VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

July 26, 2001

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No.	01-359
NL&OS/ETS	R0
Docket Nos.	50-338
	50-339
License Nos.	NPF-4
	NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION FOR
PROPOSED LICENSE CHANGES
ELIMINATION OF SEISMIC EFFECTS FROM
CONTROL ROD DROP TIME

In a letter dated June 22, 2000 (Serial No. 00-307), Virginia Electric and Power Company (Dominion) requested amendments to the Facility Operating Licenses NPF-4 and NPF-7 for North Anna Power Station Units 1 and 2, respectively. The proposed changes will add a risk-informed license condition. The license condition will eliminate the penalty of an assumed increase in the rod control cluster assembly drop time resulting from a concurrent trip and seismic event when determining if the measured rod drop time meets the Technical Specifications limit of 2.7 seconds.

A meeting was held with the NRC staff on March 22, 2001, to discuss the risk assessment which supports the proposed license condition. During that meeting and in a subsequent letter dated May 31, 2001, the NRC requested additional information, which is provided in the enclosure to this letter.

Due to the deterministic as well as probabilistic nature of the questions received on the original submittal, Dominion requests that the original submittal be superceded in aggregate by the combined correspondence represented by the June 22, 2000 original submittal, the January 19, 2001 response to a request for additional information and the material enclosed with this letter. Detailed changes proposed to the license and Technical Specification Bases remain unaltered from the original submittal.

A001

If you have any further questions or require additional information, please contact us.

Very truly yours,

Leslie N. Hartz
Vice President – Nuclear Engineering

Enclosure

Commitments made in this letter: None

cc: U.S. Nuclear Regulatory Commission
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COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz, who is Vice President - Nuclear Engineering, of Virginia Electric and Power Company. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me this 26th day of July, 2001.

My Commission Expires: 3-31-04.

Maggie McClure
Notary Public

(SEAL)

ENCLOSURE

Request for Additional Information for Proposed License Changes Elimination of Seismic Effects from Control Rod Drop Time

Virginia Electric and Power Company (Dominion) North Anna Power Station Units 1 and 2

IMPACT OF A SEISMIC EVENT ON CONTROL ROD DROP TIME RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION

NORTH ANNA POWER STATION UNITS 1 AND 2

On June 22, 2000, Virginia Electric and Power Company (Dominion) submitted a request for an amendment to the facility operating licenses for North Anna Power Station Units 1 and 2, NPF-4 and NPF-7, respectively. Since the initial submittal, there have been several phone calls between the NRC staff and Dominion. In addition, a meeting took place on March 22, 2001 at the NRC headquarters to discuss the technical issues related to the seismic effects on control rod drop time. As discussed in our letter (Serial Number 00-307) and presented in the slides during the March 22, 2001 meeting, it is our position that the risk-informed requirements in Regulatory Guides (RG) 1.174 and 1.177 are addressed in our License amendment request.

In the NRC's letter dated May 31, 2001 summarizing the meeting, the NRC stated that the license amendment request should comply with Regulatory Guide 1.174. The original Dominion submittal for the amendment request discusses the reasons as to why the request complies with Regulatory Guide 1.177, which contains a more restrictive risk allowance. The NRC meeting summary letter also noted that the Surry Seismic hazard analysis would be shown to be applicable to North Anna. Additionally during the March 22, 2001 meeting, a request was made by the staff to assess the impact of using the North Anna seismic hazard curve [Reference 1] on the Surry seismic PRA model. It was noted at that time, that a precise conversion of the Surry seismic hazard analysis to North Anna could **not** be done easily since a seismic PRA model has not been developed for North Anna. However, we have performed an analysis to calculate the seismic core damage frequency results using the Surry Seismic PRA model (cut-sets, equations) with the North Anna seismic hazard curve developed by Electric Power Research Institute (EPRI). The results from this analysis were compared with the results of the previous analysis for Surry [References 2 and 3] performed in response to Individual Plant Examination of External Events (IPEEE) in which the Surry EPRI seismic hazard curve was used. This analysis and comparisons are presented in Attachment 1. It can be seen that although the North Anna seismic hazard data is higher, the core damage frequency (CDF) results for North Anna and Surry are quite similar, and have the same order of magnitude. The ranking of the top sequences also remains unchanged.

A request was also made by the staff to consider the impact of using the Lawrence Livermore National Laboratory (LLNL) hazard curve [Reference 4]. The Surry LLNL curve was previously used in a sensitivity study in the Surry IPEEE seismic. The Surry results indicated that although the mean CDF from the LLNL curve is about 50% higher than the mean CDF using the EPRI hazard curve, there was no impact on dominant sequence rankings or on the qualitative insights [References 2 and 3]. The impact of the LLNL hazard curve for North Anna, using the Surry PRA model, was also evaluated. The conclusions from this analysis are the same as those reached in the Surry sensitivity analysis, i.e., the dominant sequences remain unchanged and the core damage frequency results are not significantly different than those obtained for Surry. The results from this analysis are also presented in Attachment 1. The computer runs using "SEISMIC" code are presented in Attachment 2.

The NRC reviewer was concerned that the original submittal did not address the impact of the change on the seismic contribution to the annual core damage frequency. At the March 22, 2001 meeting, our presentation provided the reasons as to why the seismic contribution would be negligible. First, the PORVs were analyzed during the IPEEE-seismic and USI A-46 efforts. The high-confidence-of-the-low-probability-of-failure (HCLPF) capacities[1] associated with the PORVs are above the 0.3g peak ground acceleration cutoff value used in the IPEEE analysis. The lowest HCLPF of any of the North Anna PORVs, based on the conservative deterministic failure margin (CDFM) method, is 0.41g [Reference 6]. A copy of this calculation is presented in Attachment 3. Therefore, the PORVs are not expected to fail as a result of a seismic event.

Note that the seismic PRA includes both seismic and random failures. A review of the Surry IPEEE seismic PRA results shows that there is a very small contribution to the seismic core damage frequency from a small seismic event in which a PORV fails to manually open as part of the feed and bleed strategy. The sequence frequency is 2.9E-7 /yr [Reference 3]. In this sequence, the PORV fails mechanically or the operator fails to recognize the need to use feed and bleed.

The above PORV failure mode is not relevant to the seismic rod drop issue because it involves only a manual action to open the PORVs. The NRC concern with the subject amendment request is that an overpressure condition might arise due to a delay in the rod drop time, in which there would be a PORV demand to open. The PORV would then open and remain stuck open creating a small LOCA. During the meeting on March 22, 2001, a large part of the discussion was devoted to this failure mode. First, it was discussed that the turbine trip on a reactor trip signal would have to fail in order for the pressure to rise sufficiently to cause a demand for the PORVs to open. Then, the PORV must fail in the open position. Finally, the PORV block valve must fail to close because the operator fails to take action or the MOV mechanically fails or has no power.

The Surry seismic event tree [Attachment 4] was provided to the NRC Staff during the March 22, 2001 meeting and included as an attachment to the NRC's May 31, 2001 letter. As discussed during the March 22, 2001 meeting with the staff, the seismic event tree represents the convolution of the seismic hazard curve and the seismic fragility curves for low seismic capacity structures, systems and components. For North Anna plant, the design basis seismic event itself is a very low frequency event (mean frequency of about 1E-4 /year). Therefore, the risk of a seismic event causing delay on the control rod drop time with a stuck open PORV is negligible. Switchyard failure is included in the seismic event tree on the basis of a median capacity of 0.30g. Random failures are accounted for in the last node of the seismic event tree. This final node,

[1] HCLPF capacity is defined as the capacity expressed in terms of peak ground acceleration for which there is about 95% confidence that the probability of failure is approximately 5%.

Conditional Core Damage Probabilities (CCDP), is quantified using the internal events model. In this way seismic failures and random failures are explicitly treated in a single tree.

Recall that the loss of offsite power was identified as the dominant contributor to risk for this analysis because it is a dependent event. The only dominant seismic sequence from the event tree with loss of offsite power is sequence No. S10. In this sequence, the dominant contributor to core damage frequency is from the random failure of equipment not damaged by the seismic event. PORV failures are not among the top cut sets as shown in Attachment 4. The RCS boundary failure such as the PORV failing open results in a transfer to the small LOCA event tree, which was not quantified due to the negligible contribution to the conditional core damage probability [Attachment 4, p. F-8 of F-53 of Reference 2].

However, the sequence transfer is quantified in the latest North Anna internal-events model. The initiating event frequency for the Loss of Offsite Power in the North Anna PRA model is 1.93E-2/yr [Reference 6]. The sequence of interest is T11RC (#30) on the event tree, which is shown in Attachment 5. This sequence is developed or transferred to event tree T1Q, which is also shown in the attachment. A review of this event tree shows that the impact of the PORV failing in the open position is negligible in the internal-events model. Thus, it can be concluded that the failure of the PORVs to close is not significant in either the internal-events model or the seismic model. Therefore, we conclude that the impact of the control rod drop time seismic delay on the risk of a stuck open PORV is negligible.

During the meeting on March 22, 2001, the NRC staff also requested a reliability assessment of the PORVs. In response to this, the maintenance rule data for the pressurizer PORVs is presented in Attachment 6. This data shows that the PORVs are very reliable.

The above evaluations demonstrate that our previous conclusions regarding the significance of the PORVs to a delay in the rod drop time remain valid. It is unlikely that the PORVs would be required to be opened. However, if there is a PORV open demand, it is unlikely that they would fail because of the redundancy in the design and their high seismic capacity. The internal events and seismic analyses presented herein demonstrate that the increase in risk from such a scenario is within the guidelines of RG 1.174 and 1.177.

References:

1. Probabilistic Seismic Hazard Evaluation for North Anna Power Station, Project RP 101-53, Electric Power Research Institute, April 1989.

2. Sequence Quantification – Seismic IPEEE, Surry Power Station, Units 1 and 2, Report 250226-R-001, Revision 0, November 1997, EQE International.

References (continued)

3. Technical Report No. CE-0097, Sequence Quantification – Surry Seismic IPEEE, December 1997.

4. Revised Livermore Seismic Hazard Estimates for sixty-nine Nuclear Power Plant Sites East of the Rocky Mountains, NUREG-1488, April 1994.

5. Calculation CE-1436, “Seismic Qualification of Pressure Control Valves for USI A-46 and IPEEE”, December 18, 1998.

6. Calculation SM-1274 N0A/C/D PRA Model Quantification North Anna Power Station Units 1 & 2, Revision 0, April 12, 2001

ATTACHMENT 1

Core Damage Frequencies with Surry SPRA Model and North Anna Seismic Hazard Curves

An analysis was performed using the North Anna EPRI seismic hazard curves with the Surry SPRA model. "SEISMIC" computer code [Reference 1] was used. The Surry model was initially developed in [Reference 2] and the results were refined and are obtained from [Reference 3]. Two "SEISMIC" computer runs using the North Anna EPRI hazard curves were prepared to calculate the plant level core damage frequencies and are attached. Both runs use the Surry Seismic PRA model developed in [Reference 2] and [Reference 3] with North Anna EPRI hazard curve. In the first computer run, the only change is that the EPRI hazard for Surry [Reference 4] is replaced by the EPRI hazard for North Anna [Reference 5]. In the second run, the North Anna specific fragilities of the Turbine building and two other components are utilized. The fragilities of the remaining components in the Surry model were not developed for North Anna and are assumed to be the same as those for Surry. The results from the Surry analysis and the two recent "SEISMIC" runs with North Anna hazard curve are tabulated in Table 1. The first column represents the results of the Surry analysis from [Reference 3]. The next two columns tabulate the results of the analysis from the two runs discussed above. It can be seen that although the North Anna seismic hazard data is higher, the core damage frequency (CDF) results have about the same order of magnitude. A third computer run was made for the individual sequences of the Surry PRA model with North Anna EPRI hazard curve. It shows that the ranking of the sequences remains unchanged. The "SEISMIC" computer runs are presented in Attachment 2.

Table 1 – Seismic PRA with EPRI Seismic Hazard Curves and Surry SPRA Model

	Surry seismic Hazard [Ref. 3 and 4]	North Anna hazard with Surry fragilities (computer run # 1)	North Anna hazard & North Anna fragilities for three elements (computer run # 2)
Mean CDF	8.2E-6 /yr	2.5E-5 /yr	2.1E-5 /yr
Median CDF	4.9E-6 /yr	1.75E-5 /yr	1.49E-5 /yr
5% lower confidence bound CDF	9.6E-7 /yr	4.42E-6 /yr	3.38E-6 /yr
95% upper confidence bound CDF	2.6E-5 /yr	7.0E-5 /yr	5.81E-5 /yr
Plant HCLPF capacity	0.155g	0.152g	0.158g

Lawrence Livermore National Laboratory (LLNL) Hazard Curve:

Two additional computer runs were made with the Surry PRA model with North Anna LLNL seismic hazard curve from [Reference 6]. The first run (Run # 4) is for the entire plant sequence, and the second run (Run # 5) is for individual plant sequences. These computer runs are also presented in Attachment 2. They conclude that the dominant sequences remain unchanged and the plant core damage frequency results are not significantly different than those previously determined for Surry using the Surry LLNL hazard curve. Table 2 below shows a comparison of core damage frequency results using the Surry model with Surry LLNL curve (References 3 and 6) and with the North Anna LLNL curve (Run #4 of Attachment 2).

Table 2 – Seismic PRA with LLNL Seismic Hazard Curves and Surry SPRA Model

	Surry LLNL seismic Hazard [Ref. 3, 6]	North Anna LLNL hazard with Surry fragilities [Ref. 6 and computer run # 4]
Mean Core Damage Frequency	1.27E-5 /yr	2.194E-5 /yr
Median CDF	9.81E-6 /yr	1.665E-5 /yr
5% lower confidence bound CDF	2.86E-6 /yr	4.5E-6 /yr
95% upper confidence bound CDF	3.19E-5 /yr	5.724E-5 /yr
Plant HCLPF capacity	0.145g	0.145g

References:

1. "SEISMIC" Computer Program and "SEISMIC" User's Manual, A computer Program for Seismic Risk Evaluation, Halliburton NUS Corporation, Rev. November 28, 1994.

2. Sequence Quantification – Seismic IPEEE, Surry Power Station, Units 1 and 2, Report 250226-R-001, Revision 0, November 1997, EQE International.

3. Technical Report No. CE-0097, Sequence Quantification – Seismic IPEEE, Surry Power Station, December 1997.

4. Probabilistic Seismic Hazard Evaluation for Surry Nuclear Power Plant, Project RP 101-53, Electric Power Research Institute, April 1989.

5. Probabilistic Seismic Hazard Evaluation for North Anna Power Station, Project RP 101-53, Electric Power Research Institute, April 1989.

6. Revised Livermore Seismic Hazard Estimates for sixty-nine Nuclear Power Plant Sites East of the Rocky Mountains, NUREG-1488, April 1994.

Computer Runs (Included in Attachment 2):

Run # 1 - Plant Sequence – Surry PRA model from [3] and NAPS EPRI hazard curve

Run # 2 - Plant Sequence – Surry PRA model from [3], NAPS EPRI hazard curve and NAPS-specific fragilities for three elements

Computer Runs (continued)

Run # 3 - Individual sequences – Surry PRA model from [3], NAPS EPRI hazard curve

Run # 4 - Plant Sequence – Surry PRA model from [3], NAPS LLNL hazard curve

Run # 5 - Individual sequences – Surry PRA model from [3], NAPS LLNL hazard curve

ATTACHMENT 2

"SEISMIC" Computer Runs to Support the Tables and Data of Attachment 1.

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

Seismic Analysis Module Version 1.1
Tue Jun 26 09:59:21 2001

Input File: NAPS1--1.IN Equation File: NAPS1--1.EQN
Output File: NAPSall.out

RUN # 1
NAPS EPRI HAZARD
-SURRY SPRA MODEL
PLANT SEQUENCE

NO OF ACCELERATION POINTS	45
NO OF SEISMIC FAILURE EVENTS	7
NO OF RANDOM FAILURE EVENTS	8
NO OF EQUATIONS	1
NO OF MONTE CARLO TRIALS	1000
NO OF CURVES	1
NO OF ACCELERATION RANGES	1

ACCELERATION POINTS %g

7.645E-003	1.529E-002	2.548E-002	3.568E-002	4.587E-002	5.607E-002
6.626E-002	7.645E-002	8.665E-002	9.684E-002	1.070E-001	1.172E-001
1.274E-001	1.376E-001	1.478E-001	1.580E-001	1.682E-001	1.784E-001
1.886E-001	1.988E-001	2.090E-001	2.192E-001	2.294E-001	2.396E-001
2.497E-001	2.676E-001	2.931E-001	3.186E-001	3.440E-001	3.695E-001
3.950E-001	4.205E-001	4.460E-001	4.715E-001	4.969E-001	5.352E-001
5.861E-001	6.371E-001	6.881E-001	7.390E-001	7.900E-001	8.410E-001
8.919E-001	9.429E-001	9.939E-001			

PLANT
HCLPF ≈ 0.152g

FREQUENCIES AT THE GIVEN ACCELERATIONS FOR CURVE NO. 1

4.159E-001	3.041E-001	1.972E-001	1.285E-001	8.437E-002	3.139E-002
2.551E-002	2.011E-002	1.609E-002	1.285E-002	6.377E-003	5.592E-003
4.905E-003	4.218E-003	3.728E-003	3.335E-003	2.845E-003	2.551E-003
2.158E-003	1.864E-003	1.766E-003	1.373E-003	1.324E-003	1.128E-003
9.810E-004	5.023E-004	4.120E-004	3.335E-004	2.747E-004	2.237E-004
1.805E-004	1.530E-004	1.216E-004	9.810E-005	8.240E-005	4.611E-005
3.453E-005	2.570E-005	1.923E-005	1.158E-005	9.221E-006	7.456E-006
5.690E-006	4.709E-006	3.728E-006			

PROBABILITY OF CURVE I IN RANGE J

SEISMIC FREQUENCY CURVE NUMBER	ACCELERATION RANGE ENDPOINT 1.00
1	1.0000

*** SEISMIC INDUCED FAILURES

NO.	COMPONENT NAME	MEDIAN ACC	BETAR	BETAU
1	EQ-AFW-ECST	4.860E-001	2.10E-001	3.00E-001
2	EQ-CC-SURGE-TK	5.900E-001	1.90E-001	3.10E-001
3	EQ-S2-LOCA	9.000E-001	3.00E-001	3.00E-001
4	EQ-SWITCHYARD	3.000E-001	2.50E-001	3.50E-001
5	EQ-TB-SEV-DMG	7.100E-001	4.00E-001	4.00E-001
6	EQ-LUBE-OIL	4.800E-001	2.50E-001	4.10E-001
7	EQ-FIRE-PRO-TK	2.200E-001	3.00E-001	3.00E-001

*** RANDOM FAILURES

NO.	COMPONENT NAME	MEDIAN	MEAN	ERROR FAC	TYPE
8	L	9.601E-002	1.20E-001	3.00E+000	LOGNORMA
9	LD	5.800E-001	5.80E-001	1.00E+000	LOGNORMA
10	LE	6.600E-001	6.60E-001	1.00E+000	LOGNORMA
11	M	2.107E-003	3.40E-003	5.00E+000	LOGNORMA
12	M0	1.487E-004	2.40E-004	5.00E+000	LOGNORMA
13	T-BLDG-IGN-LO	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
14	TURB-B-ACC-LO	2.000E-001	2.50E-001	3.00E+000	LOGNORMA
15	ACC-LD	7.500E-001	7.50E-001	1.00E+000	LOGNORMA

EQUATION SPS1 = (EQ-TB-SEV-DMG) + (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * T-BLDG-IGN-LO
 * ACC-LD) + (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * /T-BLDG-IGN-LO
 * EQ-SWITCHYARD * EQ-CC-SURGE-TK) + (/EQ-TB-SEV-DMG * EQ-LUBE-OIL
 * /T-BLDG-IGN-LO * EQ-SWITCHYARD * /EQ-CC-SURGE-TK * EQ-AFW-ECST
 * LE) + (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * /T-BLDG-IGN-LO
 * EQ-SWITCHYARD * /EQ-CC-SURGE-TK * /EQ-AFW-ECST * L) + (/EQ-TB-SEV-DMG * /EQ-LUBE-OIL * EQ-SWIT
) .

SEISMIC EVALUATION FOR EQUATION SPS1

MEAN FRAGILITY VALUES AT EACH ACC J :

2.398E-004	2.411E-004	2.487E-004	2.199E-004	2.519E-004	2.500E-004
3.365E-004	3.374E-004	4.895E-004	9.339E-004	1.437E-003	2.904E-003
4.895E-003	6.293E-003	7.948E-003	1.364E-002	1.649E-002	2.264E-002
2.577E-002	3.464E-002	4.227E-002	4.871E-002	5.605E-002	6.213E-002
7.480E-002	8.954E-002	1.141E-001	1.410E-001	1.809E-001	2.079E-001
2.392E-001	2.814E-001	3.134E-001	3.531E-001	3.780E-001	4.163E-001
4.560E-001	4.783E-001	4.993E-001	5.145E-001	5.268E-001	5.361E-001
5.477E-001	5.623E-001	5.764E-001			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	6.615E-007	1.285E-006	1.679E-006	1.931E-006	2.080E-006
2.164E-006	2.242E-006	2.317E-006	2.418E-006	2.526E-006	2.655E-006
2.860E-006	3.118E-006	3.404E-006	3.787E-006	4.258E-006	4.792E-006
5.369E-006	5.982E-006	6.691E-006	7.413E-006	8.132E-006	8.868E-006
9.599E-006	1.065E-005	1.183E-005	1.303E-005	1.426E-005	1.548E-005
1.663E-005	1.773E-005	1.876E-005	1.969E-005	2.053E-005	2.149E-005
2.238E-005	2.309E-005	2.365E-005	2.405E-005	2.432E-005	2.455E-005
2.473E-005	2.488E-005	2.500E-005			

Mean CDF

5 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

2.998E-005	2.882E-005	3.016E-005	2.875E-005	3.222E-005	3.120E-005
3.304E-005	3.879E-005	3.543E-005	4.082E-005	4.253E-005	5.402E-005
5.928E-005	7.199E-005	9.350E-005	1.354E-004	1.276E-004	2.161E-004
2.502E-004	5.315E-004	4.584E-004	6.461E-004	1.713E-003	2.060E-003
2.874E-003	5.178E-003	9.375E-003	1.783E-002	2.439E-002	3.954E-002
5.059E-002	6.209E-002	8.163E-002	9.160E-002	1.054E-001	1.622E-001
2.084E-001	2.520E-001	2.944E-001	3.262E-001	3.459E-001	3.558E-001
3.746E-001	3.831E-001	4.058E-001			

5 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	8.118E-008	1.562E-007	2.053E-007	2.380E-007	2.568E-007
2.661E-007	2.744E-007	2.813E-007	2.868E-007	2.909E-007	2.938E-007
2.968E-007	2.999E-007	3.032E-007	3.073E-007	3.114E-007	3.161E-007
3.216E-007	3.294E-007	3.386E-007	3.473E-007	3.634E-007	3.868E-007
4.130E-007	4.613E-007	5.437E-007	6.687E-007	8.299E-007	1.028E-006
1.257E-006	1.494E-006	1.742E-006	1.983E-006	2.208E-006	2.517E-006
2.891E-006	3.240E-006	3.549E-006	3.790E-006	3.967E-006	4.116E-006
4.238E-006	4.338E-006	4.423E-006			

5% lower Conf. CDF

10 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

4.248E-005	4.415E-005	4.102E-005	3.961E-005	4.626E-005	4.284E-005
4.821E-005	5.270E-005	5.627E-005	6.136E-005	6.328E-005	7.633E-005
9.741E-005	1.116E-004	1.427E-004	2.208E-004	2.089E-004	4.569E-004
4.979E-004	9.501E-004	1.130E-003	1.812E-003	3.527E-003	4.288E-003
5.128E-003	1.017E-002	1.801E-002	2.990E-002	4.077E-002	5.347E-002
7.048E-002	8.881E-002	1.120E-001	1.280E-001	1.611E-001	2.104E-001
2.758E-001	3.245E-001	3.587E-001	3.703E-001	3.811E-001	4.017E-001
4.196E-001	4.207E-001	4.365E-001			

10 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.189E-007	2.285E-007	2.957E-007	3.415E-007	3.683E-007
3.814E-007	3.931E-007	4.031E-007	4.117E-007	4.178E-007	4.220E-007
4.266E-007	4.315E-007	4.366E-007	4.430E-007	4.498E-007	4.588E-007
4.702E-007	4.847E-007	5.039E-007	5.268E-007	5.633E-007	6.117E-007
6.620E-007	7.524E-007	9.120E-007	1.134E-006	1.403E-006	1.699E-006
2.013E-006	2.348E-006	2.695E-006	3.029E-006	3.358E-006	3.797E-006
4.287E-006	4.742E-006	5.130E-006	5.415E-006	5.614E-006	5.780E-006
5.917E-006	6.029E-006	6.120E-006			

20 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

6.977E-005	6.846E-005	6.679E-005	6.011E-005	7.009E-005	6.491E-005
7.409E-005	7.952E-005	8.201E-005	1.011E-004	1.095E-004	1.281E-004
1.692E-004	2.153E-004	2.518E-004	4.603E-004	5.747E-004	1.142E-003
1.471E-003	2.538E-003	3.454E-003	4.423E-003	8.992E-003	1.024E-002
1.263E-002	2.275E-002	3.330E-002	4.766E-002	6.460E-002	7.939E-002
1.016E-001	1.315E-001	1.576E-001	1.904E-001	2.340E-001	2.850E-001
3.468E-001	3.887E-001	4.157E-001	4.297E-001	4.369E-001	4.514E-001
4.617E-001	4.694E-001	4.961E-001			

20 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.905E-007	3.638E-007	4.703E-007	5.398E-007	5.803E-007
6.003E-007	6.181E-007	6.330E-007	6.463E-007	6.565E-007	6.637E-007
6.716E-007	6.804E-007	6.899E-007	7.025E-007	7.186E-007	7.418E-007
7.728E-007	8.131E-007	8.683E-007	9.304E-007	1.022E-006	1.142E-006
1.264E-006	1.476E-006	1.796E-006	2.174E-006	2.602E-006	3.055E-006
3.515E-006	4.005E-006	4.506E-006	4.988E-006	5.472E-006	6.091E-006
6.731E-006	7.291E-006	7.749E-006	8.080E-006	8.309E-006	8.498E-006

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8.650E-006  8.774E-006  8.877E-006
   30 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
9.384E-005  9.172E-005  9.092E-005  8.534E-005  8.944E-005  8.916E-005
9.933E-005  1.060E-004  1.102E-004  1.314E-004  1.547E-004  2.010E-004
2.520E-004  3.299E-004  4.177E-004  8.553E-004  1.126E-003  2.493E-003
3.112E-003  5.181E-003  7.193E-003  9.275E-003  1.533E-002  1.669E-002
2.171E-002  3.269E-002  4.915E-002  6.565E-002  8.373E-002  1.067E-001
1.304E-001  1.723E-001  2.012E-001  2.463E-001  2.846E-001  3.359E-001
3.929E-001  4.323E-001  4.508E-001  4.729E-001  4.735E-001  4.877E-001
4.986E-001  5.088E-001  5.300E-001
   30 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  2.558E-007  4.894E-007  6.366E-007  7.310E-007  7.837E-007
8.109E-007  8.347E-007  8.546E-007  8.722E-007  8.858E-007  8.966E-007
9.086E-007  9.220E-007  9.370E-007  9.595E-007  9.904E-007  1.039E-006
1.106E-006  1.189E-006  1.303E-006  1.433E-006  1.601E-006  1.801E-006
2.005E-006  2.342E-006  2.809E-006  3.346E-006  3.918E-006  4.515E-006
5.119E-006  5.755E-006  6.403E-006  7.023E-006  7.630E-006  8.374E-006
9.115E-006  9.743E-006  1.025E-005  1.061E-005  1.086E-005  1.106E-005
1.123E-005  1.136E-005  1.147E-005
   40 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.208E-004  1.169E-004  1.223E-004  1.090E-004  1.162E-004  1.193E-004
1.262E-004  1.385E-004  1.463E-004  1.727E-004  2.118E-004  2.848E-004
3.706E-004  5.274E-004  6.711E-004  1.559E-003  2.114E-003  4.682E-003
5.559E-003  9.055E-003  1.267E-002  1.603E-002  2.329E-002  2.587E-002
3.199E-002  4.409E-002  6.325E-002  8.116E-002  1.095E-001  1.334E-001
1.644E-001  2.106E-001  2.509E-001  3.005E-001  3.350E-001  3.825E-001
4.325E-001  4.610E-001  4.782E-001  4.951E-001  4.986E-001  5.085E-001
5.221E-001  5.393E-001  5.614E-001
   40 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  3.280E-007  6.321E-007  8.263E-007  9.477E-007  1.017E-006
1.052E-006  1.083E-006  1.109E-006  1.132E-006  1.151E-006  1.166E-006
1.183E-006  1.204E-006  1.228E-006  1.267E-006  1.324E-006  1.416E-006
1.538E-006  1.685E-006  1.885E-006  2.111E-006  2.380E-006  2.686E-006
2.995E-006  3.473E-006  4.087E-006  4.764E-006  5.492E-006  6.256E-006
7.014E-006  7.803E-006  8.603E-006  9.367E-006  1.009E-005  1.096E-005
1.179E-005  1.247E-005  1.301E-005  1.339E-005  1.365E-005  1.387E-005
1.404E-005  1.418E-005  1.430E-005
   50 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.528E-004  1.468E-004  1.522E-004  1.359E-004  1.507E-004  1.505E-004
1.596E-004  1.784E-004  1.853E-004  2.240E-004  2.827E-004  3.941E-004
5.799E-004  8.482E-004  1.136E-003  2.632E-003  4.066E-003  7.509E-003
9.328E-003  1.439E-002  1.950E-002  2.564E-002  3.321E-002  3.630E-002
4.405E-002  5.829E-002  7.972E-002  1.017E-001  1.365E-001  1.655E-001
2.067E-001  2.547E-001  2.905E-001  3.469E-001  3.773E-001  4.213E-001
4.665E-001  4.878E-001  4.986E-001  5.102E-001  5.196E-001  5.326E-001
5.470E-001  5.701E-001  5.893E-001
   50 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  4.137E-007  7.943E-007  1.036E-006  1.190E-006  1.279E-006
1.324E-006  1.363E-006  1.396E-006  1.426E-006  1.450E-006  1.470E-006
1.496E-006  1.529E-006  1.569E-006  1.635E-006  1.739E-006  1.895E-006
2.096E-006  2.335E-006  2.647E-006  3.002E-006  3.406E-006  3.839E-006
4.268E-006  4.914E-006  5.706E-006  6.557E-006  7.467E-006  8.416E-006
9.364E-006  1.034E-005  1.128E-005  1.217E-005  1.300E-005  1.396E-005
1.487E-005  1.560E-005  1.616E-005  1.656E-005  1.683E-005  1.705E-005
1.723E-005  1.738E-005  1.750E-005                                          Median CDF
   60 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
2.009E-004  1.957E-004  1.909E-004  1.757E-004  1.927E-004  1.943E-004
2.031E-004  2.161E-004  2.346E-004  3.001E-004  3.781E-004  5.844E-004
8.945E-004  1.430E-003  2.196E-003  4.485E-003  7.480E-003  1.297E-002
1.482E-002  2.222E-002  3.052E-002  3.609E-002  4.511E-002  5.382E-002
6.023E-002  7.473E-002  1.005E-001  1.280E-001  1.720E-001  2.096E-001
2.499E-001  3.064E-001  3.376E-001  3.968E-001  4.168E-001  4.598E-001
4.949E-001  5.032E-001  5.178E-001  5.305E-001  5.491E-001  5.637E-001
5.754E-001  5.994E-001  6.150E-001
   60 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  5.469E-007  1.042E-006  1.349E-006  1.547E-006  1.661E-006
1.718E-006  1.767E-006  1.808E-006  1.847E-006  1.879E-006  1.908E-006
1.947E-006  2.000E-006  2.073E-006  2.191E-006  2.375E-006  2.653E-006
2.984E-006  3.358E-006  3.844E-006  4.371E-006  4.928E-006  5.542E-006
6.153E-006  7.015E-006  8.020E-006  9.092E-006  1.024E-005  1.144E-005
1.261E-005  1.378E-005  1.490E-005  1.592E-005  1.686E-005  1.792E-005
1.889E-005  1.966E-005  2.024E-005  2.065E-005  2.094E-005  2.117E-005
2.136E-005  2.152E-005  2.165E-005
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70 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

2.571E-004	2.596E-004	2.486E-004	2.283E-004	2.511E-004	2.561E-004
2.641E-004	2.811E-004	2.988E-004	4.066E-004	5.289E-004	8.948E-004
1.685E-003	3.163E-003	4.013E-003	7.835E-003	1.348E-002	2.156E-002
2.277E-002	3.558E-002	4.260E-002	4.910E-002	5.774E-002	6.828E-002
8.252E-002	9.689E-002	1.299E-001	1.593E-001	2.199E-001	2.613E-001
3.012E-001	3.594E-001	3.923E-001	4.410E-001	4.619E-001	4.941E-001
5.116E-001	5.284E-001	5.443E-001	5.636E-001	5.843E-001	5.923E-001
6.099E-001	6.295E-001	6.373E-001			

70 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	7.105E-007	1.363E-006	1.762E-006	2.019E-006	2.168E-006
2.244E-006	2.307E-006	2.360E-006	2.411E-006	2.455E-006	2.498E-006
2.565E-006	2.676E-006	2.820E-006	3.029E-006	3.358E-006	3.834E-006
4.364E-006	4.953E-006	5.674E-006	6.401E-006	7.135E-006	7.917E-006
8.722E-006	9.878E-006	1.118E-005	1.254E-005	1.399E-005	1.550E-005
1.694E-005	1.833E-005	1.964E-005	2.080E-005	2.184E-005	2.300E-005
2.403E-005	2.483E-005	2.544E-005	2.587E-005	2.618E-005	2.643E-005
2.663E-005	2.679E-005	2.693E-005			

80 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

3.481E-004	3.434E-004	3.479E-004	3.099E-004	3.298E-004	3.418E-004
3.789E-004	3.932E-004	4.379E-004	6.234E-004	9.168E-004	1.747E-003
3.628E-003	6.322E-003	7.555E-003	1.692E-002	2.590E-002	3.365E-002
4.007E-002	5.376E-002	7.121E-002	7.269E-002	8.039E-002	9.786E-002
1.122E-001	1.338E-001	1.738E-001	2.036E-001	2.799E-001	3.219E-001
3.659E-001	4.252E-001	4.559E-001	4.972E-001	5.094E-001	5.276E-001
5.495E-001	5.623E-001	5.816E-001	6.033E-001	6.247E-001	6.253E-001
6.413E-001	6.540E-001	6.583E-001			

80 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	9.528E-007	1.835E-006	2.387E-006	2.732E-006	2.929E-006
3.033E-006	3.122E-006	3.198E-006	3.275E-006	3.346E-006	3.425E-006
3.566E-006	3.792E-006	4.072E-006	4.503E-006	5.166E-006	5.979E-006
6.857E-006	7.809E-006	8.960E-006	1.011E-005	1.116E-005	1.227E-005
1.339E-005	1.497E-005	1.674E-005	1.852E-005	2.036E-005	2.226E-005
2.402E-005	2.569E-005	2.723E-005	2.856E-005	2.971E-005	3.098E-005
3.208E-005	3.293E-005	3.359E-005	3.405E-005	3.438E-005	3.464E-005
3.485E-005	3.502E-005	3.516E-005			

90 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

5.303E-004	5.150E-004	5.279E-004	4.795E-004	5.338E-004	4.943E-004
5.732E-004	7.025E-004	7.543E-004	1.328E-003	2.528E-003	5.498E-003
1.010E-002	1.790E-002	2.123E-002	3.696E-002	4.536E-002	6.266E-002
6.856E-002	8.880E-002	1.115E-001	1.218E-001	1.381E-001	1.525E-001
1.777E-001	1.971E-001	2.478E-001	3.071E-001	3.682E-001	4.154E-001
4.550E-001	5.102E-001	5.313E-001	5.814E-001	5.822E-001	6.111E-001
6.234E-001	6.260E-001	6.448E-001	6.529E-001	6.668E-001	6.645E-001
6.724E-001	6.845E-001	6.838E-001			

90 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.442E-006	2.771E-006	3.615E-006	4.159E-006	4.467E-006
4.621E-006	4.767E-006	4.901E-006	5.050E-006	5.219E-006	5.458E-006
5.867E-006	6.505E-006	7.293E-006	8.325E-006	9.611E-006	1.108E-005
1.265E-005	1.425E-005	1.610E-005	1.795E-005	1.974E-005	2.155E-005
2.331E-005	2.575E-005	2.831E-005	3.092E-005	3.351E-005	3.598E-005
3.821E-005	4.026E-005	4.207E-005	4.362E-005	4.496E-005	4.642E-005
4.768E-005	4.864E-005	4.937E-005	4.988E-005	5.023E-005	5.051E-005
5.073E-005	5.091E-005	5.106E-005			

95 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

6.908E-004	7.757E-004	7.918E-004	6.360E-004	7.188E-004	7.442E-004
8.515E-004	9.674E-004	1.286E-003	3.157E-003	5.168E-003	1.352E-002
2.479E-002	3.254E-002	4.288E-002	6.571E-002	6.987E-002	8.941E-002
1.097E-001	1.305E-001	1.540E-001	1.743E-001	1.845E-001	2.121E-001
2.589E-001	2.782E-001	3.333E-001	4.117E-001	4.788E-001	5.015E-001
5.236E-001	5.678E-001	6.319E-001	6.615E-001	6.774E-001	6.655E-001
6.847E-001	6.928E-001	6.970E-001	6.964E-001	7.144E-001	7.005E-001
7.041E-001	7.136E-001	7.053E-001			

95-5 Confidence for HCLPF

95 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	2.000E-006	3.998E-006	5.210E-006	5.936E-006	6.364E-006
6.594E-006	6.804E-006	7.008E-006	7.321E-006	7.696E-006	8.249E-006
9.254E-006	1.057E-005	1.209E-005	1.402E-005	1.615E-005	1.832E-005
2.069E-005	2.314E-005	2.577E-005	2.837E-005	3.084E-005	3.330E-005
3.581E-005	3.933E-005	4.286E-005	4.636E-005	4.978E-005	5.289E-005
5.552E-005	5.783E-005	5.992E-005	6.172E-005	6.326E-005	6.492E-005
6.630E-005	6.736E-005	6.815E-005	6.870E-005	6.907E-005	6.937E-005
6.961E-005	6.980E-005	6.995E-005			

95% Upper bound CDF.

INPUT DATA FOR RUN NO. 2:

In run no. 2, which uses the Surry SPRA model and the North Anna EPRI hazard curve, the input parameters are the same as run no. 1 with the exception of the seismic fragilities of three structures, systems and components (SSC). For these three SSCs, fragilities specific to North Anna plant were developed and used as the input. These three SSCs are: Emergency Condensate Storage Tank (ECST), Component Cooling Water (CCW) Pump and the Turbine Building. The references and calculations of these fragilities are discussed below.

The North Anna high-confidence-of-low-probability-of-failure (HCLPF) capacities of ECST and CCW Pump were determined using the Conservative Deterministic Failure Margin (CDFM) approach of Ref. 1 as 0.16g and 0.29g respectively (Ref. 2). The CDFM method calculates the 85 percentile capacity. The parameters for defining fragility in the "SEISMIC" code are median acceleration A_m and logarithmic standard deviations β_r and β_u representing randomness and uncertainty, respectively. Based on Ref. 3, the relationships between HCLPF capacities and fragility parameters are defined as:

$$HCLPF_{50} = A_m \exp\{-1.65(\beta_r + \beta_u)\}$$

and $$HCLPF_{85} \approx 1.22\ HCLPF_{50}$$

For ECST, the values of β_r and β_u are assumed to be the same as those for Surry, i. e., 0.21 and 0.3 respectively. A_m is calculated from the above equations as 0.304g (using $HCLPF_{85} = 0.16$).

Similarly, for CCW Pump, the values of β_r and β_u are assumed as 0.19 and 0.31 respectively. A_m is calculated from the above equations as 0.542g (using $HCLPF_{85} = 0.29$).

From Ref. 4, the Turbine Building, the values of A_m , β_r and β_u are: 0.942g, 0.4 and 0.4 respectively.

References:

1. A Methodology for Assessment of Nuclear Power Plant Seismic Margin, Revision 1, EPRI NP-6041-SL, August 1991.

2. Summary Report submitted to the NRC for Individual Plant Examination of External Events (IPEEE) - Seismic, prepared in response to USNRC Generic Letter 88-20, Supplements 4 and 5, North Anna Power Station, May, 1997.

3. Methodology for Developing Seismic Fragilities, EPRI TR-103959, Prepared by J. R. Benjamin and Associates, Inc. and RPK Structural Mechanics Consulting, June 1994.

4. EM Calculation in IPEEE-Seismic Files, "Seismic Fragility of North Anna Turbine Building", North Anna Power Station, June 24, 1999.

Prepared by: D. Bhargava (signature) 7-10-01
D. Bhargava Date

Reviewed by: K. K. Dwivedy (signature) 7-10-01
K. K. Dwivedy Date

Seismic Analysis Module Version 1.1
Wed Jun 27 11:13:58 2001

Input File: X.IN Equation File: NAPS1--1.EQN
Output File: x.out

RUN NO. 2
NAPS EPRI HAZARD
NAPS FRAGILITIES FOR TURBINE BLDG, ECST & CC.
PLANT SEQUENCE.

NO OF ACCELERATION POINTS	45
NO OF SEISMIC FAILURE EVENTS	7
NO OF RANDOM FAILURE EVENTS	8
NO OF EQUATIONS	1
NO OF MONTE CARLO TRIALS	1000
NO OF CURVES	1
NO OF ACCELERATION RANGES	1

ACCELERATION POINTS %g

7.645E-003	1.529E-002	2.548E-002	3.568E-002	4.587E-002	5.607E-002
6.626E-002	7.645E-002	8.665E-002	9.684E-002	1.070E-001	1.172E-001
1.274E-001	1.376E-001	1.478E-001	1.580E-001	1.682E-001	1.784E-001
1.886E-001	1.988E-001	2.090E-001	2.192E-001	2.294E-001	2.396E-001
2.497E-001	2.676E-001	2.931E-001	3.186E-001	3.440E-001	3.695E-001
3.950E-001	4.205E-001	4.460E-001	4.715E-001	4.969E-001	5.352E-001
5.861E-001	6.371E-001	6.881E-001	7.390E-001	7.900E-001	8.410E-001
8.919E-001	9.429E-001	9.939E-001			

Plant HCLPF

FREQUENCIES AT THE GIVEN ACCELERATIONS FOR CURVE NO. 1

4.159E-001	3.041E-001	1.972E-001	1.285E-001	8.437E-002	3.139E-002
2.551E-002	2.011E-002	1.609E-002	1.285E-002	6.377E-003	5.592E-003
4.905E-003	4.218E-003	3.728E-003	3.335E-003	2.845E-003	2.551E-003
2.158E-003	1.864E-003	1.766E-003	1.373E-003	1.324E-003	1.128E-003
9.810E-004	5.023E-004	4.120E-004	3.335E-004	2.747E-004	2.237E-004
1.805E-004	1.530E-004	1.216E-004	9.810E-005	8.240E-005	4.611E-005
3.453E-005	2.570E-005	1.923E-005	1.158E-005	9.221E-006	7.456E-006
5.690E-006	4.709E-006	3.728E-006			

PROBABILITY OF CURVE I IN RANGE J

SEISMIC FREQUENCY CURVE NUMBER	ACCELERATION RANGE ENDPOINT 1.00
1	1.0000

*** SEISMIC INDUCED FAILURES

NO.	COMPONENT NAME	MEDIAN ACC	BETAR	BETAU	
1	EQ-AFW-ECST	3.040E-001	2.10E-001	3.00E-001	← NORTH ANNA SPECIFIC
2	EQ-CC-SURGE-TK	5.420E-001	1.90E-001	3.10E-001	← NORTH ANNA SPECIFIC
3	EQ-S2-LOCA	9.000E-001	3.00E-001	3.00E-001	
4	EQ-SWITCHYARD	3.000E-001	2.50E-001	3.50E-001	
5	EQ-TB-SEV-DMG	9.420E-001	4.00E-001	4.00E-001	← NORTH ANNA SPECIFIC
6	EQ-LUBE-OIL	4.800E-001	2.50E-001	4.10E-001	
7	EQ-FIRE-PRO-TK	2.200E-001	3.00E-001	3.00E-001	

*** RANDOM FAILURES

NO.	COMPONENT NAME	MEDIAN	MEAN	ERROR FAC	TYPE
8	L	9.601E-002	1.20E-001	3.00E+000	LOGNORMA
9	LD	5.800E-001	5.80E-001	1.00E+000	LOGNORMA
10	LE	6.600E-001	6.60E-001	1.00E+000	LOGNORMA
11	M	2.107E-003	3.40E-003	5.00E+000	LOGNORMA
12	M0	1.487E-004	2.40E-004	5.00E+000	LOGNORMA
13	T-BLDG-IGN-LO	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
14	TURB-B-ACC-LO	2.000E-001	2.50E-001	3.00E+000	LOGNORMA
15	ACC-LD	7.500E-001	7.50E-001	1.00E+000	LOGNORMA

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EQUATION SPS1 =  (EQ-TB-SEV-DMG)   +   (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * T-BLDG-IGN-LO
 * ACC-LD)  +   (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * /T-BLDG-IGN-LO
 * EQ-SWITCHYARD * EQ-CC-SURGE-TK)   +   (/EQ-TB-SEV-DMG * EQ-LUBE-OIL
 * /T-BLDG-IGN-LO * EQ-SWITCHYARD * /EQ-CC-SURGE-TK * EQ-AFW-ECST
 * LE)   +   (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * /T-BLDG-IGN-LO
 * EQ-SWITCHYARD * /EQ-CC-SURGE-TK * /EQ-AFW-ECST * L)   +   (/EQ-TB-SEV-DMG * /EQ-LUBE-OIL * EQ-SWIT
) .
```

SEISMIC EVALUATION FOR EQUATION SPS1

MEAN FRAGILITY VALUES AT EACH ACC J :

2.378E-004	2.407E-004	2.532E-004	2.478E-004	2.413E-004	2.335E-004
2.549E-004	2.956E-004	6.409E-004	8.041E-004	1.106E-003	1.847E-003
2.998E-003	5.647E-003	8.204E-003	1.055E-002	1.278E-002	1.669E-002
2.237E-002	2.598E-002	2.926E-002	3.749E-002	4.124E-002	4.770E-002
5.564E-002	7.292E-002	9.451E-002	1.249E-001	1.466E-001	1.888E-001
2.056E-001	2.429E-001	2.794E-001	2.862E-001	3.234E-001	3.515E-001
3.796E-001	4.017E-001	4.259E-001	4.442E-001	4.562E-001	4.710E-001
4.860E-001	4.979E-001	5.150E-001			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	6.580E-007	1.286E-006	1.702E-006	1.968E-006	2.109E-006
2.180E-006	2.243E-006	2.326E-006	2.431E-006	2.520E-006	2.609E-006
2.736E-006	2.933E-006	3.210E-006	3.545E-006	3.910E-006	4.312E-006
4.775E-006	5.268E-006	5.778E-006	6.304E-006	6.845E-006	7.397E-006
7.950E-006	8.763E-006	9.726E-006	1.075E-005	1.180E-005	1.285E-005
1.386E-005	1.481E-005	1.571E-005	1.650E-005	1.720E-005	1.802E-005
1.877E-005	1.936E-005	1.984E-005	2.018E-005	2.041E-005	2.061E-005
2.077E-005	2.090E-005	2.101E-005			

MEAN CDF

5 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

3.214E-005	3.064E-005	2.916E-005	3.086E-005	2.818E-005	2.832E-005
2.711E-005	3.099E-005	3.240E-005	3.968E-005	3.771E-005	4.789E-005
4.994E-005	5.470E-005	7.718E-005	9.129E-005	1.037E-004	1.311E-004
1.903E-004	2.766E-004	2.819E-004	3.891E-004	5.390E-004	1.145E-003
1.285E-003	2.559E-003	4.999E-003	1.198E-002	1.876E-002	2.676E-002
3.359E-002	4.474E-002	6.857E-002	7.407E-002	9.518E-002	1.173E-001
1.588E-001	1.780E-001	2.267E-001	2.625E-001	2.830E-001	2.808E-001
3.086E-001	3.098E-001	3.271E-001			

5 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	8.672E-008	1.635E-007	2.130E-007	2.454E-007	2.620E-007
2.701E-007	2.768E-007	2.826E-007	2.879E-007	2.917E-007	2.943E-007
2.969E-007	2.993E-007	3.020E-007	3.050E-007	3.080E-007	3.112E-007
3.150E-007	3.198E-007	3.249E-007	3.302E-007	3.365E-007	3.468E-007
3.598E-007	3.825E-007	4.251E-007	5.023E-007	6.189E-007	7.608E-007
9.143E-007	1.079E-006	1.272E-006	1.471E-006	1.664E-006	1.917E-006
2.194E-006	2.451E-006	2.678E-006	2.867E-006	3.011E-006	3.131E-006
3.229E-006	3.311E-006	3.379E-006			

5% lower bound CDF

10 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

4.609E-005	4.334E-005	4.238E-005	4.561E-005	4.299E-005	3.974E-005
4.127E-005	4.796E-005	4.755E-005	5.508E-005	5.729E-005	6.801E-005
7.013E-005	8.824E-005	1.205E-004	1.467E-004	1.838E-004	2.310E-004
3.949E-004	4.599E-004	6.561E-004	8.712E-004	1.376E-003	2.597E-003
3.184E-003	5.271E-003	1.085E-002	1.972E-002	3.068E-002	4.722E-002
5.048E-002	6.910E-002	9.442E-002	1.052E-001	1.291E-001	1.581E-001
2.051E-001	2.363E-001	2.751E-001	3.036E-001	3.187E-001	3.238E-001
3.414E-001	3.396E-001	3.607E-001			

10 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.237E-007	2.334E-007	3.059E-007	3.543E-007	3.791E-007
3.908E-007	4.011E-007	4.099E-007	4.174E-007	4.229E-007	4.267E-007
4.304E-007	4.341E-007	4.382E-007	4.430E-007	4.482E-007	4.538E-007
4.612E-007	4.699E-007	4.802E-007	4.922E-007	5.076E-007	5.318E-007
5.626E-007	6.141E-007	7.048E-007	8.456E-007	1.037E-006	1.279E-006
1.529E-006	1.780E-006	2.061E-006	2.339E-006	2.606E-006	2.949E-006
3.315E-006	3.650E-006	3.940E-006	4.164E-006	4.329E-006	4.465E-006
4.576E-006	4.666E-006	4.741E-006			

20 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

6.638E-005	6.659E-005	6.644E-005	6.697E-005	6.569E-005	6.378E-005
6.498E-005	7.389E-005	7.677E-005	8.655E-005	9.056E-005	1.110E-004
1.189E-004	1.613E-004	2.139E-004	2.804E-004	3.879E-004	5.690E-004
8.582E-004	1.349E-003	1.866E-003	3.140E-003	3.674E-003	6.950E-003
7.890E-003	1.326E-002	2.487E-002	3.575E-002	5.178E-002	7.415E-002
8.804E-002	1.093E-001	1.437E-001	1.465E-001	1.922E-001	2.292E-001
2.775E-001	3.034E-001	3.280E-001	3.506E-001	3.522E-001	3.654E-001
3.784E-001	3.832E-001	4.090E-001			

20 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.830E-007	3.530E-007	4.636E-007	5.357E-007	5.742E-007
5.928E-007	6.088E-007	6.227E-007	6.347E-007	6.433E-007	6.494E-007
6.555E-007	6.620E-007	6.695E-007	6.783E-007	6.887E-007	7.017E-007
7.186E-007	7.408E-007	7.705E-007	8.092E-007	8.560E-007	9.208E-007
1.000E-006	1.129E-006	1.344E-006	1.627E-006	1.960E-006	2.352E-006
2.766E-006	3.182E-006	3.618E-006	4.024E-006	4.408E-006	4.913E-006
5.427E-006	5.870E-006	6.229E-006	6.493E-006	6.679E-006	6.832E-006

6.956E-006 7.057E-006 7.142E-006
30 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
9.172E-005 9.024E-005 9.433E-005 8.823E-005 8.683E-005 9.053E-005
9.300E-005 9.927E-005 1.080E-004 1.215E-004 1.256E-004 1.570E-004
1.911E-004 2.494E-004 3.522E-004 4.793E-004 7.622E-004 1.222E-003
1.986E-003 3.098E-003 3.735E-003 6.643E-003 7.464E-003 1.334E-002
1.476E-002 2.304E-002 3.904E-002 5.463E-002 7.523E-002 9.562E-002
1.121E-001 1.496E-001 1.880E-001 1.881E-001 2.354E-001 2.844E-001
3.186E-001 3.394E-001 3.595E-001 3.832E-001 3.848E-001 4.020E-001
4.134E-001 4.194E-001 4.459E-001
30 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :
0.000E+000 2.507E-007 4.854E-007 6.380E-007 7.331E-007 7.849E-007
8.115E-007 8.338E-007 8.528E-007 8.696E-007 8.817E-007 8.902E-007
8.995E-007 9.096E-007 9.217E-007 9.365E-007 9.557E-007 9.827E-007
1.020E-006 1.072E-006 1.135E-006 1.215E-006 1.312E-006 1.439E-006
1.589E-006 1.822E-006 2.174E-006 2.611E-006 3.107E-006 3.642E-006
4.173E-006 4.722E-006 5.306E-006 5.832E-006 6.314E-006 6.936E-006
7.550E-006 8.053E-006 8.452E-006 8.741E-006 8.944E-006 9.111E-006
9.247E-006 9.358E-006 9.450E-006
40 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.153E-004 1.189E-004 1.223E-004 1.129E-004 1.196E-004 1.173E-004
1.224E-004 1.286E-004 1.322E-004 1.691E-004 1.700E-004 2.250E-004
2.573E-004 3.846E-004 6.210E-004 8.840E-004 1.264E-003 2.276E-003
3.715E-003 5.698E-003 6.751E-003 1.086E-002 1.280E-002 2.123E-002
2.140E-002 3.496E-002 5.392E-002 7.264E-002 9.687E-002 1.275E-001
1.491E-001 1.839E-001 2.283E-001 2.321E-001 2.863E-001 3.203E-001
3.494E-001 3.745E-001 3.873E-001 4.140E-001 4.214E-001 4.361E-001
4.485E-001 4.671E-001 4.814E-001
40 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :
0.000E+000 3.215E-007 6.287E-007 8.256E-007 9.510E-007 1.021E-006
1.056E-006 1.085E-006 1.109E-006 1.131E-006 1.147E-006 1.159E-006
1.172E-006 1.187E-006 1.207E-006 1.234E-006 1.267E-006 1.315E-006
1.386E-006 1.481E-006 1.595E-006 1.732E-006 1.895E-006 2.103E-006
2.332E-006 2.676E-006 3.183E-006 3.775E-006 4.423E-006 5.125E-006
5.831E-006 6.533E-006 7.245E-006 7.889E-006 8.480E-006 9.213E-006
9.897E-006 1.045E-005 1.088E-005 1.120E-005 1.142E-005 1.160E-005
1.175E-005 1.187E-005 1.197E-005
50 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.471E-004 1.533E-004 1.545E-004 1.428E-004 1.493E-004 1.442E-004
1.554E-004 1.608E-004 1.751E-004 2.211E-004 2.383E-004 3.015E-004
3.807E-004 6.282E-004 9.947E-004 1.677E-003 2.526E-003 3.980E-003
6.288E-003 1.049E-002 1.094E-002 1.764E-002 2.101E-002 3.226E-002
3.330E-002 4.797E-002 7.088E-002 9.369E-002 1.195E-001 1.558E-001
1.789E-001 2.255E-001 2.682E-001 2.806E-001 3.322E-001 3.577E-001
3.838E-001 4.083E-001 4.256E-001 4.457E-001 4.580E-001 4.701E-001
4.790E-001 5.028E-001 5.156E-001
50 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :
0.000E+000 4.120E-007 8.048E-007 1.054E-006 1.211E-006 1.299E-006
1.342E-006 1.379E-006 1.409E-006 1.438E-006 1.461E-006 1.477E-006
1.495E-006 1.518E-006 1.550E-006 1.598E-006 1.663E-006 1.751E-006
1.872E-006 2.041E-006 2.239E-006 2.461E-006 2.726E-006 3.054E-006
3.406E-006 3.912E-006 4.591E-006 5.361E-006 6.178E-006 7.040E-006
7.896E-006 8.747E-006 9.603E-006 1.037E-005 1.107E-005 1.191E-005
1.267E-005 1.327E-005 1.375E-005 1.409E-005 1.433E-005 1.452E-005
1.468E-005 1.481E-005 1.492E-005 Median CDF
60 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.879E-004 1.960E-004 1.985E-004 1.851E-004 1.890E-004 1.843E-004
1.994E-004 2.042E-004 2.251E-004 2.856E-004 3.266E-004 4.162E-004
5.530E-004 1.154E-003 1.632E-003 3.729E-003 4.966E-003 6.721E-003
1.172E-002 1.539E-002 1.743E-002 2.777E-002 3.138E-002 4.183E-002
4.701E-002 6.167E-002 8.755E-002 1.183E-001 1.451E-001 1.961E-001
2.197E-001 2.689E-001 3.124E-001 3.239E-001 3.688E-001 3.957E-001
4.182E-001 4.437E-001 4.569E-001 4.785E-001 4.850E-001 4.999E-001
5.109E-001 5.371E-001 5.517E-001
60 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :
0.000E+000 5.266E-007 1.030E-006 1.351E-006 1.553E-006 1.664E-006
1.719E-006 1.766E-006 1.806E-006 1.843E-006 1.872E-006 1.894E-006
1.920E-006 1.959E-006 2.015E-006 2.109E-006 2.244E-006 2.404E-006
2.620E-006 2.895E-006 3.198E-006 3.550E-006 3.956E-006 4.408E-006
4.884E-006 5.572E-006 6.426E-006 7.388E-006 8.399E-006 9.466E-006
1.053E-005 1.156E-005 1.257E-005 1.346E-005 1.425E-005 1.518E-005
1.601E-005 1.667E-005 1.719E-005 1.755E-005 1.781E-005 1.801E-005
1.818E-005 1.832E-005 1.844E-005

70 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

2.352E-004	2.514E-004	2.567E-004	2.441E-004	2.477E-004	2.355E-004
2.598E-004	2.628E-004	2.994E-004	3.798E-004	4.494E-004	6.200E-004
9.846E-004	2.091E-003	3.528E-003	6.889E-003	8.416E-003	1.158E-002
1.883E-002	2.403E-002	2.593E-002	3.864E-002	4.637E-002	5.169E-002
6.420E-002	8.106E-002	1.096E-001	1.492E-001	1.825E-001	2.407E-001
2.620E-001	3.203E-001	3.602E-001	3.689E-001	4.040E-001	4.357E-001
4.550E-001	4.722E-001	4.862E-001	5.007E-001	5.103E-001	5.382E-001
5.508E-001	5.709E-001	5.859E-001			

70 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	6.663E-007	1.314E-006	1.732E-006	1.998E-006	2.142E-006
2.214E-006	2.275E-006	2.326E-006	2.376E-006	2.415E-006	2.447E-006
2.490E-006	2.559E-006	2.671E-006	2.855E-006	3.094E-006	3.367E-006
3.725E-006	4.160E-006	4.622E-006	5.126E-006	5.709E-006	6.319E-006
6.938E-006	7.863E-006	8.957E-006	1.017E-005	1.144E-005	1.276E-005
1.405E-005	1.528E-005	1.646E-005	1.748E-005	1.837E-005	1.939E-005
2.030E-005	2.101E-005	2.156E-005	2.194E-005	2.221E-005	2.243E-005
2.262E-005	2.276E-005	2.289E-005			

80 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

3.336E-004	3.646E-004	3.441E-004	3.361E-004	3.333E-004	3.251E-004
3.552E-004	3.673E-004	4.110E-004	5.581E-004	7.139E-004	1.087E-003
1.925E-003	4.079E-003	8.401E-003	1.388E-002	1.778E-002	2.128E-002
3.129E-002	3.900E-002	4.658E-002	6.190E-002	6.478E-002	7.450E-002
8.549E-002	1.117E-001	1.489E-001	1.899E-001	2.328E-001	2.946E-001
3.195E-001	3.723E-001	4.099E-001	4.211E-001	4.455E-001	4.722E-001
4.892E-001	5.028E-001	5.204E-001	5.315E-001	5.504E-001	5.756E-001
5.919E-001	6.135E-001	6.237E-001			

80 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	9.544E-007	1.865E-006	2.431E-006	2.795E-006	2.990E-006
3.088E-006	3.172E-006	3.244E-006	3.314E-006	3.374E-006	3.428E-006
3.507E-006	3.643E-006	3.890E-006	4.286E-006	4.779E-006	5.314E-006
5.935E-006	6.649E-006	7.439E-006	8.292E-006	9.162E-006	1.003E-005
1.088E-005	1.213E-005	1.363E-005	1.522E-005	1.684E-005	1.849E-005
2.007E-005	2.153E-005	2.289E-005	2.405E-005	2.505E-005	2.616E-005
2.715E-005	2.791E-005	2.849E-005	2.891E-005	2.919E-005	2.943E-005
2.963E-005	2.978E-005	2.992E-005			

90 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

5.084E-004	5.350E-004	5.619E-004	5.314E-004	5.214E-004	5.124E-004
5.375E-004	5.864E-004	7.489E-004	1.108E-003	1.696E-003	3.464E-003
6.470E-003	1.153E-002	2.047E-002	2.925E-002	3.444E-002	4.668E-002
6.048E-002	6.904E-002	8.058E-002	9.192E-002	1.041E-001	1.143E-001
1.391E-001	1.696E-001	2.131E-001	2.814E-001	3.017E-001	3.808E-001
3.900E-001	4.432E-001	4.732E-001	4.803E-001	5.018E-001	5.077E-001
5.155E-001	5.400E-001	5.777E-001	5.851E-001	6.043E-001	6.278E-001
6.456E-001	6.513E-001	6.578E-001			

90 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.430E-006	2.824E-006	3.737E-006	4.309E-006	4.616E-006
4.767E-006	4.897E-006	5.019E-006	5.153E-006	5.281E-006	5.434E-006
5.695E-006	6.105E-006	6.742E-006	7.628E-006	8.624E-006	9.731E-006
1.100E-005	1.232E-005	1.371E-005	1.507E-005	1.642E-005	1.778E-005
1.913E-005	2.111E-005	2.331E-005	2.563E-005	2.788E-005	3.002E-005
3.200E-005	3.377E-005	3.536E-005	3.670E-005	3.782E-005	3.906E-005
4.011E-005	4.092E-005	4.156E-005	4.201E-005	4.233E-005	4.259E-005
4.280E-005	4.297E-005	4.311E-005			

95 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :

7.214E-004	7.359E-004	7.845E-004	7.716E-004	7.268E-004	7.631E-004	
7.641E-004	9.636E-004	1.202E-003	2.159E-003	4.025E-003	8.263E-003	
1.543E-002	2.628E-002	3.769E-002	4.977E-002	5.996E-002	7.746E-002	95-5 Conf. for HCLPF
9.222E-002	1.070E-001	1.194E-001	1.320E-001	1.536E-001	1.561E-001	
1.839E-001	2.469E-001	2.740E-001	3.451E-001	3.602E-001	4.445E-001	
4.458E-001	4.995E-001	5.088E-001	5.108E-001	5.379E-001	5.530E-001	
5.650E-001	5.993E-001	6.245E-001	6.382E-001	6.527E-001	6.675E-001	
6.741E-001	6.754E-001	6.855E-001				

95 PERCENTILE CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	2.002E-006	3.932E-006	5.225E-006	6.043E-006	6.478E-006	
6.699E-006	6.897E-006	7.095E-006	7.335E-006	7.607E-006	7.973E-006	
8.595E-006	9.545E-006	1.083E-005	1.239E-005	1.410E-005	1.598E-005	
1.800E-005	2.003E-005	2.212E-005	2.412E-005	2.608E-005	2.802E-005	
2.983E-005	3.255E-005	3.557E-005	3.847E-005	4.120E-005	4.373E-005	
4.602E-005	4.802E-005	4.978E-005	5.121E-005	5.241E-005	5.375E-005	
5.490E-005	5.578E-005	5.648E-005	5.698E-005	5.732E-005	5.760E-005	
5.782E-005	5.800E-005	5.815E-005				95% upper bound CDF

Seismic Analysis Module   Version 1.1
Tue Jun 26 09:27:05 2001

Input File: NAPS1.IN   Equation File: NAPS1.EQN
Output File: NAPS1.out

RUN #3
NAPS EPRI HAZARD, SURRY SPRA MODEL.
INDIVIDUAL SEQUENCES

NO OF ACCELERATION POINTS	45
NO OF SEISMIC FAILURE EVENTS	9
NO OF RANDOM FAILURE EVENTS	14
NO OF EQUATIONS	20
NO OF MONTE CARLO TRIALS	1000
NO OF CURVES	1
NO OF ACCELERATION RANGES	1

ACCELERATION POINTS %g

7.645E-003	1.529E-002	2.548E-002	3.568E-002	4.587E-002	5.607E-002
6.626E-002	7.645E-002	8.665E-002	9.684E-002	1.070E-001	1.172E-001
1.274E-001	1.376E-001	1.478E-001	1.580E-001	1.682E-001	1.784E-001
1.886E-001	1.988E-001	2.090E-001	2.192E-001	2.294E-001	2.396E-001
2.497E-001	2.676E-001	2.931E-001	3.186E-001	3.440E-001	3.695E-001
3.950E-001	4.205E-001	4.460E-001	4.715E-001	4.969E-001	5.352E-001
5.861E-001	6.371E-001	6.881E-001	7.390E-001	7.900E-001	8.410E-001
8.919E-001	9.429E-001	9.939E-001			

FREQUENCIES AT THE GIVEN ACCELERATIONS FOR CURVE NO. 1

4.159E-001	3.041E-001	1.972E-001	1.285E-001	8.437E-002	3.139E-002
2.551E-002	2.011E-002	1.609E-002	1.285E-002	6.377E-003	5.592E-003
4.905E-003	4.218E-003	3.728E-003	3.335E-003	2.845E-003	2.551E-003
2.158E-003	1.864E-003	1.766E-003	1.373E-003	1.324E-003	1.128E-003
9.810E-004	5.023E-004	4.120E-004	3.335E-004	2.747E-004	2.237E-004
1.805E-004	1.530E-004	1.216E-004	9.810E-005	8.240E-005	4.611E-005
3.453E-005	2.570E-005	1.923E-005	1.158E-005	9.221E-006	7.456E-006
5.690E-006	4.709E-006	3.728E-006			

PROBABILITY OF CURVE I IN RANGE J

SEISMIC FREQUENCY CURVE NUMBER	ACCELERATION RANGE ENDPOINT 1.00
1	1.0000

*** SEISMIC INDUCED FAILURES

NO.	COMPONENT NAME	MEDIAN ACC	BETAR	BETAU
1	EQ-AFW-ECST	4.860E-001	2.10E-001	3.00E-001
2	EQ-CC-SURGE-TK	5.900E-001	1.90E-001	3.10E-001
3	EQ-S2-LOCA	9.000E-001	3.00E-001	3.00E-001
4	EQ-SWITCHYARD	3.000E-001	2.50E-001	3.50E-001
5	EQ-BLOCK-WALL	9.200E-001	3.90E-001	4.80E-001
6	EQ-ELEC-CAB	2.500E-001	2.00E-001	2.20E-001
7	EQ-TB-SEV-DMG	7.100E-001	4.00E-001	4.00E-001
8	EQ-LUBE-OIL	4.800E-001	2.50E-001	4.10E-001
9	EQ-FIRE-PRO-TK	2.200E-001	3.00E-001	3.00E-001

*** RANDOM FAILURES

NO.	COMPONENT NAME	MEDIAN	MEAN	ERROR FAC	TYPE
10	L	9.601E-002	1.20E-001	3.00E+000	LOGNORMA
11	LO	1.312E-001	1.64E-001	3.00E+000	LOGNORMA
12	LD	5.800E-001	5.80E-001	1.00E+000	LOGNORMA
13	LE	6.600E-001	6.60E-001	1.00E+000	LOGNORMA
14	LED	1.000E+000	1.00E+000	1.00E+000	LOGNORMA
15	M	2.107E-003	3.40E-003	5.00E+000	LOGNORMA
16	M0	1.487E-004	2.40E-004	5.00E+000	LOGNORMA
17	M1	5.887E-004	9.50E-004	5.00E+000	LOGNORMA
18	ME	1.921E-002	3.10E-002	5.00E+000	LOGNORMA
19	MC	3.594E-002	5.80E-002	5.00E+000	LOGNORMA
20	T-BLDG-IGN-EL	8.001E-002	1.00E-001	3.00E+000	LOGNORMA
21	T-BLDG-IGN-LO	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
22	TURB-B-ACC-EL	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
23	TURB-B-ACC-LO	2.000E-001	2.50E-001	3.00E+000	LOGNORMA

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EQUATION EQN02 =  (M0 * /EQ-FIRE-PRO-TK * /EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-CC-SURGE-TK
 * /EQ-LUBE-OIL * /EQ-TB-SEV-DMG) .
EQUATION EQN04 =  (M1 * EQ-FIRE-PRO-TK * /EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-CC-SURGE-TK
 * /EQ-LUBE-OIL * /EQ-TB-SEV-DMG) .
EQUATION EQN05 =  (ME * /EQ-SWITCHYARD * EQ-AFW-ECST * /EQ-CC-SURGE-TK * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN07 =  (MC * EQ-CC-SURGE-TK * /EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN08 =  (EQ-CC-SURGE-TK * /EQ-SWITCHYARD * EQ-AFW-ECST * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN10 =  (L * EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-CC-SURGE-TK * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN12 =  (LE * EQ-SWITCHYARD * EQ-AFW-ECST * /EQ-CC-SURGE-TK * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN13 =  (EQ-SWITCHYARD * EQ-CC-SURGE-TK * /EQ-LUBE-OIL * /EQ-TB-SEV-DMG
) .
EQUATION EQN34 =  (M * /T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-SWITCHYARD * /EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN35 =  (ME * /T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-SWITCHYARD * EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN36 =  (MC * /T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-CC-SURGE-TK * /EQ-SWITCHYARD
 * /EQ-AFW-ECST * /EQ-TB-SEV-DMG) .
EQUATION EQN37 =  (/T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-CC-SURGE-TK * /EQ-SWITCHYARD
 * EQ-AFW-ECST * /EQ-TB-SEV-DMG) .
EQUATION EQN39 =  (L * /T-BLDG-IGN-LO * EQ-SWITCHYARD * EQ-LUBE-OIL * /EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN41 =  (LE * /T-BLDG-IGN-LO * EQ-SWITCHYARD * EQ-LUBE-OIL * EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN42 =  (/T-BLDG-IGN-LO * EQ-SWITCHYARD * EQ-LUBE-OIL * EQ-CC-SURGE-TK
 * /EQ-TB-SEV-DMG) .
EQUATION EQN44 =  (/TURB-B-ACC-LO * LD * T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN45 =  (/TURB-B-ACC-LO * LED * T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN46 =  (/TURB-B-ACC-LO * T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-CC-SURGE-TK
 * /EQ-TB-SEV-DMG) .
EQUATION EQN47 =  (TURB-B-ACC-LO * T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-TB-SEV-DMG
) .
EQUATION EQN48 =  (EQ-TB-SEV-DMG) .

    SEISMIC EVALUATION FOR EQUATION EQN02
      MEAN FRAGILITY VALUES AT EACH ACC J :
  0.000E+000  0.000E+000  0.000E+000  1.463E-017  8.422E-015  3.973E-013
  9.110E-012  9.588E-011  1.940E-009  8.277E-009  5.887E-008  1.908E-007
  8.309E-007  2.962E-006  4.462E-006  1.719E-005  2.091E-005  6.168E-005
  1.319E-004  1.823E-004  2.034E-004  3.653E-004  3.922E-004  9.155E-004
  1.136E-003  2.677E-003  3.399E-003  4.043E-003  3.914E-003  5.919E-003
  6.336E-003  6.727E-003  7.248E-003  7.597E-003  7.748E-003  7.732E-003
  6.396E-003  7.871E-003  6.070E-003  6.050E-003  5.642E-003  4.291E-003
  4.082E-003  2.179E-017  7.986E-018
     MEAN CUMULATIVE RESULTS UP TO ACC J :
  0.000E+000  0.000E+000  0.000E+000  2.341E-021  1.100E-018  4.292E-017
  8.306E-016  7.857E-015  7.717E-014  3.761E-013  2.084E-012  7.657E-012
  2.755E-011  9.369E-011  2.087E-010  4.969E-010  9.504E-010  1.766E-009
  3.539E-009  6.002E-009  8.651E-009  1.212E-008  1.619E-008  2.372E-008
  3.554E-008  5.288E-008  7.616E-008  9.958E-008  1.201E-007  1.406E-007
  1.620E-007  1.802E-007  1.963E-007  2.144E-007  2.301E-007  2.420E-007
  2.502E-007  2.556E-007  2.594E-007  2.620E-007  2.639E-007  2.653E-007
  2.662E-007  2.410E-006  2.410E-006

    SEISMIC EVALUATION FOR EQUATION EQN04
      MEAN FRAGILITY VALUES AT EACH ACC J :
  2.442E-015  8.051E-013  1.495E-010  2.544E-009  2.042E-008  2.055E-007
  7.628E-007  2.786E-006  8.472E-006  2.506E-005  5.059E-005  1.276E-004
  2.410E-004  4.059E-004  7.746E-004  1.123E-003  1.717E-003  2.877E-003
  4.003E-003  7.711E-003  8.711E-003  1.132E-002  1.511E-002  2.658E-002
  3.506E-002  5.229E-002  8.327E-002  1.182E-001  1.545E-001  1.965E-001
  2.557E-001  3.325E-001  3.393E-001  4.327E-001  4.933E-001  5.610E-001
  6.594E-001  7.226E-001  7.597E-001  7.979E-001  8.644E-001  8.894E-001
  9.010E-001  1.472E-011  2.732E-012
     MEAN CUMULATIVE RESULTS UP TO ACC J :
  2.455E-018  5.323E-016  6.535E-014  5.367E-013  3.598E-012  2.732E-011
```

1.109E-010	3.560E-010	8.138E-010	1.803E-009	3.782E-009	7.791E-009
1.511E-008	2.659E-008	4.472E-008	7.056E-008	1.040E-007	1.503E-007
2.136E-007	3.036E-007	4.164E-007	5.403E-007	6.809E-007	9.322E-007
1.286E-006	1.693E-006	2.206E-006	2.835E-006	3.527E-006	4.266E-006
5.045E-006	5.857E-006	6.629E-006	7.545E-006	8.487E-006	9.289E-006
9.979E-006	1.052E-005	1.091E-005	1.124E-005	1.151E-005	1.175E-005
1.194E-005	9.607E-008	9.607E-008			

SEISMIC EVALUATION FOR EQUATION EQN05

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	9.705E-027	7.230E-022	3.999E-019
1.673E-016	1.535E-014	1.390E-012	3.048E-011	4.019E-010	3.493E-009
3.026E-008	2.472E-007	4.254E-007	2.395E-006	5.881E-006	2.388E-005
6.577E-005	1.819E-004	2.272E-004	5.036E-004	7.018E-004	2.149E-003
3.649E-003	8.017E-003	1.155E-002	1.589E-002	1.789E-002	1.710E-002
1.874E-002	1.599E-002	1.420E-002	1.152E-002	5.926E-003	3.499E-003
1.239E-003	4.439E-004	1.214E-004	7.048E-005	1.082E-005	3.251E-006
5.695E-007	1.471E-007	2.108E-008			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	1.553E-030	9.400E-026	4.118E-023
1.380E-020	1.033E-018	4.721E-017	9.612E-016	1.188E-014	9.703E-014
7.472E-013	5.525E-012	1.590E-011	5.320E-011	1.490E-010	4.406E-010
1.259E-009	3.125E-009	5.932E-009	1.036E-008	1.677E-008	3.253E-008
6.544E-008	1.187E-007	1.932E-007	2.789E-007	3.653E-007	4.398E-007
5.022E-007	5.513E-007	5.861E-007	6.187E-007	6.374E-007	6.449E-007
6.478E-007	6.486E-007	6.487E-007	6.488E-007	6.488E-007	6.488E-007
6.488E-007	1.104E-007	1.104E-007			

SEISMIC EVALUATION FOR EQUATION EQN07

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	2.948E-029	1.448E-026
7.563E-021	8.900E-018	4.051E-015	6.540E-013	1.126E-011	2.548E-010
3.765E-009	8.661E-008	4.841E-007	9.135E-007	3.046E-006	1.990E-005
3.699E-005	1.245E-004	2.876E-004	5.882E-004	9.257E-004	2.203E-003
9.088E-003	1.397E-002	2.160E-002	2.890E-002	3.773E-002	5.657E-002
6.815E-002	7.676E-002	1.073E-001	1.191E-001	1.173E-001	1.136E-001
7.976E-002	5.988E-002	3.785E-002	3.065E-002	1.625E-002	7.222E-003
4.274E-003	1.243E-007	2.616E-008			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	3.833E-033	1.492E-030
6.202E-025	5.842E-022	1.328E-019	1.890E-017	3.190E-016	6.079E-015
8.309E-014	1.627E-012	1.012E-011	2.901E-011	7.439E-011	2.969E-010
8.188E-010	2.023E-009	4.836E-009	1.016E-008	1.817E-008	3.614E-008
9.795E-008	2.050E-007	3.400E-007	4.979E-007	6.671E-007	8.642E-007
1.080E-006	1.282E-006	1.490E-006	1.764E-006	2.007E-006	2.185E-006
2.299E-006	2.355E-006	2.382E-006	2.397E-006	2.405E-006	2.408E-006
2.409E-006	4.814E-008	4.814E-008			

SEISMIC EVALUATION FOR EQUATION EQN08

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	0.000E+000	0.000E+000
0.000E+000	8.115E-031	8.618E-024	6.155E-020	2.416E-017	5.886E-016
1.230E-014	3.291E-013	9.180E-012	5.773E-011	4.530E-010	6.959E-009
2.830E-008	2.697E-007	9.371E-007	2.782E-006	7.821E-006	4.558E-005
4.872E-004	2.743E-003	7.264E-003	1.555E-002	2.987E-002	5.975E-002
8.027E-002	1.183E-001	1.612E-001	2.417E-001	2.671E-001	3.500E-001
3.571E-001	4.123E-001	3.849E-001	3.917E-001	3.844E-001	3.514E-001
3.246E-001	1.342E-004	2.717E-005			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	0.000E+000	0.000E+000
0.000E+000	5.315E-035	2.801E-028	1.755E-024	6.075E-022	1.387E-020
2.603E-019	6.089E-018	1.448E-016	1.028E-015	6.762E-015	7.785E-014
3.986E-013	2.541E-012	1.075E-011	3.308E-011	8.818E-011	3.608E-010
3.210E-009	1.742E-008	5.450E-008	1.242E-007	2.373E-007	4.225E-007
6.634E-007	9.358E-007	1.253E-006	1.720E-006	2.239E-006	2.703E-006
3.107E-006	3.404E-006	3.616E-006	3.781E-006	3.911E-006	4.009E-006
4.082E-006	2.029E-007	2.030E-007			

SEISMIC EVALUATION FOR EQUATION EQN10

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	4.696E-016	1.216E-013	2.443E-012
1.122E-010	8.299E-010	1.161E-008	6.207E-008	4.512E-007	1.162E-006
4.166E-006	1.859E-005	1.520E-005	4.965E-005	9.365E-005	1.996E-004

3.875E-004	7.126E-004	8.437E-004	1.550E-003	1.453E-003	3.759E-003
3.862E-003	8.587E-003	1.001E-002	1.091E-002	1.381E-002	1.357E-002
1.247E-002	1.333E-002	1.273E-002	9.495E-003	6.714E-003	4.840E-003
2.412E-003	8.573E-004	4.119E-004	1.715E-004	3.397E-005	2.053E-005
7.349E-006	4.214E-006	3.125E-006			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	7.514E-020	1.596E-017	2.822E-016
9.731E-015	7.329E-014	5.051E-013	2.652E-012	1.570E-011	5.197E-011
1.561E-010	5.513E-010	1.088E-009	1.954E-009	3.629E-009	6.555E-009
1.194E-008	2.041E-008	3.110E-008	4.571E-008	6.188E-008	9.144E-008
1.358E-007	1.925E-007	2.641E-007	3.302E-007	3.931E-007	4.514E-007
4.971E-007	5.331E-007	5.631E-007	5.916E-007	6.086E-007	6.177E-007
6.221E-007	6.235E-007	6.238E-007	6.240E-007	6.240E-007	6.240E-007
6.240E-007	6.509E-006	6.509E-006			

SEISMIC EVALUATION FOR EQUATION EQN12

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	1.964E-032	1.116E-024
1.288E-019	1.210E-017	6.952E-016	2.067E-014	5.337E-013	1.124E-011
9.167E-011	8.804E-010	2.090E-009	3.111E-008	7.010E-008	1.917E-007
6.904E-007	1.308E-006	2.177E-006	4.379E-006	5.807E-006	1.087E-005
2.378E-005	6.153E-005	1.380E-004	2.336E-004	4.154E-004	7.489E-004
1.225E-003	1.719E-003	2.813E-003	2.835E-003	2.737E-003	2.292E-003
1.240E-003	7.242E-004	4.612E-004	2.504E-004	9.363E-005	3.908E-005
1.647E-005	1.288E-003	9.755E-004			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	2.553E-036	1.144E-028
1.056E-023	8.134E-022	2.420E-020	6.360E-019	1.457E-017	2.696E-016
2.253E-015	1.896E-014	6.423E-014	4.990E-013	1.675E-012	4.266E-012
1.230E-011	2.767E-011	5.151E-011	9.139E-011	1.456E-010	2.451E-010
4.395E-010	8.258E-010	1.570E-009	2.719E-009	4.340E-009	6.756E-009
1.012E-008	1.416E-008	1.927E-008	2.620E-008	3.194E-008	3.585E-008
3.795E-008	3.878E-008	3.910E-008	3.925E-008	3.932E-008	3.933E-008
3.934E-008	3.002E-006	3.002E-006			

SEISMIC EVALUATION FOR EQUATION EQN13

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	2.764E-026	5.693E-023
7.178E-019	3.099E-016	1.156E-012	1.152E-012	9.008E-011	9.061E-010
9.836E-009	3.489E-008	8.798E-008	9.239E-007	1.880E-006	2.269E-006
1.001E-005	1.151E-005	1.915E-005	2.624E-005	3.222E-005	4.796E-005
7.596E-005	1.517E-004	1.888E-004	3.043E-004	5.553E-004	1.496E-003
2.239E-003	2.993E-003	5.133E-003	7.252E-003	9.447E-003	9.969E-003
9.980E-003	9.578E-003	7.940E-003	7.271E-003	5.791E-003	4.803E-003
4.465E-003	2.473E-002	1.553E-002			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	3.593E-030	5.843E-027
5.887E-023	2.042E-020	3.761E-017	1.080E-016	2.393E-015	2.413E-014
2.305E-013	1.011E-012	2.880E-012	1.617E-011	4.886E-011	9.110E-011
2.027E-010	3.734E-010	5.833E-010	8.634E-010	1.175E-009	1.672E-009
2.378E-009	3.421E-009	4.727E-009	6.255E-009	8.400E-009	1.259E-008
1.898E-008	2.619E-008	3.532E-008	4.980E-008	6.663E-008	8.148E-008
9.290E-008	1.006E-007	1.053E-007	1.085E-007	1.108E-007	1.122E-007
1.132E-007	2.759E-006	2.764E-006			

SEISMIC EVALUATION FOR EQUATION EQN34

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	1.463E-017	8.422E-015	3.969E-013
8.866E-012	9.508E-011	1.916E-009	6.947E-009	4.271E-008	1.582E-007
7.936E-007	2.564E-006	3.003E-006	9.356E-006	1.435E-005	3.566E-005
5.309E-005	7.354E-005	9.789E-005	1.315E-004	1.429E-004	2.399E-004
3.666E-004	7.544E-004	1.258E-003	1.651E-003	2.188E-003	3.454E-003
4.892E-003	5.221E-003	6.373E-003	7.597E-003	7.748E-003	7.732E-003
6.396E-003	7.871E-003	6.070E-003	6.050E-003	5.642E-003	4.291E-003
4.082E-003	1.743E-008	1.611E-009			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	2.341E-021	1.100E-018	4.288E-017
8.106E-016	7.765E-015	7.627E-014	3.365E-013	1.602E-012	6.072E-012
2.455E-011	8.322E-011	1.703E-010	3.355E-010	6.150E-010	1.112E-009
1.928E-009	2.921E-009	4.096E-009	5.513E-009	6.984E-009	9.309E-009
1.277E-008	1.790E-008	2.551E-008	3.462E-008	4.435E-008	5.612E-008
7.044E-008	8.455E-008	9.777E-008	1.145E-007	1.302E-007	1.421E-007
1.503E-007	1.558E-007	1.595E-007	1.621E-007	1.641E-007	1.654E-007

1.663E-007 2.928E-008 2.928E-008

SEISMIC EVALUATION FOR EQUATION EQN35

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	2.998E-015	1.025E-012	2.345E-011	3.678E-010	5.260E-009
3.265E-008	2.293E-007	8.200E-007	2.476E-006	6.026E-006	1.478E-005
5.181E-005	6.890E-005	1.516E-004	2.836E-004	3.433E-004	7.756E-004
9.474E-004	1.633E-003	2.242E-003	2.866E-003	3.891E-003	7.638E-003
8.387E-003	1.670E-002	2.493E-002	3.294E-002	3.909E-002	5.353E-002
7.237E-002	1.132E-001	1.124E-001	1.848E-001	2.142E-001	2.557E-001
3.534E-001	4.038E-001	4.981E-001	5.278E-001	5.665E-001	6.401E-001
6.887E-001	1.898E-006	1.060E-006			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.963E-018	4.445E-016	4.638E-015	5.621E-014	6.431E-013
3.859E-012	2.156E-011	6.323E-011	1.604E-010	3.816E-010	8.500E-010
2.152E-009	4.308E-009	7.678E-009	1.356E-008	2.103E-008	3.217E-008
4.806E-008	6.802E-008	9.458E-008	1.262E-007	1.621E-007	2.304E-007
3.233E-007	4.383E-007	5.965E-007	7.777E-007	9.614E-007	1.156E-006
1.372E-006	1.626E-006	1.885E-006	2.225E-006	2.631E-006	2.987E-006
3.327E-006	3.620E-006	3.856E-006	4.073E-006	4.256E-006	4.415E-006
4.557E-006	2.351E-008	2.351E-008			

SEISMIC EVALUATION FOR EQUATION EQN36

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	9.705E-027	7.230E-022	3.999E-019
1.673E-016	1.535E-014	1.390E-012	3.048E-011	4.019E-010	3.493E-009
3.026E-008	2.472E-007	4.254E-007	2.395E-006	5.881E-006	2.388E-005
6.577E-005	1.819E-004	2.272E-004	5.036E-004	7.018E-004	2.149E-003
3.649E-003	8.017E-003	1.155E-002	1.589E-002	1.789E-002	1.710E-002
1.874E-002	1.599E-002	1.420E-002	1.152E-002	5.926E-003	3.499E-003
1.239E-003	4.439E-004	1.214E-004	7.048E-005	1.082E-005	3.251E-006
5.695E-007	3.151E-006	4.002E-007			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	1.553E-030	9.400E-026	4.118E-023
1.380E-020	1.033E-018	4.721E-017	9.612E-016	1.188E-014	9.703E-014
7.472E-013	5.525E-012	1.590E-011	5.320E-011	1.490E-010	4.406E-010
1.259E-009	3.125E-009	5.932E-009	1.036E-008	1.677E-008	3.253E-008
6.544E-008	1.187E-007	1.932E-007	2.789E-007	3.653E-007	4.398E-007
5.022E-007	5.513E-007	5.861E-007	6.187E-007	6.374E-007	6.449E-007
6.478E-007	6.486E-007	6.487E-007	6.488E-007	6.488E-007	6.488E-007
6.488E-007	1.499E-008	1.499E-008			

SEISMIC EVALUATION FOR EQUATION EQN37

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	2.948E-029	1.448E-026
7.563E-021	8.900E-018	4.051E-015	6.540E-013	1.126E-011	2.548E-010
3.765E-009	8.661E-008	4.841E-007	9.135E-007	3.046E-006	1.990E-005
3.699E-005	1.245E-004	2.846E-004	5.882E-004	7.944E-004	2.203E-003
5.625E-003	1.068E-002	1.739E-002	2.314E-002	2.671E-002	3.357E-002
3.878E-002	4.406E-002	5.165E-002	4.765E-002	4.581E-002	3.499E-002
2.158E-002	1.225E-002	7.185E-003	4.504E-003	2.247E-003	6.975E-004
3.398E-004	1.037E-003	4.529E-004			

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	3.833E-033	1.492E-030
6.202E-025	5.842E-022	1.328E-019	1.890E-017	3.190E-016	6.079E-015
8.309E-014	1.627E-012	1.012E-011	2.901E-011	7.439E-011	2.969E-010
8.188E-010	2.023E-009	4.815E-009	1.012E-008	1.747E-008	3.429E-008
7.792E-008	1.528E-007	2.591E-007	3.859E-007	5.133E-007	6.402E-007
7.657E-007	8.809E-007	9.902E-007	1.114E-006	1.210E-006	1.273E-006
1.307E-006	1.321E-006	1.326E-006	1.329E-006	1.330E-006	1.330E-006
1.330E-006	1.429E-007	1.431E-007			

SEISMIC EVALUATION FOR EQUATION EQN39

MEAN FRAGILITY VALUES AT EACH ACC J :

0.000E+000	0.000E+000	0.000E+000	0.000E+000	0.000E+000	0.000E+000
0.000E+000	8.115E-031	8.618E-024	6.155E-020	2.416E-017	5.886E-016
1.230E-014	3.291E-013	9.180E-012	5.773E-011	4.530E-010	6.959E-009
2.830E-008	2.697E-007	9.371E-007	2.782E-006	7.821E-006	4.558E-005
4.872E-004	2.743E-003	7.264E-003	1.555E-002	2.987E-002	5.975E-002
7.472E-002	1.004E-001	1.338E-001	1.752E-001	2.023E-001	2.276E-001
2.276E-001	2.422E-001	2.213E-001	2.242E-001	1.993E-001	1.697E-001
1.583E-001	1.101E-004	8.287E-005			

MEAN CUMULATIVE RESULTS UP TO ACC J :

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0.000E+000  0.000E+000  0.000E+000  0.000E+000  0.000E+000  0.000E+000
0.000E+000  5.315E-035  2.801E-028  1.755E-024  6.075E-022  1.387E-020
2.603E-019  6.089E-018  1.448E-016  1.028E-015  6.762E-015  7.785E-014
3.986E-013  2.541E-012  1.075E-011  3.308E-011  8.818E-011  3.608E-010
3.210E-009  1.742E-008  5.450E-008  1.242E-007  2.373E-007  4.225E-007
6.548E-007  8.962E-007  1.162E-006  1.527E-006  1.911E-006  2.238E-006
2.499E-006  2.682E-006  2.805E-006  2.900E-006  2.971E-006  3.021E-006
3.056E-006  7.911E-007  7.912E-007

  SEISMIC EVALUATION FOR EQUATION EQN41
    MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  0.000E+000  0.000E+000  0.000E+000  2.841E-017  2.359E-015
1.644E-013  1.890E-012  9.455E-011  4.476E-010  3.054E-009  1.491E-008
5.279E-008  4.330E-007  7.616E-007  3.257E-006  6.014E-006  2.207E-005
4.894E-005  1.120E-004  1.910E-004  3.172E-004  3.330E-004  1.262E-003
2.094E-003  6.257E-003  9.384E-003  1.091E-002  1.381E-002  1.357E-002
1.247E-002  1.333E-002  1.273E-002  9.495E-003  6.714E-003  4.840E-003
2.412E-003  8.573E-004  4.119E-004  1.715E-004  3.397E-005  2.053E-005
7.349E-006  1.510E-002  1.268E-002
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  0.000E+000  0.000E+000  0.000E+000  3.694E-021  2.491E-019
1.397E-017  1.513E-016  3.348E-015  1.918E-014  1.083E-013  5.051E-013
1.829E-012  1.019E-011  2.860E-011  8.198E-011  1.905E-010  4.663E-010
1.116E-009  2.341E-009  4.414E-009  7.527E-009  1.102E-008  1.958E-008
3.865E-008  7.623E-008  1.357E-007  1.996E-007  2.625E-007  3.207E-007
3.665E-007  4.025E-007  4.325E-007  4.609E-007  4.780E-007  4.871E-007
4.914E-007  4.929E-007  4.932E-007  4.933E-007  4.934E-007  4.934E-007
4.934E-007  1.671E-006  1.674E-006

  SEISMIC EVALUATION FOR EQUATION EQN42
    MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  0.000E+000  0.000E+000  0.000E+000  1.964E-032  1.116E-024
1.288E-019  1.210E-017  6.952E-016  2.067E-014  5.337E-013  1.124E-011
9.167E-011  8.804E-010  2.090E-009  3.111E-008  7.010E-008  1.917E-007
6.904E-007  1.308E-006  2.177E-006  4.379E-006  5.807E-006  1.087E-005
2.378E-005  6.153E-005  1.380E-004  2.336E-004  4.154E-004  7.489E-004
1.225E-003  1.719E-003  2.813E-003  2.835E-003  2.737E-003  2.292E-003
1.240E-003  7.242E-004  4.559E-004  2.224E-004  6.802E-005  3.391E-005
1.410E-005  2.297E-001  2.080E-001
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  0.000E+000  0.000E+000  0.000E+000  2.553E-036  1.144E-028
1.056E-023  8.134E-022  2.420E-020  6.360E-019  1.457E-017  2.696E-016
2.253E-015  1.896E-014  6.423E-014  4.990E-013  1.675E-012  4.266E-012
1.230E-011  2.767E-011  5.151E-011  9.139E-011  1.456E-010  2.451E-010
4.395E-010  8.258E-010  1.570E-009  2.719E-009  4.340E-009  6.756E-009
1.012E-008  1.416E-008  1.927E-008  2.620E-008  3.194E-008  3.585E-008
3.795E-008  3.878E-008  3.910E-008  3.925E-008  3.930E-008  3.931E-008
3.932E-008  2.657E-006  2.704E-006

  SEISMIC EVALUATION FOR EQUATION EQN44
    MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  0.000E+000  0.000E+000  0.000E+000  1.820E-029  3.184E-024
3.495E-019  3.572E-017  1.802E-015  7.345E-014  2.185E-012  3.458E-011
2.665E-010  1.996E-009  5.230E-009  6.702E-008  1.634E-007  4.459E-007
1.319E-006  2.356E-006  4.084E-006  7.068E-006  1.084E-005  1.888E-005
3.880E-005  9.758E-005  1.633E-004  2.721E-004  4.910E-004  1.004E-003
1.599E-003  2.129E-003  3.888E-003  4.366E-003  5.487E-003  5.840E-003
4.949E-003  4.943E-003  4.176E-003  3.531E-003  2.315E-003  1.783E-003
1.493E-003  3.732E-005  2.880E-005
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  0.000E+000  0.000E+000  0.000E+000  2.366E-033  3.264E-028
2.866E-023  2.397E-021  6.329E-020  2.215E-018  5.894E-017  8.571E-016
6.664E-015  4.566E-014  1.554E-013  1.103E-012  3.771E-012  9.804E-012
2.591E-011  5.428E-011  9.834E-011  1.665E-010  2.614E-010  4.409E-010
7.654E-010  1.384E-009  2.370E-009  3.717E-009  5.621E-009  8.708E-009
1.314E-008  1.828E-008  2.503E-008  3.500E-008  4.496E-008  5.361E-008
5.986E-008  6.375E-008  6.619E-008  6.784E-008  6.884E-008  6.939E-008
6.975E-008  7.077E-007  7.077E-007

  SEISMIC EVALUATION FOR EQUATION EQN45
    MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  0.000E+000  0.000E+000  1.463E-017  8.422E-015  3.969E-013
8.866E-012  9.508E-011  1.916E-009  6.947E-009  4.271E-008  1.582E-007
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7.936E-007  2.564E-006  3.003E-006  9.356E-006  1.435E-005  2.792E-005
4.174E-005  4.988E-005  6.218E-005  8.229E-005  9.257E-005  1.394E-004
2.607E-004  5.993E-004  1.028E-003  1.482E-003  1.907E-003  3.292E-003
4.346E-003  5.039E-003  6.373E-003  7.563E-003  7.748E-003  7.732E-003
6.396E-003  7.871E-003  6.070E-003  6.050E-003  5.642E-003  4.291E-003
4.082E-003  2.083E-003  1.451E-003
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  0.000E+000  0.000E+000  2.341E-021  1.100E-018  4.288E-017
8.106E-016  7.765E-015  7.627E-014  3.365E-013  1.602E-012  6.072E-012
2.455E-011  8.322E-011  1.703E-010  3.355E-010  6.150E-010  1.038E-009
1.679E-009  2.404E-009  3.173E-009  4.066E-009  5.002E-009  6.436E-009
8.697E-009  1.261E-008  1.876E-008  2.658E-008  3.519E-008  4.599E-008
5.915E-008  7.218E-008  8.517E-008  1.019E-007  1.176E-007  1.295E-007
1.377E-007  1.431E-007  1.469E-007  1.494E-007  1.514E-007  1.527E-007
1.536E-007  2.769E-007  2.772E-007

  SEISMIC EVALUATION FOR EQUATION EQN46
    MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  1.110E-015  3.414E-013  1.200E-011  1.979E-010  2.372E-009
1.318E-008  1.042E-007  4.053E-007  1.240E-006  2.860E-006  6.848E-006
2.341E-005  3.320E-005  5.663E-005  1.065E-004  1.383E-004  2.344E-004
3.213E-004  4.897E-004  5.959E-004  9.337E-004  1.055E-003  2.112E-003
2.565E-003  5.560E-003  8.609E-003  1.218E-002  1.323E-002  1.673E-002
2.501E-002  3.249E-002  3.554E-002  5.082E-002  6.465E-002  6.848E-002
8.552E-002  1.117E-001  1.468E-001  1.621E-001  1.875E-001  2.317E-001
2.613E-001  1.871E-002  1.712E-002
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  7.272E-019  1.483E-016  2.215E-015  2.986E-014  2.987E-013
1.623E-012  9.531E-012  2.953E-011  7.805E-011  1.849E-010  4.036E-010
9.957E-010  2.005E-009  3.391E-009  5.596E-009  8.502E-009  1.225E-008
1.737E-008  2.369E-008  3.114E-008  4.053E-008  5.117E-008  6.986E-008
9.684E-008  1.339E-007  1.877E-007  2.525E-007  3.177E-007  3.807E-007
4.521E-007  5.315E-007  6.094E-007  7.102E-007  8.268E-007  9.285E-007
1.015E-006  1.090E-006  1.158E-006  1.223E-006  1.281E-006  1.336E-006
1.389E-006  2.543E-007  2.581E-007

  SEISMIC EVALUATION FOR EQUATION EQN47
    MEAN FRAGILITY VALUES AT EACH ACC J :
1.515E-004  1.326E-004  1.373E-004  1.244E-004  1.330E-004  1.512E-004
1.529E-004  1.536E-004  1.369E-004  1.277E-004  1.212E-004  1.161E-004
1.340E-004  9.261E-005  9.448E-005  9.473E-005  9.540E-005  7.772E-005
9.619E-005  7.852E-005  9.791E-005  1.515E-004  1.365E-004  2.215E-004
4.865E-004  1.251E-003  2.529E-003  3.972E-003  4.806E-003  9.819E-003
1.068E-002  1.378E-002  1.853E-002  1.641E-002  1.962E-002  1.558E-002
1.284E-002  8.303E-003  6.397E-003  4.830E-003  2.879E-003  1.285E-003
1.409E-003  6.959E-003  6.211E-003
   MEAN CUMULATIVE RESULTS UP TO ACC J :
7.548E-007  9.939E-007  1.140E-006  1.219E-006  1.256E-006  1.289E-006
1.317E-006  1.339E-006  1.354E-006  1.362E-006  1.369E-006  1.374E-006
1.379E-006  1.383E-006  1.386E-006  1.389E-006  1.391E-006  1.393E-006
1.395E-006  1.396E-006  1.397E-006  1.399E-006  1.400E-006  1.402E-006
1.406E-006  1.414E-006  1.428E-006  1.449E-006  1.471E-006  1.501E-006
1.537E-006  1.571E-006  1.607E-006  1.651E-006  1.688E-006  1.715E-006
1.731E-006  1.740E-006  1.744E-006  1.747E-006  1.748E-006  1.749E-006
1.749E-006  5.948E-007  5.963E-007

  SEISMIC EVALUATION FOR EQUATION EQN48
    MEAN FRAGILITY VALUES AT EACH ACC J :
4.377E-017  3.130E-013  2.954E-011  1.366E-009  1.004E-008  1.372E-007
2.966E-007  9.144E-007  2.284E-006  5.519E-006  1.223E-005  2.220E-005
4.944E-005  5.943E-005  6.196E-005  8.180E-005  1.149E-004  1.318E-004
1.366E-004  1.695E-004  1.718E-004  1.892E-004  1.736E-004  2.177E-004
2.570E-004  4.777E-004  8.590E-004  1.356E-003  2.651E-003  5.105E-003
9.175E-003  1.085E-002  1.388E-002  2.270E-002  2.426E-002  2.946E-002
3.393E-002  3.563E-002  3.906E-002  3.853E-002  3.746E-002  2.840E-002
2.669E-002  6.909E-001  7.297E-001
   MEAN CUMULATIVE RESULTS UP TO ACC J :
4.399E-020  2.051E-016  1.311E-014  2.444E-013  1.768E-012  1.714E-011
5.553E-011  1.397E-010  2.739E-010  5.054E-010  9.685E-010  1.752E-009
3.168E-009  5.118E-009  7.027E-009  8.988E-009  1.132E-008  1.383E-008
1.631E-008  1.873E-008  2.107E-008  2.332E-008  2.528E-008  2.777E-008
3.051E-008  3.389E-008  3.893E-008  4.580E-008  5.576E-008  7.181E-008
9.599E-008  1.238E-007  1.519E-007  1.938E-007  2.418E-007  2.824E-007
```

3.184E-007	3.455E-007	3.652E-007	3.817E-007	3.944E-007	4.033E-007
4.092E-007	1.265E-005	1.280E-005			

Seismic Analysis Module Version 1.1
Fri Jul 06 16:03:48 2001

Input File: ALLNL.IN Equation File: ALL.EQN
Output File: ALLNL.out

RUN#4
NAPS LLNL HAZARD, SUPPY MODEL.
PLANT SEQUENCE.

NO OF ACCELERATION POINTS 19
NO OF SEISMIC FAILURE EVENTS 7
NO OF RANDOM FAILURE EVENTS 8
NO OF EQUATIONS 1
NO OF MONTE CARLO TRIALS 1000
NO OF CURVES 1
NO OF ACCELERATION RANGES 1

ACCELERATION POINTS %g

5.734E-002	7.008E-002	8.410E-002	9.939E-002	1.147E-001	1.300E-001
1.453E-001	1.699E-001	2.039E-001	2.379E-001	2.676E-001	2.931E-001
3.313E-001	3.823E-001	4.332E-001	4.842E-001	5.861E-001	7.390E-001
9.174E-001					

PLANT HCLPF.

FREQUENCIES AT THE GIVEN ACCELERATIONS FOR CURVE NO. 1

2.199E-002	1.665E-002	8.723E-003	6.962E-003	5.556E-003	4.434E-003
3.539E-003	1.855E-003	1.308E-003	9.228E-004	5.724E-004	4.612E-004
2.988E-004	2.054E-004	1.237E-004	8.979E-005	4.426E-005	1.757E-005
7.191E-006					

PROBABILITY OF CURVE I IN RANGE J

SEISMIC FREQUENCY CURVE NUMBER	ACCELERATION RANGE ENDPOINT 1.00
1	1.0000

*** SEISMIC INDUCED FAILURES

NO.	COMPONENT NAME	MEDIAN ACC	BETAR	BETAU
1	EQ-AFW-ECST	4.860E-001	2.10E-001	3.00E-001
2	EQ-CC-SURGE-TK	5.900E-001	1.90E-001	3.10E-001
3	EQ-S2-LOCA	9.000E-001	3.00E-001	3.00E-001
4	EQ-SWITCHYARD	3.000E-001	2.50E-001	3.50E-001
5	EQ-TB-SEV-DMG	7.100E-001	4.00E-001	4.00E-001
6	EQ-LUBE-OIL	4.800E-001	2.50E-001	4.10E-001
7	EQ-FIRE-PRO-TK	2.200E-001	3.00E-001	3.00E-001

*** RANDOM FAILURES

NO.	COMPONENT NAME	MEDIAN	MEAN	ERROR FAC	TYPE
8	L	9.601E-002	1.20E-001	3.00E+000	LOGNORMA
9	LD	5.800E-001	5.80E-001	1.00E+000	LOGNORMA
10	LE	6.600E-001	6.60E-001	1.00E+000	LOGNORMA
11	M	2.107E-003	3.40E-003	5.00E+000	LOGNORMA
12	M0	1.487E-004	2.40E-004	5.00E+000	LOGNORMA
13	T-BLDG-IGN-LO	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
14	TURB-B-ACC-LO	2.000E-001	2.50E-001	3.00E+000	LOGNORMA
15	ACC-LD	7.500E-001	7.50E-001	1.00E+000	LOGNORMA

```
EQUATION SPS1 =  (EQ-TB-SEV-DMG)  +  (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * T-BLDG-IGN-LO
 * ACC-LD)  +  (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * /T-BLDG-IGN-LO
 * EQ-SWITCHYARD * EQ-CC-SURGE-TK)  +  (/EQ-TB-SEV-DMG * EQ-LUBE-OIL
 * /T-BLDG-IGN-LO * EQ-SWITCHYARD * /EQ-CC-SURGE-TK * EQ-AFW-ECST
 * LE)  +  (/EQ-TB-SEV-DMG * EQ-LUBE-OIL * /T-BLDG-IGN-LO
 * EQ-SWITCHYARD * /EQ-CC-SURGE-TK * /EQ-AFW-ECST * L)  +  (/EQ-TB-SEV-DMG * /EQ-LUBE-OIL * EQ-SWIT
) .
```

SEISMIC EVALUATION FOR EQUATION SPS1
MEAN FRAGILITY VALUES AT EACH ACC J :

2.517E-004	2.596E-004	4.595E-004	9.909E-004	2.617E-003	4.487E-003
9.803E-003	1.596E-002	3.742E-002	6.223E-002	8.898E-002	1.149E-001
1.530E-001	2.188E-001	2.900E-001	3.609E-001	4.496E-001	5.061E-001
5.628E-001					

MEAN CUMULATIVE RESULTS UP TO ACC J :

```
0.000E+000  6.281E-008  1.212E-007  2.046E-007  3.685E-007  6.317E-007
1.049E-006  1.841E-006  3.176E-006  4.983E-006  6.594E-006  7.918E-006
9.805E-006  1.211E-005  1.417E-005  1.591E-005  1.858E-005  2.078E-005
2.194E-005
```

MEAN CDF

```
   5 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
3.221E-005  2.981E-005  4.153E-005  3.668E-005  5.072E-005  5.713E-005
7.717E-005  1.444E-004  3.047E-004  2.001E-003  3.564E-003  1.125E-002
1.993E-002  4.455E-002  7.093E-002  9.604E-002  2.040E-001  3.193E-001
3.827E-001
   5 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  7.676E-009  1.369E-008  1.842E-008  2.252E-008  2.661E-008
3.064E-008  3.730E-008  4.863E-008  8.678E-008  1.446E-007  2.366E-007
4.496E-007  8.346E-007  1.291E-006  1.735E-006  2.634E-006  3.754E-006
4.500E-006
```

5% lower bound CDF.

```
  10 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
4.478E-005  4.309E-005  5.718E-005  5.506E-005  7.262E-005  9.389E-005
1.280E-004  2.612E-004  9.488E-004  3.780E-003  8.752E-003  1.896E-002
3.279E-002  5.942E-002  9.567E-002  1.448E-001  2.697E-001  3.732E-001
4.283E-001
  10 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  1.085E-008  1.937E-008  2.611E-008  3.213E-008  3.840E-008
4.504E-008  5.659E-008  8.591E-008  1.663E-007  2.926E-007  4.678E-007
8.223E-007  1.383E-006  1.996E-006  2.628E-006  3.899E-006  5.313E-006
6.173E-006
  20 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
6.960E-005  6.611E-005  8.776E-005  8.482E-005  1.227E-004  1.608E-004
2.449E-004  6.508E-004  2.745E-003  8.574E-003  1.893E-002  3.172E-002
5.314E-002  9.224E-002  1.397E-001  2.103E-001  3.430E-001  4.260E-001
4.834E-001
  20 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  1.677E-008  2.985E-008  4.021E-008  4.994E-008  6.061E-008
7.269E-008  9.823E-008  1.798E-007  3.752E-007  6.539E-007  9.784E-007
1.561E-006  2.449E-006  3.372E-006  4.293E-006  6.029E-006  7.762E-006
8.740E-006
  30 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
9.389E-005  9.380E-005  1.166E-004  1.270E-004  1.900E-004  2.495E-004
3.992E-004  1.286E-003  5.422E-003  1.595E-002  3.075E-002  4.976E-002
7.355E-002  1.167E-001  1.790E-001  2.596E-001  3.911E-001  4.634E-001
5.103E-001
  30 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  2.311E-008  4.118E-008  5.571E-008  7.055E-008  8.707E-008
1.063E-007  1.531E-007  3.142E-007  6.848E-007  1.165E-006  1.682E-006
2.541E-006  3.712E-006  4.887E-006  6.045E-006  8.116E-006  1.006E-005
1.112E-005
  40 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.234E-004  1.225E-004  1.494E-004  1.711E-004  2.750E-004  4.042E-004
7.488E-004  2.472E-003  9.703E-003  2.544E-002  4.366E-002  6.444E-002
9.423E-002  1.470E-001  2.242E-001  3.176E-001  4.328E-001  4.861E-001
5.389E-001
  40 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  3.029E-008  5.371E-008  7.279E-008  9.357E-008  1.190E-007
1.529E-007  2.421E-007  5.357E-007  1.150E-006  1.871E-006  2.568E-006
3.674E-006  5.161E-006  6.637E-006  8.071E-006  1.050E-005  1.262E-005
1.373E-005
  50 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.556E-004  1.530E-004  1.918E-004  2.213E-004  3.653E-004  5.738E-004
1.351E-003  4.898E-003  1.644E-002  3.520E-002  5.879E-002  8.242E-002
1.173E-001  1.873E-001  2.722E-001  3.667E-001  4.648E-001  5.026E-001
5.652E-001
  50 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  3.803E-008  6.761E-008  9.219E-008  1.195E-007  1.545E-007
2.105E-007  3.813E-007  9.012E-007  1.818E-006  2.802E-006  3.715E-006
5.111E-006  6.985E-006  8.823E-006  1.052E-005  1.325E-005  1.549E-005
1.665E-005
```

MEDIAN CDF.

```
  60 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
1.978E-004  1.949E-004  2.582E-004  3.099E-004  5.247E-004  9.358E-004
2.486E-003  8.485E-003  2.518E-002  4.913E-002  7.614E-002  1.068E-001
1.454E-001  2.271E-001  3.166E-001  4.025E-001  4.888E-001  5.195E-001
5.922E-001
  60 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  4.839E-008  8.691E-008  1.206E-007  1.594E-007  2.134E-007
3.124E-007  6.146E-007  1.442E-006  2.772E-006  4.094E-006  5.277E-006
7.049E-006  9.345E-006  1.153E-005  1.345E-005  1.640E-005  1.875E-005
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1.994E-005
   70 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
2.589E-004  2.520E-004  3.515E-004  4.225E-004  8.586E-004  1.765E-003
4.402E-003  1.401E-002  3.871E-002  6.821E-002  9.944E-002  1.323E-001
1.785E-001  2.779E-001  3.645E-001  4.520E-001  5.107E-001  5.486E-001
6.237E-001
   70 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  6.302E-008  1.139E-007  1.598E-007  2.188E-007  3.151E-007
4.940E-007  1.006E-006  2.308E-006  4.238E-006  6.020E-006  7.523E-006
9.709E-006  1.252E-005  1.513E-005  1.731E-005  2.053E-005  2.300E-005
2.426E-005
   80 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
3.472E-004  3.498E-004  4.857E-004  7.067E-004  1.697E-003  3.584E-003
9.017E-003  2.477E-002  5.805E-002  9.465E-002  1.391E-001  1.688E-001
2.299E-001  3.362E-001  4.282E-001  4.982E-001  5.423E-001  5.868E-001
6.520E-001
   80 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  8.575E-008  1.563E-007  2.263E-007  3.359E-007  5.295E-007
8.950E-007  1.854E-006  3.925E-006  6.699E-006  9.181E-006  1.119E-005
1.399E-005  1.750E-005  2.061E-005  2.310E-005  2.660E-005  2.923E-005
3.056E-005
   90 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
5.169E-004  5.516E-004  8.044E-004  1.511E-003  5.039E-003  8.920E-003
2.390E-002  4.276E-002  1.006E-001  1.480E-001  2.097E-001  2.465E-001
3.305E-001  4.207E-001  5.086E-001  5.661E-001  6.068E-001  6.434E-001
6.802E-001
   90 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  1.309E-007  2.445E-007  3.785E-007  6.730E-007  1.189E-006
2.139E-006  4.158E-006  7.743E-006  1.230E-005  1.612E-005  1.909E-005
2.315E-005  2.787E-005  3.168E-005  3.458E-005  3.854E-005  4.145E-005
4.290E-005
   95 PERCENTILE FRAGILITY VALUES AT EACH ACC. J :
7.606E-004  7.939E-004  1.250E-003  3.755E-003  1.232E-002  2.147E-002
5.296E-002  6.419E-002  1.437E-001  2.125E-001  2.695E-001  3.278E-001
4.159E-001  4.962E-001  5.784E-001  6.293E-001  6.678E-001  6.971E-001
7.078E-001
   95 PERCENTILE  CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  1.908E-007  3.598E-007  6.430E-007  1.366E-006  2.618E-006
4.778E-006  8.554E-006  1.377E-005  2.030E-005  2.550E-005  2.940E-005
3.466E-005  4.042E-005  4.484E-005  4.811E-005  5.249E-005  5.569E-005
5.724E-005
```

95-5 Confidence for HCLPF

95% Upper bound CDF

Seismic Analysis Module   Version 1.1
Mon Jul 09 07:38:17 2001

Input File: LLNL1.IN   Equation File: NAPS1.EQN
Output File: llnl1.out

RUN#5

NAPS LLNL HAZARD, SURRY SPRA MODEL
INDIVIDUAL SEQUENCES

NO OF ACCELERATION POINTS	19
NO OF SEISMIC FAILURE EVENTS	9
NO OF RANDOM FAILURE EVENTS	14
NO OF EQUATIONS	20
NO OF MONTE CARLO TRIALS	1000
NO OF CURVES	1
NO OF ACCELERATION RANGES	1

ACCELERATION POINTS %g

5.734E-002	7.008E-002	8.410E-002	9.939E-002	1.147E-001	1.300E-001
1.453E-001	1.699E-001	2.039E-001	2.379E-001	2.676E-001	2.931E-001
3.313E-001	3.823E-001	4.332E-001	4.842E-001	5.861E-001	7.390E-001
9.174E-001					

FREQUENCIES AT THE GIVEN ACCELERATIONS FOR CURVE NO. 1

2.199E-002	1.665E-002	8.723E-003	6.962E-003	5.556E-003	4.434E-003
3.539E-003	1.855E-003	1.308E-003	9.228E-004	5.724E-004	4.612E-004
2.988E-004	2.054E-004	1.237E-004	8.979E-005	4.426E-005	1.757E-005
7.191E-006					

PROBABILITY OF CURVE I IN RANGE J

SEISMIC FREQUENCY	ACCELERATION RANGE ENDPOINT
CURVE NUMBER	1.00
1	1.0000

*** SEISMIC INDUCED FAILURES

NO.	COMPONENT NAME	MEDIAN ACC	BETAR	BETAU
1	EQ-AFW-ECST	4.860E-001	2.10E-001	3.00E-001
2	EQ-CC-SURGE-TK	5.900E-001	1.90E-001	3.10E-001
3	EQ-S2-LOCA	9.000E-001	3.00E-001	3.00E-001
4	EQ-SWITCHYARD	3.000E-001	2.50E-001	3.50E-001
5	EQ-BLOCK-WALL	9.200E-001	3.90E-001	4.80E-001
6	EQ-ELEC-CAB	2.500E-001	2.00E-001	2.20E-001
7	EQ-TB-SEV-DMG	7.100E-001	4.00E-001	4.00E-001
8	EQ-LUBE-OIL	4.800E-001	2.50E-001	4.10E-001
9	EQ-FIRE-PRO-TK	2.200E-001	3.00E-001	3.00E-001

*** RANDOM FAILURES

NO.	COMPONENT NAME	MEDIAN	MEAN	ERROR FAC	TYPE
10	L	9.601E-002	1.20E-001	3.00E+000	LOGNORMA
11	LO	1.312E-001	1.64E-001	3.00E+000	LOGNORMA
12	LD	5.800E-001	5.80E-001	1.00E+000	LOGNORMA
13	LE	6.600E-001	6.60E-001	1.00E+000	LOGNORMA
14	LED	1.000E+000	1.00E+000	1.00E+000	LOGNORMA
15	M	2.107E-003	3.40E-003	5.00E+000	LOGNORMA
16	M0	1.487E-004	2.40E-004	5.00E+000	LOGNORMA
17	M1	5.887E-004	9.50E-004	5.00E+000	LOGNORMA
18	ME	1.921E-002	3.10E-002	5.00E+000	LOGNORMA
19	MC	3.594E-002	5.80E-002	5.00E+000	LOGNORMA
20	T-BLDG-IGN-EL	8.001E-002	1.00E-001	3.00E+000	LOGNORMA
21	T-BLDG-IGN-LO	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
22	TURB-B-ACC-EL	6.196E-002	1.00E-001	5.00E+000	LOGNORMA
23	TURB-B-ACC-LO	2.000E-001	2.50E-001	3.00E+000	LOGNORMA

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EQUATION EQN02 =  (M0 * /EQ-FIRE-PRO-TK * /EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-CC-SURGE-TK
 * /EQ-LUBE-OIL * /EQ-TB-SEV-DMG) .
EQUATION EQN04 =  (M1 * EQ-FIRE-PRO-TK * /EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-CC-SURGE-TK
 * /EQ-LUBE-OIL * /EQ-TB-SEV-DMG) .
EQUATION EQN05 =  (ME * /EQ-SWITCHYARD * EQ-AFW-ECST * /EQ-CC-SURGE-TK * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN07 =  (MC * EQ-CC-SURGE-TK * /EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-LUBE-OIL
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 * /EQ-TB-SEV-DMG) .
EQUATION EQN08 =  (EQ-CC-SURGE-TK * /EQ-SWITCHYARD * EQ-AFW-ECST * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN10 =  (L * EQ-SWITCHYARD * /EQ-AFW-ECST * /EQ-CC-SURGE-TK * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN12 =  (LE * EQ-SWITCHYARD * EQ-AFW-ECST * /EQ-CC-SURGE-TK * /EQ-LUBE-OIL
 * /EQ-TB-SEV-DMG) .
EQUATION EQN13 =  (EQ-SWITCHYARD * EQ-CC-SURGE-TK * /EQ-LUBE-OIL * /EQ-TB-SEV-DMG
) .
EQUATION EQN34 =  (M * /T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-SWITCHYARD * /EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN35 =  (ME * /T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-SWITCHYARD * EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN36 =  (MC * /T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-CC-SURGE-TK * /EQ-SWITCHYARD
 * /EQ-AFW-ECST * /EQ-TB-SEV-DMG) .
EQUATION EQN37 =  (/T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-CC-SURGE-TK * /EQ-SWITCHYARD
 * EQ-AFW-ECST * /EQ-TB-SEV-DMG) .
EQUATION EQN39 =  (L * /T-BLDG-IGN-LO * EQ-SWITCHYARD * EQ-LUBE-OIL * /EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN41 =  (LE * /T-BLDG-IGN-LO * EQ-SWITCHYARD * EQ-LUBE-OIL * EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN42 =  (/T-BLDG-IGN-LO * EQ-SWITCHYARD * EQ-LUBE-OIL * EQ-CC-SURGE-TK
 * /EQ-TB-SEV-DMG) .
EQUATION EQN44 =  (/TURB-B-ACC-LO * LD * T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN45 =  (/TURB-B-ACC-LO * LED * T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-AFW-ECST
 * /EQ-CC-SURGE-TK * /EQ-TB-SEV-DMG) .
EQUATION EQN46 =  (/TURB-B-ACC-LO * T-BLDG-IGN-LO * EQ-LUBE-OIL * EQ-CC-SURGE-TK
 * /EQ-TB-SEV-DMG) .
EQUATION EQN47 =  (TURB-B-ACC-LO * T-BLDG-IGN-LO * EQ-LUBE-OIL * /EQ-TB-SEV-DMG
) .
EQUATION EQN48 =  (EQ-TB-SEV-DMG) .

    SEISMIC EVALUATION FOR EQUATION EQN02
      MEAN FRAGILITY VALUES AT EACH ACC J :
  2.608E-004  2.396E-004  2.241E-004  2.363E-004  2.200E-004  2.135E-004
  1.876E-004  1.533E-004  1.089E-004  6.234E-005  4.471E-005  1.914E-005
  7.580E-006  1.885E-006  3.701E-007  1.621E-007  2.859E-009  3.605E-012
  1.944E-015
     MEAN CUMULATIVE RESULTS UP TO ACC J :
  0.000E+000  6.196E-008  1.036E-007  1.311E-007  1.531E-007  1.696E-007
  1.820E-007  1.936E-007  2.009E-007  2.043E-007  2.055E-007  2.060E-007
  2.062E-007  2.062E-007  2.062E-007  2.062E-007  2.062E-007  2.062E-007
  2.062E-007

    SEISMIC EVALUATION FOR EQUATION EQN04
      MEAN FRAGILITY VALUES AT EACH ACC J :
  5.127E-007  2.906E-006  1.295E-005  2.914E-005  6.307E-005  9.015E-005
  1.520E-004  2.024E-004  3.222E-004  3.164E-004  3.189E-004  2.812E-004
  1.779E-004  8.625E-005  4.238E-005  2.068E-005  1.067E-006  8.702E-009
  7.628E-010
     MEAN CUMULATIVE RESULTS UP TO ACC J :
  0.000E+000  3.800E-010  1.511E-009  3.926E-009  8.156E-009  1.389E-008
  2.106E-008  3.231E-008  4.586E-008  5.798E-008  6.504E-008  6.901E-008
  7.251E-008  7.431E-008  7.490E-008  7.508E-008  7.518E-008  7.518E-008
  7.518E-008

    SEISMIC EVALUATION FOR EQUATION EQN05
      MEAN FRAGILITY VALUES AT EACH ACC J :
  2.166E-012  1.140E-010  3.666E-010  6.017E-008  4.033E-007  1.476E-006
  1.916E-005  8.522E-005  1.747E-004  5.524E-004  7.357E-004  1.146E-003
  1.137E-003  1.159E-003  8.114E-004  5.205E-004  1.321E-004  1.318E-005
  2.776E-007
     MEAN CUMULATIVE RESULTS UP TO ACC J :
  0.000E+000  1.240E-014  4.811E-014  3.275E-012  2.361E-011  9.079E-011
  6.593E-010  3.442E-009  1.001E-008  2.256E-008  3.640E-008  4.850E-008
  6.509E-008  7.981E-008  8.843E-008  9.218E-008  9.486E-008  9.532E-008
  9.534E-008

    SEISMIC EVALUATION FOR EQUATION EQN07
      MEAN FRAGILITY VALUES AT EACH ACC J :
  6.506E-018  1.555E-015  6.615E-012  3.677E-010  1.370E-008  6.191E-007
  3.452E-006  1.521E-005  4.048E-005  1.224E-004  5.112E-004  3.753E-004
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6.222E-004  8.177E-004  6.163E-004  3.085E-004  1.022E-004  7.892E-006
6.463E-007
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  1.658E-019  4.048E-016  2.042E-014  6.217E-013  2.219E-011
1.366E-010  6.346E-010  2.014E-009  4.834E-009  1.086E-008  1.680E-008
2.366E-008  3.268E-008  3.890E-008  4.155E-008  4.319E-008  4.355E-008
4.356E-008

  SEISMIC EVALUATION FOR EQUATION EQN08
    MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  3.667E-026  1.414E-023  2.345E-017  6.859E-017  1.950E-010
8.334E-012  2.340E-007  4.136E-006  1.772E-004  2.331E-004  7.904E-004
2.671E-003  6.166E-003  5.698E-003  8.064E-003  5.518E-003  7.829E-004
7.943E-005
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  3.889E-030  8.724E-028  1.248E-021  5.410E-021  6.611E-015
1.345E-014  5.361E-012  1.047E-010  2.975E-009  7.390E-009  1.374E-008
3.596E-008  8.858E-008  1.388E-007  1.752E-007  2.246E-007  2.443E-007
2.456E-007

  SEISMIC EVALUATION FOR EQUATION EQN10
    MEAN FRAGILITY VALUES AT EACH ACC J :
1.894E-005  3.399E-005  1.538E-004  8.748E-004  9.451E-004  2.633E-003
6.213E-003  1.220E-002  1.941E-002  3.076E-002  3.799E-002  4.210E-002
4.155E-002  3.291E-002  2.410E-002  1.225E-002  3.917E-003  2.983E-004
7.585E-006
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  6.259E-009  1.963E-008  7.644E-008  1.631E-007  2.925E-007
5.499E-007  1.100E-006  1.916E-006  2.829E-006  3.575E-006  4.099E-006
4.708E-006  5.196E-006  5.444E-006  5.548E-006  5.613E-006  5.627E-006
5.627E-006

  SEISMIC EVALUATION FOR EQUATION EQN12
    MEAN FRAGILITY VALUES AT EACH ACC J :
8.596E-021  2.532E-015  8.236E-012  1.862E-009  5.073E-008  1.789E-007
3.263E-005  1.264E-004  1.083E-003  4.942E-003  1.104E-002  2.367E-002
4.005E-002  6.452E-002  7.861E-002  7.504E-002  4.397E-002  1.119E-002
1.684E-003
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  2.685E-019  5.040E-016  1.002E-013  2.354E-012  1.057E-011
8.995E-010  5.209E-009  3.326E-008  1.348E-007  2.965E-007  5.162E-007
9.536E-007  1.596E-006  2.182E-006  2.601E-006  3.044E-006  3.208E-006
3.226E-006

  SEISMIC EVALUATION FOR EQUATION EQN13
    MEAN FRAGILITY VALUES AT EACH ACC J :
2.733E-023  6.182E-017  9.980E-015  1.208E-011  4.565E-010  1.522E-008
1.525E-007  2.393E-005  2.985E-004  1.621E-003  5.752E-003  1.128E-002
2.579E-002  5.242E-002  7.771E-002  8.499E-002  9.933E-002  5.584E-002
2.848E-002
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  6.557E-021  6.239E-019  6.442E-016  2.068E-014  5.560E-013
5.198E-012  5.586E-010  7.949E-009  4.000E-008  1.112E-007  2.194E-007
4.662E-007  9.369E-007  1.456E-006  1.896E-006  2.509E-006  2.920E-006
3.026E-006

  SEISMIC EVALUATION FOR EQUATION EQN34
    MEAN FRAGILITY VALUES AT EACH ACC J :
8.116E-010  5.670E-008  5.517E-007  1.230E-006  3.847E-006  6.933E-006
1.343E-005  4.631E-005  9.461E-005  1.771E-004  1.831E-004  2.258E-004
1.709E-004  1.615E-004  8.848E-005  4.895E-005  1.258E-005  3.457E-007
2.881E-009
   MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  6.128E-012  4.647E-011  1.487E-010  3.776E-010  7.760E-010
1.374E-009  3.018E-009  6.580E-009  1.146E-008  1.545E-008  1.811E-008
2.108E-008  2.322E-008  2.435E-008  2.474E-008  2.499E-008  2.503E-008
2.504E-008

  SEISMIC EVALUATION FOR EQUATION EQN35
    MEAN FRAGILITY VALUES AT EACH ACC J :
5.829E-019  1.256E-016  1.275E-015  1.791E-013  6.702E-011  3.085E-008
1.632E-008  3.280E-006  2.797E-006  2.642E-005  6.382E-005  2.184E-004
3.563E-004  4.730E-004  4.806E-004  4.411E-004  2.384E-004  6.187E-005
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8.746E-007
  MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  1.341E-020  1.060E-019  9.723E-018  2.866E-015  1.051E-012
2.539E-012  7.821E-011  2.438E-010  7.201E-010  1.626E-009  3.374E-009
7.335E-009  1.252E-008  1.651E-008  1.904E-008  2.160E-008  2.248E-008
2.258E-008

 SEISMIC EVALUATION FOR EQUATION EQN36
   MEAN FRAGILITY VALUES AT EACH ACC J :
1.643E-024  2.524E-023  2.446E-019  4.748E-018  9.456E-014  3.311E-009
7.984E-008  1.050E-006  3.091E-007  4.970E-006  3.587E-005  5.953E-005
2.951E-004  3.830E-004  2.958E-004  3.423E-004  2.306E-004  2.098E-005
1.354E-006
  MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  2.908E-027  1.496E-023  2.840E-022  4.017E-018  1.123E-013
2.385E-012  2.985E-011  6.981E-011  1.546E-010  5.280E-010  1.139E-009
3.350E-009  7.602E-009  1.054E-008  1.225E-008  1.434E-008  1.515E-008
1.518E-008

 SEISMIC EVALUATION FOR EQUATION EQN37
   MEAN FRAGILITY VALUES AT EACH ACC J :
0.000E+000  2.697E-037  7.643E-031  2.318E-025  8.370E-021  1.817E-015
1.037E-014  5.084E-010  5.238E-009  6.333E-006  4.326E-005  1.461E-004
9.581E-004  2.104E-003  4.877E-003  6.854E-003  8.015E-003  3.927E-003
5.029E-004
  MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  2.860E-041  4.672E-035  1.234E-029  3.556E-025  6.158E-020
4.037E-019  1.162E-014  1.441E-013  9.955E-011  5.546E-010  1.728E-009
8.488E-009  2.680E-008  5.318E-008  8.424E-008  1.337E-007  1.661E-007
1.726E-007

 SEISMIC EVALUATION FOR EQUATION EQN39
   MEAN FRAGILITY VALUES AT EACH ACC J :
1.147E-012  1.761E-011  4.073E-010  2.561E-008  1.874E-007  7.464E-006
4.520E-005  1.914E-004  8.283E-004  2.548E-003  4.793E-003  6.179E-003
1.035E-002  1.446E-002  1.441E-002  1.289E-002  6.733E-003  1.327E-003
8.090E-005
  MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  2.029E-015  2.898E-014  1.419E-012  1.074E-011  2.717E-010
1.748E-009  8.091E-009  3.253E-008  9.089E-008  1.666E-007  2.379E-007
3.515E-007  5.060E-007  6.271E-007  7.020E-007  7.762E-007  8.007E-007
8.029E-007

 SEISMIC EVALUATION FOR EQUATION EQN41
   MEAN FRAGILITY VALUES AT EACH ACC J :
2.511E-027  8.117E-020  2.914E-020  2.121E-016  1.212E-012  7.552E-011
6.598E-009  1.605E-006  2.207E-005  2.537E-004  1.553E-003  3.708E-003
8.904E-003  2.865E-002  4.577E-002  7.572E-002  8.150E-002  5.495E-002
1.631E-002
  MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  8.610E-024  1.986E-023  1.131E-020  5.149E-017  2.663E-015
1.837E-013  3.714E-011  5.783E-010  5.046E-009  2.174E-008  5.486E-008
1.384E-007  3.562E-007  6.504E-007  9.679E-007  1.498E-006  1.848E-006
1.945E-006

 SEISMIC EVALUATION FOR EQUATION EQN42
   MEAN FRAGILITY VALUES AT EACH ACC J :
1.481E-029  6.036E-027  7.938E-020  9.007E-019  8.221E-017  1.036E-010
1.130E-009  6.227E-007  1.065E-006  1.202E-004  7.839E-004  1.542E-003
6.179E-003  2.132E-002  4.730E-002  8.683E-002  1.742E-001  2.491E-001
2.307E-001
  MEAN CUMULATIVE RESULTS UP TO ACC J :
0.000E+000  6.423E-031  4.853E-024  5.808E-023  3.598E-021  3.511E-015
3.761E-014  1.432E-011  5.762E-011  1.966E-009  1.029E-008  2.506E-008
7.394E-008  2.326E-007  4.933E-007  8.411E-007  1.632E-006  2.556E-006
3.094E-006

 SEISMIC EVALUATION FOR EQUATION EQN44
   MEAN FRAGILITY VALUES AT EACH ACC J :
1.083E-008  6.318E-007  2.542E-006  7.075E-006  3.122E-005  1.711E-004
3.456E-004  7.969E-004  1.775E-003  3.297E-003  3.362E-003  5.027E-003
7.516E-003  6.724E-003  6.436E-003  6.172E-003  2.785E-003  5.196E-004
3.506E-005
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MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	6.853E-011	2.976E-010	8.437E-010	2.547E-009	9.675E-009
2.483E-008	5.810E-008	1.227E-007	2.138E-007	2.877E-007	3.417E-007
4.290E-007	5.214E-007	5.769E-007	6.113E-007	6.458E-007	6.559E-007
6.568E-007					

SEISMIC EVALUATION FOR EQUATION EQN45

MEAN FRAGILITY VALUES AT EACH ACC J :

1.156E-017	1.436E-016	1.069E-015	4.907E-013	7.903E-011	1.749E-007
2.882E-007	7.753E-007	9.390E-006	1.142E-004	2.666E-004	1.500E-003
2.415E-003	4.815E-003	7.589E-003	1.034E-002	1.129E-002	7.333E-003
1.909E-003					

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	1.685E-020	9.895E-020	2.629E-017	3.409E-015	5.935E-012
1.966E-011	4.994E-011	2.831E-010	2.283E-009	6.118E-009	1.687E-008
4.388E-008	8.747E-008	1.366E-007	1.842E-007	2.570E-007	3.050E-007
3.178E-007					

SEISMIC EVALUATION FOR EQUATION EQN46

MEAN FRAGILITY VALUES AT EACH ACC J :

3.908E-025	4.172E-024	1.334E-019	3.703E-018	8.823E-014	1.741E-009
3.975E-008	5.856E-006	4.303E-007	3.699E-005	7.326E-005	2.622E-004
1.249E-003	2.047E-003	4.674E-003	7.121E-003	1.547E-002	2.194E-002
1.723E-002					

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	4.972E-028	8.158E-024	2.142E-022	3.748E-018	5.904E-014
1.193E-012	1.367E-010	3.309E-010	9.204E-010	2.051E-009	4.127E-009
1.357E-008	3.380E-008	5.924E-008	9.027E-008	1.578E-007	2.396E-007
2.850E-007					

SEISMIC EVALUATION FOR EQUATION EQN47

MEAN FRAGILITY VALUES AT EACH ACC J :

4.063E-009	3.700E-007	2.962E-006	1.276E-005	1.351E-005	6.929E-005
1.516E-004	5.766E-004	8.958E-004	2.013E-003	2.143E-003	3.296E-003
5.172E-003	6.054E-003	8.262E-003	9.459E-003	9.993E-003	1.068E-002
7.621E-003					

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	3.981E-011	2.641E-010	1.141E-009	2.394E-009	5.317E-009
1.177E-008	3.155E-008	6.964E-008	1.211E-007	1.670E-007	2.020E-007
2.606E-007	3.316E-007	3.894E-007	4.370E-007	5.029E-007	5.511E-007
5.727E-007					

SEISMIC EVALUATION FOR EQUATION EQN48

MEAN FRAGILITY VALUES AT EACH ACC J :

3.696E-006	2.772E-005	8.797E-005	2.246E-004	5.016E-004	1.608E-003
2.863E-003	6.812E-003	1.487E-002	3.067E-002	4.056E-002	5.447E-002
8.511E-002	1.298E-001	1.951E-001	2.468E-001	3.731E-001	5.328E-001
6.853E-001					

MEAN CUMULATIVE RESULTS UP TO ACC J :

0.000E+000	3.458E-009	1.207E-008	2.989E-008	6.316E-008	1.390E-007
2.709E-007	5.514E-007	1.097E-006	1.908E-006	2.674E-006	3.290E-006
4.256E-006	5.584E-006	6.878E-006	8.057E-006	1.003E-005	1.201E-005
1.328E-005					

ATTACHMENT 3

Copy of Calculation CE-1436

Seismic Qualification of Pressure Control Valves

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

Total No. of Pages (including four Attachments) = 42

VIRGINIA POWER

CALCULATION COVER SHEET

Type Sub Station Unit Status System Code(s)
[CALC] [STR] [59] [00] [AC] [RC]

Calc. Number Rev. QA Cat.
[CE-1436] [0] [SR]

Calc Title (Subject): SEISMIC QUALIFICATION OF PRESSURE CONTROL VALVES FOR USI A-46 AND IPEEE

Key Words: SEISMIC, DBE, ARS, USI A-46, IPEEE

Reference Numbers: IR No.: Job No. B0002
Initiating Document: (DCP, IEER, REA, etc.): Letters to NRC Serial Nos. 97-303 and 97-246, both dated May 27, 1997.

Originator: [x] Virginia Power Discipline: ENGINEERING MECHANICS
[ ] Other Firm Name:________ Vendor Code:

EDS Mark Number References:

Station	Unit	System	Prefix	Sequence	Comp. Code	Suffix
NAPS	1	RC	PCV	1455C	VALVE	
NAPS	1	RC	PCV	1456	VALVE	
NAPS	2	RC	PCV	2455C	VALVE	
NAPS	2	RC	PCV	2456	VALVE	

[ ] Additional Mark Numbers? (Check if "yes").

Objective:

This calculation is prepared to complete the resolution of outstanding issues associated with valves 1-RC-PCV-1455C, 1-RC-PCV-1456, 2-RC-PCV-2455C and 2-RC-PCV-2456 which were identified in USI A-46 and IPEEE (Seismic) summary reports submitted to the NRC in May 1997.

Conclusions:

The valves are acceptable for USI A-46. For IPEEE, the high-confidence-of-low-probability-of-failure (HCLPF) capacity of valve 1-RC-PCV-1455C is calculated to be 0.41g, expressed in terms of peak ground acceleration. The remaining three valves evaluated in this calculation also have their HCLPF capacity >0.3g.

Superseded Calcs:
None

	Signature	Date
Prepared By (Print Name) Divakar Bhargava	Divakar Bhargava	11-12-98
Reviewed By (Print Name) Casaba G. Ranganath	Casaba Ranganath	12-10-98
Approved By: (Print Name) Mark F. Walker	Mark Walker	12-18-98

CA030727

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 2 of 18
Prepared By: Divakar Bhargava			Date: 11-12-98
Reviewed By:			Date: 12-10-98
Other (If Applicable):			Date:

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ATTACHMENTS

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Prepared By: Divakar Bhargava DB			Date: 11-12-98
Reviewed By: CSR			Date: 12-10-98
Other (If Applicable):			Date:

1. OBJECTIVE

This calculation is prepared to complete the resolution of outstanding issues associated with valves 1-RC-PCV-1455C, 1-RC-PCV-1456, 2-RC-PCV-2455C and 2-RC-PCV-2456 which were identified in USI A-46 and IPEEE (Seismic) summary reports submitted to the NRC in May 1997. The valves did not meet the experience database caveats - the floor spectra are higher than the Reference Spectra of the GIP and the valve may be flexible, therefore, the seismic demand at the operator c.g. may be more than 3g. This is the acceleration value listed in the valve specification to which the valve is presumed to be qualified. In addition, the height of the valves exceeds that found in the experience database.

The purpose is to determine the seismic demand (i.e., g values) at the c.g. of the valve extended structure for both A-46 and IPEEE spectral inputs, and to establish the valve capacity. The demand and capacity will be compared to satisfy the USI A-46 requirements, and for IPEEE, a HCLPF value will be calculated.

2. METHOD/ANALYSIS

The following steps are used:

A. Determine/establish the natural frequency of the valve extended structure and the c.g. and mass of the valve extended structure.

B. Model the valve extended structure with one member with stiffness and mass representing the valve natural frequency in the NUPIPE model of the piping systems for both Units. Perform Response Spectrum modal analyses for both DBE and IPEEE (median centered spectra - 0.3g pga) to determine the acceleration responses at the valve center of gravity. This step is performed in references 14 and 15 and the valve responses from these references are tabulated in this calculation.

C. Determine stresses in the valve critical sections (yoke and bonnet) using seismic inertial forces obtained from references 14 and 15, together with operating loads for comparison with the allowable values for USI A-46. For IPEEE (Seismic), calculate HCLPF values.

A. Valve Natural frequency:

The Valve specification (Ref. 1) does not provide any requirements regarding the minimum natural frequency of the valve. Information was received from the valve vendor - Masoneilan (Reference 10 - Attachment B), which indicates that Masoneilan tested a similar valve whose natural frequency was determined to be 16 hz. Masoneilan provided parameters (dimensions etc.) of the tested valve and of the North Anna valve, as documented in Attachment B. Additional information (section properties, dimensions etc.) for the North Anna valves was obtained from the walkdowns performed at Unit 1 and 2 (Reference 2 - Attachment C). Based on the information available, the following analyses are made:

1. An initial model is prepared in STARDYNE code for the valve tested by Masoneilan using information mainly from Ref. 10 (Attach. B). A modal extraction analysis is performed to calculate its natural frequencies.

2. Adjust parameters in the valve model and run the modal extraction again such that the first natural frequency matches 16 hz., which was obtained from the test.

3. Based on the information obtained from Ref. 2, 3, 4 and 10, make a model of the North Anna valve and run a modal extraction analysis to calculate its natural frequencies.

4. Make similar adjustments as were done in the Masoneilan tested valve in step 2. above, to obtain a more realistic, adjusted value of the natural frequency for the North Anna valves.

5. Based on the adjusted North Anna valve frequencies determined in step 4 above, calculate area A and moment of inertia I of an equivalent member that can be modeled in the piping analyses (ref. 14, 15) to represent the valve with its natural frequencies in the two horizontal directions. Once this member is modeled in the piping analyses, the valve responses, i.e. accelerations in all three orientations for the DBE and IPEEE spectra can be determined.

The various parameters and valve models for cases 1 through 5 above are discussed below.

1. **Initial Model of the Valve tested by Masoneilan in report 13535-1:**

Per Attachment B, the valve that was tested by Masoneilan has the same yoke material and section properties as the North Anna valves, but different bonnet section, weights and c.g., etc. Its natural frequency by testing was found to be 16 hz. The yoke information is obtained from Attachment C.

For the initial model, the tested valve properties are based on information in Attachments B and C.

Valve operator weight = 250 lb. (Attach. B)
Valve body weight = 110 lb. (Attach. B)
Bonnet weight = 64 lb. (Attach. B)

c.g. of the entire assembly from the piping centerline = 19.2" (Attach. B)
c.g. of the extended structure = 26.0" (Attach. B)

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Prepared By: Divakar Bhargava *DB*			Date: *11-12-98*
Reviewed By: *CRR*			Date: *12-10-98*
Other (If Applicable):			Date:

The extended structure c.g. is assumed to be the c.g. for the weights of the operator and the bonnet, but not the valve body. This is verified from the data provided in Attachment B as follows:

26.0 * (64.0+250.0) = (250+110+64) * c.g.,

i.e., c.g. = 19.2", which is the same c.g. distance as given in Attach. B for the entire valve assembly.

From Attachment C, the distance from piping c.l. to body/bonnet flange is 5.5". This dimension is assumed to be the same for the tested valve also. The bonnet is bolted to the body, and its length for the tested valve is estimated based on the weights and NAPS valve measurement, as follows:

Weight of bonnet for the tested valve = 64 lb (Attach. B)
Weight of bonnet for the North Anna valves = 36 lb (Attach. B)
Length of bonnet for the North Anna valves = 4.5" (Attach. C)

Therefore, the approx. length of bonnet for the tested valve = 4.5*64/36 = 8"

Calculate the c.g. of the operator (excluding bonnet):

250*X +64*(5.5+4) = 314*26, i.e., X = 30.22"

Bonnet Section properties of the tested valve (based on dimensions from Attach. B):

X-section area = $\pi * (3.25^2 - 1.75^2)/4 = 5.89$ sq. in., and
$I_1 = I_2 = \pi * (3.25^4 - 1.75^4)/64 = 5.02\ in^4$, $J = 10.04\ in^4$

Yoke Section properties of the tested valve (same as NAPS valves – from p. 13 of this calculation):

Yoke length = 11.0 in, Area = 4.5 sq. in.
$I_{xx} = 7.6\ in^4$
$I_{yy} = 61.3\ in^4$
$J = 68.9\ in^4$

The Young's modulus of all members is taken as 28.0E6 psi, and members 1-29 and 27-28 are coded as rigid.

Based on the above properties, a model of the valve tested by Masoneilan is prepared in the STARDYNE computer code. A listing of the model is shown below. Also a sketch of the model is shown in Fig. 1.

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 6 of 18
Prepared By: Divakar Bhargava DB			Date: 11-12-98
Reviewed By: CR			Date: 12-10-98
Other (If Applicable):			Date:

```
START                                           3
  PCV TESTED BY MASONEILAN   - INITIAL MODEL
MATLG        1     Steel     28.0E6        0.30
END
NODE    1        0.0            0.0           0.0
NODE    2        0.0            0.0          13.5
NODE    3        1.00           0.0           0.0
NODE   27        0.00           0.0          24.5
NODE   28        0.0            0.0          30.2
NODE   29        0.0            0.0           5.5
END
RESTG        1         111111
END
WGHT         2     32.0      32.0      32.0
WGHT        28    250.0     250.0     250.0
WGHT        29     32.0      32.0      32.0
END
BEAMG        1       1       29        3    1    1
BEAMG        2      29        2        3    1    2
BEAMG        3       2       27        3    1    3
BEAMG       15      27       28        3    1    1
END
BPROP1       1    50.0      2.0E3    1.0E3    1.0E3
BPROP1       2     5.89    10.04     5.02     5.02
BPROP1       3    4.5      68.90     7.6     61.30
END
ENDGEOM
 PCV TESTED BY MASONEILAN-NATURAL FREQUENCY - LANCZOS
DYNAMIC                                              20       0
OPTION                 0        0                             0
ENDMODEL
```

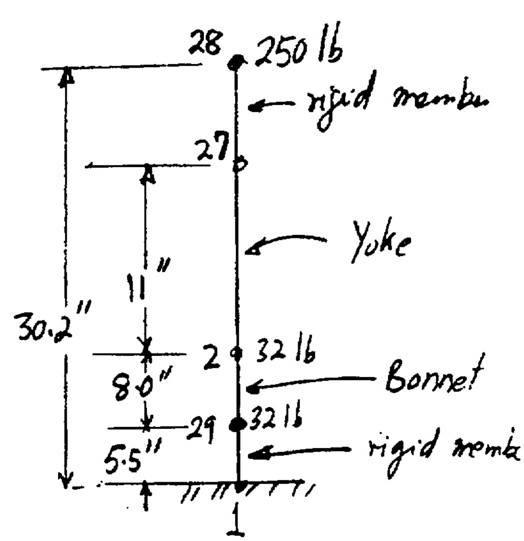

FIGURE 1

STARDYNE run no 1 (Lanczos - Attachment D) run provides the natural frequency of this valve. From this analysis, the first frequency is calculated to be 35.0 hz. Note that the natural frequency from the Masoneilan test was 16 hz. Therefore, the model is adjusted to match the frequency obtained from the test. The adjusted parameters are discussed in the next section.

2. **Adjusted Model of the Valve tested by Masoneilan in report 13535-1:**

There are probably several reasons as to why the test predicted a natural frequency lower than 35.0 hz. These could be: the bonnet length used in the analysis is approximate, the members between pipe c.l. to base of bonnet and yoke top to the c.g. are modeled as rigid but they may not be, the operator weight/c.g. in the test may be higher than the model to include limit switch and other appurtenances, there may be non-linearities in the extended structure of the valve which are not modeled, etc. To match the tested frequency, the following changes are made:

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Other (If Applicable):			Date:

Increase c.g. locations of bonnet (which was approximately determined in the initial model) and the c.g. of operator by 25%. This is done by making bonnet length as 10" and operator c.g. 37.7".

Increase operator weight by 25% to 312.5 lb (instead of 250 lb). Reduce E by 25% to 21.0E6 psi.

Reduce section properties of the yoke and bonnet by 25% (bonnet $I_1 = I_2 = 3.77$ in^4, yoke $I_1 = 5.7$in^4, $I_2 = 46.0$ in^4)

STARDYNE Lanczos run no. 2 (Attachment D) provides the natural frequency of this valve. From this model, the first frequency is calculated 16 hz. Based on this, North Anna's initial valve model will be adjusted to obtain a realistic natural frequency. A listing is shown below.

```
START                                                       3
  PCV TESTED BY MASONEILAN - ADJUSTED MODEL
MATLG       1     Steel     21.0E6       0.30
END
NODE   1            0.0                0.0            0.0
NODE   2            0.0                0.0           15.5
NODE   3            1.00               0.0            0.0
NODE  27            0.00               0.0           26.5
NODE  28            0.0                0.0           37.7
NODE  29            0.0                0.0            5.5
END
RESTG       1       111111
END
WGHT        2     32.0      32.0      32.0
WGHT       28    312.5     312.5     312.5
WGHT       29     32.0      32.0      32.0
END
BEAMG       1        1       29       3    1    1
BEAMG       2       29        2       3    1    2
BEAMG       3        2       27       3    1    3
BEAMG      15       27       28       3    1    1
END
BPROP1      1    50.0       2.0E3      1.0E3      1.0E3
BPROP1      2    5.89       7.53       3.77       3.77
BPROP1      3    4.5       51.70       5.7       46.0
END
ENDGEOM
 PCV TESTED BY MASONEILAN-ADJUSTED MODEL - NATURAL FREQ.
DYNAMIC                                                    20       0
OPTION                 0       0                                           0
ENDMODEL
```

This model gives the first two natural frequencies as 16.04 hz. and 17.83 hz. The first frequency matches exactly the frequency determined from the Masoneilan test.

3. **Initial Model of the North Anna Masoneilan PCVs:**

From Attach. B:

Bonnet cross section area = $\pi *(2.75^2 - 1.25^2)/4 = 4.71$ sq. in., and,
$I_1 = I_2 = \pi *(2.75^4 - 1.25^4)/64 = 2.69$ in^4, $J = 5.38$ in^4
Valve body weight = 55 lb
Bonnet weight = 36 lb

Distance from piping c.l. to body/bonnet flange = 5.5"	(Attachment C)
Length of bonnet for the North Anna valves = 4.5"	(Attachment C)
Valve assembly weight = 480 lb	(ref. 4)
Valve assembly c.g. (from piping c.l.) = 31.3"	(ref. 4)

Calculate c.g. of extended structure (i.e., excluding valve body and bonnet)

$480 *31.3 = (480\text{-}55\text{-}36)*X + (4.5 + 5.5/2)*36$,
i.e., X = 37.9" or approx. 38"

Yoke Section properties (from p. 14 of this calculation):

Yoke length = 11.0 in, Area = 4.5 sq. in.
I_{xx} = 7.6 in^4
I_{yy} = 61.3 in^4
J = 68.9 in^4

Based on the above, a model of the valve is prepared as follows, and analyzed using Lanczos routine of STARDYNE code. A listing of the model is shown below. Also a sketch of the model is shown in Fig. 2.

```
START                                                3
  MASONEILAN PCV NAPS - INITIAL MODEL
MATLG        1       Steel     28.0E6       0.30
END
NODE    1            0.0          0.0           0.0
NODE    2            0.0          0.0          10.0
NODE    3            1.00         0.0           0.0
NODE   27            0.00         0.0          21.0
```

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Calculation CE-1436	Rev. 0		Sheet: 9 of18
Prepared By: Divakar Bhargava [signature]			Date: 11-12-98
Reviewed By: [signature]			Date: 12-10-98
Other (If Applicable):			Date:

```
NODE   28          0.0          0.0         38.0
NODE   29          0.0          0.0          5.5
END
RESTG        1        111111
END
WGHT         2      18.0       18.0       18.0
WGHT        28     389.0      389.0      389.0
WGHT        29      18.0       18.0       18.0
END
BEAMG        1         1     - 29        3    1    1
BEAMG        2        29        2        3    1    2
BEAMG        3         2       27        3    1    3
BEAMG       15        27       28        3    1    1
END
BPROP1       1    50.0      2.0E3     1.0E3      1.0E3
BPROP1       2    4.71      5.38      2.69       2.69
BPROP1       3    4.5      68.90      7.6       61.30
END
ENDGEOM
 PCV AT NAPS  (MASONEILAN)-NATURAL FREQ.
DYNAMIC                                              20        0
OPTION             0        0                                          0
ENDMODEL
```

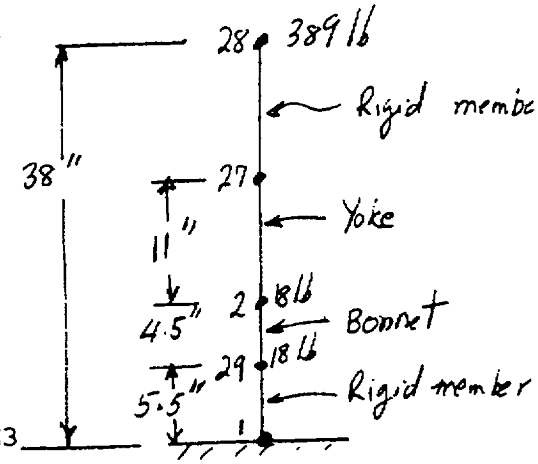

FIG. 2

This model (run no. 3) gives the first natural frequency as 17.54 hz. However, this model needs to be adjusted as was done for the valve tested by Masoneilan.

4. Adjusted Model of the North Anna Masoneilan PCVs:

As seen, the initial model of the valve tested by Masoneilan over-predicted the valve natural frequency. Therefore, it is reasonable to assume that the correct frequency of the North Anna valves will be less than 17.54 hz., which was determined from the initial model of the valve. The parameters are adjusted in a similar manner as was done for the tested valve.

Increase c.g. location of operator by 25%. (make operator c.g. 47.5")

Note that the bonnet length for the North Anna valves was measured in the field (Attach. C). The initial length of bonnet in the test model was approximate, and was changed in the adjusted model of the tested valve. However, for the North Anna valves, this dimension is not changed in the adjusted model and remains to be 4.5".

Increase operator weight by 25% to 486 lb (instead of 389 lb).

Reduce E by 25% to 21.0E6 psi.

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Calculation CE-1436	Rev. 0		Sheet: 10 of18
Prepared By: Divakar Bhargava DB			Date: 11-12-98
Reviewed By: CSR			Date: 12-10-98
Other (If Applicable):			Date:

Reduce section properties of the yoke and bonnet by 25% (bonnet $I_1 = I_2 = 2.02$ in^4 , yoke $I_1 = 5.7$in^4, $I_2 = 46.0$ in^4)

These adjustments are about the same as those made for the tested valve. STARDYNE run no. 4 analyzes the natural frequencies from this model. A listing of the model is shown below.

```
START                                                         3
  MASONEILAN PCV - NAPS ADJUSTED MODEL
MATLG       1      Steel   - 21.0E6       0.30
END
NODE    1          0.0          0.0          0.0
NODE    2          0.0          0.0         10.0
NODE    3          1.00         0.0          0.0
NODE   27          0.00         0.0         21.0
NODE   28          0.0          0.0         47.5
NODE   29          0.0          0.0          5.5
END
RESTG       1         111111
END
WGHT        2       18.0       18.0       18.0
WGHT       28      486.0      486.0      486.0
WGHT       29       18.0       18.0       18.0
END
BEAMG       1        1       29        3    1    1
BEAMG       2       29        2        3    1    2
BEAMG       3        2       27        3    1    3
BEAMG      15       27       28        3    1    1
END
BPROP1      1     50.0       2.0E3      1.0E3      1.0E3
BPROP1      2     4.71      4.04        2.02       2.02
BPROP1      3     4.5      51.70        5.7       46.00
END
ENDGEOM
 MASONEILAN PCV AT NAPS - NATURAL FREQ. ANALYSIS
DYNAMIC                                                        20        0
OPTION                                                       0                  0
0
ENDMODEL
```

From this run, the two natural frequencies are 8.74 hz. And 10.57 hz. The third frequency, which is in the vertical direction, is 323.1 hz.

5. Model of the PCVs to be used in piping analyses to determine responses at the c.g. of the extended structure:

Based on the results of run no. 4, the natural frequencies of the valve extended in the two directions are not too much different. These frequencies are approximate since the model was adjusted in an attempt to match the results of the testing done by Masoneilan on a similar valve. Therefore, an average natural frequency of 9.7 hz. in each of the two horizontal orientations will be modeled with one member in the Unit 1 and Unit 2 piping analyses.

The parameters to be used to model the valve in the piping analysis are as follows:

Weight of the valve body = 55 lb (Attach. B)
Weight of the valve assembly = 480 lb (ref. 4)

Therefore, weight of the extended structure (Operator, bonnet etc.) = 480 – 55 = 425 lb

c.g. of the assembly = 31.3" (ref. 4)

c.g. of extended structure, L = 480*31.3/425 = 35.4"

Use E = 28E6 psi.

Calculate area and moment of inertia of a member connecting the valve body to the c.g. of the extended structure:

$(1/(2\pi)) \times (AxEx386.4/(Lx425)) = 323.1$

Use L=35.4" (extended structure c.g. length from piping centerline)

Therefore, A = 5.73 sq. in.

And $(1/(2\pi)) \times (3ExIx386.4/(L^3 \times 425)) = 9.7$

Therefore, $I = I_1 = I_2 = 2.16 \text{ in}^4$

And $J = I_1 + I_2 = 4.32 \text{ in}^4$

B. **Seismic accelerations at valve extended structure c.g. locations from piping analyses:**

Accelerations (in g units) are tabulated below from the NUPIPE computer analyses performed in references 14 and 15 for NAPS Units 1 and 2 respectively.

From Reference 14 - NAPS Unit 1:

Valve 1-RC-PCV-1455C – Node 260

	X	Y (vertical)	Z
DBE (N411 damping)	1.16	0.60	4.63
SMA (broadened curve, 5% damping)	3.27	1.16	8.74
SMA (unbroadened curve, 5% damping)	2.39	1.02	7.84
SMA(unbroadened, 5% damp, +15% shift)	3.26	1.07	7.26
SMA(unbroadened, 5% damp, -15% shift)	1.93	0.83	4.40

Valve 1-RC-PCV-1456 – Node 435

	X	Y (vertical)	Z
DBE (N411 damping)	1.05	0.38	3.26
SMA (broadened curve, 5% damping)	2.13	0.59	6.44
SMA (unbroadened curve, 5% damping)	1.71	0.53	5.49
SMA(unbroadened, 5% damp, +15% shift)	2.07	0.57	5.51
SMA(unbroadened, 5% damp, -15% shift)	1.43	0.50	3.23

From Reference 15 - NAPS Unit 2:

Valve 2-RC-PCV-2455C – Node 227

	X	Y (vertical)	Z
DBE (N411 damping)	0.99	0.60	1.65
SMA (broadened curve, 5% damping)	2.15	1.19	4.54
SMA (unbroadened curve, 5% damping)	1.98	1.13	2.89

Valve 2-RC-PCV-2456 – Node 431

	X	Y (vertical)	Z
DBE (N411 damping)	1.40	0.48	1.95
SMA (broadened curve, 5% damping)	3.30	0.99	5.36
SMA (unbroadened curve, 5% damping)	2.71	0.89	3.42

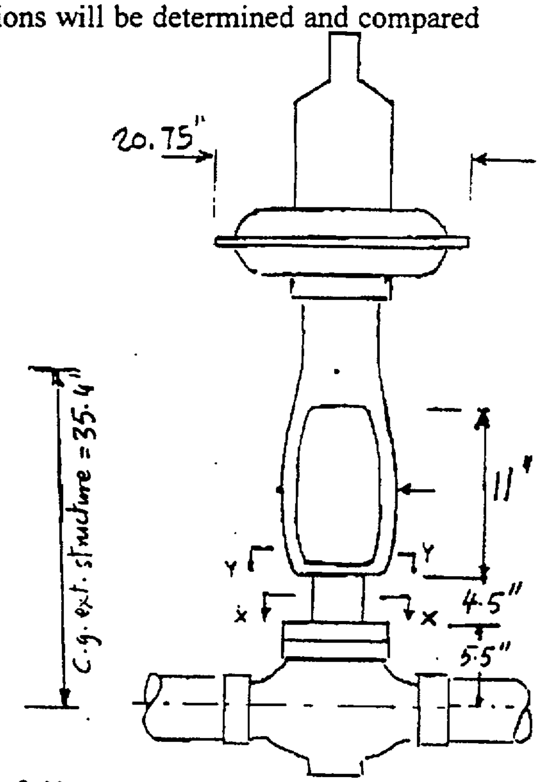
As is evident from the above tabulation, the highest responses are obtained for valve 1-RC-PCV-1455C for both USI A-46 and IPEEE (Seismic).

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 13 of 18
Prepared By: Divakar Bhargava			Date: 11-12-98
Reviewed By:			Date: 12-10-98
Other (If Applicable):			Date:

C. **Determination of Valve Capacity:**

It is judged that the critical valve components that will govern the valve capacity are the valve yoke and valve bonnet. Therefore, stresses in these two valve sections will be determined and compared to their respective allowable values.



Maximum operating pressure = 55 psi (ref. 3)
Diaphragm diameter = 20.75"

Thus, maximum operating load = $(\pi/4)x20.75^2x55 = 18599$ lb
Valve extended structure weight = 425 lb
c.g. of extended structure from valve centerline = 35.4"

Valve Yoke:

Material, Allowable Limits and Properties:

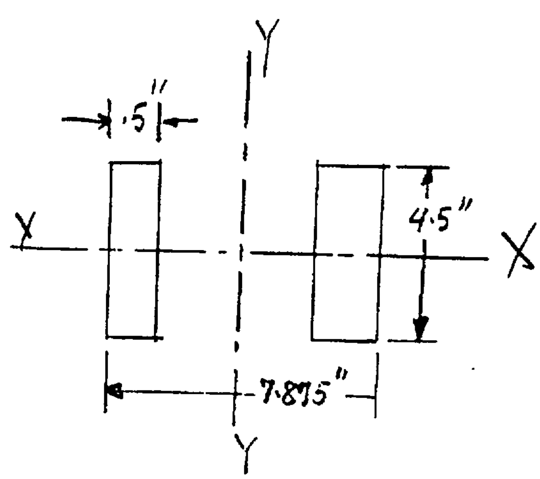
From ref. 3, the Yoke material is ASTM A216 GR WCB.

From ref. 11, Table I-7.1,
Min. yield strength = 36 ksi
Min. ultimate tensile strength = 70 ksi
And allowable stress value, S = 17.5 ksi (at 600 F)

Use ASME code allowable for class 2 and 3 valves, based on ref. 13.
For faulted condition, the allowable local membrane + primary bending stress limit is 2.4S. This limit is also stated in ref. 9 and is therefore applicable to both USI A-46 and IPEEE evaluations.

Thus, stress limit = 2.4x17.5 = 42 ksi.

Yoke cress-section at Y-Y:



Cross section area = 2x4.5x0.5 = 4.5 sq. in.
$I_{xx} = (2x.5x4.5^3)/12 = 7.6$ in^4
$I_{yy} = 2x4.5x.5x(7.875/2 - .25)^2 + 2x4.5x.5^3/12 = 61.3$ in^4

And section moduli are:

$S_{xx} = 7.6/2.25 = 3.38$ in^3
$S_{yy} = 61.3/(7.875/2) = 15.57$ in^3

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 14 of 18
Prepared By: Divakar Bhargava [signature]			Date: 11-12-98
Reviewed By: [signature]			Date: 12-10-98
Other (If Applicable):			Date:

USI A-46 Evaluation of Yoke:

Use the design basis accelerations for valve 1-RC-PCV-1455C (highest of any valve).

Moment M = 4.63x(35.4-10)x425 = 49981 in-lb

$\sigma_{xx} = M/S_{xx}$ = 49981/3.38 = 14787 psi, $\sigma_{yy} = M/S_{yy}$ = 49981/15.57 = 3210 psi,
σ_{axial} = (.6x425)/4.5 = 57 psi

SRSS of all three directions = 15.13 ksi

Operating loads + deadweight = (18599+425)/4.5 = 4.23 ksi

Total stress = 15.13 + 4.23 = 19.36 ksi

Factor of safety = 42/19.36 = 2.17

Valve Bonnet:

Material, Allowable Limits and Properties:

From ref. 3, the bonnet material is ASTM A 351 GR CF8M.

From ref. 11, Table I-7.2,
Min. yield strength = 30 ksi
Min. ultimate tensile strength = 70 ksi
And allowable stress value, S = 16.8 ksi (at 600 F)

Although the valves are Class 1, conservatively use ASME code allowable for class 2 and 3 valves, based on ref. 13. For faulted condition, the allowable stress limit is 2.4S. This stress limit is applicable to USI A-46 evaluation.

Thus, stress limit = 2.4x16.8 = 40.32 ksi.

Bonnet cress-section at X-X:

O.D. = 2.75", I.D. = 1.25"

Area A= 4.71 in^2, and I=(π/64)x($2.75^4-1.25^4$) = 2.69 in^4, section modulus s = 2.69/1.375 = 1.954 in^3

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 15 of 18
Prepared By: Divakar Bhargava DB			Date: 11-12-98
Reviewed By: CR			Date: 12-10-98
Other (If Applicable):			Date:

USI A-46 Evaluation of Bonnet:

Use design basis accelerations for valve 1-RC-PCV-1455C (highest of any valve).
Moment M = 4.63x29.9x425 = 58,836 in-lb

σ_x = M/s = 58836/1.954 = 30110 psi, ignore the other direction, since this is a circular section.
σ_{axial} = (.6x425)/4.5 = 57 psi

SRSS of all directions = 30.11 ksi
Operating loads + deadweight = (18599+425)/4.5 = 4.23 ksi
Thus total stress = 30.11 + 4.23 = 34.34 ksi
And factor of safety = 40.32/34.34 = 1.17, O.K.

HCLPF Calculation for IPEEE (Seismic):

By inspection, the bonnet section governs. Thus the HCLPF capacity will be based on this section.

Use SMA accelerations for valve 1-RC-PCV-1455C (highest of all valves). Note that the Unit 1 piping is analyzed for two cases: Nupipe run with peak broadened spectra and with un-broadened spectra. For the un-broadened spectra case, two additional runs are prepared - with +15% and –15% peak shifting of spectra in the horizontal direction. From the three cases of the un-broadened spectra, the maximum horizontal acceleration at valve 1-RC-PCV-1455C is 7.84g. This value is somewhat conservative because the modal combination method is per RG 1.92 (i.e., closely spaced modes absolutely summed). The allowable stress limit is per reference 9.

Allowable Stress = 3.6 S_m = 3.6 x 16.9 (Ref. 11, Table I-10.2) = 60.84 ksi

Moment at bonnet base M = 7.84x29.9x425 = 99,627 in-lb

σ_x = M/s = 99627/1.954 = 50986 psi, ignore the other direction, since this is a circular section.
σ_{axial} = (1.16x425)/4.5 = 110 psi

SRSS of all directions = 50.99 ksi

Per p. 6.29 of ref. 9, a load reduction factor, K_μ, of 0.8 is appropriate and applicable for seismic loads. Thus, seismic stress = 0.8x50.99 = 40.79 ksi

Operating loads + deadweight = (18599+425)/4.5 = 4.23 ksi
And factor of safety FS = (60.84 – 4.23)/40.79 = 1.38

Thus the HCLPF capacity for valve 1-RC-PCV-1455C is: 1.38x.3 = 0.414g

Of the remaining valves, the highest horizontal acceleration is predicted for 1-RC-PCV-1456. For this valve, SMA acceleration = 5.51g, thus, seismic stress = 40.79x5.51/7.84 = 28.67 ksi.

FS = (60.84-4.23)/28.67 = 1.97, and HCLPF capacity = 1.97x.3 = 0.59g.

Therefore, all the valves have a HCLPF capacity > 0.3g

3. DESIGN INPUTS

The inputs used in this calculation are from Attachments B and C (references 3 and 4), and from pipe stress calculations - references 14 and 15 for North Anna Units 1 and 2 respectively.

4. ASSUMPTIONS/COMMENTS

Minor assumptions are made in section 2 of this calculation, as stated in the applicable places.

5. SUMMARY OF RESULTS AND CONCLUSIONS

The valve capacity is based on calculated stresses in the valve yoke and the valve bonnet, and comparing them with the respective allowable values. The bonnet section is weaker and controls the capacity. The results for USI A-46 and IPEEE are stated below:

USI A-46:

From the piping analyses, references 14 and 15, the highest design basis earthquake accelerations of any valve extended structure are for valve 1-RC-PCV-1455C. They are 1.2g and 4.63g in the two horizontal directions, and 0.6g in the vertical direction. The predicted accelerations are less than the valve capacity, and the safety factors for the yoke and the bonnet are 2.17 and 1.17 respectively. Thus the valves are acceptable for USI A-46.

IPEEE (Seismic):

The HCLPF capacity of these valves for IPEEE program is based on the acceleration responses determined from the piping analyses. From the piping analyses, references 14 and 15, the highest SMA accelerations (0.3g pga basis) at the valve extended structure are predicted for valve 1-RC-PCV-1455C. The maximum horizontal acceleration for this valve is 7.84g and based on this, the valve HCLPF capacity is calculated to be 0.41g. Therefore, for all the four valves evaluated in this calculation, the HCLPF capacity is >0.3g.

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 17 of 18
Prepared By: Divakar Bhargava [signature]			Date: 11-12-98
Reviewed By: [signature]			Date: 12-10-98
Other (If Applicable):			Date:

6. REFERENCES:

No.	NUMBER (If Applicable)	REV No.	SHT No.	TITLE
1	E-Spec 676270	1	N/A	Westinghouse Specification – Control valves
2	Attachment B	N/A	N/A	Field Walkdown Information on 4-17-09 forValves 2-RC-PCV-2455C, 2456, and on 9-21-98 for valves 1-RC-PCV-1455C and 1456
3	A8429	B	N/A	Masoneilan Dwg. – Control Valve
4	CPI-18-55	J	N/A	DWG. – Control Valve Model 38-20721
5	VEPSPEC Code and Technical Report 94164-TR-01	N/A	N/A	ARS Database Code (VEPSPEC), Version 5.0, Dec. 94, and Technical Report, Altran Corporation
6	N/A	N/A	N/A	USNRC Generic Letter No. 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operation Reactors"
7	N/A	N/A	N/A	Generic Implementation Procedure (GIP) Revision 2, Prepared by Seismic Qualification Utilities Group, Feb. '92
8	N/A	N/A	N/A	Supplement No.1 to Generic Letter 87-02 that transmits Supplemental Safety Evaluation Report No. 2 on SQUG GIP Revision 2, May 22, 1992.
9	EPRI-NP-6041	N/A	N/A	A Methodology for the Assessment of Nuclear Plant Seismic Margin
10	Attachment A	N/A	N/A	Notes of telephone conversation with Masoneilan on 9-8-98 and information from Masoneilan received on 9-10-98.
11	ASME Section III,	N/A	N/A	ASME Section III, Division 1, Subsection NA and Appendix I, Tables I-7.1, I-7.2, I-10.2, 1989 Edition
12	STARDYNE Code, Version 4.05	N/A	N/A	STARDYNE Computer Code, Version 4.05, Reasearch Engineers Inc.
13	ASME Section III, Subsection NC	N/A	N/A	ASME Section III, Division 1, Subsection NC, 1995 Edition.
14	CE-1109	0	N/A	Pipe Stress Calculation – PSARV piping, North Anna Unit 1, up to and including Addendum 00C.

ENGINEERING WORK SHEET

Calculation CE-1436	Rev. 0		Sheet: 18 of 18
Prepared By: Divakar Bhargava *DB*			Date: *11-12-98*
Reviewed By: *CJR*			Date: *12-10-98*
Other (If Applicable):			Date:

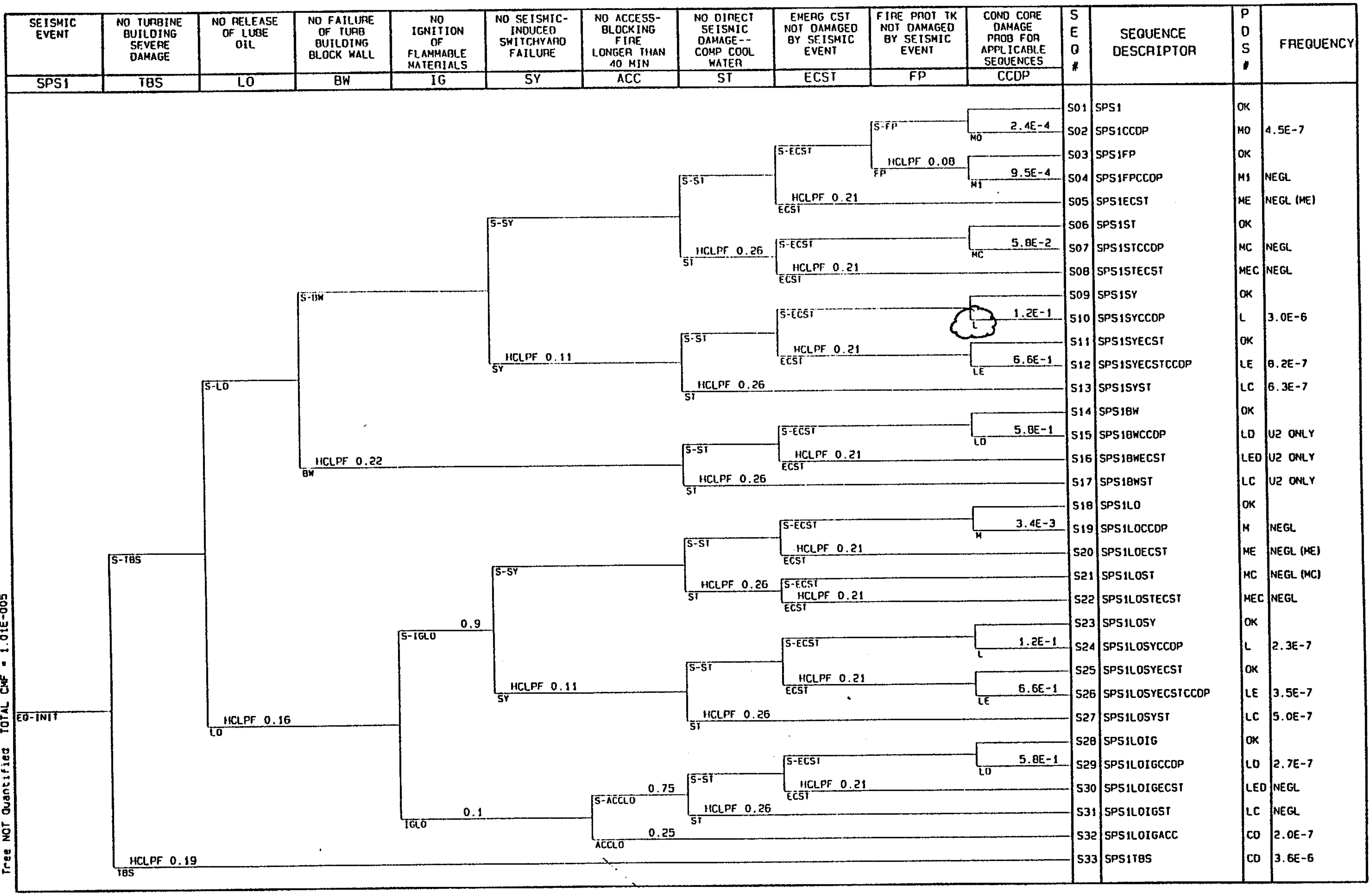
No.	NUMBER (If Applicable)	REV No.	SHT No.	TITLE
15	14938.02-NP(B)-010-XC	0	N/A	Pipe Stress Calculation – PSARV piping, North Anna Unit 2, up to and including Addendum 0D.
16	Serial No. 97-303 and 97-246	N/A	N/A	Letters to NRC dated 5-27-98 transmitting summary reports for IPEEE (Seismic) and USI A-46

ATTACHMENT 4

Seismic Event Tree, Top Sequences and Conditional Core Damage Probability from Report 250226-R-001, Revision 0, "Sequence Quantification – Seismic IPEEE, Surry Power Station, Units 1 and 2", November 1997, EQE International.

Virginia Electric and Power Company (Dominion) North Anna Power Station Units 1 and 2

Figure 2-1 Surry Power Station Master Seismic Event Tree



3.0 SEISMIC QUANTIFICATION RESULTS

The seismic core damage frequency using the mean EPRI hazard curve is calculated to be 8.0E-06/yr. Table 3-1 presents the dominant SPS seismic sequences, associated core damage frequencies, and percent contribution to overall seismic core damage frequency. The dominant sequences are grouped and discussed below.

S33 3.6E-06/yr 36% Severe seismic-induced damage to turbine building

This sequence represents excessive movement of the turbine building structure such that equipment, piping, and cables are damaged extensively. It is assumed that the isolation valves from the intake canal do not automatically close, and the building is damaged such that operators cannot access the valves for manual operation, resulting in draining of the intake canal. This causes loss of emergency switchgear room cooling (if recovery is unsuccessful), charging pump cooling, RHR heat exchanger cooling, and recirculation spray cooling, resulting in eventual core damage. Operators cannot access the condenser steam blowdown valves in order to depressurize the secondary and primary systems. Long-term containment overpressure will occur unless containment heat removal systems are restored.

S10, S24 3.3E-06/yr 33% Seismic-induced loss of offsite power

These sequences involve a seismic-induced loss of offsite power, with additional nonseismic random and human errors leading to core damage. Sequence S24 also has a seismic-induced lube oil spill, but it does not ignite, and is not a contributing factor to core damage. The dominant nonseismic contributors are failure of the emergency diesel, DG1; or failure of RHR valve alignment inside containment. Recirculation sprays are not available for scenarios without emergency power, and long-term containment overpressure will occur unless power and containment heat removal systems are restored.

S12, S26 1.2E-06/yr 12% Seismic-induced loss of offsite power and AFW ECST

These sequences involve seismic failures of offsite power and the AFW emergency condensate storage tank, with additional nonseismic failures leading to core damage. In addition, for S26 there is a seismic-induced lube oil spill, but it does not ignite, and is not a contributing factor to core damage. The dominant nonseismic failures are failure to stop AFW pumps before cavitation due to loss of the ECST, or failure of the emergency diesel generator. Recirculation sprays are not available for about 10% of these sequences, and long-term containment overpressure will occur unless power and containment heat removal systems are restored.

S13, S27 1.1E-06/yr 11% Seismic-induced loss of offsite power and CC surge tank

These sequences involve seismic failures of offsite power and the component cooling surge tank, which is assumed to lead to core damage. Loss of component cooling leads to loss of cooling to the RHR pumps and heat exchangers. Unless operator action to crosstie the DC buses is taken, feed and bleed is not available with the loss of offsite power, since both trains of emergency power are required to open both PORVs. In addition, in S27 there is a seismic-induced lube oil spill, but it does not ignite, and is not a contributing factor to core damage. Recirculation sprays are available for containment heat removal, so containment overpressure will not occur.

S02 4.5E-07/yr 4% Small seismic event with assumed failures

This sequence is a small seismic event which is conservatively assumed to fail equipment which has not been evaluated during the seismic walkdowns. In particular, it is assumed that main feedwater, condensate, instrument air, and circ water systems are damaged and unavailable. Failure to align the AFW pumps to the fire protection water tank combined with common cause failure of charging pump cooling water (fails feed and bleed and makeup for primary shrinkage), or failure of PORVs (fails feed and bleed) and RHR or secondary steam dump lead to core damage. Containment cooling is available from the recirculation sprays, so containment overpressure will not occur. The assumption of the seismic failures is very conservative for these low-level seismic events.

S29, S32 4.7E-07/yr 5% Seismic-induced lube oil fire in turbine building

These sequences involve a seismic-induced failure of the lube oil reservoir tank 1-LO-TK-1, with subsequent ignition of the spill in the diked area. It is then assumed that the electrical cables to the condenser waterbox, BCW heat exchanger and CCW heat exchanger isolation valves are disabled by the fire. The operator fails to stop flow through the condenser water boxes due to inadequate time (S29) by opening vacuum breakers, or fails to manually isolate the BCW and CCW heat exchangers, either because of the fire preventing access (S32) or inadequate time (S29), resulting in excessive draining of the intake canal. This causes loss of charging pump cooling, RHR heat exchanger cooling, recirculation spray cooling, and potentially emergency switchgear room cooling (if recovery is unsuccessful), resulting in eventual core damage. Long-term containment overpressure will occur unless containment heat removal systems are restored.

The median seismic capacity of the plant is about 0.7g. The HCLPF (95% confidence of a less than 5% probability of failure) of the plant can be estimated to be about 0.16g. These estimates represent the "seismic capacity" of the plant, including operator recovery actions and conditional core damage probabilities. They are independent of the seismic hazard (i.e., do not depend on whether the EPRI baseline or LLNL hazard curve is used).

Table 3-2 presents the percentage of the core damage frequency that derives from each interval in the seismic hazard curve, for the EPRI baseline hazard curve. About 1/3 of the seismic core damage frequency is contributed in the ranges up to 0.23g. Another 1/3 is contributed in the range between 0.23g and 0.35g. The final 1/3 of the core damage frequency comes from accelerations above 0.35g.

Table 3-1 SPS Unit 1 Seismic PSA Accident Sequence Results

Sequence	Description	Frequency (1/yr)[1]	Percentage of Total Seismic Core Damage Frequency[1]
S33	Severe seismic damage to turbine building	3.6E-06	36%
S10	Seismic-induced loss of offsite power with additional random failures leading to core damage	3.0E-06	30%
S12	Seismic-induced loss of offsite power and AFW ECST with additional random failures leading to core damage	8.2E-07	8%
S13	Seismic-induced losses of offsite power and CC surge tank leading to core damage	6.3E-07	6%
S27	Seismic-induced losses of offsite power and CC surge tank leading to core damage, with lube oil spill but no fire	5.0E-07	5%
S02	Small seismic event assumed to fail MFW, condensate, instrument air and circ water, with additional random failures leading to core damage	4.5E-07	4%
S26	Seismic-induced losses of offsite power and AFW ECST with additional random failures leading to core damage, with lube oil spill but no fire	3.5E-07	3%
S29	Seismic-induced lube oil fire in turbine building with failure of intake canal isolation and failure of recovery actions	2.7E-07	3%
S24	Seismic-induced loss of offsite power with additional random failures leading to core damage, with lube oil spill but no fire	2.3E-07	2%
S32	Seismic-induced lube oil fire in turbine building with failure of intake canal isolation and prevention of operator access	2.0E-07	2%

Note

1 The mathematical sum of the dominant core damage sequences shown here is 1.0E-5/yr, which is 25 percent more than the actual calculated overall core damage frequency value of 8.0E-06/yr obtained analytically using SEISMIC. This small disparity is normal and arises from the different treatment of events common to multiple accident sequences. In the calculation of overall core damage frequency, SEISMIC treats such common events as single occurrences (that is, they are thus correctly treated as fully dependent). However, when individual accident sequences are solved and reported individually as shown in this table, events common to multiple sequences are actually treated as independent occurrences (they are thus conservatively treated as fully independent). The percentage contributions of the sequences shown in the table were calculated based on the mathematical sum of the core damage frequencies of 1.0E-05/yr.

Table F.1-2 Surry Seismic Damage States

Seismic Damage State	Discussion	Conditional Core Damage Probability
OK	These sequences are the success portions of branches placed in the event tree to model conditional core damage probabilities. They are not used in the quantification and serve solely as place holders in the seismic event tree.	Not Applicable
L	Loss of offsite power induced by the seismic event. Event tree Eql was developed to calculate a conditional core damage probability. The functional equations modeled are: K, Ic, Vs, Q, L, DEP, RHR as described below. K - reactor subcritical, ATWS results from failure of this function, the contribution of this event to the CCDP was negligible and therefore no transfer was made to the ATWS event tree Ic - Intake canal level > 10.9 ft; failure of this function results in core damage due to the loss of charging needed to offset RCS shrinkage during secondary cooldown (feed and bleed also is not available) and to the loss of switchgear room cooling at both units Vs - switchgear room cooling; failure results in core damage Q - RCS boundary intact; failure results in a transfer to the small LOCA event tree; however, due to the negligible contribution to the CCDP, the transfer was not quantified. L - Auxiliary feedwater available; since only one diesel is postulated to be available for Unit 1 (diesel 3 was assumed to be aligned to Unit 2) feed and bleed is not available. Therefore, failure of auxiliary feedwater results in core damage. Sufficient condensate is available in either 1-CN-TK-1 or 1-CN-TK-3 for using AFW to depressurize the RCS to a level at which RHR can be operated for removal of decay heat. DEP and RHR - secondary cooldown and RHR operation; failure results in core damage due to the unavailability of feed and bleed.	1.2E-1
LD	Development similar to that for seismic damage state L. However, severe drain down of the canal is postulated to occur, and operators must respond to stop the outflow and maintain level.	5.8E-1
LE	Development similar to that for seismic damage state L. However, seismic failure of emergency condensate tank 1-CN-TK-1 requires operator action to stop the AFW pumps (the pumps do not stop automatically on low suction header pressure) prior to aligning the emergency makeup condensate storage tank 1-CN-TK-3 to AFW pump suction.	6.6E-1
LC	Loss of offsite power coincident with a seismic-induced loss of component cooling water. The unavailability of feed and bleed due to the LOSP requires that secondary cooldown and RHR be used to shut down the plant. However, RHR is unavailable without component cooling water and core damage therefore occurs.	1.0

Table F.1-2 Surry Seismic Damage States

Seismic Damage State	Discussion	Conditional Core Damage Probability
LED	Seismic-induced loss of offsite power, loss of the emergency condensate storage tank, 1-CN-TK-1, coincident with severe drain-down of the intake canal. The CCDP was conservatively assumed to be 1.0, based on combined HEPs for actions necessary to be taken.	1.0
M	Seismic-induced loss of main feedwater. CCDP quantified using the EQM and EQML event trees. The functional equations modeled in EQM are: K, Ic, Vs, Q, L, DEP, RHR as described below. K - reactor subcritical, ATWS results from failure of this function, the contribution of this event to the CCDP was negligible and therefore no transfer was made to the ATWS event tree Ic - Intake canal level > 10.9 ft; failure of this function results in core damage due to the loss of charging needed to offset RCS shrinkage during secondary cooldown (feed and bleed also is not available) and to the loss of switchgear room cooling at both units Vs - switchgear room cooling; failure results in core damage Q - RCS boundary intact; failure results in a transfer to the small LOCA event tree; however, due to the negligible contribution to the CCDP, the transfer was not quantifiied. L - Auxiliary feedwater available; failure of this function requires that operators establish feed and bleed which is modeled by a transfer to an event tree named EQML that is based on the Surry PSA T2L event tree DEP and RHR - secondary cooldown and RHR operation; failure of these functions require that operators establish feed and bleed, which is modeled by a transfer to an event tree named EQML that is based on the Surry PSA T2L event tree	3.4E-3
M1	Development similar to that for seismic damage state M, with the exception that three operator actions--HEP-AP12:01-11, HEP-1OP14:1-5:10, and HEP-1FRH:1-16--were assigned the original HEP values used in the Surry internal events PSA as discussed in Section F.1.4 of this appendix.	9.5E-4
ME	Development similar to that for seismic damage state M, with the addition of a seismic failure of the emergency condensate storage tank 1-CN-TK-1. Event trees EQME and EQMEL were used to quantify the CCDP.	3.1E-2
MC	Development similar to that for seismic damage state M, with the addition of a seismic failure of the component cooling water system (due to seismic failure of the component cooling water surge tank). CCDP quantified using the EQMC and EQMCL event trees.	5.8E-2
MEC	The frequency of occurrence for this seismic damage state is low, based on the seismic event tree quantification results (see Section F.2). Therefore, a conditional core damage probability of 1.0 was conservatively assumed.	1.0
M0	This event is similar to M1 above, but includes the ability to use the fire protection and domestic water tanks for long term AFW. The cut sets in M1 were modified to account for the operator recovery actions needed to align FP water to the AFW suction.	2.4E-4

EQE

Table F.1-2 Surry Seismic Damage States

Seismic Damage State	Discussion	Conditional Core Damage Probability
CD	Sufficient seismic damage has occurred to lead eventually to core damage. See Section F.1.1.1 for discusion.	1.0

Note: Cutsets 1, 4, and 5 were modified by hand to reflect the potential availability of DG3 to be used to power the Unit 1 B train. A conservative value of 0.5 was used to estimate the unavailability of DG3 (FS, FR, UM), common cause DG failure, inability to transfer DG3 because it is needed for Unit 2, and operator action. It is recommended that a future model incorporates these dependencies in better detail, to obtain a more realistic estimate.

```
VIRGINIA DATA                                                   Page    1
FILE : EQL.EQP              Tue Oct 28 16:15:01 1997

Equation File                                  = EQL.EQN
Basic Event Data file referenced               = L.BED
Number of cut sets in equation                 = 1600
Top event unavailability  (rare event)         = 1.590E-001 (modified to
1.24E-1, as discussed in the note above.)
Top event unavailability  (Third order)        = 1.494E-001
-----------------------------------------------------------------------
```

Station blackout (Modified by 0.5 to 2.61E-02, as discussed in the note above)

1	5.2200E-002	1EGEDG-FR-1	CCDP

Failure to align RHR for decay heat removal

2	2.6600E-002	HEP-1OP14:1-5:10	CCDP

Failures that cause a loss of RHR

3	1.8579E-002	1RHHEX-LF-1RHE2A	CCDP

Station blackout (Modified by 0.5 to 5.57E-03 and 3.94E-3 as discussed in the note above)

4	1.1139E-002	1EGEDG-UM-1	CCDP
5	7.8692E-003	1EGEDG-FS-1	CCDP

Failures that cause a loss of RHR

6	3.9325E-003	1RHPSB-FS-1RHP1A	CCDP
7	3.7495E-003	1RHPSB-UM-1RHP1A	CCDP

Failures that cause a loss of secondary heat removal

8	3.4424E-003	CCDP	1FWCKV-FO-1FW172

Failure to locally isolate a bearing cooling water heat exchanger due to failure of power to the associated isolation valve (the valve is supplied with power from bus EJ which is de-energized for loss of offsite power scenarios due to the assumption that diesel generator 3 is connected to Unit 2 loads)

9	2.6600E-003	CCDP	HEP-AP12:01-11

Failures that cause a loss of secondary heat removal

10	2.6600E-003	CCDP	HEP-1FRC:1-12-EQ

Failure to re-energize bus need for RHR operation; the bus normally de-energizes on loss of offsite power

11	2.6600E-003	HEP-AP10:00-4	CCDP

Failures that cause a loss of RHR

12	2.2834E-003	1RHHCV-FC-1758 CCDP	REC-RHR-LOCAL
13	2.2834E-003	1CCAOV-FC-TV109B CCDP	REC-RHR-LOCAL

Failures that cause a loss of secondary heat removal

14	1.4061E-003	CCDP	1FWHEP-FULLRECRC

Severe drain-down of intake canal due to failure of four or more water boxes to isolate (caused by the unavailability of two diesels) and failure of operators to respond)

15	1.1469E-003	CCDP 2EGEDG-UM-2	1EGEDG-FR-3 HEP-1ECA0:0-7-SV
16	8.8557E-004	CCDP 2EGEDG-FR-2	1EGEDG-FR-3 HEP-1ECA0:0-7-SV

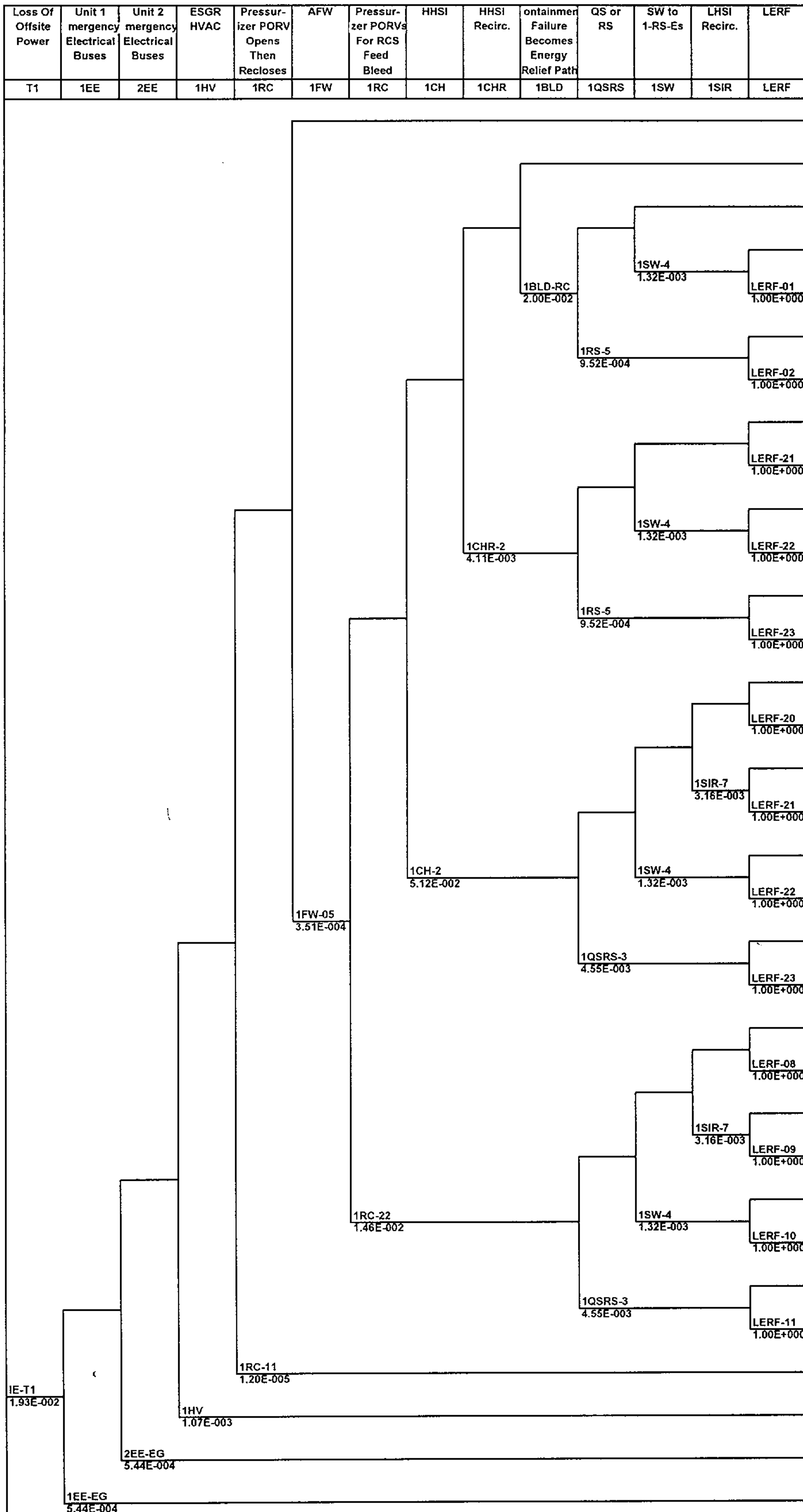
Failures that cause a loss of RHR

17	8.7926E-004	1RHMOV-FC-1700 CCDP	REC-RHR-LOCAL
18	8.7926E-004	1RHMOV-FC-1701 CCDP	REC-RHR-LOCAL
19	7.9302E-004	1CCPAT-FR-1CCP1A	CCDP
20	7.9266E-004	1RHPSB-FR-1RHP1A	CCDP

ATTACHMENT 5

North Anna Event Tree for a Stuck Open PORV

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

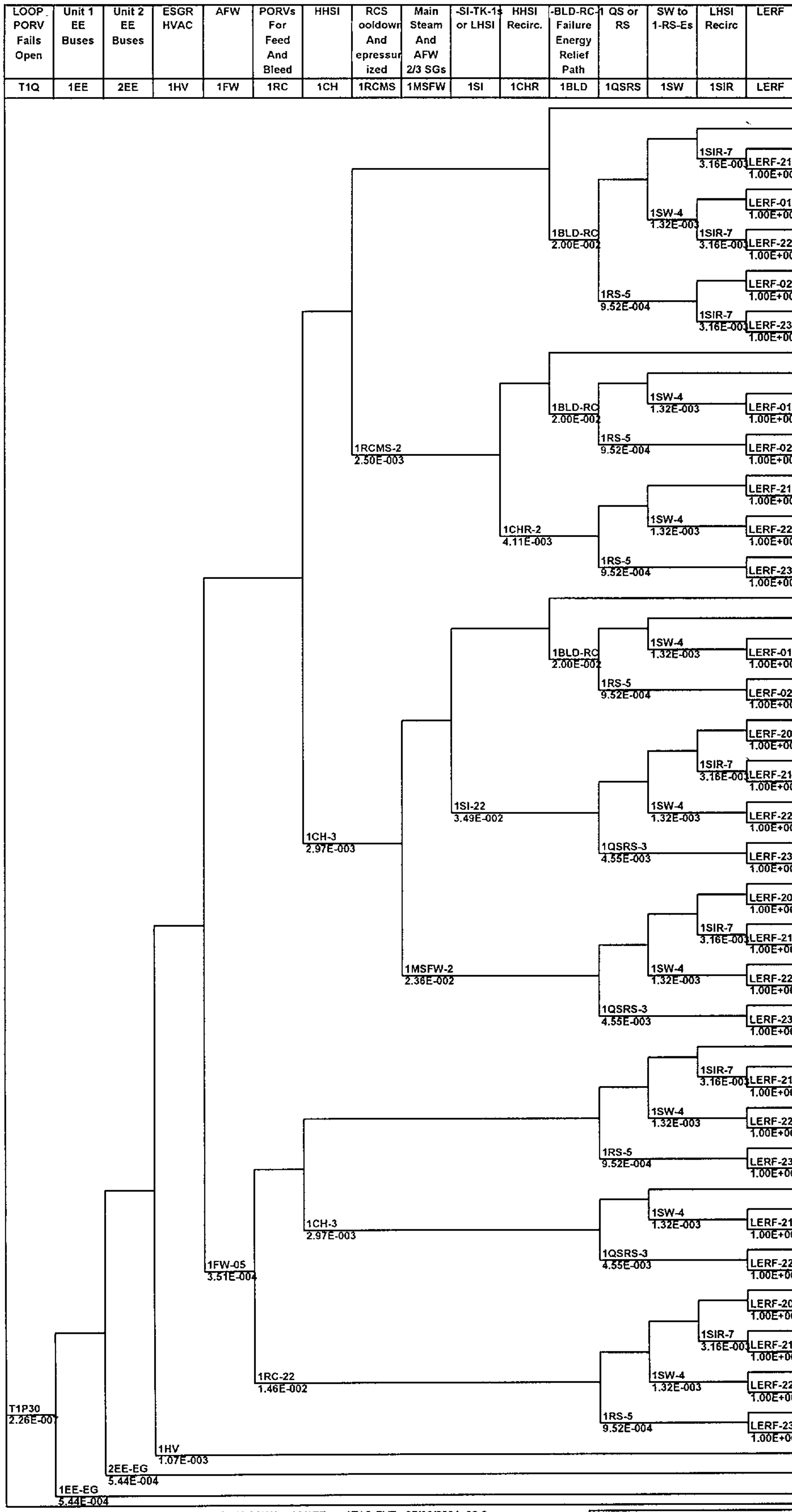


SEQ #	SEQUENCE DESCRIPTOR	PDS #	FREQUENCY
P01	T1	OK	
P02	T11FW	OK	
P03	T11FW1BLD	OK	
P04	T11FW1BLD1SW	OK	
P05	T11FW1BLD1SWLERF	1	0.00E+000
P06	T11FW1BLD1QSRS	OK	
P07	T11FW1BLD1QSRSLERF	2	0.00E+000
P08	T11FW1CHR	OK	
P09	T11FW1CHRLERF	21	7.93E-009
P10	T11FW1CHR1SW	OK	
P11	T11FW1CHR1SWLERF	22	0.00E+000
P12	T11FW1CHR1QSRS	OK	
P13	T11FW1CHR1QSRSLERF	23	0.00E+000
P14	T11FW1CH	OK	
P15	T11FW1CHLERF	20	3.19E-007
P16	T11FW1CH1SIR	OK	
P17	T11FW1CH1SIRLERF	21	5.00E-010
P18	T11FW1CH1SW	OK	
P19	T11FW1CH1SWLERF	22	0.00E+000
P20	T11FW1CH1QSRS	OK	
P21	T11FW1CH1QSRSLERF	23	1.30E-010
P22	T11FW1RC	OK	
P23	T11FW1RCLERF	8	8.48E-008
P24	T11FW1RC1SIR	OK	
P25	T11FW1RC1SIRLERF	9	0.00E+000
P26	T11FW1RC1SW	OK	
P27	T11FW1RC1SWLERF	10	0.00E+000
P28	T11FW1RC1QSRS	OK	
P29	T11FW1RC1QSRSLERF	11	0.00E+000
P30	T11RC	TR	2.26E-007
P31	T11HV	TR	8.96E-006
P32	T12EE	TR	6.97E-006
P33	T11EE	TR	9.82E-006

P:\Pra\PRA 2000 Update\Naps\Quantification\N0A\N0a_300\ETrees\T1.EVT 07/06/2001 09:03
Quantification Date: 11/18/2000 06:57:48 TOTAL CMF = 4.12E-007
Licensed to: VEPCO

NORTH ANNA PROBABILISTIC SAFETY ASSESSMENT
NAPS UNIT 1 ALL MODES N0A 3 YR AVG

T1: LOSS OF OFF-SITE POWER (LOOP)
(96FEB = 1EP)



SEQ #	SEQUENCE DESCRIPTOR	PDS #	FREQUENCY
P01	T1Q	TR	2.26E-007
P02	T1Q1BLD	TR	3.81E-009
P03	T1Q1BLD1SIR	OK	
P04	T1Q1BLD1SIRLERF	21	0.00E+000
P05	T1Q1BLD1SW	OK	
P06	T1Q1BLD1SWLERF	1	0.00E+000
P07	T1Q1BLD1SW1SIR	OK	
P08	T1Q1BLD1SW1SIRLERF	22	0.00E+000
P09	T1Q1BLD1QSRS	OK	
P10	T1Q1BLD1QSRSLERF	2	0.00E+000
P11	T1Q1BLD1QSRS1SIR	OK	
P12	T1Q1BLD1QSRS1SIRLERF	23	0.00E+000
P13	T1Q1RCMS	OK	
P14	T1Q1RCMS1BLD	OK	
P15	T1Q1RCMS1BLD1SW	OK	
P16	T1Q1RCMS1BLD1SWLERF	1	0.00E+000
P17	T1Q1RCMS1BLD1QSRS	OK	
P18	T1Q1RCMS1BLD1QSRSLERF	2	0.00E+000
P19	T1Q1RCMS1CHR	OK	
P20	T1Q1RCMS1CHRLERF	21	0.00E+000
P21	T1Q1RCMS1CHR1SW	OK	
P22	T1Q1RCMS1CHR1SWLERF	22	0.00E+000
P23	T1Q1RCMS1CHR1QSRS	OK	
P24	T1Q1RCMS1CHR1QSRSLERF	23	0.00E+000
P25	T1Q1CH	OK	
P26	T1Q1CH1BLD	OK	
P27	T1Q1CH1BLD1SW	OK	
P28	T1Q1CH1BLD1SWLERF	1	0.00E+000
P29	T1Q1CH1BLD1QSRS	OK	
P30	T1Q1CH1BLD1QSRSLERF	2	0.00E+000
P31	T1Q1CH1SI	OK	
P32	T1Q1CH1SILERF	20	0.00E+000
P33	T1Q1CH1SI1SIR	OK	
P34	T1Q1CH1SI1SIRLERF	21	0.00E+000
P35	T1Q1CH1SI1SW	OK	
P36	T1Q1CH1SI1SWLERF	22	0.00E+000
P37	T1Q1CH1SI1QSRS	OK	
P38	T1Q1CH1SI1QSRSLERF	23	0.00E+000
P39	T1Q1CH1MSFW	OK	
P40	T1Q1CH1MSFWLERF	20	0.00E+000
P41	T1Q1CH1MSFW1SIR	OK	
P42	T1Q1CH1MSFW1SIRLERF	21	0.00E+000
P43	T1Q1CH1MSFW1SW	OK	
P44	T1Q1CH1MSFW1SWLERF	22	0.00E+000
P45	T1Q1CH1MSFW1QSRS	OK	
P46	T1Q1CH1MSFW1QSRSLERF	23	0.00E+000
P47	T1Q1FW	OK	
P48	T1Q1FW1SIR	OK	
P49	T1Q1FW1SIRLERF	21	0.00E+000
P50	T1Q1FW1SW	OK	
P51	T1Q1FW1SWLERF	22	0.00E+000
P52	T1Q1FW1QSRS	OK	
P53	T1Q1FW1QSRSLERF	23	0.00E+000
P54	T1Q1FW1CH	OK	
P55	T1Q1FW1CH1SW	OK	
P56	T1Q1FW1CH1SWLERF	21	0.00E+000
P57	T1Q1FW1CH1QSRS	OK	
P58	T1Q1FW1CH1QSRSLERF	22	0.00E+000
P59	T1Q1FW1RC	OK	
P60	T1Q1FW1RCLERF	20	0.00E+000
P61	T1Q1FW1RC1SIR	OK	
P62	T1Q1FW1RC1SIRLERF	21	0.00E+000
P63	T1Q1FW1RC1SW	OK	
P64	T1Q1FW1RC1SWLERF	22	0.00E+000
P65	T1Q1FW1RC1QSRS	OK	
P66	T1Q1FW1RC1QSRSLERF	23	0.00E+000
P67	T1Q1HV	TR	0.00E+000
P68	T1Q2EE	TR	0.00E+000
P69	T1Q1EE	TR	0.00E+000

P:\Pra\PRA 2000 Update\Naps\Quantification\N0A\N0a_300\ETrees\T1Q.EVT 07/06/2001 09:0
Quantification Date: 11/18/2000 06:59:07 TOTAL CMF = 0.00E+000
Licensed to: VEPCO

NORTH ANNA PROBABILISTIC SAFETY ASSESSMENT
NAPS UNIT 1 ALL MODES N0A 3 YR AVG

T1Q: LOSS OF OFF-SITE POWER (LOOP)
PRESSURIZER PORV FAILS OPEN
(96FEB = 1EPRC)

ATTACHMENT 6

PORV Unavailability Since 1/1/98

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

Record of Unavailability From 1/1/98 to 7/23/01

component_ID *1-RC-PCV-1455C*

time_OOS	*time_RTS*	*event_description*	*Time OOS*
01/18/98 10:33	01/18/98 10:52	1-PT-44.9	0.32
01/30/98 9:40	01/30/98 9:42	1-PT-44.7	0.03
02/14/98 15:18	02/14/98 15:38	Closed for 1-PT-44.9	0.33
03/15/98 16:22	03/15/98 16:35	Closed for 1-PT-44.9	0.22
03/27/98 8:24	03/27/98 8:25	1-PT-44.7	0.02
04/11/98 15:55	04/11/98 16:15	Channel IV protection PT's	0.33
05/10/98 16:16	05/10/98 16:39	1-PT-44.9	0.38
06/06/98 10:45	06/06/98 10:58	For I&C PT	0.22
07/05/98 15:23	07/05/98 15:44	PCV inoperable during Channel IV protection PT's	0.35
08/01/98 15:40	08/01/98 15:55	Closed for channel functional test	0.25
08/14/98 14:05	08/14/98 14:07	Isolated for 1-PT-44.7	0.03
08/29/98 15:45	08/29/98 15:57	Closed for 1-PT-44.9 PORV Inst. Functional	0.20
09/11/98 15:44	09/11/98 15:46	Isolated for 1-PT-44.7	0.03
10/08/98 1:30	10/09/98 13:51	Leakby caused the mov to be isolated.	36.35
10/09/98 16:49	10/09/98 16:49	Leakby caused the mov to be isolated	0.00
10/31/98 15:55	10/31/98 16:07	Inoperable during 1-PT-44.9 while it is closed	0.20
10/31/98 16:22	10/31/98 16:23	Inoperable during 1-PT-44.9 while MOV 1536 is closed	0.02
11/29/98 14:28	11/29/98 14:44	Closed during 1-PT-44.9	0.27
12/26/98 14:55	12/26/98 15:11	Closed during 1-PT-44.9	0.27
01/05/99 3:33	01/05/99 3:40	Inoperable while RC-MOV-1535 is closed.	0.12
01/24/99 10:40	01/24/99 10:54	Closed during 1-PT-44.9	0.23
02/21/99 15:22	02/21/99 15:34	Closed for 1-PT-44.9	0.20
02/26/99 12:59	02/26/99 13:01	Closed 1-RC-MOV-1535 for 1-PT-44.7	0.03
04/23/99 10:24	04/23/99 10:26	Inoperable while testing 1-PT-44.7	0.03
05/10/99 15:28	05/10/99 15:44	Closed in support of 1-PT-44.9	0.27
06/18/99 14:27	06/18/99 14:32	1-PT-44.7 Cycling Block Valves	0.08
07/09/99 14:47	07/09/99 15:12	Closed during 1-PT-44.9	0.42
07/16/99 9:45	07/16/99 9:53	Closed during 1-PT-44.7	0.13

Record of Unavailability From 1/1/98 to 7/23/01

08/06/99 14:45	08/06/99 14:58	Closed for 1-PT-44.9	0.22
08/29/99 14:49	08/29/99 15:10	Closed per 1-PT-44.9	0.35
09/20/99 13:58	09/20/99 14:01	Closed while changing Light Bulb	0.05
09/27/99 13:37	09/27/99 13:57	Closed for 1-PT-44.9 (PORV functional test)	0.33
10/16/99 15:22	10/16/99 15:36	In manual and closed for 1-PT-44.9	0.23
11/05/99 10:09	11/05/99 10:13	Closed MOV-1535 for 1-PT-44.7 entered action 3.4.3.2	0.07
11/13/99 15:50	11/13/99 16:05	Closed during 1-PT-44.9	0.25
12/04/99 10:29	12/04/99 10:29	MOV failed to stroke for 1-PT-44.7, out for maintenance.	0.00
12/11/99 15:59	12/11/99 16:16	Closed for 1-PT-44.9	0.28
01/03/00 9:15	01/03/00 9:18	1-RC-MOV-1535 is closed for 1-PT-44.7	0.05
01/08/00 10:41	01/08/00 11:00	Closed for 1-PT-44.9	0.32
02/05/00 16:05	02/05/00 16:18	Closed for 1-PT-44.9	0.22
02/25/00 10:34	02/25/00 10:36	Closed 1-RC-MOV-1535 for 1-PT-44.7	0.03
03/04/00 14:44	03/04/00 14:57	Closed during 1-PT-44.9	0.22
03/12/00 14:07	03/12/00 14:14	Entered action for 1-PT-212.29	0.12
04/21/00 8:07	04/21/00 8:09	1-RC-MOV-1536 closed per 1-PT-44.7	0.03
04/30/00 14:49	04/30/00 15:02	PCV closed.	0.22
05/27/00 10:43	05/27/00 10:58	Performed PT-44.9	0.25
06/16/00 11:01	06/16/00 11:02	Performed PT-44.7	0.02
06/24/00 15:24	06/24/00 15:46	Performed PT-44.9	0.37
07/14/00 8:02	07/14/00 8:05	Performed PT-44.7	0.05
07/22/00 15:44	07/22/00 16:01	Performed PT-44.9	0.28
08/11/00 12:44	08/11/00 12:45	Performed PT-44.7	0.02
08/19/00 13:32	08/19/00 13:49	Performed PT-44.9	0.28
09/08/00 12:14	09/08/00 12:16	Performed PT-44.7	0.03
09/15/00 13:00	09/15/00 13:24	Performed PT-44.9	0.40
10/17/00 9:07	10/17/00 9:20	Performed PT-44.9	0.22
11/03/00 9:24	11/03/00 9:25	Performed PT-44.7	0.02
11/19/00 14:53	11/19/00 15:12	Performed PT-44.9	0.32
12/01/00 14:25	12/01/00 14:28	Performed PT-44.7	0.05
12/16/00 9:54	12/16/00 10:08	Performed PT-44.9	0.23
12/29/00 9:59	12/29/00 10:01	Performed PT-44.7	0.03
01/20/01 20:57	01/20/01 21:20	Performed PT-44.9	0.38

Record of Unavailability From 1/1/98 to 7/23/01

01/26/01 10:20	01/26/01 10:21	Performed PT-44.7	0.02
02/17/01 14:19	02/17/01 14:34	Performed PT-44.9	0.25
02/23/01 9:32	02/23/01 9:37	Performed PT-44.7	0.08
03/17/01 9:01	03/17/01 9:26	Performed PT-44.9	0.42
03/23/01 14:01	03/23/01 14:07	Performed PT-44.7	0.10
04/20/01 14:45	04/20/01 14:47	Performed PT-44.7	0.03
04/21/01 9:43	04/21/01 10:03	Performed PT-44.9	0.33
05/23/01 15:05	05/23/01 15:24	Performed PT-44.9	0.32
05/25/01 9:48	05/25/01 9:54	Performed PT-44.7	0.10
06/15/01 8:47	06/15/01 8:49	Performed PT-44.7	0.03
06/25/01 13:56	06/25/01 14:22	Performed PT-44.9	0.43
07/13/01 10:01	07/13/01 10:03	Performed PT-44.7	0.03

Total unavailability hours for last 12 months 49.42

Record of Unavailability From 1/1/98 to 7/23/01

component_ID *1-RC-PCV-1456*

time_OOS	time_RTS	event_description	Time OOS
01/18/98 10:53	01/18/98 11:04	1-PT-44.9	0.18
01/30/98 9:37	01/30/98 9:39	1-PT-44.7	0.03
02/14/98 15:39	02/14/98 15:52	Closed for 1-PT-44.9	0.22
03/15/98 16:36	03/15/98 16:43	Closed for 1-PT-44.9	0.12
03/27/98 8:21	03/27/98 8:23	1-PT-44.7	0.03
04/11/98 16:15	04/11/98 16:15	Channel IV protection PT's	0.00
05/10/98 16:40	05/10/98 16:47	1-PT-44.9	0.12
06/06/98 10:59	06/06/98 11:07	For I&C PT	0.13
07/05/98 15:45	07/05/98 15:55	PCV inoperable during Channel IV protection PT's	0.17
08/01/98 15:55	08/01/98 16:04	Closed for channel functional test	0.15
08/14/98 14:07	08/14/98 14:09	Isolated for 1-PT-44.7	0.03
08/29/98 15:58	08/29/98 16:07	Closed for 1-PT-44.9 PORV Inst. Functional	0.15
09/11/98 15:42	09/11/98 15:44	Isolated for 1-PT-44.7	0.03
10/07/98 16:42	10/07/98 23:21	Leakby caused the mov to be isolated.	6.65
10/13/98 15:19	10/31/98 15:50	Inoperable while MOV is closed due to leak by of the PCV	432.52
10/31/98 16:09	10/31/98 16:15	Inoperable during 1-PT-44.9 while it is closed	0.10
10/31/98 16:16	10/31/98 16:20	Inoperable during 1-PT-44.9 while MOV 1535 is closed	0.07
11/29/98 14:45	11/29/98 14:54	Closed during 1-PT-44.9	0.15
12/26/98 15:13	12/26/98 15:22	Closed during 1-PT-44.9	0.15
01/05/99 3:41	01/05/99 3:45	Inoperable while RC-MOV-1536 is closed.	0.07
01/24/99 10:55	01/24/99 11:04	Closed during 1-PT-44.9	0.15
02/21/99 15:35	02/21/99 15:42	Closed for 1-PT-44.9	0.12
02/26/99 13:04	02/26/99 13:05	Closed 1-RC-MOV-1536 for 1-PT-44.7	0.02
04/23/99 10:26	04/23/99 10:28	Inoperable while testing 1-PT-44.7	0.03
05/10/99 15:45	05/10/99 15:55	Closed in support of 1-PT-44.9	0.17
06/18/99 14:32	06/18/99 14:37	1-PT-44.7 Cycling Block Valves	0.08
07/09/99 15:13	07/09/99 15:21	Closed during 1-PT-44.9	0.13
07/16/99 9:53	07/16/99 10:02	Closed during 1-PT-44.7	0.15
08/06/99 14:59	08/06/99 15:06	Closed for 1-PT-44.9	0.12
08/29/99 15:13	08/29/99 15:24	Closed per 1-PT-44.9	0.18

Record of Unavailability From 1/1/98 to 7/23/01

09/27/99 13:58	09/27/99 14:07	Closed for 1-PT-44.9 (PORV functional test)	0.15
10/16/99 15:37	10/16/99 15:44	In manual and closed for 1-PT-44.9	0.12
11/05/99 10:14	11/05/99 10:20	Closed MOV-1536 for 1-PT-44.7 entered action 3.4.3.2	0.10
11/13/99 16:05	11/13/99 16:20	Closed during 1-PT-44.9	0.25
12/04/99 10:25	12/04/99 10:28	MOV closed for 1-PT-44.7	0.05
12/11/99 16:17	12/11/99 16:26	Closed for 1-PT-44.9	0.15
01/03/00 9:18	01/03/00 9:22	1-RC-MOV-1536 is closed for 1-PT-44.7	0.07
01/08/00 11:00	01/08/00 11:10	Closed for 1-PT-44.9	0.17
02/05/00 16:19	02/05/00 16:27	Closed for 1-PT-44.9	0.13
02/25/00 10:38	02/25/00 10:40	Closed 1-RC-MOV-1536 for 1-PT-44.7	0.03
03/04/00 14:58	03/04/00 15:06	Closed during 1-PT-44.9	0.13
03/12/00 14:16	03/12/00 14:19	Entered action for 1-PT-212.29	0.05
04/21/00 8:12	04/21/00 8:14	1-RC-MOV-1535 closed per 1-PT-44.7	0.03
04/30/00 15:03	04/30/00 15:10	PCV closed to perform 1-P44.9	0.12
05/27/00 10:59	05/27/00 11:06	Performed PT-44.9	0.12
06/16/00 10:58	06/16/00 10:59	Performed PT-44.7	0.02
06/24/00 15:46	06/24/00 16:02	Performed PT-44.9	0.27
07/14/00 8:05	07/14/00 8:09	Performed PT-44.7	0.07
07/22/00 16:01	07/22/00 16:10	Performed PT-44.9	0.15
08/11/00 12:15	08/11/00 12:17	Performed PT-44.7	0.03
08/11/00 12:40	08/11/00 12:42	Performed PT-44.7	0.03
08/19/00 13:50	08/19/00 14:02	Performed PT-44.9	0.20
09/08/00 12:11	09/08/00 12:13	Performed PT-44.7	0.03
09/15/00 13:25	09/15/00 13:36	Performed PT-44.9	0.18
10/17/00 9:21	10/17/00 9:28	Performed PT-44.9	0.12
11/03/00 9:22	11/03/00 9:23	Performed PT-44.7	0.02
11/19/00 15:13	11/19/00 15:20	Performed PT-44.9	0.12
12/01/00 14:20	12/01/00 14:25	Performed PT-44.7	0.08
12/16/00 10:10	12/16/00 10:18	Performed PT-44.9	0.13
12/29/00 9:53	12/29/00 9:57	Performed PT-44.7	0.07
01/20/01 21:21	01/20/01 21:29	Performed PT-44.9	0.13
01/26/01 10:15	01/26/01 10:17	Performed PT-44.7	0.03
02/17/01 14:35	02/17/01 14:45	Performed PT-44.9	0.17

Record of Unavailability From 1/1/98 to 7/23/01

02/23/01 9:25	02/23/01 9:28	Performed PT-44.7	0.05
03/17/01 9:27	03/17/01 9:38	Performed PT-44.9	0.18
03/23/01 13:57	03/23/01 13:59	Performed PT-44.7	0.03
04/20/01 14:41	04/20/01 14:43	Performed PT-44.7	0.03
04/21/01 10:04	04/21/01 10:15	Performed PT-44.9	0.18
05/23/01 15:26	05/23/01 15:36	Performed PT-44.9	0.17
05/25/01 9:54	05/25/01 10:00	Performed PT-44.7	0.10
06/15/01 8:43	06/15/01 8:46	Performed PT-44.7	0.05
06/25/01 14:23	06/25/01 14:36	Performed PT-44.9	0.22
07/13/01 10:04	07/13/01 10:06	Performed PT-44.7	0.03

Total unavailability hours for last 12 months 446.78

Record of Unavailability From 1/1/98 to 7/23/01

component_ID *2-RC-PCV-2455C*

time_OOS	*time_RTS*	*event_description*	*Time OOS*
01/04/98 14:43	01/04/98 15:07	2-PT-44.6	0.40
01/30/98 9:24	01/30/98 9:25	2-PT-44.7	0.02
02/01/98 9:40	02/01/98 10:14	2-PT-44.6	0.57
03/01/98 8:40	03/01/98 8:55	Closed for 2-PT-44.6	0.25
03/27/98 13:50	03/27/98 13:54	2-PT-44.7	0.07
03/28/98 10:59	03/28/98 11:21	CHANNEL IV Protection PST	0.37
05/24/98 10:40	05/24/98 10:56	2-PT-44.6	0.27
06/20/98 16:06	06/20/98 16:25	PORV functional test	0.32
07/18/98 15:09	07/18/98 15:28	Closed for 2-PT-44.9 entered TS 3.4.3.2	0.32
08/14/98 12:02	08/14/98 12:04	Isolated for 2-PT-44.7	0.03
08/15/98 14:47	08/15/98 14:49	Shut during 2-PT-44.9	0.03
09/11/98 16:07	09/11/98 16:09	Closed during 2-PT-44.7	0.03
09/12/98 15:07	09/12/98 15:24	Closed position for 2-PT-44.9	0.28
10/09/98 15:02	10/09/98 15:05	Entered action while performing 2-PT-44.7	0.05
10/18/98 10:18	10/18/98 10:31	Closed for 2-PT-44.9	0.22
11/06/98 9:53	11/06/98 9:53	Inoperable while MOV-2536 is closed	0.00
11/14/98 15:54	11/14/98 16:08	Shut during 2-PT-44.9	0.23
12/12/98 15:30	12/12/98 15:47	2-PT-44.9 Instrumentation functional test.	0.28
01/06/99 20:40	01/06/99 20:43	Inoperable while RC-MOV-2535 is closed.	0.05
01/09/99 15:56	01/09/99 16:13	Closed during the Protection PT	0.28
02/06/99 15:55	02/06/99 16:10	Closed for 2-PT-44.7	0.25
02/26/99 11:57	02/26/99 12:01	Inoperable while 2-RC-MOV-2535 Closed	0.07
03/07/99 16:07	03/07/99 16:26	2-PT-44.9	0.32
04/23/99 10:00	04/23/99 10:03	Inoperable while testing 2-PT-44.7	0.05
04/24/99 16:11	04/24/99 16:26	2-PT-44.9 closed PCV 1hr action	0.25
05/14/99 3:38	09/12/99 15:11	Seat Leakage, inoperable automatic control, Mov closed.	2,915.55
10/02/99 9:34	10/02/99 12:34	Entered action because indicated midposition when valve was closed	3.00
10/31/99 9:45	10/31/99 9:59	Inoperable while performing 2-PT-44.9	0.23
11/05/99 9:45	11/05/99 9:49	Closed MOV-2535 for 2-PT-44.7 entered action 3.4.3.2	0.07
11/27/99 14:52	11/27/99 15:07	Inoperable to perform 2-PT-44.9	0.25

Record of Unavailability From 1/1/98 to 7/23/01

12/02/99 22:23	12/02/99 22:33	10 minutes while pulling driver card for 2-RC-PCV-2455B	0.17
12/03/99 13:31	12/03/99 13:41	10 minutes while pulling driver card for 2-RC-PCV-2455B	0.17
12/07/99 8:05	12/07/99 8:06	Stroked MOV for 2-PT-44.7	0.02
12/23/99 14:30	12/23/99 14:43	Inoperable during 2-PT-44.9	0.22
01/03/00 10:12	01/03/00 10:13	2-RC-MOV-2535 is closed for 2-PT-44.7	0.02
01/25/00 15:42	01/25/00 15:58	Inoperable to perform 2-PT-44.9	0.27
02/19/00 15:35	02/19/00 15:52	Declared inoperable for 2-PT-44.9	0.28
02/25/00 11:17	02/25/00 11:19	Entered 1Hour action while MOV-2535 was closed for 2-PT-44.7	0.03
03/18/00 15:08	03/18/00 15:27	Closed for Functional Test	0.32
03/24/00 14:18	03/24/00 14:19	Closed for 2-PT-44.7 PORV test	0.02
03/24/00 14:18	03/24/00 14:19	Entered action for 2-Pt-44.7	0.02
04/16/00 15:34	04/16/00 15:51	Performed 2-PT-44.9	0.28
04/21/00 11:17	04/21/00 11:19	2-RC-MOV-2536 closed per 2-PT-44.7	0.03
05/13/00 15:36	05/13/00 15:55	PORV closed for PT-44.9	0.32
05/25/00 10:39	05/25/00 10:41	Performed PT-44.7	0.03
06/10/00 11:18	06/10/00 11:32	Performed PT-44.9	0.23
07/08/00 11:39	07/08/00 11:55	Performed PT-44.9	0.27
08/06/00 13:56	08/06/00 14:13	Performed PT-44.9	0.28
08/11/00 12:18	08/11/00 12:19	Performed PT-44.7	0.02
09/02/00 14:18	09/02/00 14:30	Performed PT-44.9	0.20
09/08/00 9:44	09/08/00 9:45	Performed PT-44.7	0.02
10/01/00 8:44	10/01/00 9:03	Performed PT-44.9	0.32
10/06/00 9:02	10/06/00 9:14	Performed PT-44,7	0.20
11/03/00 11:33	11/03/00 11:35	Performed PT-44.7	0.03
11/05/00 12:59	11/05/00 13:17	Performed PT-44.9	0.30
12/02/00 15:04	12/02/00 15:18	Performed PT-44.9	0.23
12/29/00 8:38	12/29/00 8:40	Performed PT-44.7	0.03
01/06/01 15:07	01/06/01 15:22	Performed PT-44.9	0.25
01/26/01 8:58	01/26/01 9:02	Performed PT-44.7	0.07
02/05/01 1:19	02/05/01 1:38	Performed PT-44.9	0.32
02/23/01 9:50	02/23/01 9:54	Performed PT-44.7	0.07
04/20/01 15:05	04/20/01 15:09	Performed PT-44.7	0.07
05/05/01 14:55	05/05/01 15:10	Performed PT-44.9	0.25

Record of Unavailability From 1/1/98 to 7/23/01

05/18/01 11:30	05/18/01 11:37	Performed PT-44.7	0.12
06/09/01 14:37	06/09/01 14:58	Performed PT-44.9	0.35
06/15/01 9:05	06/15/01 9:08	Performed PT-44.7	0.05
07/07/01 15:05	07/07/01 15:23	Performed PT44.9	0.30
07/13/01 15:50	07/13/01 15:51	Performed PT-44.7	0.02

Total unavailability hours for last 12 months 2,930.27

Record of Unavailability From 1/1/98 to 7/23/01

component_ID *2-RC-PCV-2456*

time_OOS	*time_RTS*	*event_description*	*Time OOS*
01/04/98 15:07	01/04/98 15:19	2-PT-44.6	0.20
01/30/98 9:22	01/30/98 9:23	2-PT-44.7	0.02
02/01/98 10:14	02/01/98 10:30	2-PT-44.6	0.27
03/01/98 8:59	03/01/98 9:08	Closed for 2-PT-44.6	0.15
03/27/98 13:50	03/27/98 13:54	2-PT-44.7	0.07
03/28/98 11:24	03/28/98 11:34	CHANNEL IV Protection PTs	0.17
05/24/98 10:57	05/24/98 11:06	2-PT-44.6	0.15
06/20/98 16:26	06/20/98 16:35	PORV functional test	0.15
07/18/98 15:29	07/18/98 15:40	Closed for 2-PT-44.9 entered TS 3.4.3.2	0.18
08/14/98 12:00	08/14/98 12:02	Isolated for 2-PT-44.7	0.03
08/15/98 15:00	08/15/98 15:08	Shut during 2-PT-44.9	0.13
09/11/98 16:09	09/11/98 16:11	Closed during 2-PT-44.7	0.03
09/12/98 15:26	09/12/98 15:35	Closed position for 2-PT-44.9	0.15
10/09/98 15:01	10/09/98 15:02	Entered action while performing 2-PT-44.7	0.02
10/18/98 10:35	10/18/98 10:42	Closed for 2-PT-44.	0.12
11/06/98 9:53	11/06/98 9:53	Inoperable while MOV-2535 is closed	0.00
11/14/98 16:10	11/14/98 16:18	Shut during 2-PT-44.9	0.13
12/12/98 15:49	12/12/98 15:59	2-PT-44.9 Instrumentation functional test.	0.17
01/06/99 20:45	01/06/99 20:48	Inoperable while RC-MOV-2536 is closed	0.05
01/09/99 16:14	01/09/99 16:23	Closed during the Protection PT	0.15
02/06/99 16:12	02/06/99 16:20	Closed for 2-PT-44.7	0.13
02/26/99 12:02	02/26/99 12:04	Inoperable while 2-MOV-2536 is closed	0.03
03/07/99 16:29	03/07/99 16:38	2-PT-44.9	0.15
04/23/99 10:06	04/23/99 10:08	Inoperable while testing 1-PT-44.7	0.03
04/24/99 16:27	04/24/99 16:39	2-PT-44.9 closed PCV 1hr action	0.20
06/18/99 14:26	06/18/99 14:31	2-PT-44.7 Cycling Block Valves	0.08
06/19/99 16:00	06/19/99 16:07	Closed for 2-PT-44.9	0.12
07/17/99 16:09	07/17/99 16:19	Closed for (2-PT-44.9) PORV functional testing	0.17
08/15/99 8:27	08/15/99 8:36	Entered action for PCV-2456 during 2-PT-44.9	0.15
10/31/99 9:59	10/31/99 10:07	Inoperable while performing 2-PT-44.9	0.13

Record of Unavailability From 1/1/98 to 7/23/01

11/05/99 9:50	11/05/99 9:52	Closed MOV-2536 for 2-PT-44.7 entered action 3.4.3.2	0.03
11/27/99 15:07	11/27/99 15:17	Inoperable to perform 2-PT-44.9	0.17
12/07/99 7:59	12/07/99 8:01	Stroked MOV for 2-PT-44.7	0.03
12/23/99 14:43	12/23/99 14:49	Inoperable during 2-PT-44.9	0.10
01/03/00 10:14	01/03/00 10:15	2-RC-MOV-2536 is closed for 2-PT-44.7	0.02
01/25/00 15:58	01/25/00 16:06	Inoperable to perform 2-PT-44.9	0.13
02/19/00 15:53	02/19/00 16:02	Declared inoperable for 2-PT-44.9	0.15
02/25/00 11:21	02/25/00 11:23	Entered 1Hour action while MOV-2536 was closed for 2-PT-44.7	0.03
03/18/00 15:28	03/18/00 15:37	Closed for Functional Test	0.15
03/24/00 14:22	03/24/00 14:23	Entered action for 2-Pt-44.7	0.02
04/16/00 15:53	04/16/00 16:03	Performed 2-PT-44.9	0.17
04/21/00 11:11	04/21/00 11:13	2-RC-MOV-2535 closed per 2-PT-44.7	0.03
05/13/00 15:56	05/13/00 16:05	PORV closed for PT-44.9	0.15
05/25/00 10:34	05/25/00 10:37	Performed PT-44.7	0.05
06/10/00 11:34	06/10/00 11:42	Performed PT-44.9	0.13
07/08/00 11:55	07/08/00 12:11	Performed PT-44.9	0.27
08/06/00 14:15	08/06/00 14:23	Performed PT-44.9	0.13
09/02/00 14:31	09/02/00 14:38	Performed PT-44.9	0.12
09/08/00 9:40	09/08/00 9:41	Performed PT-44.7	0.02
10/01/00 9:05	10/01/00 9:15	Performed PT-44.9	0.17
10/06/00 8:50	10/06/00 9:02	Performed PT-44.7	0.20
11/03/00 11:31	11/03/00 11:32	Performed PT-44.7	0.02
11/05/00 13:21	11/05/00 13:31	Performed PT-44.9	0.17
12/02/00 15:19	12/02/00 15:28	Performed PT-44.9	0.15
12/29/00 8:30	12/29/00 8:32	Performed PT-44.7	0.03
01/06/01 15:23	01/06/01 15:33	Performed PT-44.9	0.17
01/26/01 8:58	01/26/01 8:59	Performed PT-44.7	0.02
02/05/01 1:41	02/05/01 1:49	Performed PT-4.9	0.13
02/23/01 9:50	02/23/01 9:51	Performed PT-44.7	0.02
04/20/01 15:09	04/20/01 15:12	Performed PT-44.7	0.05
05/05/01 15:11	05/05/01 15:20	Performed PT-44.9	0.15
05/18/01 11:37	05/18/01 11:43	Performed PT-44.7	0.10
06/09/01 14:58	06/09/01 15:09	Performed PT-44.9	0.18

Record of Unavailability From 1/1/98 to 7/23/01

06/15/01 9:02	06/15/01 9:04	Performed PT-44.7	0.03
07/07/01 15:23	07/07/01 15:32	Performed PT-44.9	0.15
07/13/01 15:45	07/13/01 15:47	Performed PT-44.7	0.03

Total unavailability hours for last 12 months 7.20