.91	5.67
16	21	6.04	1.305	.323	1034.01	3.05
16	22	6.04	1.395	.323	1034.02	1.95
16	23	6.04	1.480	.287	1034.03	.86
16	24	6.04	1.565	.323	1034.07	.05
16	25	6.04	1.655	.323	1034.19	-.29
16	26	6.04	1.740	.287	1034.30	.27
16	27	6.04	1.825	.323	1034.33	.81
16	28	6.04	1.915	.323	1034.34	1.21
16	29	6.04	2.005	.323	1034.34	1.63
16	30	6.04	2.090	.287	1034.36	1.97
16	31	6.04	2.175	.323	1034.40	3.64
16	32	6.04	2.265	.323	1034.44	5.41
16	33	6.04	2.355	.323	1034.46	6.39
16	34	6.04	2.440	.287	1034.46	6.28
16	35	6.04	2.525	.323	1034.46	7.58
16	36	6.04	2.615	.323	1034.46	7.99
16	37	6.04	2.700	.287	1034.45	7.02
16	38	6.04	2.795	.395	1034.43	8.78
16	39	6.04	2.905	.395	1034.40	7.90
16	40	6.04	3.020	.431	1034.41	8.87

16	41	6.04	3.110	.215	1034.42	4.86
17	1	6.46	.005	.092	1030.84	45.55
17	2	6.46	.030	.369	1030.57	196.22
17	3	6.46	.065	.277	1030.20	161.67
17	4	6.46	.100	.369	1029.88	231.79
17	5	6.46	.140	.369	1029.69	240.54
17	6	6.46	.180	.369	1029.62	243.00
17	7	6.46	.220	.369	1029.60	241.72
17	8	6.46	.260	.369	1029.59	240.20
17	9	6.46	.300	.369	1029.52	241.09
17	10	6.46	.355	.646	1029.31	432.29
17	11	6.46	.435	.831	1029.43	524.72
17	12	6.46	.520	.739	1030.02	391.85
17	13	6.46	.605	.831	1031.36	285.30
17	14	6.46	.695	.831	1032.63	149.84
17	15	6.46	.780	.739	1032.90	103.10
17	16	6.46	.865	.831	1032.88	107.53
17	17	6.46	.955	.831	1032.89	95.11
17	18	6.46	1.045	.831	1033.02	74.67
17	19	6.46	1.130	.739	1033.47	35.95
17	20	6.46	1.215	.831	1033.92	14.29
17	21	6.46	1.305	.831	1034.00	8.06
17	22	6.46	1.395	.831	1034.01	5.17
17	23	6.46	1.480	.739	1034.03	2.24
17	24	6.46	1.565	.831	1034.07	.13
17	25	6.46	1.655	.831	1034.19	-.75
17	26	6.46	1.740	.739	1034.30	.61
17	27	6.46	1.825	.831	1034.32	1.82
17	28	6.46	1.915	.831	1034.33	2.71
17	29	6.46	2.005	.831	1034.34	3.81
17	30	6.46	2.090	.739	1034.35	4.88
17	31	6.46	2.175	.831	1034.40	9.14
17	32	6.46	2.265	.831	1034.44	13.32
17	33	6.46	2.355	.831	1034.44	15.34
17	34	6.46	2.440	.739	1034.45	15.01
17	35	6.46	2.525	.831	1034.45	18.45
17	36	6.46	2.615	.831	1034.45	19.92
17	37	6.46	2.700	.739	1034.45	17.95
17	38	6.46	2.795	1.016	1034.43	23.32
17	39	6.46	2.905	1.016	1034.41	21.62
17	40	6.46	3.020	1.108	1034.41	23.24
17	41	6.46	3.110	.554	1034.41	11.88
18	1	7.53	.005	.149	1031.54	58.28
18	2	7.53	.030	.595	1031.48	238.62
18	3	7.53	.065	.446	1031.39	184.33
18	4	7.53	.100	.595	1031.31	251.42
18	5	7.53	.140	.595	1031.27	254.14
18	6	7.53	.180	.595	1031.24	254.93
18	7	7.53	.220	.595	1031.21	254.97
18	8	7.53	.260	.595	1031.17	255.71
18	9	7.53	.300	.595	1031.11	258.25
18	10	7.53	.355	1.041	1030.97	462.30
18	11	7.53	.435	1.339	1031.05	561.31
18	12	7.53	.520	1.190	1031.42	422.41
18	13	7.53	.605	1.339	1032.18	329.34
18	14	7.53	.695	1.339	1032.88	204.71
18	15	7.53	.780	1.190	1033.03	150.15
18	16	7.53	.865	1.339	1033.02	155.49
18	17	7.53	.955	1.339	1033.05	135.12
18	18	7.53	1.045	1.339	1033.19	103.84

18	19	7.53	1.130	1.190	1033.55	52.01
18	20	7.53	1.215	1.339	1033.89	24.67
18	21	7.53	1.305	1.339	1033.97	14.66
[illegible]	22	7.53	1.395	1.339	1033.98	9.40
[illegible]	23	7.53	1.480	1.190	1034.00	4.05
18	24	7.53	1.565	1.339	1034.05	.24
18	25	7.53	1.655	1.339	1034.16	-1.57
18	26	7.53	1.740	1.190	1034.27	.30
18	27	7.53	1.825	1.339	1034.30	1.77
18	28	7.53	1.915	1.339	1034.30	2.82
18	29	7.53	2.005	1.339	1034.32	4.37
18	30	7.53	2.090	1.190	1034.34	6.43
18	31	7.53	2.175	1.339	1034.38	13.05
18	32	7.53	2.265	1.339	1034.42	19.34
18	33	7.53	2.355	1.339	1034.43	22.44
18	34	7.53	2.440	1.190	1034.43	22.16
18	35	7.53	2.525	1.339	1034.44	27.35
18	36	7.53	2.615	1.339	1034.44	29.45
18	37	7.53	2.700	1.190	1034.43	26.87
18	38	7.53	2.795	1.637	1034.43	36.47
18	39	7.53	2.905	1.637	1034.42	35.45
18	40	7.53	3.020	1.785	1034.41	37.86
18	41	7.53	3.110	.893	1034.41	18.67
19	1	9.25	.005	.149	1032.31	41.68
19	2	9.25	.030	.595	1032.28	170.01
19	3	9.25	.065	.446	1032.22	130.61
19	4	9.25	.100	.595	1032.18	177.19
19	5	9.25	.140	.595	1032.16	178.39
[illegible]	6	9.25	.180	.595	1032.14	178.38
[illegible]	7	9.25	.220	.595	1032.13	177.82
19	8	9.25	.260	.595	1032.12	177.48
19	9	9.25	.300	.595	1032.08	178.09
19	10	9.25	.355	1.041	1032.01	316.32
19	11	9.25	.435	1.338	1032.01	393.30
19	12	9.25	.520	1.190	1032.16	312.77
19	13	9.25	.605	1.338	1032.61	261.42
19	14	9.25	.695	1.338	1033.07	177.00
19	15	9.25	.780	1.190	1033.17	132.38
19	16	9.25	.865	1.338	1033.17	136.21
19	17	9.25	.955	1.338	1033.20	118.51
19	18	9.25	1.045	1.338	1033.31	92.41
19	19	9.25	1.130	1.190	1033.60	48.57
19	20	9.25	1.215	1.338	1033.88	25.81
19	21	9.25	1.305	1.338	1033.94	16.09
19	22	9.25	1.395	1.338	1033.95	10.42
19	23	9.25	1.480	1.190	1033.97	4.55
19	24	9.25	1.565	1.338	1034.02	.27
19	25	9.25	1.655	1.338	1034.13	-2.08
19	26	9.25	1.740	1.190	1034.24	-.54
19	27	9.25	1.825	1.338	1034.27	.37
19	28	9.25	1.915	1.338	1034.27	.88
19	29	9.25	2.005	1.338	1034.28	1.88
19	30	9.25	2.090	1.190	1034.31	3.80
19	31	9.25	2.175	1.338	1034.35	10.01
[illegible]	32	9.25	2.265	1.338	1034.39	16.49
[illegible]	33	9.25	2.355	1.338	1034.41	19.62
19	34	9.25	2.440	1.190	1034.41	19.43
19	35	9.25	2.525	1.338	1034.41	23.78
19	36	9.25	2.615	1.338	1034.41	25.51
19	37	9.25	2.700	1.190	1034.41	23.69

19	38	9.25	2.795	1.636	1034.41	33.27
19	39	9.25	2.905	1.636	1034.41	33.46
19	40	9.25	3.020	1.784	1034.40	36.57
19	41	9.25	3.110	.892	1034.40	18.23
20	1	10.98	.005	.149	1032.78	31.77
20	2	10.98	.030	.595	1032.75	129.41
20	3	10.98	.065	.446	1032.71	99.17
20	4	10.98	.100	.595	1032.69	134.18
20	5	10.98	.140	.595	1032.67	134.88
20	6	10.98	.180	.595	1032.66	134.83
20	7	10.98	.220	.595	1032.65	134.42
20	8	10.98	.260	.595	1032.64	134.08
20	9	10.98	.300	.595	1032.62	134.22
20	10	10.98	.355	1.041	1032.57	237.25
20	11	10.98	.435	1.338	1032.56	296.57
20	12	10.98	.520	1.190	1032.64	240.58
20	13	10.98	.605	1.338	1032.93	210.44
20	14	10.98	.695	1.338	1033.23	152.47
20	15	10.98	.780	1.190	1033.30	116.93
20	16	10.98	.865	1.338	1033.29	121.03
20	17	10.98	.955	1.338	1033.31	105.99
20	18	10.98	1.045	1.338	1033.40	83.72
20	19	10.98	1.130	1.190	1033.64	45.59
20	20	10.98	1.215	1.338	1033.87	26.20
20	21	10.98	1.305	1.338	1033.93	17.01
20	22	10.98	1.395	1.338	1033.93	11.19
20	23	10.98	1.480	1.190	1033.94	4.96
20	24	10.98	1.565	1.338	1033.99	.31
20	25	10.98	1.655	1.338	1034.10	-2.56
20	26	10.98	1.740	1.190	1034.21	-1.38
20	27	10.98	1.825	1.338	1034.24	-1.10
20	28	10.98	1.915	1.338	1034.24	-1.20
20	29	10.98	2.005	1.338	1034.25	-.89
20	30	10.98	2.090	1.190	1034.27	.78
20	31	10.98	2.175	1.338	1034.32	6.42
20	32	10.98	2.265	1.338	1034.37	12.94
20	33	10.98	2.355	1.338	1034.38	15.86
20	34	10.98	2.440	1.190	1034.38	15.71
20	35	10.98	2.525	1.338	1034.38	19.12
20	36	10.98	2.615	1.338	1034.38	20.57
20	37	10.98	2.700	1.190	1034.39	19.72
20	38	10.98	2.795	1.636	1034.39	29.04
20	39	10.98	2.905	1.636	1034.39	30.26
20	40	10.98	3.020	1.784	1034.39	33.82
20	41	10.98	3.110	.892	1034.39	17.05
21	1	12.70	.005	.149	1033.08	25.32
21	2	12.70	.030	.595	1033.06	103.21
21	3	12.70	.065	.446	1033.03	79.08
21	4	12.70	.100	.595	1033.01	106.86
21	5	12.70	.140	.595	1033.00	107.33
21	6	12.70	.180	.595	1032.99	107.37
21	7	12.70	.220	.595	1032.98	107.31
21	8	12.70	.260	.595	1032.96	107.41
21	9	12.70	.300	.595	1032.94	107.96
21	10	12.70	.355	1.041	1032.90	191.81
21	11	12.70	.435	1.339	1032.88	241.81
21	12	12.70	.520	1.190	1032.93	197.68
21	13	12.70	.605	1.339	1033.15	176.10
21	14	12.70	.695	1.339	1033.37	132.20
21	15	12.70	.780	1.190	1033.41	103.85

21	16	12.70	.865	1.339	1033.39	109.57
21	17	12.70	.955	1.339	1033.39	97.27
21	18	12.70	1.045	1.339	1033.46	77.33
[illegible]	19	12.70	1.130	1.190	1033.68	42.82
2[illegible]	20	12.70	1.215	1.339	1033.88	25.80
21	21	12.70	1.305	1.339	1033.92	17.45
21	22	12.70	1.395	1.339	1033.91	11.85
21	23	12.70	1.480	1.190	1033.92	5.38
21	24	12.70	1.565	1.339	1033.96	.34
21	25	12.70	1.655	1.339	1034.08	-2.96
21	26	12.70	1.740	1.190	1034.19	-2.07
21	27	12.70	1.825	1.339	1034.21	-2.40
21	28	12.70	1.915	1.339	1034.21	-3.33
21	29	12.70	2.005	1.339	1034.21	-3.99
21	30	12.70	2.090	1.190	1034.23	-2.54
21	31	12.70	2.175	1.339	1034.29	2.70
21	32	12.70	2.265	1.339	1034.34	9.45
21	33	12.70	2.355	1.339	1034.35	12.10
21	34	12.70	2.440	1.190	1034.35	11.65
21	35	12.70	2.525	1.339	1034.35	13.61
21	36	12.70	2.615	1.339	1034.35	14.61
21	37	12.70	2.700	1.190	1034.36	15.20
21	38	12.70	2.795	1.637	1034.37	24.79
21	39	12.70	2.905	1.637	1034.38	27.20
21	40	12.70	3.020	1.785	1034.38	31.03
21	41	12.70	3.110	.893	1034.38	15.77
22	1	14.42	.005	.149	1033.30	20.64
22	2	14.42	.030	.595	1033.28	84.39
[illegible]	3	14.42	.065	.446	1033.25	64.72
[illegible]	4	14.42	.100	.595	1033.24	87.20
22	5	14.42	.140	.595	1033.23	87.16
22	6	14.42	.180	.595	1033.23	86.72
22	7	14.42	.220	.595	1033.23	86.17
22	8	14.42	.260	.595	1033.23	85.66
22	9	14.42	.300	.595	1033.22	85.27
22	10	14.42	.355	1.041	1033.20	148.65
22	11	14.42	.435	1.338	1033.22	181.23
22	12	14.42	.520	1.190	1033.30	143.42
22	13	14.42	.605	1.338	1033.42	133.27
22	14	14.42	.695	1.338	1033.52	109.55
22	15	14.42	.780	1.190	1033.54	87.75
22	16	14.42	.865	1.338	1033.54	90.26
22	17	14.42	.955	1.338	1033.57	76.42
22	18	14.42	1.045	1.338	1033.66	58.15
22	19	14.42	1.130	1.190	1033.79	34.13
22	20	14.42	1.215	1.338	1033.90	23.98
22	21	14.42	1.305	1.338	1033.93	16.58
22	22	14.42	1.395	1.338	1033.95	10.65
22	23	14.42	1.480	1.190	1033.98	4.41
22	24	14.42	1.565	1.338	1034.04	.25
22	25	14.42	1.655	1.338	1034.12	-2.32
22	26	14.42	1.740	1.190	1034.18	-2.23
22	27	14.42	1.825	1.338	1034.20	-2.79
[illegible]	28	14.42	1.915	1.338	1034.21	-3.03
[illegible]	29	14.42	2.005	1.338	1034.24	-2.08
22	30	14.42	2.090	1.190	1034.27	.49
22	31	14.42	2.175	1.338	1034.30	4.74
22	32	14.42	2.265	1.338	1034.33	8.92
22	33	14.42	2.355	1.338	1034.34	11.17
22	34	14.42	2.440	1.190	1034.35	11.64

22	35	14.42	2.525	1.338	1034.36	15.67
22	36	14.42	2.615	1.338	1034.37	18.20
22	37	14.42	2.700	1.190	1034.37	17.52
[illegible]	38	14.42	2.795	1.636	1034.38	25.45
[illegible]	39	14.42	2.905	1.636	1034.38	26.30
22	40	14.42	3.020	1.784	1034.38	29.25
22	41	14.42	3.110	.892	1034.38	14.71
23	1	16.15	.005	.149	1033.43	17.74
23	2	16.15	.030	.595	1033.41	72.77
23	3	16.15	.065	.446	1033.39	55.80
23	4	16.15	.100	.595	1033.39	74.65
23	5	16.15	.140	.595	1033.39	73.87
23	6	16.15	.180	.595	1033.40	72.71
23	7	16.15	.220	.595	1033.41	71.38
23	8	16.15	.260	.595	1033.42	69.91
23	9	16.15	.300	.595	1033.43	68.24
23	10	16.15	.355	1.041	1033.44	114.87
23	11	16.15	.435	1.338	1033.49	134.51
23	12	16.15	.520	1.190	1033.56	104.51
23	13	16.15	.605	1.338	1033.60	105.05
23	14	16.15	.695	1.338	1033.62	95.28
23	15	16.15	.780	1.190	1033.64	75.73
23	16	16.15	.865	1.338	1033.67	73.35
23	17	16.15	.955	1.338	1033.74	58.51
23	18	16.15	1.045	1.338	1033.81	43.64
23	19	16.15	1.130	1.190	1033.87	28.95
23	20	16.15	1.215	1.338	1033.90	24.15
23	21	16.15	1.305	1.338	1033.94	16.48
[illegible]	22	16.15	1.395	1.338	1033.98	9.64
[illegible]	23	16.15	1.480	1.190	1034.03	3.61
[illegible]	24	16.15	1.565	1.338	1034.09	.20
23	25	16.15	1.655	1.338	1034.13	-2.18
23	26	16.15	1.740	1.190	1034.15	-3.13
23	27	16.15	1.825	1.338	1034.18	-4.06
23	28	16.15	1.915	1.338	1034.21	-3.58
23	29	16.15	2.005	1.338	1034.24	-1.51
23	30	16.15	2.090	1.190	1034.28	1.39
23	31	16.15	2.175	1.338	1034.30	3.88
23	32	16.15	2.265	1.338	1034.31	5.54
23	33	16.15	2.355	1.338	1034.32	7.61
23	34	16.15	2.440	1.190	1034.33	9.33
23	35	16.15	2.525	1.338	1034.35	14.41
23	36	16.15	2.615	1.338	1034.37	17.60
23	37	16.15	2.700	1.190	1034.36	16.06
23	38	16.15	2.795	1.636	1034.36	21.08
23	39	16.15	2.905	1.636	1034.35	20.40
23	40	16.15	3.020	1.784	1034.35	22.01
23	41	16.15	3.110	.892	1034.35	10.93
24	1	17.87	.005	.149	1033.52	15.92
24	2	17.87	.030	.595	1033.49	66.42
24	3	17.87	.065	.446	1033.45	51.75
24	4	17.87	.100	.595	1033.44	69.71
24	5	17.87	.140	.595	1033.45	69.10
24	6	17.87	.180	.595	1033.45	68.09
[illegible]	7	17.87	.220	.595	1033.46	66.95
[illegible]	8	17.87	.260	.595	1033.47	65.67
24	9	17.87	.300	.595	1033.48	64.25
24	10	17.87	.355	1.041	1033.49	108.76
24	11	17.87	.435	1.339	1033.51	131.45
24	12	17.87	.520	1.190	1033.54	107.33

24	13	17.87	.605	1.339	1033.57	109.88
24	14	17.87	.695	1.339	1033.60	98.04
24	15	17.87	.780	1.190	1033.63	76.81
24	16	17.87	.865	1.339	1033.67	74.29
[illegible]	17	17.87	.955	1.339	1033.71	61.46
[illegible]	18	17.87	1.045	1.339	1033.75	49.02
24	19	17.87	1.130	1.190	1033.80	33.83
24	20	17.87	1.215	1.339	1033.84	28.32
24	21	17.87	1.305	1.339	1033.88	19.34
24	22	17.87	1.395	1.339	1033.92	11.52
24	23	17.87	1.480	1.190	1033.96	4.67
24	24	17.87	1.565	1.339	1034.00	.29
24	25	17.87	1.655	1.339	1034.04	-3.61
24	26	17.87	1.740	1.190	1034.07	-5.49
24	27	17.87	1.825	1.339	1034.10	-7.76
24	28	17.87	1.915	1.339	1034.13	-8.53
24	29	17.87	2.005	1.339	1034.16	-8.37
24	30	17.87	2.090	1.190	1034.18	-6.60
24	31	17.87	2.175	1.339	1034.21	-6.15
24	32	17.87	2.265	1.339	1034.22	-4.75
24	33	17.87	2.355	1.339	1034.24	-3.18
24	34	17.87	2.440	1.190	1034.25	-1.24
24	35	17.87	2.525	1.339	1034.26	.44
24	36	17.87	2.615	1.339	1034.27	2.01
24	37	17.87	2.700	1.190	1034.28	2.70
24	38	17.87	2.795	1.637	1034.28	4.47
24	39	17.87	2.905	1.637	1034.28	4.93
24	40	17.87	3.020	1.785	1034.28	5.61
24	41	17.87	3.110	.893	1034.28	2.84
[illegible]	1	19.59	.005	.149	1033.56	15.04
[illegible]	2	19.59	.030	.595	1033.54	62.16
25	3	19.59	.065	.446	1033.51	48.14
25	4	19.59	.100	.595	1033.50	65.06
25	5	19.59	.140	.595	1033.49	65.02
25	6	19.59	.180	.595	1033.49	64.59
25	7	19.59	.220	.595	1033.50	63.92
25	8	19.59	.260	.595	1033.50	63.04
25	9	19.59	.300	.595	1033.50	61.97
25	10	19.59	.355	1.041	1033.51	105.49
25	11	19.59	.435	1.338	1033.52	128.78
25	12	19.59	.520	1.190	1033.55	106.43
25	13	19.59	.605	1.338	1033.57	109.58
25	14	19.59	.695	1.338	1033.60	98.26
25	15	19.59	.780	1.190	1033.63	77.12
25	16	19.59	.865	1.338	1033.66	74.97
25	17	19.59	.955	1.338	1033.70	62.73
25	18	19.59	1.045	1.338	1033.74	50.82
25	19	19.59	1.130	1.190	1033.77	35.57
25	20	19.59	1.215	1.338	1033.81	30.08
25	21	19.59	1.305	1.338	1033.85	20.75
25	22	19.59	1.395	1.338	1033.89	12.54
25	23	19.59	1.480	1.190	1033.93	5.20
25	24	19.59	1.565	1.338	1033.96	.33
25	25	19.59	1.655	1.338	1034.00	-4.29
25	26	19.59	1.740	1.190	1034.03	-6.70
[illegible]	27	19.59	1.825	1.338	1034.06	-9.82
25	28	19.59	1.915	1.338	1034.09	-11.37
25	29	19.59	2.005	1.338	1034.11	-12.08
25	30	19.59	2.090	1.190	1034.14	-10.65
25	31	19.59	2.175	1.338	1034.16	-11.41

25	32	19.59	2.265	1.338	1034.18	-10.58
25	33	19.59	2.355	1.338	1034.19	-9.53
25	34	19.59	2.440	1.190	1034.20	-7.39
25	35	19.59	2.525	1.338	1034.22	-7.06
[illegible]	36	19.59	2.615	1.338	1034.23	-5.87
[illegible]	37	19.59	2.700	1.190	1034.23	-4.24
25	38	19.59	2.795	1.636	1034.24	-4.59
25	39	19.59	2.905	1.636	1034.25	-3.55
25	40	19.59	3.020	1.784	1034.25	-3.19
25	41	19.59	3.110	.892	1034.25	-1.43
26	1	21.32	.005	.149	1033.56	15.07
26	2	21.32	.030	.595	1033.56	60.44
26	3	21.32	.065	.446	1033.55	45.46
26	4	21.32	.100	.595	1033.55	60.71
26	5	21.32	.140	.595	1033.55	60.62
26	6	21.32	.180	.595	1033.55	60.33
26	7	21.32	.220	.595	1033.55	59.83
26	8	21.32	.260	.595	1033.55	59.11
26	9	21.32	.300	.595	1033.55	58.21
26	10	21.32	.355	1.041	1033.56	99.24
26	11	21.32	.435	1.338	1033.57	121.45
26	12	21.32	.520	1.190	1033.58	100.67
26	13	21.32	.605	1.338	1033.61	103.85
26	14	21.32	.695	1.338	1033.63	93.20
26	15	21.32	.780	1.190	1033.66	73.19
26	16	21.32	.865	1.338	1033.69	71.22
26	17	21.32	.955	1.338	1033.72	59.69
26	18	21.32	1.045	1.338	1033.76	48.49
26	19	21.32	1.130	1.190	1033.80	34.02
26	20	21.32	1.215	1.338	1033.83	28.81
[illegible]	21	21.32	1.305	1.338	1033.87	19.90
26	22	21.32	1.395	1.338	1033.90	12.05
26	23	21.32	1.480	1.190	1033.94	5.01
26	24	21.32	1.565	1.338	1033.97	.32
26	25	21.32	1.655	1.338	1034.01	-4.15
26	26	21.32	1.740	1.190	1034.04	-6.50
26	27	21.32	1.825	1.338	1034.06	-9.53
26	28	21.32	1.915	1.338	1034.09	-11.04
26	29	21.32	2.005	1.338	1034.12	-11.75
26	30	21.32	2.090	1.190	1034.14	-10.39
26	31	21.32	2.175	1.338	1034.16	-11.14
26	32	21.32	2.265	1.338	1034.18	-10.30
26	33	21.32	2.355	1.338	1034.19	-9.20
26	34	21.32	2.440	1.190	1034.21	-7.05
26	35	21.32	2.525	1.338	1034.22	-6.61
26	36	21.32	2.615	1.338	1034.23	-5.33
26	37	21.32	2.700	1.190	1034.24	-3.66
26	38	21.32	2.795	1.636	1034.24	-3.65
26	39	21.32	2.905	1.636	1034.25	-2.41
26	40	21.32	3.020	1.784	1034.25	-1.75
26	41	21.32	3.110	.892	1034.26	-.66
27	1	23.04	.005	.074	1033.56	7.52
27	2	23.04	.030	.298	1033.56	30.04
27	3	23.04	.065	.223	1033.56	22.47
27	4	23.04	.100	.298	1033.56	29.85
[illegible]	5	23.04	.140	.298	1033.56	29.69
27	6	23.04	.180	.298	1033.56	29.48
27	7	23.04	.220	.298	1033.56	29.19
27	8	23.04	.260	.298	1033.57	28.82
27	9	23.04	.300	.298	1033.57	28.37

27	10	23.04	.355	.521	1033.57	48.37
27	11	23.04	.435	.670	1033.58	59.21
27	12	23.04	.520	.595	1033.60	49.12
[illegible]	13	23.04	.605	.670	1033.62	50.72
[illegible]	14	23.04	.695	.670	1033.65	45.54
27	15	23.04	.780	.595	1033.67	35.78
27	16	23.04	.865	.670	1033.70	34.82
27	17	23.04	.955	.670	1033.74	29.21
27	18	23.04	1.045	.670	1033.77	23.75
27	19	23.04	1.130	.595	1033.81	16.68
27	20	23.04	1.215	.670	1033.84	14.13
27	21	23.04	1.305	.670	1033.88	9.77
27	22	23.04	1.395	.670	1033.91	5.91
27	23	23.04	1.480	.595	1033.94	2.46
27	24	23.04	1.565	.670	1033.98	.16
27	25	23.04	1.655	.670	1034.01	-2.04
27	26	23.04	1.740	.595	1034.04	-3.20
27	27	23.04	1.825	.670	1034.07	-4.68
27	28	23.04	1.915	.670	1034.09	-5.42
27	29	23.04	2.005	.670	1034.12	-5.76
27	30	23.04	2.090	.595	1034.14	-5.09
27	31	23.04	2.175	.670	1034.16	-5.44
27	32	23.04	2.265	.670	1034.18	-5.01
27	33	23.04	2.355	.670	1034.20	-4.44
27	34	23.04	2.440	.595	1034.21	-3.35
27	35	23.04	2.525	.670	1034.22	-3.07
27	36	23.04	2.615	.670	1034.23	-2.41
27	37	23.04	2.700	.595	1034.24	-1.59
[illegible]	38	23.04	2.795	.818	1034.25	-1.48
[illegible]	39	23.04	2.905	.818	1034.25	-.84
27	40	23.04	3.020	.893	1034.26	-.45
27	41	23.04	3.110	.446	1034.26	-.11

Weld Elevation = .000 in
Asymmetric Load = 119955. Lbs
Moment = 878862. Ft-Lbs

TO: George Inch
From: Hwang Choe

Part (I)

GE Nuclear Energy
Engineering Calculation Sheet

Subject	NMP1 shroud	Originator Josué Villalta	Date
Number		Verifier	Date

Input needed for Excel spreadsheet to Calculate Blowdown load on NMP1 shroud from Recirc. line break

✓ b = 16 in (shroud bottom to center of recirc. suction nozzle)
✓ y_{max} = 423.75 in (shroud dome elevation from vessel 0)
✓ D = 179 in (shroud O.D)
✓ W = 34 in (annulus gap)
✓ d = 25.154 in (recirc. suction nozzle I.D.)

✓ $G_c = 8500 \frac{lbm}{ft^2 \cdot sec}$ (Critical subcooled Blowdown Mass Flux based on FSAR Normal operating conditions 100% power / 100% flow

y (H6A) = 178.125 in
y (H3) = 345.75 in
} elevation of welds from vessel 0

y (Shroud bottom) = 152 in from vessel 0

GE Nuclear Energy
Engineering Calculation Sheet

Subject	Blowdown Load	Originator	Date
Number	NMP1	Verifier	Date

The blowdown load is analyzed by ① examining expected flow pattern near the suction nozzle, ② Potential flow modeling assuming constant pressure across the downcomer annulus gap and using two-dimension flow sinks (this is a very good approximation away from the suction nozzle, and ③ Potential flow modeling using three-dimensional flow sinks to simulate a point sink in front of an infinite plate

Figure 1 shows the expected flow pattern. This shows that the static pressure on the shroud wall would be quite different from the static pressure on the RPV wall or suction nozzle as the flow approaches the suction nozzle. For this reason, the static pressure below H5 near the suction nozzle is assumed to be constant & is approximately the same as at H5. Inside the flow separation region, velocity is very low and pressure does not vary much.

A. 2-D Potential Flow Model.

Assumptions

① Viscosity effect is ignored. It is a small effect.

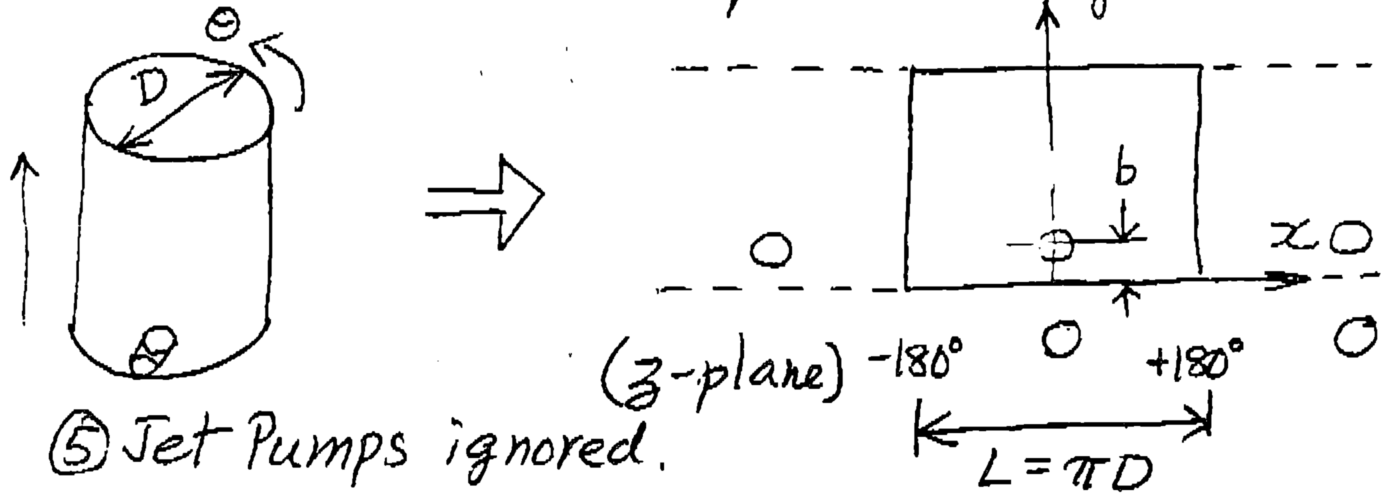
② Annulus gap is assumed to be constant, the same as at H5. Actual annulus gap changes, but the constant gap assumption provides an accurate result for the blowdown load for the shroud assembly above H5. The annulus gap change at H3 does not affect the resu[lt] much because H3 is far enough away from the suction nozzle.

③ All flow properties ($p, \vec{V}$) are constant across the annulus gap.

GE Nuclear Energy
Engineering Calculation Sheet

Subject | Originator | Date
Number | Verifier | Date

④ The annulus is modeled as a repeated two dimensional plane



⑤ Jet Pumps ignored.

For two-dimensional potential flows, complex potential function can be used. For the flow sinks with strength, q, separated by π, and located at $\pm n\pi$ on x-axis, we have

$$\phi = -\frac{q}{2\pi} \log \sin z, \quad z = x + iy$$

when our problem is approximated by flow sinks located at $(\pm n\pi, b)$ and $(\pm n\pi, -b)$ to satisfy the boundary condition at the jet pump base plate,

Subject	Originator	Date
Number	Verifier	Date

we have

$$\phi = -\frac{Q/W}{2\pi}\left\{\log \sin\left[\frac{\pi}{L}(z-bi)\right] + \log \sin\left[\frac{\pi}{L}(z+bi)\right]\right\}$$

where

Q = Total volume flow (ft^3/sec)

W = annulus gap (ft)

q = volume flow / unit thickness $ft^3/sec/ft$

Now $\bar{V} = V_x - iV_y = \frac{d\phi}{dz}$

$$\therefore \bar{V} = -\frac{Q/W}{2\pi D}\left\{\cot\left(\frac{z-bi}{D}\right) + \cot\left(\frac{z+bi}{D}\right)\right\}$$

$$= -\frac{V_\infty}{4}\left\{\frac{\sin\left(\frac{2x}{D}\right) - i\sinh\left\{\frac{2(y-b)}{D}\right\}}{\sin^2\left(\frac{x}{D}\right) + \sinh^2\left(\frac{y-b}{D}\right)} + \frac{\sin\left(\frac{2x}{D}\right) - i\sinh\left\{\frac{2(y+b)}{D}\right\}}{\sin^2\left(\frac{x}{D}\right) + \sinh^2\left(\frac{y+b}{D}\right)}\right\}$$

The following relations were used in the above calculation

$$\cot(x+iy) = \frac{1}{2}\,\frac{\sin 2x - i\sinh 2y}{\sin^2 x + \sinh^2 y}$$

$$V_\infty = \frac{Q}{\pi D W}$$

Now $P_0 = P_s + \rho\frac{V^2}{2g_c}$

GE Nuclear Energy
Engineering Calculation Sheet

Subject	Originator	Date
Number	Verifier	Date

$$\therefore \quad P_o - P_s = \frac{\rho V^2}{2 g_c} = \frac{\rho V_\infty^2}{2 g_c}\left(\frac{V^2}{V_\infty^2}\right)$$

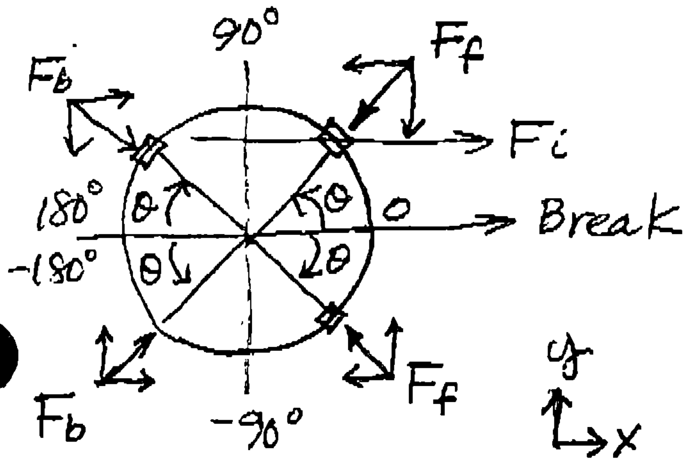
Now

$$\frac{P_o - P_s}{\left(\frac{\rho V_\infty^2}{2 g_c}\right)} = \left(\frac{V}{V_\infty}\right)^2$$, non-dimensionalized pressure distribution

$$= \frac{V_x^2 + V_y^2}{V_\infty^2}$$

$\left(\frac{V}{V_\infty}\right)^2$ is calculated at 10° interval in the annulus (x-direction), and with the same interval in y-direction. This is shown on pages 1 and 3 of the spread sheet.

The pressure obtained is integrated to calculate the net force. Due to the symmetry with respect to (0°-180°) y-direction forces all cancels out, and the net x-direction forces are calculated.



$$F_i = (F_b - F_f)\cos\theta$$

Subject | Originator | Date
Number | Verifier | Date

The pressure is integrated above H5 and below H5 separately for each 10° segment, and the total resulting force is calculated for the shroud above H5 and below H5. The result is shown in pages 5 and 7.

$$F(180^\circ\ half) = \int_{HALF}\int_{H5}^{TOP}(p\,dy)\cdot\cos\theta\cdot dx$$

$$\simeq \sum (F_b - F_F)_i \cos\theta_i = \sum F_i$$

In order to calculate the application pt of the force, the moment is calculated with the axis of rotation at H5.

$$Moment = F\cdot Y$$

$$= \int_{HALF}\int_{H5}^{TOP}(p\,y\,dy)\,dx\cos\theta$$

For each 10° section,

$$\int_{H5}^{TOP} p\,y\,dy = y_i \underbrace{\int_{H5}^{TOP} p\,dy}_{F_i} = y_i F_i$$

y_i = moment arm for each 10° section.

GE Nuclear Energy
Engineering Calculation Sheet

Subject		Originator	Date
Number		Verifier	Date

∴ Moment = F · Y

$\simeq \Sigma F_i y_i$

and $Y = \dfrac{\Sigma F_i y_i}{F}$

This result is shown in spread sheet pages 6 and 8.

Summary of Results

F = 17.2 Kips above H5

Y = 61.7 inches

Moment = 1060 Kips-inches

Note: QC & Dresden Restoring Moment after ΔP inside the shroud and Seismic acceleration (upward) are considered

QC: 37 Kips x 100 inches = 3700 Kips-in

Dresden: 75 Kips x 100 in = 7500 Kips-in

TO: George Inch
From: Hwang Choe

~~Part (I)~~
part (II)

			C1(pi/36) =	0.087		D (inches) =	179.000	b (inches) =	16.000
	X/D =		Y (H5, inch) =	178.125	Y(H3,inch)=	350.750	Ymax(inch)=	423.750	Y(H5)/D =
ANGLE (DEG)	0	10	20	30	40	50	60	70	80
Y/D =	0.000	0.087	0.175	0.262	0.349	0.436	0.524	0.611	0.698
0.000	0.000	30.948	20.078	11.112	6.612	4.213	2.817	1.944	1.367
0.087	54335.397	51.216	19.855	10.635	6.388	4.114	2.773	1.926	1.361
0.175	61.225	33.483	16.060	9.177	5.772	3.841	2.652	1.876	1.346
0.262	19.452	16.130	10.924	7.253	4.942	3.461	2.477	1.801	1.323
0.349	10.119	9.253	7.393	5.559	4.115	3.051	2.278	1.712	1.293
0.436	6.429	6.096	5.278	4.310	3.414	2.670	2.079	1.619	1.262
0.524	4.573	4.412	3.990	3.436	2.865	2.344	1.898	1.529	1.229
0.611	3.502	3.412	3.169	2.827	2.449	2.079	1.741	1.448	1.198
0.698	2.827	2.772	2.619	2.395	2.135	1.866	1.610	1.376	1.170
0.785	2.375	2.339	2.237	2.083	1.897	1.698	1.501	1.314	1.145
0.873	2.059	2.034	1.962	1.852	1.716	1.565	1.411	1.262	1.123
0.960	1.829	1.811	1.759	1.678	1.575	1.460	1.339	1.218	1.104
1.047	1.658	1.644	1.605	1.544	1.466	1.375	1.279	1.182	1.087
1.134	1.527	1.517	1.487	1.440	1.379	1.308	1.231	1.152	1.073
1.222	1.426	1.418	1.395	1.358	1.310	1.253	1.191	1.127	1.062
1.309	1.347	1.341	1.322	1.293	1.255	1.209	1.159	1.106	1.052
1.396	1.284	1.279	1.264	1.241	1.210	1.173	1.132	1.088	1.044
1.484	1.233	1.229	1.218	1.199	1.174	1.144	1.110	1.074	1.037
1.518	1.216	1.212	1.202	1.184	1.161	1.133	1.102	1.069	1.034
1.571	1.192	1.189	1.180	1.164	1.144	1.119	1.092	1.062	1.031
1.658	1.159	1.157	1.149	1.136	1.120	1.099	1.076	1.052	1.026
1.745	1.132	1.130	1.124	1.113	1.100	1.083	1.064	1.043	1.022
1.833	1.110	1.108	1.103	1.094	1.083	1.069	1.053	1.036	1.018
3.665	1.003	1.003	1.003	1.002	1.002	1.002	1.001	1.001	1.000
Gm =	8500.000	lbm/sec.ft^2		A (ft^2) =	3.451		mdot(lm/sec) =	29333.242	
A(anl.,ft^2)=	66.388	V (ft/sec) =	9.421	VHead(psi) =	0.449		rho(lm/ft^3) =	46.900	
		v (ft/sec) =	181.237	VHead(psi) =	166.118		Q (ft^3/sec) =	625.442	
OWDOWN F	55742.436	lmf		ratio =	370.080				

		STREAM FUNCTION DIVIDED BY Q/W							
	X/D =								
ANGLE (DEG)	0	10	20	30	40	50	60	70	80
Y/D =	0.000	0.087	0.175	0.262	0.349	0.436	0.524	0.611	0.698
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.087	0.000	0.172	0.122	0.091	0.070	0.056	0.046	0.038	0.032
0.175	0.500	0.321	0.226	0.171	0.135	0.109	0.090	0.075	0.064
0.262	0.500	0.384	0.296	0.233	0.189	0.156	0.130	0.110	0.093
0.349	0.500	0.414	0.339	0.279	0.232	0.195	0.165	0.140	0.119
0.436	0.500	0.431	0.367	0.312	0.265	0.226	0.194	0.167	0.143
0.524	0.500	0.441	0.385	0.335	0.291	0.252	0.219	0.190	0.164
0.611	0.500	0.448	0.399	0.352	0.310	0.273	0.239	0.209	0.182
0.698	0.500	0.454	0.408	0.365	0.326	0.289	0.255	0.225	0.197
0.785	0.500	0.457	0.416	0.375	0.337	0.302	0.269	0.238	0.210
0.873	0.500	0.460	0.421	0.383	0.347	0.312	0.280	0.250	0.221
0.960	0.500	0.463	0.425	0.389	0.354	0.321	0.289	0.259	0.230
1.047	0.500	0.464	0.429	0.394	0.361	0.328	0.297	0.267	0.238
1.134	0.500	0.466	0.432	0.398	0.365	0.334	0.303	0.273	0.244
1.222	0.500	0.467	0.434	0.401	0.370	0.338	0.308	0.278	0.250
1.309	0.500	0.468	0.436	0.404	0.373	0.342	0.312	0.283	0.254
1.396	0.500	0.469	0.437	0.406	0.376	0.345	0.316	0.287	0.258
1.484	0.500	0.469	0.438	0.408	0.378	0.348	0.319	0.290	0.261
1.518	0.500	0.469	0.439	0.409	0.379	0.349	0.320	0.291	0.262
1.571	0.500	0.470	0.439	0.409	0.380	0.350	0.321	0.292	0.264
1.658	0.500	0.470	0.440	0.411	0.381	0.352	0.323	0.294	0.266
1.745	0.500	0.470	0.441	0.412	0.382	0.353	0.325	0.296	0.268
1.833	0.500	0.471	0.442	0.412	0.383	0.355	0.326	0.298	0.270
3.665	0.500	0.472	0.444	0.417	0.389	0.361	0.333	0.305	0.278
		Modified Stream Function							
	X/D =								
ANGLE (DEG)	0	10	20	30	40	50	60	70	80
Y/D =	0.000	0.087	0.175	0.262	0.349	0.436	0.524	0.611	0.698

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.087	0.000	6.203	4.407	3.267	2.532	2.029	1.664	1.385	1.163
0.175	18.000	11.542	8.137	6.150	4.846	3.927	3.244	2.714	2.287
0.262	18.000	13.833	10.649	8.405	6.796	5.600	4.678	3.943	3.341
0.349	18.000	14.902	12.208	10.045	8.348	7.006	5.928	5.043	4.301
0.436	18.000	15.502	13.206	11.217	9.546	8.154	6.989	6.003	5.156
0.524	18.000	15.882	13.878	12.063	10.465	9.076	7.872	6.824	5.904
0.611	18.000	16.141	14.352	12.686	11.171	9.811	8.599	7.517	6.548
0.698	18.000	16.327	14.699	13.156	11.719	10.399	9.195	8.098	7.098
0.785	18.000	16.464	14.961	13.516	12.149	10.870	9.683	8.583	7.564
0.873	18.000	16.569	15.161	13.796	12.489	11.250	10.082	8.985	7.957
0.960	18.000	16.651	15.318	14.017	12.761	11.557	10.410	9.320	8.287
1.047	18.000	16.715	15.442	14.194	12.980	11.807	10.679	9.598	8.564
1.134	18.000	16.766	15.542	14.336	13.157	12.011	10.901	9.829	8.796
1.222	18.000	16.807	15.622	14.451	13.302	12.179	11.085	10.022	8.991
1.309	18.000	16.840	15.687	14.545	13.421	12.317	11.236	10.182	9.154
1.396	18.000	16.868	15.740	14.622	13.518	12.431	11.362	10.316	9.291
1.484	18.000	16.890	15.784	14.686	13.598	12.525	11.467	10.427	9.405
1.518	18.000	16.898	15.799	14.708	13.626	12.558	11.504	10.466	9.445

EA1_RLB

EA1_RLB.XLS

b/D =	0.089	W (inches) =	17.000	d (inches) =	25.154				
0.146	Y(H3)/D =	1.110	Ymax/D =	1.518					
90	100	110	120	130	140	150	160	170	180
0.785	0.873	0.960	1.047	1.134	1.222	1.309	1.396	1.484	1.571
0.969	0.685	0.479	0.326	0.213	0.130	0.071	0.031	0.008	0.000
0.970	0.689	0.485	0.333	0.220	0.137	0.078	0.038	0.015	0.007
0.972	0.701	0.501	0.352	0.241	0.159	0.100	0.060	0.037	0.029
0.976	0.720	0.528	0.383	0.274	0.193	0.135	0.095	0.072	0.065
0.980	0.742	0.561	0.423	0.317	0.238	0.180	0.141	0.118	0.111
0.984	0.768	0.599	0.468	0.367	0.290	0.234	0.196	0.174	0.166
0.988	0.794	0.639	0.517	0.421	0.348	0.294	0.257	0.235	0.228
0.991	0.819	0.680	0.567	0.478	0.408	0.357	0.321	0.300	0.293
0.993	0.843	0.718	0.616	0.533	0.469	0.420	0.387	0.367	0.360
0.995	0.865	0.755	0.662	0.587	0.528	0.483	0.451	0.432	0.426
0.996	0.884	0.788	0.706	0.638	0.583	0.542	0.513	0.496	0.490
0.997	0.902	0.817	0.745	0.684	0.635	0.598	0.571	0.555	0.550
0.998	0.916	0.843	0.780	0.726	0.683	0.649	0.625	0.611	0.606
0.999	0.929	0.866	0.811	0.764	0.725	0.695	0.674	0.661	0.657
0.999	0.940	0.886	0.839	0.798	0.764	0.737	0.718	0.706	0.703
0.999	0.949	0.904	0.862	0.827	0.797	0.774	0.757	0.747	0.744
1.000	0.957	0.918	0.883	0.852	0.827	0.806	0.792	0.783	0.780
1.000	0.964	0.931	0.901	0.874	0.852	0.834	0.822	0.814	0.811
1.000	0.966	0.935	0.907	0.882	0.861	0.845	0.833	0.825	0.823
1.000	0.970	0.942	0.916	0.893	0.874	0.859	0.848	0.841	0.839
1.000	0.975	0.951	0.929	0.910	0.893	0.880	0.871	0.865	0.863
1.000	0.979	0.958	0.940	0.923	0.910	0.898	0.890	0.885	0.884
1.000	0.982	0.965	0.949	0.935	0.923	0.914	0.907	0.903	0.901
1.000	1.000	0.999	0.999	0.998	0.998	0.998	0.998	0.997	0.997

90	100	110	120	130	140	150	160	170	180
0.785	0.873	0.960	1.047	1.134	1.222	1.309	1.396	1.484	1.571
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.027	0.023	0.019	0.016	0.013	0.010	0.007	0.005	0.002	0.000
0.054	0.045	0.038	0.031	0.025	0.020	0.015	0.010	0.005	0.000
0.079	0.067	0.056	0.046	0.037	0.029	0.022	0.014	0.007	0.000
0.102	0.086	0.073	0.060	0.049	0.038	0.028	0.019	0.009	0.000
0.123	0.105	0.088	0.073	0.060	0.047	0.035	0.023	0.011	0.000
0.141	0.121	0.103	0.086	0.070	0.055	0.040	0.027	0.013	0.000
0.158	0.136	0.115	0.096	0.079	0.062	0.046	0.030	0.015	0.000
0.172	0.148	0.126	0.106	0.087	0.068	0.051	0.034	0.017	0.000
0.184	0.159	0.136	0.115	0.094	0.074	0.055	0.036	0.018	0.000
0.194	0.169	0.145	0.122	0.100	0.079	0.059	0.039	0.019	0.000
0.203	0.177	0.152	0.129	0.106	0.084	0.062	0.041	0.021	0.000
0.210	0.184	0.159	0.134	0.111	0.088	0.065	0.043	0.022	0.000
0.217	0.190	0.164	0.139	0.115	0.091	0.068	0.045	0.023	0.000
0.222	0.195	0.169	0.143	0.119	0.094	0.070	0.047	0.023	0.000
0.226	0.199	0.173	0.147	0.122	0.097	0.072	0.048	0.024	0.000
0.230	0.203	0.176	0.150	0.124	0.099	0.074	0.049	0.025	0.000
0.233	0.206	0.179	0.153	0.127	0.101	0.075	0.050	0.025	0.000
0.234	0.207	0.180	0.154	0.127	0.102	0.076	0.050	0.025	0.000
0.236	0.209	0.182	0.155	0.128	0.102	0.077	0.051	0.025	0.000
0.238	0.211	0.184	0.157	0.130	0.104	0.078	0.052	0.026	0.000
0.240	0.213	0.185	0.158	0.131	0.105	0.079	0.052	0.026	0.000
0.242	0.214	0.187	0.160	0.133	0.106	0.079	0.053	0.026	0.000
0.250	0.222	0.194	0.166	0.139	0.111	0.083	0.055	0.028	0.000
90	100	110	120	130	140	150	160	170	180
0.785	0.873	0.960	1.047	1.134	1.222	1.309	1.396	1.484	1.571

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.980	0.824	0.689	0.569	0.460	0.360	0.265	0.174	0.087	0.000
1.932	1.629	1.364	1.128	0.913	0.713	0.526	0.346	0.172	0.000
2.833	2.396	2.011	1.665	1.349	1.056	0.779	0.513	0.255	0.000
3.666	3.112	2.619	2.173	1.764	1.382	1.020	0.672	0.334	0.000
4.419	3.767	3.180	2.646	2.151	1.688	1.247	0.823	0.409	0.000
5.088	4.356	3.691	3.078	2.508	1.971	1.458	0.962	0.478	0.000
5.674	4.879	4.148	3.469	2.833	2.230	1.651	1.091	0.543	0.000
6.182	5.337	4.553	3.819	3.125	2.463	1.827	1.208	0.601	0.000
6.618	5.736	4.909	4.127	3.385	2.672	1.984	1.313	0.654	0.000
6.990	6.080	5.218	4.398	3.614	2.858	2.124	1.407	0.701	0.000
7.306	6.374	5.485	4.634	3.814	3.020	2.248	1.490	0.742	0.000
7.574	6.626	5.715	4.838	3.988	3.163	2.356	1.563	0.779	0.000
7.801	6.840	5.912	5.013	4.139	3.286	2.450	1.626	0.811	0.000
7.992	7.022	6.081	5.164	4.269	3.393	2.532	1.681	0.839	0.000
8.152	7.176	6.224	5.292	4.380	3.485	2.602	1.729	0.863	0.000
8.288	7.306	6.345	5.402	4.476	3.563	2.662	1.770	0.883	0.000
8.402	7.416	6.448	5.495	4.557	3.630	2.714	1.805	0.901	0.000
8.441	7.455	6.484	5.528	4.585	3.654	2.732	1.817	0.908	0.000

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0.536	1.007	0.372	0.723	0.251	0.466	0.155	0.228	0.074	
0.219		0.228		0.235		0.239		0.242	
0.036		0.021		0.011		0.005		0.001	
0.648	0.978	0.459	0.717	0.314	0.469	0.196	0.232	0.094	
0.244		0.257		0.266		0.272		0.275	
0.043		0.026		0.014		0.006		0.001	
0.753	0.931	0.542	0.694	0.375	0.459	0.237	0.228	0.114	
0.268		0.284		0.295		0.302		0.306	
0.050		0.030		0.016		0.007		0.002	
0.851	0.873	0.621	0.658	0.434	0.440	0.276	0.220	0.134	
0.289		0.308		0.321		0.330		0.335	
0.057		0.035		0.019		0.008		0.002	
0.941	0.809	0.694	0.616	0.490	0.414	0.313	0.208	0.153	
0.308		0.329		0.345		0.355		0.361	
0.063		0.039		0.021		0.009		0.002	
1.023	0.744	0.762	0.570	0.542	0.385	0.348	0.194	0.170	
0.325		0.349		0.366		0.378		0.385	
0.068		0.043		0.024		0.010		0.003	
1.099	0.680	0.824	0.523	0.589	0.355	0.380	0.179	0.186	
0.341		0.367		0.386		0.399		0.407	
0.073		0.046		0.026		0.011		0.003	
1.167	0.617	0.881	0.476	0.633	0.324	0.410	0.164	0.201	
0.355		0.384		0.404		0.418		0.426	
0.078		0.049		0.028		0.012		0.003	
1.228	0.557	0.932	0.431	0.673	0.293	0.437	0.149	0.215	
0.368		0.398		0.420		0.436		0.444	
0.082		0.052		0.029		0.013		0.003	
1.283	0.500	0.978	0.388	0.708	0.264	0.461	0.134	0.227	
0.380		0.412		0.435		0.451		0.461	
0.086		0.055		0.031		0.014		0.003	
1.333	0.448	1.019	0.347	0.740	0.237	0.483	0.120	0.238	
0.390		0.424		0.448		0.465		0.475	
0.089		0.057		0.032		0.014		0.004	
1.377	0.399	1.056	0.310	0.769	0.212	0.502	0.107	0.248	
0.399		0.434		0.460		0.478		0.488	
0.092		0.059		0.034		0.015		0.004	

1.393	0.381	1.070	0.296	0.780	0.202	0.510	0.103	0.252	
0.403		0.438		0.464		0.482		0.493	
0.093		0.060		0.034		0.015		0.004	
80	90	100	110	120	130	140	150	160	170
0.698	0.785	0.873	0.960	1.047	1.134	1.222	1.309	1.396	1.484
1.367	0.969	0.685	0.479	0.326	0.213	0.130	0.071	0.031	0.008
1.361	0.970	0.689	0.485	0.333	0.220	0.137	0.078	0.038	0.015
1.346	0.972	0.701	0.501	0.352	0.241	0.159	0.100	0.060	0.037
1.323	0.976	0.720	0.528	0.383	0.274	0.193	0.135	0.095	0.072
1.293	0.980	0.742	0.561	0.423	0.317	0.238	0.180	0.141	0.118
1.262	0.984	0.768	0.599	0.468	0.367	0.290	0.234	0.196	0.174
1.229	0.988	0.794	0.639	0.517	0.421	0.348	0.294	0.257	0.235
1.198	0.991	0.819	0.680	0.567	0.478	0.408	0.357	0.321	0.300
1.170	0.993	0.843	0.718	0.616	0.533	0.469	0.420	0.387	0.367
1.145	0.995	0.865	0.755	0.662	0.587	0.528	0.483	0.451	0.432
1.123	0.996	0.884	0.788	0.706	0.638	0.583	0.542	0.513	0.496
1.104	0.997	0.902	0.817	0.745	0.684	0.635	0.598	0.571	0.555
1.087	0.998	0.916	0.843	0.780	0.726	0.683	0.649	0.625	0.611
1.073	0.999	0.929	0.866	0.811	0.764	0.725	0.695	0.674	0.661
1.062	0.999	0.940	0.886	0.839	0.798	0.764	0.737	0.718	0.706
1.052	0.999	0.949	0.904	0.862	0.827	0.797	0.774	0.757	0.747
1.044	1.000	0.957	0.918	0.883	0.852	0.827	0.806	0.792	0.783

1.037	1.000	0.964	0.931	0.901	0.874	0.852	0.834	0.822	0.814
1.034	1.000	0.966	0.935	0.907	0.882	0.861	0.845	0.833	0.825
1.031	1.000	0.970	0.942	0.916	0.893	0.874	0.859	0.848	0.841
1.026	1.000	0.975	0.951	0.929	0.910	0.893	0.880	0.871	0.865
1.022	1.000	0.979	0.958	0.940	0.923	0.910	0.898	0.890	0.885
1.018	1.000	0.982	0.965	0.949	0.935	0.923	0.914	0.907	0.903
1.000	1.000	1.000	0.999	0.999	0.998	0.998	0.998	0.998	0.997

FORCE (lbf)				force at level	force above level		
	Y/D	Y(in)	lbf	lbf	kips		
	0.000	152.000	0.000	43039.807	86.080		
	0.087	167.621	9204.689	33835.117	67.670		
	0.175	183.241	18869.862	24169.945	48.340		
	0.262	198.862	25759.234	17280.573	34.561		
	0.349	214.483	30180.805	12859.002	25.718		
	0.436	230.103	33137.996	9901.811	19.804		
	0.524	245.724	35281.029	7758.778	15.518		
	0.611	261.345	36909.797	6130.009	12.260		
	0.698	276.966	38186.579	4853.228	9.706		
	0.785	292.586	39208.568	3831.239	7.662		
	0.873	308.207	40038.470	3001.337	6.003		
	0.960	323.828	40719.174	2320.632	4.641		
	1.047	339.448	41281.431	1758.375	3.517		
	1.134	355.069	41748.143	1291.664	2.583		
	1.222	370.690	42136.888	902.918	1.806		
	1.309	386.310	42461.482	578.325	1.157		
	1.396	401.931	42732.976	306.830	0.614		
	1.484	417.552	42960.332	79.475	0.159		
	1.518	423.750	43039.807	0.000	0.000		

		Moment above level					
		about bottom of shroud				adjustment moment	moment above elevation
Y/D	Y(in)	M(in-lbf)	M(kips-in)		H (in)	M (kip-in)	M(kip-in)
0.000	152.000	0.000	4702.988		0.000	0.000	4702.988
0.087	167.621	85381	4532.225		15.621	1057.056	3475.169
0.175	183.241	301953	4099.081		31.241	1510.206	2588.876
0.262	198.862	559209	3584.571		46.862	1619.608	1964.963
0.349	214.483	793459	3116.070		62.483	1606.933	1509.137
0.436	230.103	997380	2708.229		78.103	1546.732	1161.497
0.524	245.724	1179087	2344.815		93.724	1454.370	890.445
0.611	261.345	1342855	2017.277		109.345	1340.570	676.707
0.698	276.966	1491295	1720.397		124.966	1212.973	507.425
0.785	292.586	1626143	1450.703		140.586	1077.239	373.464
0.873	308.207	1748645	1205.698		156.207	937.659	268.038
0.960	323.828	1859779	983.430		171.828	797.498	185.932
1.047	339.448	1960370	782.248		187.448	659.209	123.039
1.134	355.069	2051165	600.658		203.069	524.594	76.064
1.222	370.690	2132869	437.250		218.690	394.918	42.332
1.309	386.310	2206163	290.662		234.310	271.015	19.647

1.396	401.931	2271709	159.569		249.931	153.373	6.196
1.484	417.552	2330152	42.685		265.552	42.209	0.475
1.518	423.750	2351494	0.000		271.750	0.000	0.000

180							
1.571							
0.000							
0.007							
0.029							
0.065							
0.111							
0.166							
0.228							
0.293							
0.360							
0.426							
0.490							
0.550							
0.606							
0.657							
0.703							
0.744							
0.780							

0.811							
0.823							
0.839							
0.863							
0.884							
0.901							
0.997							

TO: George Inch
From: Hwang Choe

~~Part (I)~~

~~part (II)~~

part (III)

Figure 3-3 NMP1 RLB Shroud Lateral Force vs. Elevation

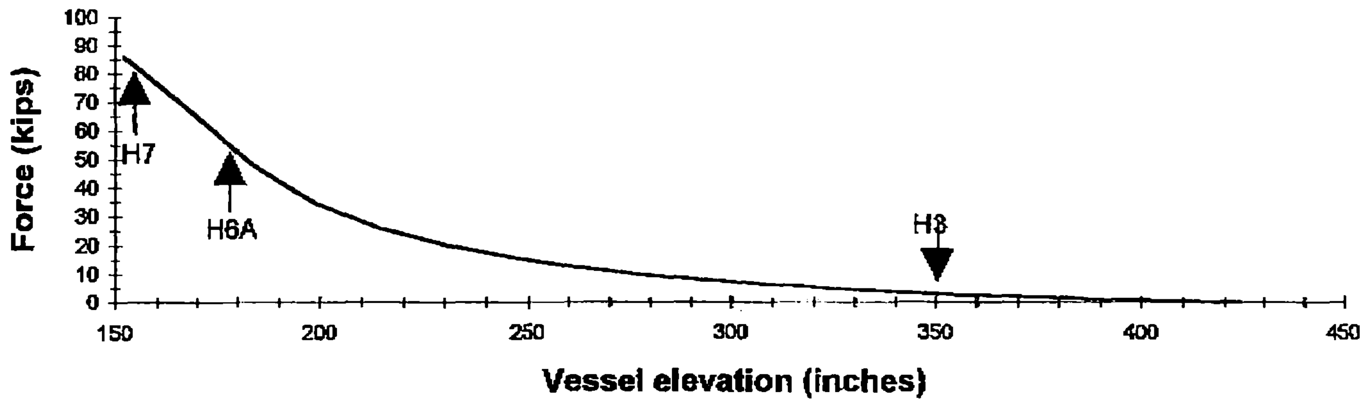
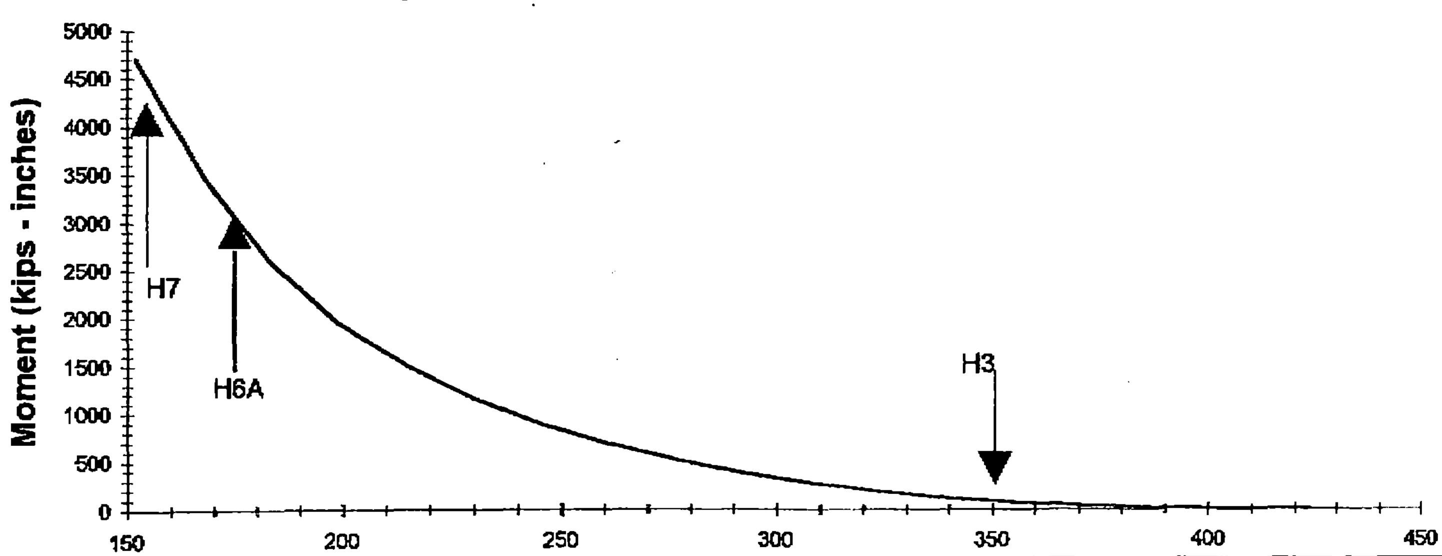


Figure 3-5 NMP1 RLB Shroud Moment vs Elevation



	Vessel elevation (inches)								
moment arm									
L (in)									
54.635									
51.354									
53.556									
56.855									
58.680									
58.651									
57.383									
55.196									
52.277									
48.739									
44.653									
40.061									
34.986									
29.444									
23.442									
16.986									

10.097									
2.991									

EA1_RLB.XLS

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EA1_RLB.

EA1_RLB.XLS

To: George Inch
From: Hwang Choe

Part (IV)

3.2 Recirculation Line Break

For the particular BWR/2 geometry, the RLB can be classified in two categories, the Discharge RLB (on the shroud side) and the Suction RLB (on the lower plenum). The Discharge RLB results in large downward loads and small lateral loads on the shroud. The Suction RLB results in large lateral loads and small downward loads on the shroud. For the H1 through H7 shroud welds, in the Suction RLB is the limiting event because of the lateral loads. For the Discharge RLB, the welds are supported in the downward direction and are therefore not impacted.

For the Suction RLB, the differential pressure across the shroud decreases from the initial value as the core flow is reduced due to the break, upward forces are reduced, and thus there is no significant threat to core shroud integrity. Any initial shroud separation along a particular weld location will be limited to a tight crack, since any significant separation, prior to the accident, would be detected during normal operation as discussed in section 2.1.

Lateral forces for weld locations in the beginning of a RLB are large acoustic forces of short duration, less than ten milliseconds, followed by smaller blowdown forces for several seconds. Horizontal motion is not expected because of the resistance of the irregular crack surface to horizontal motion without lifting. If sufficient lifting occurs prior to the accident, it will be detected during normal operation as discussed in section 2.1. Tipping (i.e. rotation) is not expected from the acoustic loading as it is of very short duration. The acoustic load calculated for the shroud is conservatively applied to the rotation. The lateral RLB Blowdown force was calculated considering both, the NMP1 and OC plant characteristics. The resulting lateral shear forces and tipping moments, as a function of shroud elevation, are shown in Figures 3-3 through 3-6 for both plants. The blowdown calculation is based on a two dimensional potential flow expression, with the pressure distribution based on the Bernoulli relationship. The break flow is calculated with the TRACG code based on conservatively low temperature fluid conditions. Based on these results, the limiting tipping moment is for the H6A location as shown on Tables 3-3 and 3-4. Any tipping for weld locations lower than H6A is limited by the guide tube interference, and for higher weld locations the moment is much lower. Also included on Tables 3-3 and 3-4 is the restoring moment resulting from the shroud weight. A comparison of the RLB tipping moment against the restoring moment shows that the restoring moment is much larger, and in the absence of upward forces will maintain the shroud in place. Any upward forces are the result of the core flow, which will decrease as a result of the RLB to a very low value in less than one second. Therefore, shroud tipping is very unlikely because the upper welds experience a small RLB moment, and the lower welds have large restoring moment. However, any postulated tipping at the limiting H6A weld is restricted by the core spray piping clearance with the shroud and vessel to two inches. The duration of this tipping is less than 1 second and by its restoring moment the shroud returns to its original position. Therefore, since no permanent shroud displacement occurs, the RLB results are unchanged.

Figure 3-3 NMP1 RLB Shroud Lateral Force vs. Elevation

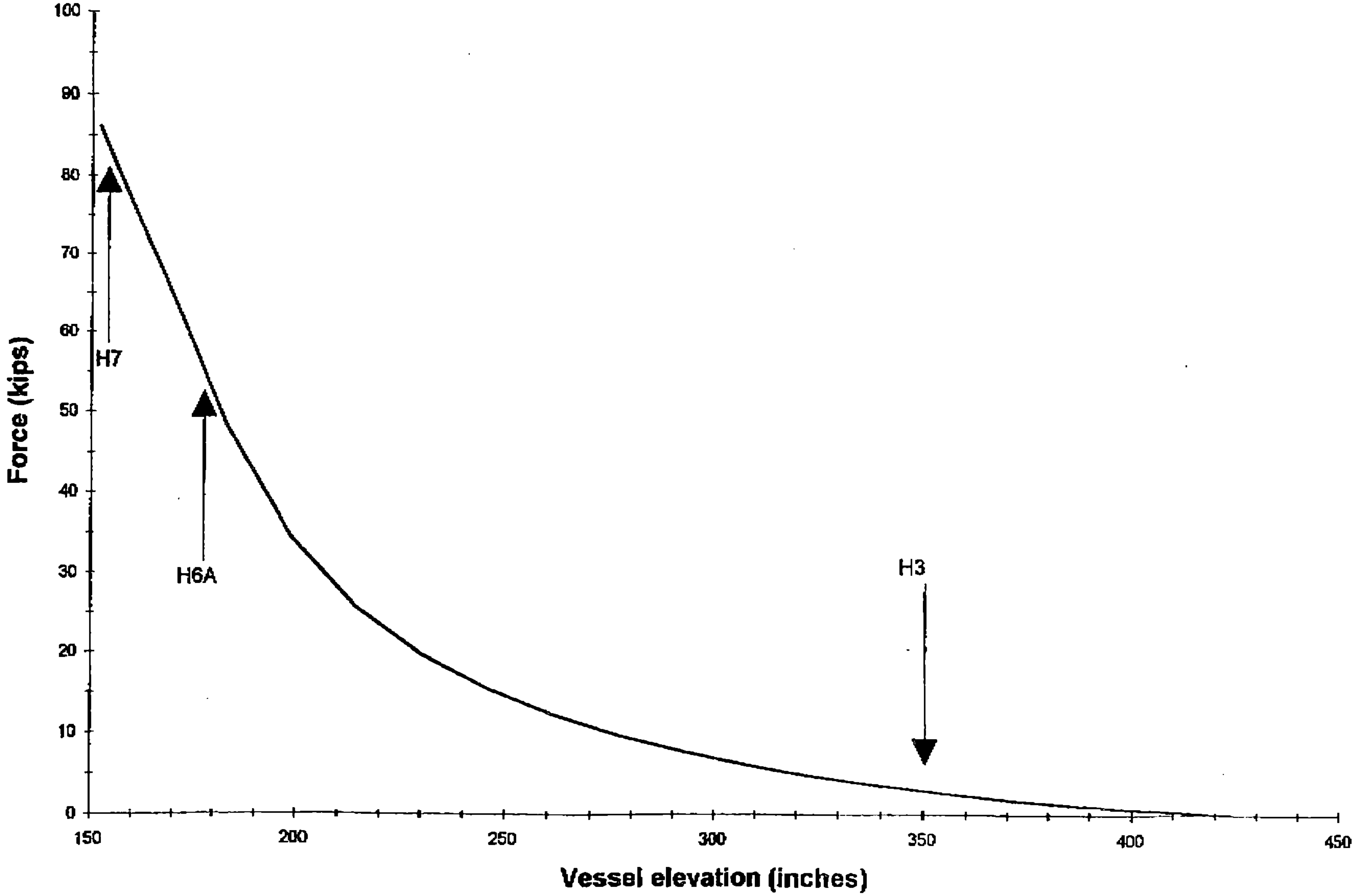

Figure 3-4 OC RLB Shroud Lateral Force vs. Elevation

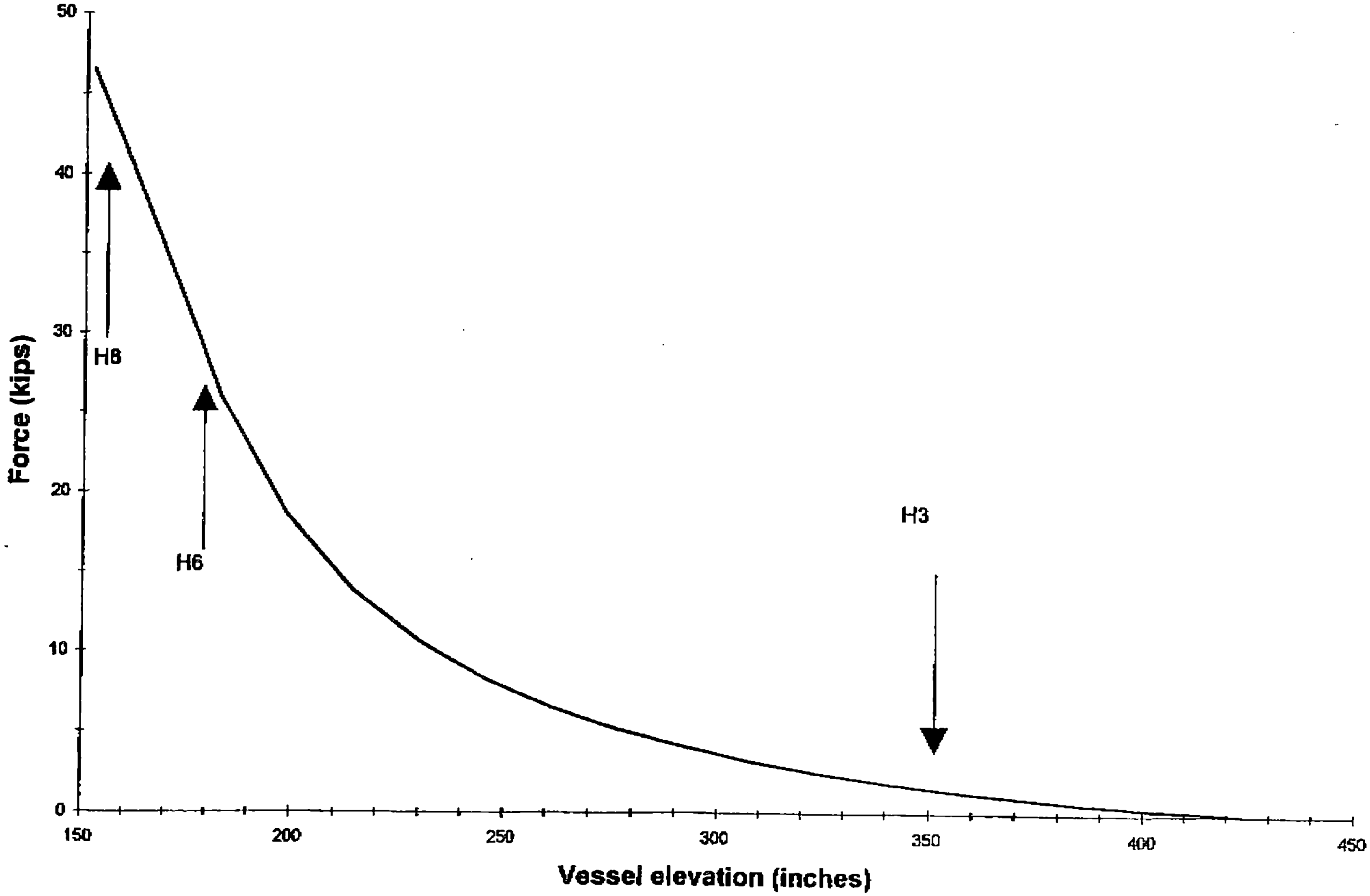

Figure 3-5 NMP1 RLB Shroud Moment vs Elevation

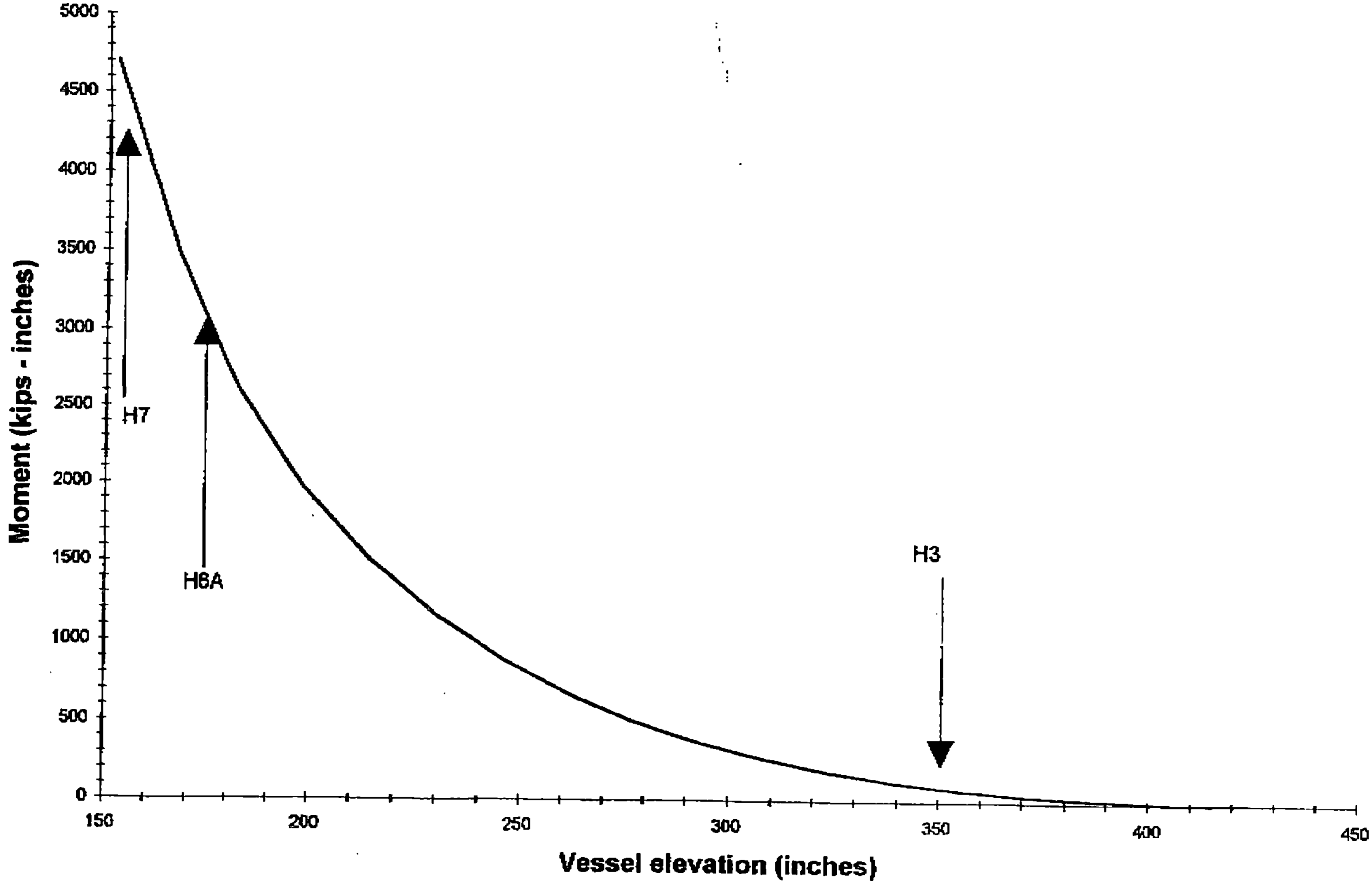

Figure 3-6 OC RLB Shroud Moment vs. Elevation

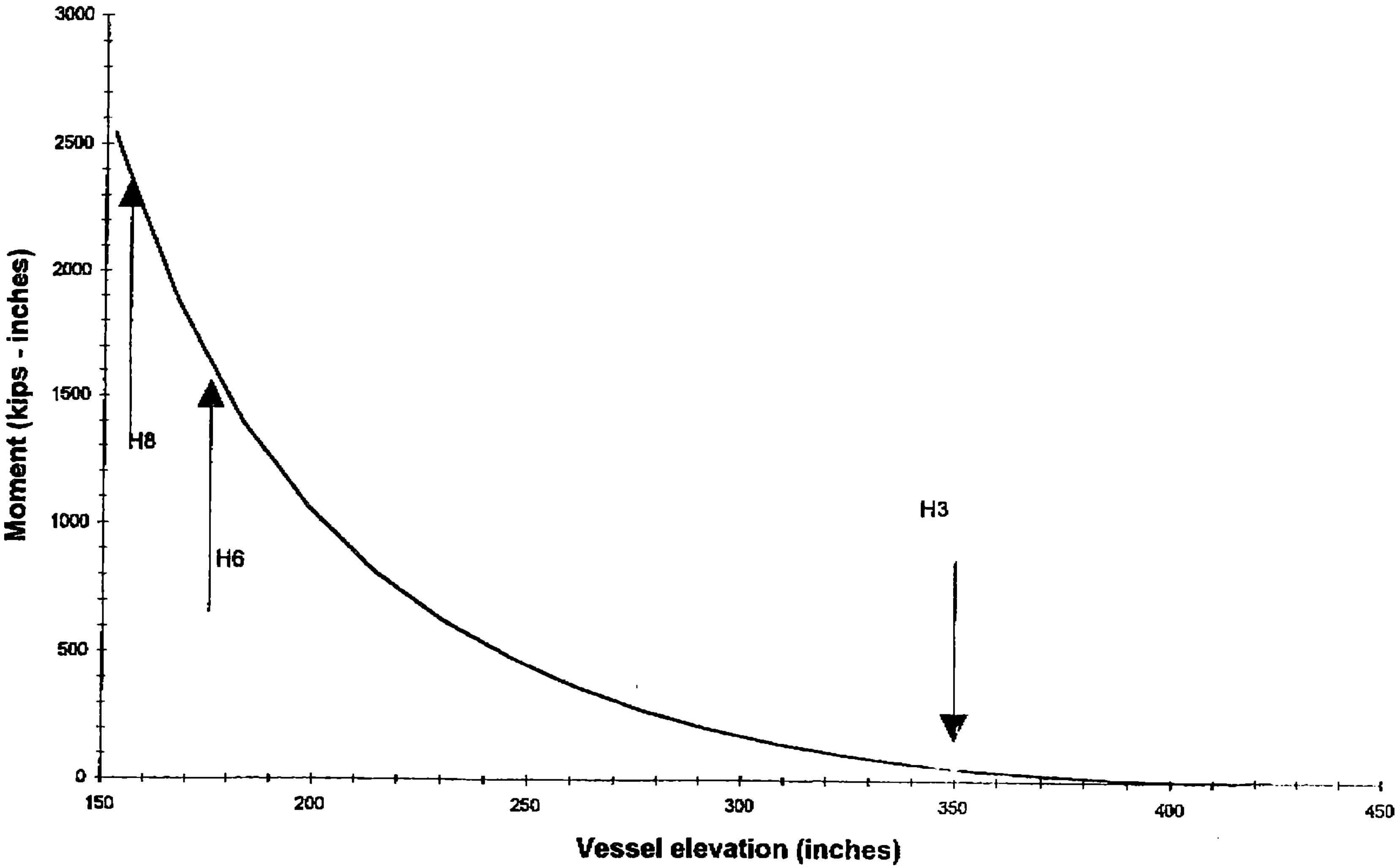

Table 3-3 NMP1 RLB and Restoring Moments

Weld	Weld Elevation (in)	RLB Tipping Moment (E6 in-lb)	Restoring Moment (E6 in-lb)	Lateral Displacement (in)
H1	385.0	0.3	7.5	0
H2	352.75	0.6	10.0	0
H3	350.75	0.6	10.2	0
H4	332.25	0.9	10.6	0
H5	242.125	2.4	12.7	0
H6A	178.125	4.2	14.2	<2.0*
H6B	175.125	4.3	15.5	<0.5**
H7	152.0	4.7	16.0	<0.5**

Table 3-4 OC RLB and Restoring Moments

Weld	Weld Elevation (in)	RLB Tipping Moment (E6 in-lb)	Restoring Moment (E6 in-lb)	Lateral Displacement (in)
H1	385.0	0.2	7.5	0
H2	352.75	0.3	10.0	0
H3	350.75	0.4	10.2	0
H4	332.25	0.5	10.6	0
H5	242.125	1.3	12.7	0
H6A	178.125	2.3	14.2	<2.0*
H6B	175.125	2.3	15.5	<0.5**
H7	152.0	2.5	16.0	<0.5**

* Lateral motion limited by the core spray piping.
** The lateral rotational movement of these weld locations is limited by the vertical displacement of the core support plate against the control rod guide tubes.

For the RLB simultaneous with a seismic event, additional vertical and lateral forces will exist. As discussed above, the forces in the core region resulting from the RLB exert an almost instantaneous downward pull on the shroud and will prevent vertical and lateral displacement along a weld location. The lateral seismic loads, combined with the asymmetric blowdown loads may result in a small momentary tipping. This tipping will be limited by the core spray piping clearance between the vessel and the shroud. However, the restoring moment of the shroud weight will prevent permanent displacement.

The momentary displacement calculated for the postulated RLB event impacts the core spray piping, however the results of a RLB remain unchanged. Current Loss of Coolant Accident analyses are unaffected, and limiting calculated results are applicable.

3.3 Plant Safety Systems

This section addresses the impact of an undetected crack as it affects the key safety factors of control rod insertability, coolable geometry, ECCS performance, and SLCS effectiveness. The primary factor in this determination is the expected movement of the shroud during the postulated event. The basis for the shroud movement is as documented in sections 2, 3.1 and 3.2.

Control rod insertability will be assured if the fuel remains properly arranged in the core, and the guide tubes and shroud remain aligned. No permanent misalignment occurs for either the MSLB or the RLB, without seismic effects, and thus the control rod motion will not be affected. With seismic effects, the maximum misalignment is only 1.0 inch at the top guide or the core support plate. The control rod motion will not be affected by this small misalignment. Control Rod Insertion tests conducted by GE show that control rod insertion is not affected up to at least a displacement of 4.8 inches at the top guide, or 1.5 inches at the core support plate. For these BWR/2 evaluations, since the top guide remains in contact with the fuel channels, for all conditions, the fuel assemblies will remain properly arranged in the core. Additionally, a seismic oscillatory motion will assure that