ENCLOSURE 1 TO

PNPS Letter 2.14.027

Entergy Nuclear Engineering Report No. PNPS-RPT-11-00001, "Re-assessment of Pilgrim Seismic Core Damage Frequency"

June 2011

ENTERGY NUCLEAR
Engineering White Paper
Engineering Report No

PNPS-RPT-11-00001

Rev. 0

Re-Assessment of Pilgrim Seismic Core Damage Frequency

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Engineering White Paper

Re-Assessment of
Pilgrim Seismic Core Damage Frequency

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1.0 EXECUTIVE SUMMARY

Recent NRC Safety/Risk Assessment of US Nuclear Plant Seismic Core Damage Frequencies based on the 2008 US Geological Survey (USGS) Seismic Hazard Curves used Pilgrim's Individual Plant Examination of External Events (IPEEE) [9.1] information to perform risk assessments in support of reaching a resolution to GI-199. The report identified Pilgrim Nuclear Power Station (PNPS) as the plant with the second-largest calculated Seismic Core Damage Frequency (SCDF). Since the Pilgrim IPEEE work included conservatisms, Entergy assembled a Seismic Review Team tasked with developing an SCDF estimate that more closely reflects the robustness of the Pilgrim Plant.

Although the NRC-estimated SCDF was below the target goal of 1.0E-04 per year, and thus acceptable in terms of the plant seismic risk, the review team re-assessed key PNPS components and demonstrated a larger plant-level seismic capacity than that used in the NRC assessment. The NRC used values for plant capacity extracted from the PNPS IPEEE report submitted in 1994. This resulted in the NRC determining a conservative SCDF estimate of 6.9E-05 per year, or 1 in 14,493 reactor-years. Using the improved plant level capacities developed by the team a re-assessment of the SCDF estimate was performed. This resulted in a SCDF of 3.98E-05 per year, or 1 in 25,126 reactor-years, using the same USGS Hazard Curves relied upon by NRC for the seismic risk assessment.

Using the improved plant level capacity developed by the review team and the EPRI updated 2010 Seismic Hazard Curves [9.12], the SCDF estimate is further reduced to 1.46E-05 per year (or 1 in 68,493 reactor-years).

2.0 PURPOSE

The purpose of this Engineering Report is to provide an assessment relative to the seismic robustness of PNPS. A Seismic Review Team was therefore formed with an established main goal to re-assess the Seismic Core Damage Frequency (SCDF) for PNPS and demonstrate whether the actual PNPS SCDF value is in fact lower than the NRC reported estimate of 6.9E-05 per year. (SCDF, if not explicitly shown, is expressed in occurrences per year throughout this document).

3.0 BACKGROUND

During NRC's review of the Early Site Permit (ESP) applications for new nuclear plants, it appeared that the seismic hazard for operating plants in the Central and Eastern United States (CEUS) region may have increased for some sites. Based on the evaluations of the Individual Plant Examination of External Events (IPEEE) Program, the NRC had determined that seismic designs of operating plants in the CEUS provided an adequate level of protection. However, in light of the preliminary results from the review of ESP applications, the NRC also recognized that the probability of exceeding the Safe Shutdown Earthquake (SSE) at some of the currently operating sites in the CEUS may be higher than previously thought. Therefore, the NRC initiated Generic Issue GI-199 to assess the impact of increased estimates of seismic hazards on selected current nuclear power plants in the CEUS region that might be impacted by the updated seismic research, information, and models.

On 09/02/10, the NRC issued Safety/Risk Assessment (SRA) results for Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants" [9.3]. The SRA consists of three separate evaluations performed using, respectively, the 1989 Electric Power Research Institute (EPRI), 1994 Lawrence Livermore National Laboratory (LLNL), and the updated 2008 U.S. Geological Survey (USGS) seismic hazard curves to calculate the SCDF for all U.S. nuclear plants. The results of the GI-199 assessment raised the possibility that the probability of exceeding the design basis ground motion may have increased at some sites, but only by a relatively small amount. The NRC concluded that "no concern exists regarding adequate protection and that the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis." However, since the changes in seismic core-damage frequency estimated in the Safety/Risk Assessment Stage of GI-199 for numerous plants lie in the range of 1.0E-04 per year to 1.0E-05 per year, NRC decided that the issue will proceed to the Regulatory Assessment Stage of the Generic Issues Program. It should be noted that the NRC-DOE-EPRI team is developing a new CEUS seismic source model, and the Senior Seismic Hazard Analysis Committee (SSHAC) Next Generation Attenuation (NGA) East project is developing a revised ground motion model.

The objective of the GI-199 Safety/Risk Assessment (SRA) was to perform a conservative, screening-level assessment to evaluate if further investigations of seismic safety for operating reactors in the CEUS are warranted consistent with NRC directives.

The results of the GI-199 SRA should not be interpreted as definitive estimates of plant-specific seismic risk. The nature of the information used (both seismic hazard data and plant-level fragility information) make these estimates useful only as a screening tool. The NRC does not rank plants by seismic risk.

NRC evaluation results showed PNPS as having the second-largest SCDF value of the U.S. nuclear plants (SCDF estimate of 6.9E-05 per year) using the 2008 updated USGS Seismic Hazard Curves [9.7] for the PNPS site. Note that this is still within the range considered acceptable in the NRC's process for evaluating emergent issues.

The NRC used information from the PNPS IPEEE [9.1] submittal to derive the plant-level fragility used to calculate the SCDF. Conservatism in the information could have resulted in an overly conservative (high) SCDF estimate.

As a result of the Tohoku-Taiheiyou-Oki Earthquake in Japan and its effect on the Fukushima Daiichi Nuclear Station, increased attention has been directed to nuclear plants [9.4, 9.6] and in particular PNPS's ability to withstand an earthquake without suffering core damage.

4.0 DEFINITIONS & ACRONYMS

4.1 Definitions

- Composite Uncertainty (β_c) - The composite logarithmic standard deviation of the capacity about the best-estimate, or median value. It represents the variation due to both inherent randomness (β_r) and uncertainty (β_u).
- Fragility – The conditional probability of failure as a function of a ground motion parameter (for example, peak ground acceleration).
- High Confidence of a Low Probability of Failure (HCLPF) – The ground motion parameter (for example, peak ground acceleration) at which there is at least 95% confidence of less than 5% probability of failure (for example, core damage).
- Median Capacity (A_m or C_{50}) – The ground motion parameter (for example, peak ground acceleration) for which there is a 50% probability of failure (for example, core damage).

- Plant-Level Fragility – The probability of core damage as a function of the site earthquake-induced vibratory ground motion.
- Seismic Core Damage Frequency (SCDF) - The expected frequency of core damage caused by earthquake ground motion (expressed as occurrences per reactor-year) for a nuclear power plant at a specific location.
- Seismic Hazard Curve – The annual frequency at which the site earthquake-induced vibratory ground motion exceeds a given value of a ground motion parameter (for example, peak ground acceleration)
- Seismic Hazard Map - A seismic hazard map displays an earthquake ground motion parameter (for example, peak ground acceleration) for a specific probability of occurrence at many locations (for example, across the United States). Seismic hazard maps are derived from seismic hazard curves calculated for a grid of sites across the United States.
- Surrogate Element – Element used to represent all of the components with relatively high seismic capacity.
- Uniform Hazard Spectrum (UHS) - A plot of the maximum acceleration of a single-frequency system over a range of frequencies for a ground motion with a specific probability of occurrence.

4.2 Acronyms

- ATWS – Anticipated Transient Without Scram
- BE – Basic Event
- CAV - Cumulative Absolute Velocity
- CDF – Core Damage Frequency
- CDFM – Conservative Deterministic Failure Margin
- CEUS - Central and Eastern United States
- CRD – Control Rod Drive
- EDG – Emergency Diesel Generator
- EPRI - Electric Power Research Institute
- ESP - Early Site Permit

- GERS – Generic Equipment Ruggedness Spectra
- GI - Generic Issue
- GIP – Generic Implementation Procedure
- GMI – Ground Motion Incoherence
- GMRS - Ground Motion Response Spectrum
- GSI – Generic Safety Issue
- HCLPF - High Confidence of a Low Probability of Failure
- HPCI – High Pressure Coolant Injection
- IPEEE - Individual Plant Examination of External Events
- ISRS – In-Structure Response Spectra
- LLNL - Lawrence Livermore National Laboratory
- LOCA – Loss of Coolant Accident
- LOOP or LOSP – Loss of Off-Site Power
- LPCI - Low Pressure Coolant Injection
- NGA - Next Generation Attenuation
- NRC – US Nuclear Regulatory Commission
- PGA - Peak Ground Acceleration
- PNPS – Pilgrim Nuclear Power Station
- PRA - Probabilistic Risk Assessment
- PSD – Power Spectral Density
- RBCCW – Reactor Building Closed Cooling Water
- RCIC – Reactor Core Isolation Cooling
- RCP – Reactor Coolant Pump
- RHR – Residual Heat Removal
- RPV - Reactor Pressure Vessel
- SBO – Station Blackout

- SCDF – Seismic Core Damage Frequency
- SEWS – Screening Evaluation Worksheet
- SHIP – Seismic Hazard Integration Package
- SMA - Seismic Margins Assessment
- SPRA - Seismic Probabilistic Risk Assessment
- SRA - Safety/Risk Assessment
- SSE - Safe Shutdown Earthquake
- SSHAC – Senior Seismic Hazard Analysis Committee
- UHS – Uniform Hazard Spectra
- USI - Unresolved Safety Issue
- USGS - U.S. Geological Survey
- ZPA – Zero Period Acceleration

5.0 GENERAL DISCUSSION

5.1 Assessment Approach

The team effort consisted of completing the following:

- Understanding the current seismic risk to the station, in terms of SCDF.
- Identifying potential conservatisms within the PNPS IPEEE submittal information used by the NRC in the SCDF calculation.
- Exploring and, where appropriate, removing conservatisms in the IPEEE component fragility values. The plant-level fragility value is expected to increase.
- Exploring, and where appropriate, reducing conservatism in the USGS Seismic Hazard Curves. For example, the USGS seismic hazard calculations did not include Cumulative Absolute Velocity (CAV) filtering and ground motion incoherence, which tend to reduce the acceleration values.

- Using the original seismic PRA computer model Seismic Hazard Integration Package (SHIP) to estimate a more realistic SCDF using revised fragilities, revised risk significant random failure probabilities, revised operator action failure probability to align suppression pool cooling and removal of Reactor Building quad coolers requirements (for RHR A/B quadrant, CRD quadrant, and HPCI room) in the SPRA model. It should be noted that the 2002 GOTHIC calculation [9.5] showed that the function of RHR pumps A/B/C/D, CRD pumps and HPCI were not impacted by the loss of their respective area coolers during the mission time. Table 5.1 below provides a summary of these changes – (See Attachment 10.7).
- Fully understanding the methodology used by NRC in developing the SCDF estimates reported in [9.3], and subsequently, developing a method that emulates the NRC's approach and duplicates the NRC results, as described in Attachment 10.2. This methodology was used to obtain revised SCDF estimates based on the peak ground acceleration (PGA) and the 10 Hz, 5 Hz, and 1 Hz hazard curves. The revised SCDF reflected changes in seismic fragilities, random failure probabilities, operation action failure probabilities, or system modeling changes as described in the previous bullet above.
- Developing recommendations for short-term and long-term actions to improve the seismic risk estimates to more accurately reflect the robustness of the plant.

Table 5.1

Summary of Pilgrim SPRA Basic Events Changes

Basic Event Name	Description	Probability [3]	
		Old [1]	New
EPTHPCIXXR	HPCI Pump Fail to Run	1.96E-02	3.93E-03 [2]
IPTRCICXXS	RCIC Pump Fail to Start	3.33E-02	3.33E-03 [2]
HSYHPCIMNU	HPCI unavailable due to maintenance	2.54E-02	1.21E-02 [2]
ILPRCICMNU	RCIC unavailable due to maintenance	3.55E-02	8.74E-03 [2]
EPTRCICXXR	RCIC Pump Fail to Run	1.96E-02	9.78E-03 [2]
HVMMO3XXXN	HPCI steam admission valve fails to open	1.30E-02	1.03E-03 [2]
SPMALLXCCS	Common cause failure of all SSW pumps to start	7.00E-04	1.63E-05 [2]
HPTHPCIXXS	HPCI pump fail to start	6.11E-03	3.33E-03 [2]
HPTHPRCCCR	Common cause failure of HPCI & RCIC pumps to run	3.56E-04	2.31E-07 [2]
HPMAUXOILS	HPCI aux oil pump fail to start	3.00E-03	3.33E-03 [2]
HPTHPRCCCS	Common cause failure of HPCI & RCIC pumps to start	3.90E-04	3.46E-05 [2]
ADLGEBXXXU	B DG out for corrective maintenance	1.18E-02	1.09E-02 [2]
EFN201ABXZ	HPCI ROOM COOLING FANs VAC201A/B FAILURE	1.23g	2.00g [4]
EFN202ABXZ	VAC202A&B FAIL RBCCW PRESSURE BOUNDARY	1.23g	2.00g [4]
EFN203ABXZ	CRD QUAD ROOM COOLING FANS VAC 203A/B FAILURE	1.23g	2.00g [4]
EFN204ABXZ	QUAD ROOM COOLER FANs 204A/B FAILURE	0.61g	2.00g [4]
EFN204CDXZ	QUAD ROOM COOLER FANs 204C/D FAILURE	0.61g	2.00g [4]
EFN207A-DZ	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY	1.01g	2.00g [4]
EFNDWCOOLZ	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS	1.06g	2.00g [4]
ERE159X9!Z	SEISMICALLY CORR RELAY CHATTER OF 159-509 & 609	0.55g	2.22g [5]
ERE132X9!Z	SEISMICALLY CORR RELAY CHATTER OF 132-509 & 609	0.55g	1.50g [5]
EBW209/0XZ	BLOCK WALL 209.0 FAILS	0.82g	2.00g [5]
EBDDGBLDXZ	DIESEL GENERATOR BUILDING FAILS	0.77g	1.04g [5]
EBW45/3XXZ	BLOCK WALL 45.3 FAILS	1.07g	2.00g [5]
EBSB2XXXXZ	SEISMICALLY INDUCED FAILURE OF BUS B2	0.84g	1.13g [5]
EPM184AXXZ	BODG FUEL OIL PUMP P184 FAILURE	1.05g	1.42g [5]
ECMK103ABZ	DIESEL STARTING AIR COMPRESSORS	1.28g	1.73g [5]
EPM141ABXZ	DIESEL FUEL OIL PUMPS P-141A/B FAILURE	1.28g	1.73g [5]
EVPEABXXXZ	DG A&B FUEL OIL PRESSURE REG VALVE E FAILURE	1.28g	1.73g [5]
EVRCABXXXZ	DG A&B FUEL OIL RELIEF VALVE C FAIL	1.28g	1.73g [5]
EVS4565CDZ	DIESEL AIR PSV4565C AND D SEISMIC COR FAILURE	1.28g	1.73g [5]
ETKT105ABZ	CSTs T105A/B FAILURE	0.94g	1.27g [5]
EBW195/23Z	BLOCKWALL 195.23 FAILS	1.00g	2.00g [5]

ETK105ABNZ	CST 105 A/B FAILS DUE TO N2 TANK INTERACTION	0.16g	5.00g [5]
ESPCOOLXXY	OPERATOR FAILS TO INITIATE SPC WHEN REQUIRED	5.0E-01	5.0E-02 [6]

Notes to Table 5.1:

(1) Probability based on original SHIP input file PILRUN1.CMP.

(2) Revised data reflects updated Basic Event (BE) data from PNPS_07_maint.rr dated 12/16/2009. [9.18]

(3) Entries expressed in terms of "g" denote median capacity used to calculate CDF.

(4) GOTHIC calculation (Reference 9.5) showed that the function of RHR pumps A/B/C/D, CRD pumps and HPCI were not impacted by the loss of RHR Loop A/B quad coolers during the mission time. Hence, a value of 2.0g is assumed for median seismic capacity.

(5) Based on revised seismic fragility calculation from Attachment 10.4.

(6) Human error probability reflects more realistic value for higher accelerations.

5.2 NRC Review Results

The results of the NRC analysis described in Section 6.1, for PNPS are summarized below Table 5.2:

Table 5.2
NRC Results for SCDF

PLANT	SEISMIC CORE DAMAGE FREQUENCY WEAKEST LINK			INCREASE	INCREASE
	2008 USGS	1989 EPRI	1994 LLNL	USGS-EPRI	USGS-LLNL
PNPS	6.9E-05 1 in 14,500 yrs	8.0E-06 1 in 125,000 yrs	1.1E-04 1 in 9,091 yrs	6.1E-05	-4.1E-05

The NRC acknowledges [9.3] that "The results of the GI-199 safety risk assessment should not be interpreted as definitive estimates of plant-specific seismic risk because some analyses were very conservative making the calculated risk higher than in reality".

The 1989 EPRI and 1994 LLNL results for PNPS are quite different. The difference in SCDF is positive for USGS-EPRI and negative for USGS-LLNL.

As a result of the GI-199 SRA, the NRC compiled a list of 27 plants requiring further review. PNPS is not among those selected plants, due to the negative USGS-LLNL change in SCDF. The criteria used for selection by NRC are described in Attachment 10.1.

6.0 EVALUATIONS

6.1 NRC Methodology in Determining SCDF

The SCDF is calculated as:

$$SCDF = \int_0^\infty P(a) * \left[-\frac{dH(a)}{da}\right] da$$

where P(a) is the plant-level fragility function and H(a) is the seismic hazard curve. The equation is evaluated numerically.

The fragility function used by the NRC was characterized by a median capacity, A_m, and a composite uncertainty, β_C. The NRC derived these parameters from the IPEEE submittals for each plant. The submittal information varied from plant to plant; therefore, the NRC used different methods for different plants. The different methods are defined in Table C-1 of Appendix C of [9.3]. The method used for each plant is listed in Table C-2 of Appendix C of [9.3].

The method used for PNPS was supposed to take the median capacity, C_{50}, and HCLPF from the IPEEE submittal and calculate β_C as $\beta_C = \ln(C_{50}/HCLPF)/2.33$.

- The NRC lists 0.49g for median capacity, C_{50}, in Table C-2. The number given in Table 3-13 of the PNPS IPEEE submittal [9.1] is 0.48g.
- The NRC lists 0.27 for composite uncertainty, β_C in Table C-2. The PNPS HCLPF is listed as 0.25g in Table 3-13. Using C_{50} = 0.48g and HCLPF = 0.25g gives β_C = 0.28. Using C_{50} = 0.49g and HCLPF = 0.25g gives β_C = 0.29. Neither of these is the same as 0.27. Use of C_{50} = 0.49g and β_C = 0.27 give HCLPF = 0.26g.

It is surmised that the NRC adjusted the fragility parameters to get agreement with PNPS IPEEE reported SCDF when using the 1989 EPRI PGA Seismic Hazard Curve. See Attachment 10.2 for more discussion.

For seismic hazard input the NRC used three sets of seismic hazard curves: USGS 2008, EPRI 1989 and LLNL 1993. Each set had individual hazard curves for PGA, 10 Hz, 5 Hz and 1 Hz. For a given set the NRC calculated the SCDF corresponding to each curve. The highest SCDF calculated was used as the plant SCDF corresponding to the set of curves (the "weakest link approach"). The SCDFs for each plant and for each set of curves are presented in Tables D-1, D-2 and D-3 of Appendix D of [9.3].

The "weakest link" SCDF for PNPS for the USGS 2008 seismic hazard is listed in Table D-1 of the GI-199 SRA [9.3] as 6.9E-05 per year. The corresponding "weakest link" SCDFs for the EPRI 1989 hazard and LLNL 1993 hazard are 8.0E-06 and 1.1E-04, respectively. The NRC then used the differences between the SCDF for the USGS 2008 hazard and the SCDFs for the EPRI 1989 and LLNL 1994 hazards to select plants for further review. PNPS was not selected because the SCDF based on the USGS 2008 seismic hazard is lower than the SCDF for the LLNL 1993 Seismic Hazard Curve.

The fragility information from the IPEEE submittals was in general characterized in terms of PGA. In order to calculate the SCDF for the 10 Hz, 5 Hz or 1 Hz Seismic Hazard Curves, the fragilities must be changed to be in terms of the spectral acceleration at that frequency. This was done by multiplying the median capacity acceleration, C_{50}, by a spectral ratio, m. The spectral ratios for all of the plants are given in Table C2 of Appendix C of the GI-199 SRA [9.3] (and are also discussed in Attachment 10.2).

6.2 Methodology That Emulates NRC's Results

A full understanding of the methodology used in the NRC report was achieved. The NRC SRA results were duplicated, validating our understanding. The same methodology was used to develop the more realistic estimates of SCDF.

The methodology developed for calculating SCDF for a given hazard curve and fragility was derived and used in conjunction with the USGS Seismic Hazard Curves for which the acceleration interval was refined using a log-log interpolation between the raw

acceleration data points for a 0.001g interval. Excerpts from the SCDF analyses for the PGA, 10 Hz, 5 Hz, and 1Hz Hazard Curves showing the 0.001g discretization for each hazard curve are presented in Attachments 10.2 and 10.5.

The SCDF results obtained using the methodology described above, with the USGS Hazard Curve and PNPS fragility used by the NRC, match those reported in the NRC GI-199 SRA. This same methodology was then used in the SCDF calculation estimates that more accurately reflect the robustness of the PNPS components as outlined in Attachments 10.3 and 10.5.

6.3 USGS Hazard Curves for PNPS

In developing the SCDF estimates, the NRC SRA indicates that the PNPS Seismic PRA (SPRA) was used to establish plant-level fragility curve parameters. This plant-level fragility was then convolved with Seismic Hazard Curves derived by the United States Geological Survey (USGS) for the PNPS plant site. The curves were obtained from NRC [9.7]. The curves as transmitted by NRC are contained in Attachment 10.6.

Current NRC guidance for the estimation of design ground motions for new plants (Regulatory Guide 1.208 [9.8]) allows for a period and amplitude-dependent reduction in event frequency to represent the observation that some fraction of earthquake ground motions of a given amplitude fall below the threshold of damage for most engineered structures. One measure of this threshold is the cumulative absolute velocity (CAV) value. The USGS hazard analysis did not include the CAV threshold effect [9.3]. It is believed that if the CAV threshold effect were to be incorporated in the seismic hazard analysis, the hazard curves would be lowered and the SCDF would decrease as a result. However, it is not possible to incorporate the effect within the scope of this assessment beyond calculating SCDF values using the EPRI Seismic Hazard Curves.

EPRI performed an independent seismic hazard analysis. The results have not been publicly released, but EPRI provided its hazard results to Entergy. These hazard analysis included consideration of the CAV threshold effect. Therefore, SCDF calculations will also be done using the EPRI updated curves [9.12] for comparison to the SCDF calculations using the USGS curves.

6.4 Identification of Margin

6.4.1 Identification of Low Capacity Components

In Section 3.1.5.5 of the PNPS IPEEE submittal [9.1], the mean core damage frequency (CDF) due to a seismic event is reported to be 5.8E-05 per year. The dominant core damage sequence is a seismic-induced loss-of-offsite power (LOSP) and the subsequent loss of reactor pressure vessel (RPV) injection. This sequence contributes 2.72E-05 per year, or 46.7% of the total seismic CDF. Important contributors are relay chattering failures associated with both emergency diesel generators (EDG) and the SBO diesel. Other contributors are loss of the condensate storage tank (due to system interaction with the nitrogen supply tank) and diesel generator building structural failure. In addition to seismic related faults, non seismic failures that contribute to this sequence involve operator action failure to reset SBO diesel-related relays and failure to complete SBO diesel start procedure.

The second-highest sequence contributing to the seismic CDF involves LOSP and failure to provide containment decay heat removal. This sequence contributes 2.09E-05 per year, or 35.9% of the total seismic CDF. The loss of containment decay heat removal involves failure of the RHR system or failure of systems that support the RHR system (these include loss of RHR pumps quadrant room cooling, Reactor Building Closed Cooling Water (RBCCW) system surge tank and pumps failures, SSW pumps failure, seismic-induced block wall system interaction failure (block walls 209.0 or 45.3), or seismically-induced failure of bus B2. In addition to seismic-related faults, non-seismic failures that contribute to this sequence involve operator action failure to align for suppression pool cooling and failure to complete SBO diesel start procedure.

The third and fourth dominant sequences involve the occurrence of a small break LOCA and subsequent loss of RPV injection or containment decay heat removal. These sequences contribute 5.90E-06 per year, or 10.1% of the total seismic CDF. These sequences are identical to dominant seismic sequence one and two above except for the occurrence of small break LOCA and involve the occurrence of small LOCA and subsequent loss of RPV injection or containment decay heat removal.

With consideration of the above seismic sequences, seven types of seismic-induced accidents dominate the seismic core damage frequency: loss of makeup at high RPV pressure, loss of containment heat removal, small LOCA with high pressure makeup

failure, small LOCA with containment control failure, surrogate element (element representing all components with relatively high seismic capacity), vessel rupture, and anticipated transient without scram (ATWS). Their mean contributions to the seismic core damage frequency for events up to seismic failure of the surrogate element are summarized below in Table 6.1:

Table 6.1
Events and Contribution to SCDF from IPEEE

Seismic Accident Sequence	Initiating Event(s)	Key Seismic Contributing Components	Per year Mean CDF	Contribution to SCDF
1	LOSP/Loss of injection	Electrical faults, seismic interactions, and DG building failure	2.72E-05	46.7 %
2	LOSP/RHR	Pumps (RHR, RBCCW, and SSW), RBCCW surge tank, and Electrical faults	2.09E-05	35.9 %
3	Small LOCAs	Same as above sequences 1 & 2	5.90E-06	10.1 %
4	Seismic	Failure of Surrogate	1.64E-06	2.8 %

From a review of the contribution to SCDF, it is evident that the sequences associated with loss of RPV injection (SITQU) resulted in a significant risk contribution. As a result, components associated with the SITQU were identified as requiring review to determine if conservatisms existed in the calculation of their fragility values. This was done by reviewing Table 3-15 of the PNPS IPEEE submittal [9.1], which summarizes important seismic faults.

To broaden the review additional components were selected associated with other sequences which resulted in significant risk contribution to the SCDF, and with IPEEE-calculated fragility levels below the surrogate element. In this approach a selection of the low capacity components were reviewed to ascertain if conservatisms exist, and if the findings, on a sample basis, are applicable to the remaining low capacity components with fragility levels below the surrogate element value.

The SHIP model was run with successive change to the median capacity of each of the components in the model with a median capacity lower than the surrogate. The median capacity was increased to 2g to reflect the component seismic contribution to risk without having to modify the SHIP model, and the model was run to calculate a new SCDF. The reduction in SCDF was recorded. The components were then ranked in order of the percentage reduction in SCDF attributable just to reduced conservatism in that one component fragility. The results are shown in Table 6.2 below.

Table 6.2
Components Ranked by Potential Reduction in SCDF

Number	Component Name	Median	Beta-C	HCLPF	Component Description	Revised SCDF	% Change
5	ELOSPXXXXZ	0.35	0.55	0.141	LOSS OF OFFSITE POWER	3.45E-06	94.072
28	EFN204ABXZ	0.61	0.46	0.286	QUAD ROOM COOLER FANs 204A/B FAILURE	5.16E-05	11.340
29	EFN204CDXZ	0.61	0.46	0.286	QUAD ROOM COOLER FANs 204C/D FAILURE	5.21E-05	10.481
3	ERE18781!Z	0.25	0.597	0.065	SEISMICALLY INDUCED CHATTER OF RELAY 187-801A	5.24E-05	9.966
6	ERE132X9!Z	0.55	0.597	0.142	SEISMICALLY CORRELATED RELAY CHATTER OF 132-509 AND 609	5.35E-05	8.076
7	ERE159X9!Z	0.55	0.597	0.142	SEISMICALLY CORRELATED RELAY CHATTER OF 159-509 AND 609 (1 AND 2)	5.35E-05	8.076
36	EBW209/0XZ	0.82	0.46	0.384	BLOCK WALL 209.0 FAILS	5.37E-05	7.732
35	EBDDGBLDXZ	0.77	0.46	0.36	DIESEL GENERATOR BUILDING FAILS	5.38E-05	7.560
45	EBW45/3XXZ	1.07	0.46	0.501	BLOCK WALL 45.3 FAILS	5.39E-05	7.388
33	EBSA8XXXXZ	0.96	0.47	0.323	A8 BUS FAILURE	5.40E-05	7.216
37	EBSB2XXXXZ	0.84	0.46	0.393	SEISMICALLY INDUCED FAILURE OF BUS B2	5.40E-05	7.216

Number	Component Name	Median	Beta-C	HCLPF	Component Description	Revised SCDF	% Change
43	EPM184AXXZ	1.05	0.46	0.492	BODG FUEL OIL PUMP P184 FAILURE	5.44E-05	6.529
13	ERE16059!Z	0.89	0.597	0.23	SEISMICALLY CORRELATED RELAY CHATTER OF 160-509	5.45E-05	6.357
14	ERE18159!Z	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF RELAY 181-509	5.45E-05	6.357
15	ERE18759!Z	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF RELAY 187-509	5.45E-05	6.357
16	ERE27A5X!Z	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF RELAY 127-A5X	5.45E-05	6.357
32	EDLGEABXXZ	1.39	0.654	0.32	SEISMICALY INDUCED DIESEL GENERATOR A/B CORELATED FAILURE	5.45E-05	6.357
42	EFN207A-DZ	1.01	0.46	0.473	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY	5.45E-05	6.357
23	ERE15169!Z	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF 151V-609/A,B,C	5.46E-05	6.186
24	ERE16069!Z	1.04	0.597	0.269	SEISMICALLY CORRELATED RELAY CHATTER OF 160-609	5.46E-05	6.186
25	ERE18169!Z	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF RELAY 181-609	5.46E-05	6.186
26	ERE18769!Z	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF RELAY 187-609	5.46E-05	6.186
27	ERE27A6X!Z	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF RELAY 127-A6X	5.46E-05	6.186

Number	Component Name	Median	Beta-C	HCLPF	Component Description	Revised SCDF	% Change
44	EFNDWCOOLZ	1.06	0.46	0.496	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS	5.46E-05	6.186
17	ERE32801!Z	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 132-801A	5.47E-05	6.014
18	ERE51N81!Z	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 151N-801A	5.47E-05	6.014
19	ERE51NG8!Z	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 151NG-801A	5.47E-05	6.014
20	ERE51V81!Z	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 151V-801A	5.47E-05	6.014
21	ERE59801!Z	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 159-801A	5.47E-05	6.014
31	ERE2352X!Z	1.2	0.597	0.31	SEISMICALLY CORRELATED RELAY CHATTER OF 23A-K52A AND B	5.47E-05	6.014
46	EFN201ABXZ	1.23	0.46	0.576	HPCI ROOM COOLING FANs VAC201A/B FAILURE	5.47E-05	6.014
47	EFN202ABXZ	1.23	0.46	0.576	VAC202A&B FAIL RBCCW PRESSURE BOUNDARY	5.47E-05	6.014
48	EFN203ABXZ	1.23	0.46	0.576	CRD QUAD ROOM COOLING FANS VAC 203A/B FAILURE	5.47E-05	6.014
49	ECMK103ABZ	1.28	0.46	0.599	DIESEL STARTING AIR COMPRESSORS K103A/B CORRELATED FAILURE	5.47E-05	6.014

Number	Component Name	Median	Beta-C	HCLPF	Component Description	Revised SCDF	% Change
50	EPM141ABXZ	1.28	0.46	0.599	DIESEL FUEL OIL PUMPS P-141A/B FAILURE	5.47E-05	6.014
51	EVPEABXXXZ	1.28	0.46	0.599	DG A & B SEIS CORREL FUEL OIL PRESSURE REG VALVE E FAILURE	5.47E-05	6.014
52	EVRCABXXXZ	1.28	0.46	0.599	DG A & B SEISMICALLY CORRELATED FUEL OIL RELIEF VALVE C FAIL	5.47E-05	6.014
53	EVS4565CDZ	1.28	0.46	0.599	DIESEL AIR PSV4565C AND D SEISMIC CORRELATION FAILURE	5.47E-05	6.014
22	ERE12769!Z	1.04	0.597	0.269	SEISMICALLY CORRELATED CHATTER OF RELAY 127-609 AND 159N-609	5.48E-05	5.842
30	ERE1425B!Z	1.14	0.597	0.295	SEISMICALLY INDUCED CHATTER OF 420-1846	5.48E-05	5.842
34	ERE18681!Z	1.34	0.597	0.346	SEISMICALLY INDUCED CHATTER OF RELAY 186-801A	5.48E-05	5.842
38	ERE2759X!Z	1.55	0.597	0.401	SEISMICALLY INDUCED CHATTER OF 127-509X	5.48E-05	5.842
39	ETKT105ABZ	0.94	0.46	0.44	CSTs T105A/B FAILURE	5.48E-05	5.842
40	EBW210/0XZ	1.65	0.572	0.441	BLOCK WALL 210.0 FAILS	5.48E-05	5.842
41	EBW195/23Z	1	0.46	0.468	BLOCKWALL 195.23 FAILS	5.48E-05	5.842
4	ETK105ABNZ	0.16	0.46	0.075	CST 105 A/B FAILS DUE TO N2 TANK INTERACTION	5.77E-05	0.859
8	ERE40801!Z	0.67	0.597	0.173	SEISMICALLY INDUCED CHATTER OF RELAY 140-801A	5.79E-05	0.515

Number	Component Name	Median	Beta-C	HCLPF	Component Description	Revised SCDF	% Change
9	ERE46801!Z	0.67	0.597	0.173	SEISMICALLY INDUCED CHATTER OF RELAY 146-801A	5.79E-05	0.515
10	ERE1865X!Z	0.73	0.597	0.189	SEISMICALLY INDUCED CHATTER OF RELAY 181-5X	5.80E-05	0.344
12	ERE15159!Z	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF 151V-509/A,B,C	5.80E-05	0.344
1	EISLOCACSZ	0	0.46	0	SEISMICALLY INDUCED CORE SPRAY PIPE RUPTURE	5.82E-05	0.000
2	EISLOCRHRZ	0	0.46	0	SEISMICALLY INDUCED RHR PIPING RUPTURE	5.82E-05	0.000
11	ERE12759!Z	0.89	0.597	0.23	SEISMICALLY CORRELATED CHATTER OF RELAY 127-509 AND 159N-509	5.82E-05	0.000
54	EBW198/1XZ	3.43	0.792	0.607	BLOCK WALL 198.1 FAILS	5.82E-05	0.000
55	EBW198/2XZ	3.43	0.792	0.607	BLOCK WALL 198.2 FAILS	5.82E-05	0.000
56	ESURROGATZ	1	0.3	0.61	SURROGATE ELEMENT FOR "ALL OTHER" SEISMIC FAILURE		

The first component in the list is LOSS OF OFFSITE POWER. The fragility for this is a generic fragility and cannot be modified without a significant amount of work, which is beyond the scope of this re-assessment. The next two components, QUAD ROOM COOLER FANs 204A/B FAILURE and QUAD ROOM COOLER FANs 204C/D FAILURE are no longer required to be in the model [9.5] (note that EFN201ABXZ and EFN203ABXZ--CRD quad coolers and HPCI room coolers are also not required). Therefore, these components were not examined further.

The fragility calculations for the remaining components were examined to see if conservatism could be removed, which would result in a higher median capacity. These

reviews focused on conservatism in seismic demand and conservatism in seismic capacity. The main source of conservatism in seismic demand would be in the in-structure response spectra. This is discussed in Section 6.4.2. Conservatism in seismic capacity is discussed in Sections 6.4.3 to 6.4.5. Calculations of revised fragilities removing conservatism are contained in Attachment 10.4.

6.4.2 In-Structure Response Spectra

To determine component seismic response within a structure, floor response spectra are typically generated. The generation of the floor response for the PNPS SPRA is described in Section 3.1.4.3 of the PNPS IPEEE submittal [9.1]. For PNPS, floor response spectra based on design ground input spectra were generated as part of the original plant design. Within the PNPS IPEEE assessment to develop component capacity, in-structure response spectra (ISRS) were calculated using median-centered soil-structure interaction analysis with the 1989 LLNL [9.11] uniform hazard spectral shape with a 1.0E-04 exceedance probability and anchored to 0.4g peak ground acceleration as input, was used in accordance with NUREG 1407 [9.10]. Structural damping was set to 7% in accordance with the recommendation of EPRI NP-6041 [9.2]. The floor response spectra generation and soil-structure interaction analysis were performed generally in accordance with NRC Standard Review Plan requirements, except that certain limitations were not applied. This is reasonable since the structural response calculations should be median-centered rather than conservative. The review team assessed that the ISRS generation approach did not result in over-estimation of in-structure floor amplification. Thus, this was not pursued further as a source of conservatism in the SCDF.

6.4.3 Review of Capacities of Relays

Many of the components in the list, including the top three with potential for risk reduction, are relays. The relay fragilities were calculated in Stevenson & Associates Calculation C-015 [9.13]. C-015 states that the relay list with GERS capacities was provided by PNPS in a spreadsheet. This spreadsheet has not been located, and the GERS values used have not been independently verified by the review team. Some of the relays, including most of those in the Table 6.2 above, did not have GERS. The fragilities for these relays were calculated assuming the relays would eventually be shown to meet the minimum capacity for USI A-46 [9.17]. The documentation demonstrating this has not been located. Therefore, these fragilities have not been

changed. If these relays were indeed seismic verified in the USI A-46 program, the capacities may potentially be increased since it is likely the relay capacity would exceed the minimum required to meet the USI A-46 acceptance criteria.

The methodology for calculating the median fragility is described in calculation C-015 [9.13]. The methodology does not contain excess conservatism. Using various intermediate scaling factors based on EPRI TR-103959 [9.9], two factors are determined which give the median capacity as a factor times the GERS 4-16 Hz spectral acceleration, and as a factor times the GERS Zero Period Acceleration (ZPA) acceleration. The factors depend on the type of cabinet containing the relay and the location of the cabinet in the plant. The lower of the two products is used for the final median capacity. While the methodology is correct, the actual values used in the scale factor calculations have not been independently verified because the spreadsheet has not been located.

Table 6.3 below shows the relay fragilities with a potential significant impact on the SCDF. It gives the basis for the median capacity. The value of 0.6 for Beta-c is a standard value for relay fragilities.

Table 6.3
Relay Fragilities

Name	Median	Beta-C	Component Description	PANEL	LOC	GERS 4-16	GERS ZPA	Am PEAK	Am ZPA	MAKE	MODEL
ERE18781!Z	0.25	0.60	187-801A	A8	GND	1.80	0.75	0.33	0.25	GE	12CFD22B1A
ERE132X9!Z	0.55	0.60	132-509 AND 609	C101	DG23					W	CRN-1
ERE159X9!Z	0.55	0.60	159-509 AND 609	C101	DG23					GE	SV
ERE16059!Z	0.89	0.60	160-509	A5	TB37					GE	12CFVB11A3A
ERE18159!Z	0.89	0.60	181-509	A5	TB37					GE	12IJF52A45
ERE18759!Z	0.89	0.60	187-509	A5	TB37					W	SA-1
ERE27A5X!Z	0.89	0.60	127-A5X	A5	TB37					GE	12HFA51A42H
ERE15169!Z	1.04	0.60	151V-609/A,B,C	A6	TB23					GE	12IJCV52A9A
ERE16069!Z	1.04	0.60	160-609	A6	TB23					GE	12CFVB11A3A
ERE18169!Z	1.04	0.60	181-609	A6	TB23					GE	12IJF52A4A
ERE18769!Z	1.04	0.60	187-609	A6	TB23					W	SA-1
ERE27A6X!Z	1.04	0.60	127-A6X	A6	TB23					GE	12HFA51A42H
ERE32801!Z	1.00	0.60	132-801A	A8	GND	7.50	3.00	1.39	1.00	GE	12ICW51A2A
ERE51N81!Z	1.00	0.60	151N-801A	A8	GND	7.50	3.00	1.39	1.00	GE	12IFC51A2A
ERE51NG8!Z	1.00	0.60	151NG-801A	A8	GND	7.50	3.00	1.39	1.00	GE	12IFC51A2A
ERE51V81!Z	1.00	0.60	151V-801A	A8	GND	7.50	3.00	1.39	1.00	GE	12IFCV51AD1A
ERE59801!Z	1.00	0.60	159-801A	A8	GND	7.50	3.00	1.39	1.00	GE	12IAV71B2A
ERE2352X!Z	1.20	0.60	23A-K52A AND B	C941	RW23	3.30	1.32	1.24	1.20	AGASTAT	EGP-D-002
ERE12769!Z	1.04	0.60	127-609	A6	TB23					GE	12IAV51D1A

Name	Median	Beta-C	Component Description	PANEL	LOC	GERS 4-16	GERS ZPA	Am PEAK	Am ZPA	MAKE	MODEL
			AND 159N-609								
ERE1425B!Z	1.14	0.60	420-1846								
ERE18681!Z	1.34	0.60	186-801A	A8	GND	10.00	4.00	1.85	1.34	GE	HEA61
ERE2759X!Z	1.55	0.60	127-509X	A5	TB37	7.50	3.00	1.73	1.55	GE	12IAV53B
ERE40801!Z	0.67	0.60	140-801A	A8	GND	5.00	2.00	0.93	0.67		12CEH51A1A
ERE46801!Z	0.67	0.60	146-801A	A8	GND	5.00	2.00	0.93	0.67		12SGC21A1A
ERE1865X!Z	0.73	0.60	186-5X	C5	RW37	5.00	2.00	1.83	0.73		HFA54E
ERE15159!Z	0.89	0.60	151V-509/A,B,C	A5	TB37						12IJCV52A9A
ERE12759!Z	0.89	0.60	127-509 AND 159N-509	A5	TB37						12IAV51D(B)1A/IAV-51D

As stated above, the basis for the GERS values in this table, and the disposition of the relays without GERS, could not be determined in the time available for this review (with two exceptions which are discussed below). Further review could locate GERS or determine that the relays were replaced, in which cases the fragilities could be increased.

For two of the relays, it has been possible to revise the fragility based on new information. For relays 132-509 and 132-609, a GERS for the Westinghouse CRN-1 relay was located [9.14]. This GERS has a 4-16 Hz spectral acceleration of 7g, which yields a median capacity of 1.55g using the factor from Calculation C-015 [9.13]. For relays 159-509 and 159-609, the relays have been replaced. The replacement relay was seismically qualified by test. The test response spectrum had a spectral acceleration of 15g in the 4-16 Hz range, and a ZPA acceleration of 6g. For conservatism, a 4-16 Hz spectral acceleration of 10g was assumed, which resulted in a median capacity of 2.22g. This is higher than the surrogate median capacity. The calculations are in Attachment 10.4.

6.4.4 Review of Capacities of Block Walls

A number of the significant components are block wall failures (209.0, 45.3, 210.0, 195.23, 198.1 and 198.2). Block wall fragilities were calculated in Calculation C-017 [9.15]. Three of these walls (209.0, 45.3 and 195.23) had fragilities calculated by scaling the results of the IEB 80-11 [9.16] calculations. The scale factor contained two terms which result in conservatism. The first is the reduction for the peak-to-valley variability in the ground response spectra. For PNPS fragility calculations, this factor is 1/1.35. The USGS and updated EPRI Hazard Curves include this variability; therefore, it should not be included in the fragility calculation. This means that all of the median

capacities that were derived from the scaled HCLPFs can be increased by 35%. The second term is the building amplification factor. A multiplying factor of 2.1 was used for all of the walls in C-017 [9.15], yet table of building amplification factors on Page 5 of C-017 gives amplification factors between 2.6 and 12.6. For the block walls in Table 6.2 above, the building amplification factors vary from 4.47 to 9.00, which are 2.12 and 4.29, respectively, times the 2.1 factor used in the fragility calculation. Thus, the median capacities can be multiplied by a factor of at least 2. Multiplying the C-017 fragilities by 2, and also by 1.35, results in median capacities for the three block walls above 2g. For the purpose of this evaluation a median capacity of 2g was used. The calculations are in Attachment 10.4.

Block walls 210.0, 198.1 and 198.2 had full fragility analysis. No excess conservatism in these analyses was identified. Therefore, the fragility values for these block walls were not changed.

6.4.5 Review of Capacities of Other Components

Many components in the model had median capacities based on factoring the anchorage calculations for Unresolved Safety Issue (USI) A-46 [9.17]. The calculation process is described in Section 3.1.4.2 of the PNPS IPEEE submittal [9.1]. The capacity determined in the reference calculation was assumed to be calculated following the Conservative Deterministic Failure Margin (CDFM) HCLPF methodology in EPRI NP-6041 [9.2]. This is a conservative assumption, but the individual reference calculations have not been located at this time and the degree of conservatism has not been assessed. This capacity was converted to a median HCLPF by dividing by a factor of 1.35 for peak-to-valley variability, and the median capacity was calculated using a generic composite variability (β_C) of 0.46. As noted above, this factor should not be included when using the USGS or updated EPRI Hazard Curves. The median capacities for these components can be in increased by 1.35. Those fragilities in Table 6.2 above, other than those for relays and block walls, that had $\beta_C = 0.46$ were assumed have a median capacity based on factoring the A-46 capacity. These median capacities were increased by 1.35. The calculations are in Attachment 10.4.

6.4.6 Revised Fragilities

The revised fragilities are shown in Table 6.4 below. The basis for the change is noted in the "Comments" column. For a component noted as "Not needed", the median was

changed to 2g to effectively remove it from the risk calculation. For a component noted as "Brs", the revised median is 1.35 times the original median, reflecting removal of the reduction for peak-to-valley variability.

Table 6.4
Revised Fragilities

		Revised Fragility			Original Fragility		
Number	Name	Median	Beta-C	Comments	Median	Beta-C	Component Description
5	ELOSPXXXXZ				0.35	0.55	LOSS OF OFFSITE POWER
28	EFN204ABXZ	2.00	0.46	Not needed	0.61	0.46	QUAD ROOM COOLER FANs 204A/B FAILURE
29	EFN204CDXZ	2.00	0.46	Not needed	0.61	0.46	QUAD ROOM COOLER FANs 204C/D FAILURE
3	ERE18781!Z	0.25	0.60		0.25	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 187-801A
6	ERE132X9!Z	1.50	0.60	Found GERS	0.55	0.60	SEISMICALLY CORRELATED RELAY CHATTER OF 132-509 AND 609
7	ERE159X9!Z	2.22	0.60	Replaced with qualified ABB 59N	0.55	0.60	SEISMICALLY CORRELATED RELAY CHATTER OF 159-509 AND 609 (1 AND 2)
36	EBW209/0XZ	2.00	0.46	Limited to 2.00	0.82	0.46	BLOCK WALL 209.0 FAILS
35	EBDDGBLDXZ	1.04	0.46	Brs	0.77	0.46	DIESEL GENERATOR BUILDING FAILS
45	EBW45/3XXZ	2.00	0.46	Limited to 2.00	1.07	0.46	BLOCK WALL 45.3 FAILS
33	EBSA8XXXXZ			Full fragility analysis	0.96	0.47	A8 BUS FAILURE
37	EBSB2XXXXZ	1.13	0.46	Brs	0.84	0.46	SEISMICALLY INDUCED FAILURE OF BUS B2

		Revised Fragility			Original Fragility		
Number	Name	Median	Beta-C	Comments	Median	Beta-C	Component Description
43	EPM184AXXZ	1.42	0.46	Brs	1.05	0.46	BODG FUEL OIL PUMP P184 FAILURE
13	ERE16059!Z				0.89	0.60	SEISMICALLY CORRELATED RELAY CHATTER OF 160-509
14	ERE18159!Z				0.89	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 181-509
15	ERE18759!Z				0.89	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 187-509
16	ERE27A5X!Z				0.89	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 127-A5X
32	EDLGEABXXZ				1.39	0.65	SEISMICALY INDUCED DIESEL GENERATOR A/B CORELATED FAILURE
42	EFN207A-DZ	1.36	0.46	Brs	1.01	0.46	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY
23	ERE15169!Z				1.04	0.60	SEISMICALLY INDUCED CHATTER OF 151V-609/A,B,C
24	ERE16069!Z				1.04	0.60	SEISMICALLY CORRELATED RELAY CHATTER OF 160-609
25	ERE18169!Z				1.04	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 181-609
26	ERE18769!Z				1.04	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 187-609

		Revised Fragility			Original Fragility		
Number	Name	Median	Beta-C	Comments	Median	Beta-C	Component Description
27	ERE27A6X!Z				1.04	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 127-A6X
44	EFNDWCOOLZ	1.43	0.46	Brs	1.06	0.46	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS
17	ERE32801!Z				1.00	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 132-801A
18	ERE51N81!Z				1.00	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 151N-801A
19	ERE51NG8!Z				1.00	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 151NG-801A
20	ERE51V81!Z				1.00	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 151V-801A
21	ERE59801!Z				1.00	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 159-801A
31	ERE2352X!Z				1.20	0.60	SEISMICALLY CORRELATED RELAY CHATTER OF 23A-K52A AND B
46	EFN201ABXZ	2.00	0.46	Not needed	1.23	0.46	HPCI ROOM COOLING FANs VAC201A/B FAILURE
47	EFN202ABXZ	2.00	0.46	Not needed	1.23	0.46	VAC202A&B FAIL RBCCW PRESSURE BOUNDARY

		Revised Fragility			Original Fragility		
Number	Name	Median	Beta-C	Comments	Median	Beta-C	Component Description
48	EFN203ABXZ	2.00	0.46	Not needed	1.23	0.46	CRD QUAD ROOM COOLING FANS VAC 203A/B FAILURE
49	ECMK103ABZ	1.73	0.46	Brs	1.28	0.46	DIESEL STARTING AIR COMPRESSORS K103A/B CORRELATED FAILURE
50	EPM141ABXZ	1.73	0.46	Brs	1.28	0.46	DIESEL FUEL OIL PUMPS P-141A/B FAILURE
51	EVPEABXXXZ	1.73	0.46	Brs	1.28	0.46	DG A & B SEIS CORREL FUEL OIL PRESSURE REG VALVE E FAILURE
52	EVRCABXXXZ	1.73	0.46	Brs	1.28	0.46	DG A & B SEISMICALLY CORRELATED FUEL OIL RELIEF VALVE C FAIL
53	EVS4565CDZ	1.73	0.46	Brs	1.28	0.46	DIESEL AIR PSV4565C AND D SEISMIC CORRELATION FAILURE
22	ERE12769!Z				1.04	0.60	SEISMICALLY CORRELATED CHATTER OF RELAY 127-609 AND 159N-609
30	ERE1425B!Z				1.14	0.60	SEISMICALLY INDUCED CHATTER OF 420-1846
34	ERE18681!Z				1.34	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 186-801A
38	ERE2759X!Z				1.55	0.60	SEISMICALLY INDUCED CHATTER OF 127-509X

		Revised Fragility			Original Fragility		
Number	Name	Median	Beta-C	Comments	Median	Beta-C	Component Description
39	ETKT105ABZ	1.27	0.46	Brs	0.94	0.46	CSTs T105A/B FAILURE
40	EBW210/0XZ			Full fragility analysis	1.65	0.57	BLOCK WALL 210.0 FAILS
41	EBW195/23Z	2.00	0.46	Limited to 2.00	1.00	0.46	BLOCKWALL 195.23 FAILS
4	ETK105ABNZ	2.00	0.46	Interaction fixed	0.16	0.46	CST 105 A/B FAILS DUE TO N2 TANK INTERACTION
8	ERE40801!Z				0.67	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 140-801A
9	ERE46801!Z				0.67	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 146-801A
10	ERE1865X!Z				0.73	0.60	SEISMICALLY INDUCED CHATTER OF RELAY 186-5X
12	ERE15159!Z				0.89	0.60	SEISMICALLY INDUCED CHATTER OF 151V-509/A,B,C
1	EISLOCACSZ				0.00	0.46	SEISMICALLY INDUCED CORE SPRAY PIPE RUPTURE
2	EISLOCRHRZ				0.00	0.46	SEISMICALLY INDUCED RHR PIPING RUPTURE
11	ERE12759!Z				0.89	0.60	SEISMICALLY CORRELATED CHATTER OF RELAY 127-509 AND 159N-509
54	EBW198/1XZ			Full fragility analysis	3.43	0.79	BLOCK WALL 198.1 FAILS
55	EBW198/2XZ			Full fragility analysis	3.43	0.79	BLOCK WALL 198.2 FAILS

6.5 Re-Assessment of SCDF

The PNPS SCDF was calculated in the PNPS IPEEE SPRA using the systems model as input to the SHIP model. The model incorporated seismic fragilities for components into event trees and fault trees, producing sequences representing combinations of system failures that could lead to core damage following the seismic event. For this evaluation, the effect on plant SCDF of changing the fragility of a given component (structure, system or equipment) can be determined by changing the fragility parameters in the model and re-running it using the SHIP software. However, all of the fragilities in the SHIP model are expressed in terms of PGA. In order to calculate the SCDF using hazard curves for 10 Hz, 5 Hz and 1 Hz it is necessary to change the fragilities to reference the spectral acceleration at that frequency rather than the PGA. It is not possible, at this time, to change all of the fragilities in the model. Therefore, the change in plant SCDF was estimated using the process described below, which is the same as the NRC used.

The NRC developed a plant-fragility from the median capacity and HCLPF reported in the PNPS IPEEE submittal. These numbers came from the SHIP risk quantification. However, the median capacity and composite variability in the NRC GI-199 SRA are slightly different than those that would be calculated using the SHIP numbers. The NRC notes that in some cases the fragility values were modified so as to match the reported SCDF. If the plant-level fragility reported by the NRC is used with EPRI 1989 PGA Hazard Curve, the SCDF is computed as 5.8E-05 per year. This is what SHIP computes. If the median capacity and composite variability computed directly from the SHIP output (median capacity and HCLPF) are used, the computed SCDF is higher. Therefore, it is reasonable to adjust the fragility to get agreement with the SHIP quantification for the same hazard curve.

The SHIP model was re-run with the USGS PGA hazard and using revised fragilities as per Table 6.4, which results in a revised SCDF of 2.14E-5 per year. The median capacity and HCLPF were 0.57g and 0.33g, respectively. The composite variability calculated from the median capacity and HCLPF is 0.23. Convolving the USGS PGA Hazard Curve with this fragility (C_{50} = 0.57g, β_C = 0.23), the SCDF is 2.78E-05 per year. This is higher than the SHIP result of 2.14E-05 per year. Adjusting the fragility to C_{50} = 0.63g and β_C = 0.23 and convolving with the USGS PGA hazard, the SCDF is 2.14E-05 per year. This agrees with the SHIP result.

Using this fragility and convolving with 10 Hz, 5 Hz and 1 Hz gives the results shown below in Table 6.5 compared to the original NRC results. The convolution calculations are summarized in Attachment 10.3. The detailed calculations are contained in Attachment 10.5.

Table 6.5
2008 USGS Hazard SCDF with Revised Fragilities

	PGA	10 Hz	5 Hz	1 Hz	Max
NRC Fragility	4.26E-05	6.88E-05	6.19E-05	2.40E-05	6.88E-05
Revised Fragility	2.78E05	4.88E-05	4.36E-05	1.79E-05	4.88E-05
Revised Fragility SHIP Adjusted	2.14E05	3.98E-05	3.53E-05	1.49E-05	3.98E-05

Note that the SCDFs in the first row of Table 6.5 were calculated by Entergy using the NRC plant-level fragility and the 2008 USGS seismic hazard curves. For comparison the NRC GI-199 SRA reported SCDFs of 4.3E-05, 6.9E-05, 6.2E-05, 2.4E-05, and 6.9E-05 for PGA, 10 Hz, 5 Hz, 1 Hz and Maximum, respectively.

The same process was also done with the updated EPRI Seismic Hazard Curves [9.12] and the same fragilities considered in conjunction with the USGS Hazard Curves. The EPRI Hazard Curves were prepared using different ground motion experts and use a Cumulative Absolute Velocity (CAV) filter to remove high frequency waves with limited energy. The results are shown in Table 6.6 below.

Table 6.6
2010 EPRI Hazard SCDF with Revised Fragilities

	PGA	10 Hz	1 Hz	Max
NRC Fragility	3.11E-05	2.74E-05	1.87E-05	3.11E-05
Revised Fragility	2.54E05	2.20E-05	1.39E-05	2.54E-05
Revised Fragility SHIP Adjusted	1.46E05	1.22E-05	5.57E-07	1.46E05

7.0 CONCLUSIONS

It is concluded that the PNPS plant is more robust than shown in the PNPS IPEEE study and the NRC GI-199 SRA. The site median capacity and composite uncertainty used by the NRC resulted in a conservative estimate of SCDF of 6.9E-05 per year.

The improved values for the median capacity and composite uncertainty calculated by the review team resulted in a SCDF estimate of 3.98E-05 per year associated with the current USGS Hazard Curves, which represents a significant reduction from the GI-199 reported SCDF estimate and is a more realistic estimate of the seismic risk.

It should also be noted that using the improved fragility along with the 2010 EPRI updated Seismic Hazard Curves instead of the USGS curves further reduces the SCDF value to 1.46E-05 per year.

8.0 RECOMMENDATIONS

8.1 Short Term Recommendations:

- Consider developing more formal calculations per EN-DC-126 to enhance the supporting documentation associated with this Engineering Report.

- Verify the assumption used in the relay fragility calculation C-015 [9.13] that relays without GERS were verified by PNPS to meet A-46 requirements.

8.2 Long Term Recommendations:

- Consider modeling reactor pressure vessel (RPV) depressurization function for seismic sequences that involve loss of high pressure RPV injection and potential use of low pressure RPV injection (from RHR/Low Pressure Coolant Injection (LPCI) and Core Spray systems) in a future SPRA.

- Consider modeling the direct torus vent system for seismic sequences that involve loss of containment decay heat removal (loss of suppression pool cooling and drywell sprays) in a future SPRA.

- Continue locating GERS or test data for relays in C-015 [9.13] to enable increasing the median capacity of the fragilities. Investigate the operational requirements of the relays.

9.0 REFERENCES

9.1 Pilgrim Individual Plant Examination of External Events Report, July 1994.

9.2 EPRI, "Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1)," NP-6041-SL, August 1991

9.3 NRC, "Safety/Risk Assessment Results for Generic Issue (GI) 199, Implications of Updated Probabilistic Hazard Estimates in Central and Eastern United States on Existing Plants," dated September 2, 2010 (ADAMS Accession Number ML 100270582)

9.4 NRC Information Notice 2011-05: Tohoku-Taiheiyou-Oki Earthquake Effects on Japanese Nuclear Power Plants

9.5 NEA-02-044, February 13, 2002, "The Temperature Profile of the HVAC Systems for the Pilgrim IPE and Update for the Life Extension Project

9.6 NRC Frequently Asked Questions related to the March 11, 2011 Japanese Earthquake and Tsunami

9.7 Email from Martin Stutzke (USNRC) to John Bretti (Entergy), "Pilgrim Seismic Hazard Curves used in GI-199", dated April 7, 2011 (see Attachment 10.6).

9.8 NRC Regulatory Guide 1.208, "A Performance Based Approach to Define the Site Specific Earthquake Ground Motion", March 2007.

9.9 EPRI TR-103959, "Methodology for Developing Seismic Fragilities", 1994.

9.10 USNRC, "Procedural & Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities", NUREG-1407, June 1991.

9.11 USNRC, "Seismic Hazard Characteristics of 69 Nuclear Power Plant Sites East of the Rocky Mountains," NUREG/CR-5250, Vols. 1-8, January 1989.

9.12 EPRI, "Updated Seismic Hazard Results for the Arkansas, Fitzpatrick, Grand Gulf, Indian Point, Pilgrim, River Bend, Vermont Yankee, and Waterford Nuclear Sites." August 2010 (Not published, Proprietary).

9.13 Stevenson & Associates, C-015: Relay Fragility Analysis for Seismic PRA (BECo SUDDS/RF 94-10).

9.14 EPRI, "Seismic Ruggedness of Relays," NP-7147-SL, V2, Addendum 2, April 1995.

9.15 Stevenson & Associates, C-017: Estimated Fragilities for Blockwalls for Pilgrim Station Seismic PRA (BECo SUDDS/RF 94-10).

9.16 NRC, "Masonry Wall Design," IE Bulletin 80-11, May 1980.

9.17 NRC, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," Generic Letter 87-03, February 1987.

9.18 Engineering Report PNPS-NE-07-0006, "Pilgrim Probabilistic Safety Assessment (PSA)," Rev.2, April 2008.

10.0 ATTACHMENTS

10.1 Selection Criteria for 27 Plants that Require Further Investigation (3 pages)

10.2 Develop Methodology that Emulates NRC's Use of IPEEE Parameters to Calculate Seismic Core Damage Frequency (SCDF) Values (19 pages)

10.3 Revised SCDF for PNPS Using USGS & EPRI Hazard Curves (2 pages)

10.4 Revised Calculations for Identified Low Capacity Components (14 pages)

10.5 SCDF Calculations Using Plant Level Fragility (23 pages)

10.6 Email from Martin Stutzke (USNRC) to John Bretti (Entergy) (7 pages)

10.7 SHIP Model Input and Output (102 pages)

11.0 REVIEW TEAM MEMBERS

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Attachment 1

Selection Criteria for 27 Plants that Require Further Investigation

Re-assessment of Pilgrim Seismic Core Damage Frequency

NRC's August 2010 List

This is NRC's explanation of how they compiled the list that was shared at the NRUG meeting at Amelia Island in early August and again during the presentation to the ACRS in Nov 2010.

Please note that NRC says they were not trying to identify specific plants but, instead, were trying to determine if further evaluation by the Generic Issue Program was warranted. Because there are plants in the "continue" region (with a change in seismic CDF greater than 10E-5), their conclusion is that they should continue to evaluate the Generic Issue.

****

Two sets of seismic hazard curves were developed to support the Individual Plant Examination of External Events (IPEEE) that was requested by Generic Letter 88-20, Supplement 4:

1. Lawrence Livermore National Laboratory (LLNL), as reported in NUREG-1488
2. Electric Power Research Institute Seismic Owners Group (EPRI/SOG), as reported in EPRI NP-6395.

Note that there are LLNL seismic hazard curves all for Central and Eastern United States (CEUS) plants, but that some plants did not participate in the EPRI/SOG. The observation that there are two sets of credible, IPEEE-era seismic hazard curves implies that there are two ways to compute the change in seismic core-damage frequency (delta-SCDF). Specifically, you can compute the change with respect to the LLNL curves and/or with respect to the EPRI/SOG curves.

For plants that had both sets of curves, we computed both delta-SCDFs and developed the so-called "delta-delta plot" (Figure 1) to decide which plants warranted further investigation. If one of the delta-SCDFs was greater than or equal to 1E-5/y and the other was positive, then we binned the plant into the "continue" region. This process identified 24 plants as listed below:

1. Crystal River 3
2. Dresden 2
3. Dresden 3
4. Farley 1
5. Farley 2
6. Indian Point 2
7. Indian Point 3
8. Limerick 1
9. Limerick 2
10. North Anna 1
11. North Anna 2
12. Oconee 1
13. Oconee 2
14. Oconee 3
15. Peach Bottom 2
16. Peach Bottom 3
17. Perry 1
18. River Bend 1

19. Seabrook 1
20. Sequoyah 1
21. Sequoyah 2
22. Summer
23. Watts Bar 1
24. Wolf Creek 1

For plants that did not participate in the EPRI/SOG, we were limited to considering only the delta-SCDF with respect to the LLNL seismic hazard curves. If this delta-SCDF was greater than or equal to 1E-5/y, then we binned the plant into the "continue" zone. This process identified 3 plants as listed below:

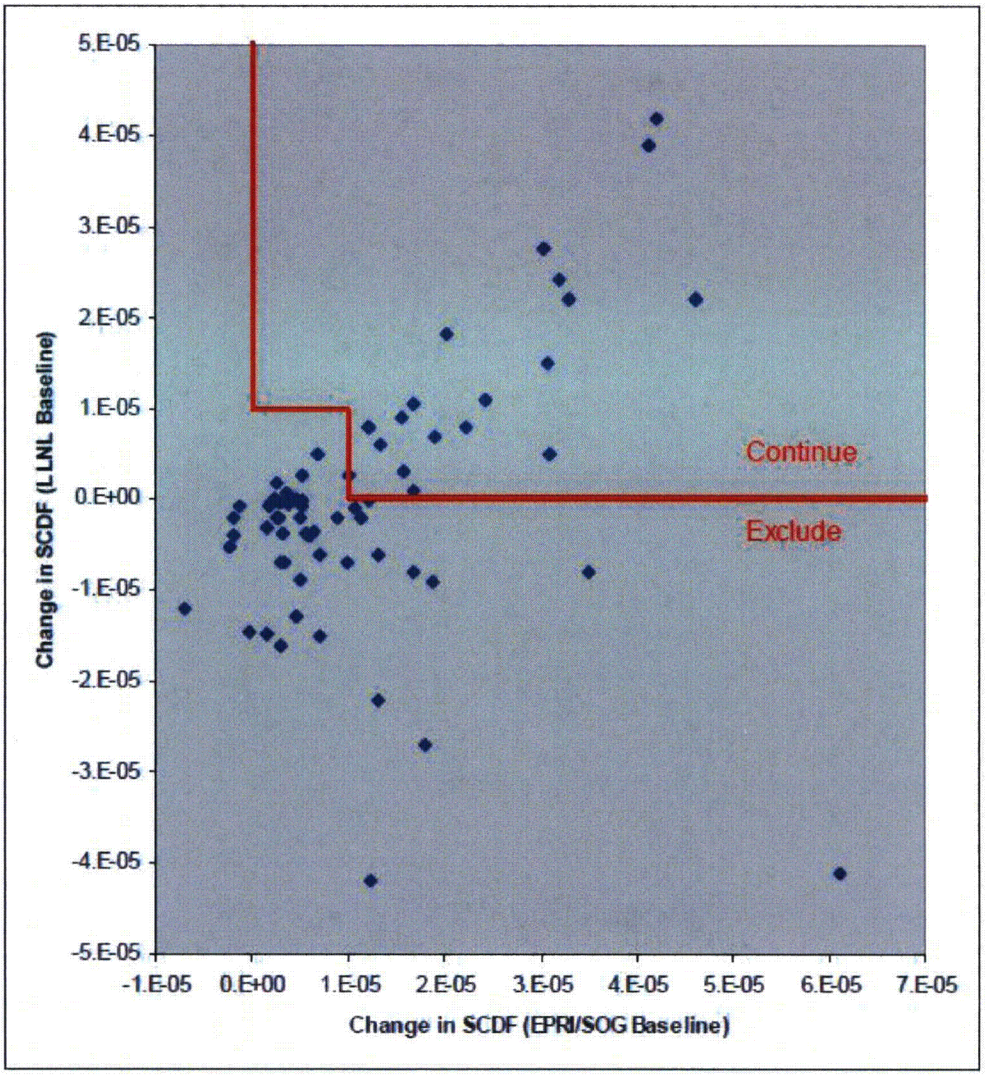
1. Duane Arnold
2. Saint Lucie 1
3. Saint Lucie 2

Hence, there are a total of 27 plants (24 + 3) that fall into the "continue" zone.

Reference:

NRC staff presentation to ACRS Siting Subcommittee, November 30, 2010.

Figure 1


5.E-05
4.E-05
3.E-05
2.E-05
1.E-05
0.E+00
-1.E-05
-2.E-05
-3.E-05
-4.E-05
-5.E-05
Change in SCDF (LLNL Baseline)
-1.E-05
0.E+00
1.E-05
2.E-05
3.E-05
4.E-05
5.E-05
6.E-05
7.E-05
Change in SCDF (EPRI/SOG Baseline)
Continue
Exclude

Attachment 2

Develop Methodology that Emulates NRC's Use of IPEEE Parameters to Calculate Seismic Core Damage Frequency (SCDF) Values

Develop Methodology that Emulates NRC's use of IPEEE Parameters to Calculate Seismic Core Damage Frequency (SCDF) Values

Prepared by: Dragos Nuta, PE Reviewed by: Paul Baughman

EXECUTIVE SUMMARY

- Full understanding of methodology used by NRC to calculate SCDF values was achieved.
- The NRC Report results were duplicated, validating our understanding.
- The methodology is used to develop more realistic estimates of risk

In developing the SCDF estimates, the NRC report (Ref.1) indicates that the Pilgrim Nuclear Power Station (PNPS) Seismic PRA (SPRA) was used to establish plant-level fragility curves parameters. These parameters were then convolved with the hazard curves derived by United States Geological Survey (USGS) for the PNPS coordinates, and resulted in the estimates of the SCDFs based on the peak ground acceleration (PGA), 10 Hz, 5 Hz, and 1 Hz hazard curves.

It was decided that the most effective way for developing more realistic seismic hazard estimates is to fully understand the basis for the NRC developed parameters and methodology used, after which the NRC SCDF calculation methodology would be used to reflect the revised fragilities and calculate more realistic SCDF estimates. In order to clearly understand the various parameters used by NRC in their work, our understanding of the NRC methodology had to be verified by duplicating the results obtained by the NRC.

Activities undertaken to achieve verification of the NRC SCDF estimates included:

1. Document input information referred to in the NRC report (Ref. 1)
2. Extract all information from the NRC report describing how various parameters were established.
3. Document the methodology used to calculate the SCDF estimates.
4. Obtain USGS Hazard Curves (which were used in the NRC Report)
5. Derive parameters and develop mathematical formulation for all terms used in the SCDF calculations.
6. Use the methodology and derived parameters and perform risk analyses that duplicate the NRC Report SCDFs for PNPS.

A discussion of the work performed in support of all activities described above and the results obtained is provided below.

1. Document input information referred to in the NRC report (Ref. 1)

Page C-5 of the NRC Report (Ref. 1) states that the C_{50} and βc parameters were obtained from the SPRA probability plot of the reported plant-level fragility data.

Table C.1. Bases for Establishing Plant-Level Fragility Curves Parameters From IPEEE Information.		
Basis	**Source**	**Parameters**
1a	SPRA	C_{50} and β_C determined by probability plot of the reported plant-level fragility curve

Applicability of the 1a basis is provided in Table C-2 from which an excerpt is provided below.

Indeed, the PNPS IEEE Report (Ref. 2) developed a plant level fragility that reflects not only the seismic robustness of the PNPS Structures, Systems, and Components (SSCs), but also the effects of random and other non-seismic related failures. The Mean Capacity at the plant level (in terms of PGA) was given as 0.48g (Figure 3-17 of Ref. 2).

The NRC work used a 0.49g median capacity, together with a composite lognormal standard deviation βc, representing randomness and uncertainty, of 0.27 in their risk assessment work.

The parameters are introduced in Table C-2 (Page C-7) of the NRC report, as extracted below:

Table C-2. Plant-Level Fragility Data.									
			PGA Fragility			Spectral Ratios			
Plant	Docket Number	IPEEE Method	HCLPF	C_{50}	β_C	10 Hz	5 Hz	1 Hz	Basis
Pilgrim 1	05000293	seismic PRA		0.49	0.27	1.55	1.66	0.5	1a

It should be noted that the C_{50} and βc parameters, as well as the Spectral Ratios, will be discussed below.

2. Extract all information from the NRC report describing how various parameters were established.

In using plant level fragilities based on the IPEEE Review Level Earthquake (RLE), taken by NRC to be the 1989 EPRI hazard data and ground response spectra, adjustments to the fragilities had to be made so that they may be used in conjunction with the hazard curves, and ground spectra, based on 2008 USGS data.

The NRC captures the adjustments in Figure C-1 (Page C-4) of the NRC Report (Ref. 1) as follows:

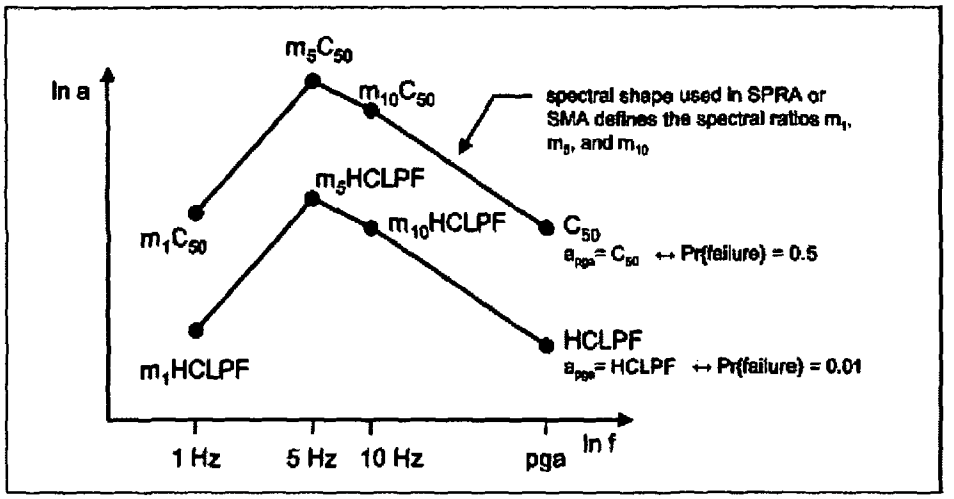


Figure C-1. The Definition of Spectral Fragility in Terms of the PGA-Based Fragility and the Review-Level Response Spectrum.

The median seismic capacity C_{50} is calculated as follows:

The High Confidence of a Low Probability of Failure (HCLPF) reported in Table 3-13 of Ref. 2 is 0.25g:

Table 3-13
SPRA Results (EPRI)

Result	Value	Value[1]
Seismic Core Damage Frequency	5.82 E-05	3.13 E-05
Plant Median Capacity (PGA(g))	0.48g	0.57g
Plant High Confidence of a Low Probability of Failure (HCLPF) (PGA(g))	0.25g	0.32g

[1] Plant HCLPF based on seismic faults only - random failures and human reliability excluded

The HCLPF is related to the median seismic capacity C_{50} to be used in the work reflecting the USGS hazard curves as follows:

$$C_{50} = \text{HCLPF}\ e^{(2.3264 \times \beta c)}$$

NRC assumed a $\beta c = 0.27$ which results in $C_{50} = 0.25g \times e^{(2.3264 \times 0.27)} = 0.25g \times 1.874 = 0.48g$. This median capacity matches the median capacity reported in Table 3-13 of Ref. 2, as shown above.

However, NRC adjusted slightly the fragilities so that the calculated SCDF matched the results obtained when using the 1989 EPRI PGA hazard curve, and a $C_{50} = 0.49g$ was used in the assessments. [Note that when the deconvolution is done with the 1989 EPRI PGA hazard curve and the NRC fragility, the resulting SCDF is 5.76E-05. The value reported by the NRC in Table D.2 of the GI-199 SRA is 6.8E-06. The reason for this discrepancy is not known.]

The m_1, m_5, and m_{10} spectral ratios were obtained from the EPRI based RLE as the ratio between the spectral amplitudes at 1 Hz, 5 Hz, and 10 Hz, and the peak ground acceleration for the spectrum.

The calculated spectral ratios are provided in Table C-2 from which excerpts were provided above. The PNPS spectral ratios for 1 Hz, 5 Hz, and 10 Hz are given as 0.5, 1.66, and 1.55, respectively, as shown in the Table C2 excerpt above.

3. Document the methodology used to calculate the SCDF estimates.

Appendix A of the NRC Report (Ref.1) contains an extensive explanation as to how the SCDF is calculated using the Hazard Curve for a certain frequency and the fragilities for a certain SSC or, in our case, the plant level fragility (consisting of the median capacity and composite uncertainty). The mathematical formulation shown below in the excerpt from Appendix A of Ref. 1:

$$SCDF(a_i, a_{i-1}) = \int_{a_{i-1}}^{a_i} H_i(a)\left[\frac{dP_{CD}(a)}{da}\right]da - H_i(a)P_{CD}(a)\Big|_{a_{i-1}}^{a_i} \qquad \text{(A-12)}$$

is solved numerically.

To allow an understanding of exactly what was done as part of this task that validated our understanding of the NRC parameters used and methodology by duplicating the SCDF estimates published by NRC for PNPS, we present a plain language description of the steps involved in estimating a SCDF.

The steps involved in obtaining a seismic core damage frequency estimate are as follows:

a) Obtain the hazard curves for various frequencies of interest, including the PGA.
b) Tabulated values of accelerations and their annual exceedance frequency are usually provided so data needs not be read off of the Hazard Curve. The data is arranged in order of increasing accelerations.
c) Between each ascending pair of accelerations (interval), establish the interval acceleration and interval frequency as described below.
d) Calculate the interval z-value for a normal distribution, given the interval acceleration, the median capacity of the item for which the SCDF is calculated, and the composite βc, which represents the randomness and uncertainty in the median capacity, as described below.
e) Calculate the conditional probability of failure
f) Convolve the interval frequency with the conditional probability of failure and obtain the probability of failure for each interval.
g) The summation of the probabilities of failure for all acceleration intervals represents the total probability of failure or the SCDF for the item having a median capacity A_m and the associated β_c when the hazard curve for the selected frequency is considered.

The steps discussed above under b) through g) were incorporated into an EXCEL spreadsheet as shown below:

A	B	C	D	E	F	G	H
Hazard Curve	Freq.	Interval	Interval	Interval	Z	Conditional Probability	Probability
Acceleration			Acceleration (a)	Frequency	ln(a/Am)/βc	of Failure	of Failure
			$(A_i + A_{i+1})/2$	$(B_i - B_{i+1})$		NORMDIST Z = (F_i)	$E_i \times G_i$

where "i" is the row number under consideration

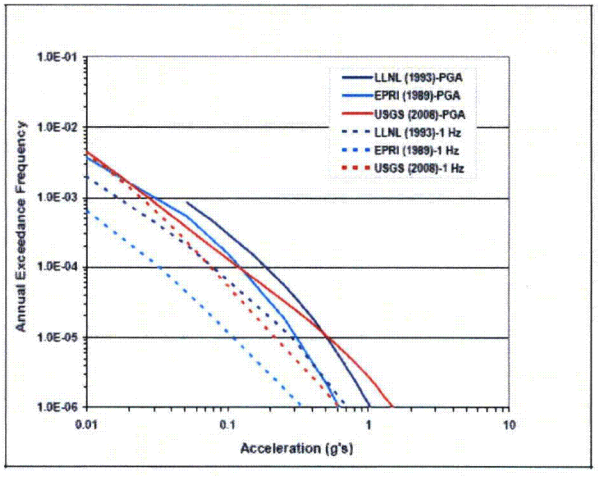
A discussion of the various steps, with headings captured under Columns A through H in the EXCEL spreadsheet, is presented below.

a) Obtain the hazard curves for various frequencies of interest, including the PGA.

Hazard Curves are developed by ground motion experts. After establishing all seismic zones of known seismic activity that could affect a particular location, each seismic zone is associated with a magnitude M that may occur at the specific seismic zone, including its recurrence interval, the distance from the seismic zone to the site where the Hazard Curves must be established, as well as other parameters that deal with variability and wave propagation.

From each seismic zone, wave propagation formulations are used to propagate seismic waves of various frequencies to the site where the Hazard Curves are established. The frequencies considered include, as a minimum, 1 Hz, 5 Hz, 10 Hz, and PGA.

As mentioned above, Hazard Curves are calculated for various frequencies. An excerpt from the NRC report (Ref. 1) shows PGA and 1 Hz Hazard Curve plots:



The X-axis contains acceleration levels, while the Y-axis contains annual exceedance probabilities, or annual exceedance frequencies. A point on a Hazard Curve is associated with an acceleration and an annual exceedance probability.

While the pairs of acceleration and exceedance probability may be read off of the Hazard Curves, a tabulation of accelerations and their annual exceedance probabilities is usually provided and contains a minimum of 10-12 pairs of values. Given the summation process used to emulate an integral, the more points considered, the more accurate the representation of the Hazard Curve in calculating the SCDF.

c) For every interval, establish the interval acceleration and frequency.

Given a tabulation that has acceleration values increasing in magnitude, and corresponding annual exceedance frequencies that decrease in magnitude, the interval from one acceleration value to the one immediately below, has an interval acceleration and frequency established as follows:

- The interval acceleration is the average of the top acceleration and the one immediately below. In the tabulation excerpted above, having columns A through H, the interval acceleration for the i^{th} row is $(A_i + A_{i+1}) / 2$. The result is placed in Column D of the excerpt.
- The interval frequency is calculated as the difference between the annual exceedance frequencies for two accelerations. In the tabulation above, the frequency for the i^{th} row is the difference between the exceedance probabilities shown on row "i" and row "i + 1". This value is entered in Column E of the excerpted tabulation.

d) Calculate the z-value for the acceleration interval

The z-value is associated with a normal distribution that has the mean value of zero and an area under the distribution curve of 1.0. It is calculated as

$Z = (\ln (a/A_m)) / \beta_c$ where

- a = acceleration value for the interval. It is captured under Column D of the excerpted EXCEL spreadsheet above.
- A_m is the median capacity of the SSC considered or, in our case, the point estimate fragility developed for the plant. When the plant A_m value established using the 1989 EPRI Hazard Curves is used in conjunction with Hazard Curves developed by USGS, the median capacity for the plant is introduced as C_{50} when the PGA Hazard curve is considered, and m_i C_{50} when the frequency "i" Hazard Curve is considered. Both C_{50} and the "m" factors were discussed under 2. above.
- β_c is the composite uncertainty.

For normal distributions, the z-value represents the number of standard deviations away from the mean (which is the center of the symmetrical distribution curve).

e) Calculate the conditional probability of failure.

The conditional probability of failure for a normal distribution is the area from the left tail of the distribution to the calculated z-value. For these calculations, the conditional probability of failure was calculated using the NORMDIST Z function in EXCEL and the z-value calculated as discussed above (and present in Column F of the tabulated excerpt).

The conditional probability of failure may be calculated by hand using tabulations of Z values and probabilities (area under the curve), remembering that the given area is always given from the mean to the absolute value of "z". Thus, probability for a negative z-value (z-value is to the left of the mean) will be obtained by reading the area (probability) from the normal distribution table, and subtracting from 0.5 (which is the area for each half of the normal distribution plot) to obtain the area from the left tail of the distribution to the negative z-value. The probability for a positive z-value (z-value is to the right of the mean) will be obtained by reading the area (probability) from the normal distribution table, and adding it to 0.5 (which is the area for each half of the normal distribution plot) to obtain the area from the left tail of the distribution to the positive z-value.

d) Multiply the interval (annual exceedance) frequency and the conditional probability of failure to obtain the probability of failure for each interval.

Values captured under Columns E and G of the excerpted tabulation, respectively, for each acceleration interval are multiplied and the results are entered under Column H of the excerpted tabulation.

e) Calculate the total probability of failure (SCDF)

The total probability of failure for an SSC having a median capacity A_m and β_c composite uncertainty, when considering a Hazard Curve representing a specific frequency, is obtained by adding the probabilities of failure for all acceleration intervals used to discretize the Hazard Curve. The values of probability of failure in Column H were summed to provide the Total Probability of Failure. When the PNPS point estimate fragilities are used, as discussed under d) above, the summation represents the SCDF.

As discussed below, the NRC Report (Ref. 1) provides SCDF using the 1 Hz, 5 Hz, 10 Hz, and PGA USGS Hazard Curves. The NRC reported SCDF results were duplicated using the methodology described above, as described under 6, below.

4. Obtain USGS Hazard Curves (which were used in the NRC Report)

While hazard curves for various wave frequencies could have been obtained from USGS developed module 2008. CEUS.Op10.2000.txt.gz by selecting the coordinates for the PNPS, the data was obtained from the NRC (Refer to Attachment 10.6 of Report PNPS-RPT-11-0001).

USGS Hazard Curves used for the work discussed herein were obtained from the NRC and are as follows (Note Hazard Curves are based on 2008 USGS adjusted for site soil conditions using EPRI/SOG site amplification functions (EPRI NP-6395-D):

PGA		10 Hz		5 Hz		1 Hz	
Acceleration (g's)	Annual exceedence frequency (per year)	Acceleration (g's)	Annual exceedence frequency (per year)	Acceleration (g's)	Annual exceedence frequency (per year)	Acceleration (g's)	Annual exceedence frequency (per year)
0.0148	6.76E-03	0.0178	1.04E-02	0.0215	1.31E-02	0.0040	1.16E-02
0.0207	4.63E-03	0.0266	7.07E-03	0.0320	8.44E-03	0.0060	7.39E-03
0.0288	3.12E-03	0.0392	4.70E-03	0.0473	5.30E-03	0.0092	4.48E-03
0.0401	2.06E-03	0.0584	3.03E-03	0.0698	3.21E-03	0.0140	2.57E-03
0.0560	1.34E-03	0.0870	1.88E-03	0.1037	1.88E-03	0.0211	1.40E-03
0.0771	8.68E-04	0.1294	1.14E-03	0.1539	1.07E-03	0.0328	7.24E-04
0.1065	5.55E-04	0.1922	6.69E-04	0.2272	5.92E-04	0.0495	3.58E-04
0.1446	3.52E-04	0.2790	3.83E-04	0.3213	3.20E-04	0.0763	1.71E-04
0.1957	2.23E-04	0.3955	2.15E-04	0.4608	1.69E-04	0.1163	8.09E-05
0.2610	1.38E-04	0.5443	1.18E-04	0.6365	8.74E-05	0.1757	3.81E-05
0.3410	8.57E-05	0.6864	7.37E-05	0.8229	5.26E-05	0.2743	1.79E-05
0.4203	5.23E-05	0.7301	6.26E-05	0.8986	4.41E-05	0.4147	8.21E-06
0.5161	3.11E-05	1.0449	3.20E-05	1.2591	2.14E-05	0.5200	5.37E-06
0.6283	1.77E-05	1.2560	2.21E-05	1.4560	1.44E-05	0.6428	3.55E-06
0.7936	9.51E-06	1.4206	1.54E-05	1.6444	9.77E-06	0.9636	1.41E-06
0.9000	7.08E-06	1.7228	6.74E-06	1.9126	4.03E-06	1.1880	8.42E-07
1.0464	4.65E-06	2.1900	2.52E-06	2.1900	1.44E-06	1.4388	5.10E-07
1.3832	1.96E-06	2.6240	7.00E-07	2.6240	4.16E-07	2.1648	1.59E-07
1.8744	5.99E-07	4.0000	7.31E-08	3.9360	6.69E-08	3.2472	4.28E-08
						4.8708	8.57E-09

As discussed under 6. below, the USGS Hazard Curves, which were plotted in Attachment 1, will be further discretized to provide better estimates of the SCDFs that may be compared to those presented in the NRC Report (Ref. 1).

5. Derive parameters and develop mathematical formulation for all terms used in the SCDF calculations.

Parameters and mathematical formulations were discussed under Item 3. above, as the methodology used to calculate the SCDF was documented. Below, we cover all these parameters and formulations and provide, when appropriate, quantifications for use in the SCDF analyses for comparison against the NRC results.

As mentioned above, the methodology used to calculate the SCDF was incorporated into an EXCEL spreadsheet that contains, in Columns A through H, the parameters and formulations used. It is duplicated below:

A	B	C	D	E	F	G	H
	Annual						
Hazard Curve	Exceedance	Interval	Interval	Interval	Z	Conditional Probability	Probability
Acceleration	Freq		Acceleration (a)	Frequency	ln(a/Am)/βc	of Failure	of Failure

a) Hazard Curve acceleration and annual exceedance frequency - The tabulation above contains in Columns A and B pairs of acceleration values and their corresponding annual exceedance frequency. While a "sample" run using this "raw" data will be presented and discussed below, the curves will be discretized further when calculating SCDFs for comparison with the NRC calculated values.

b) Acceleration interval, the interval acceleration (a) and the interval frequency are calculated values using the Hazard Curve information, as discussed under 3. above.

c) Z-Value - This is a calculated value based on the quantification of the following parameters:

- The interval acceleration (a) - This value is calculated as discussed under 3.
- The Median Capacity (A_m) - When performing analyses using the USGS Hazard Curves and USGS spectra, the median capacities calculated using the 1989 EPRI ground spectra must be modified. As discussed under 2. above, the median capacities to be used for the 1 Hz, 5 Hz, 10 Hz, and PGA SCDF analyses are expressed in terms of C_{50} as follows:

Hazard Curve Frequency (Hz)	**Spectral Ratio**	**Median Capacity Formula**	**Calculated Median Capacity (g)**
PGA	1	1 x C_{50}	0.49
1 Hz	0.50	0.50 x C_{50}	0.245
5 Hz	1.66	1.66 x C_{50}	0.8134
10 Hz	1.55	1.55 x C_{50}	0.7595

- The Composite Uncertainty coefficient (βc) - βc is taken as 0.27, as discussed under 2. above.

d) Conditional Probability of Failure and Probability of Failure - These values are calculated for each of the acceleration intervals (into which the Hazard Curve was discretized), and are contained under Columns G and H of the EXCEL spreadsheet header shown above.

e) Total Probability of Failure (SCDF) - This is a calculated value, equal to the summation of the probabilities of failure calculated for each acceleration interval.

An example of the use of these parameters and formulations for calculating the SCDF using the raw 1 Hz USGS Hazard Curve presented above is presented below:

PNPS	NRC	Probability of Failure Solution				Am - 0.49 x 0.50 0.245	βc 0.27	f 1Hz
A	B	C	D	E	F	G	H	
Hazard Curve Acceleration	Freq.	Interval	Interval Acceleration (a)	Interval Frequency	Z ln(a/Am)/βc	Conditional Probability of Failure	Probability of Failure	
			(A12 + A13)/2	(B12 - B13)		NORMDIST Z = (F12)	E12 x G12	
0.004	1.16E-02		0.005	0.00421	-14.41414925	2.10801E-47	8.87473E-50	
0.006	7.39E-03		0.0076	0.00291	-12.86337023	3.6176E-38	1.05272E-40	
0.0092	4.48E-03		0.0116	0.00191	-11.29723375	6.77083E-30	1.29323E-32	
0.014	2.57E-03		0.01755	0.00117	-9.763719484	8.05673E-23	9.42638E-26	
0.0211	1.40E-03		0.02695	0.000676	-8.175092271	1.4782E-16	9.99262E-20	
0.0328	7.24E-04		0.04115	0.000366	-6.607534383	1.95387E-11	7.15115E-15	
0.0495	3.58E-04		0.0629	0.000187	-5.035970544	2.37717E-07	4.4453E-11	
0.0763	1.71E-04		0.0963	0.0000901	-3.458481081	0.000271615	2.44725E-08	
0.1163	8.09E-05		0.146	0.0000428	-1.917228107	0.027604479	1.18147E-06	
0.1757	3.81E-05		0.225	0.0000202	-0.31539929	0.376229253	7.59983E-06	
0.2743	1.79E-05		0.3445	0.00000969	1.262355111	0.896589483	8.68795E-06	
0.4147	8.21E-06		0.46735	0.00000284	2.391926782	0.991619907	2.8162E-06	
0.52	5.37E-06		0.5814	0.00000182	3.200669547	0.999314457	1.81875E-06	
0.6428	3.55E-06		0.8032	0.00000214	4.397576068	0.999994527	2.13999E-06	
0.9636	1.41E-06		1.0758	5.68E-07	5.479857923	0.999999979	5.68E-07	
1.188	8.42E-07		1.3134	3.32E-07	6.218949123	1	3.32E-07	
1.4388	5.10E-07		1.8018	3.51E-07	7.389937902	1	3.51E-07	
2.1648	1.59E-07		2.706	1.16E-07	8.896179993	1	1.162E-07	
3.2472	4.28E-08		4.059	3.42E-08	10.39790262	1	3.423E-08	
4.8708	8.57E-09		4.8708	8.57E-09	11.07316764	1	8.57E-09	
						Total Prob of Failure	2.56787E-05	

A discussion of the plant level SCDF obtained using the 1 Hz USGS seismic Hazard Curve is presented hereafter, together with a "manual" check of a few of the calculated conditional probabilities of failure.

The upper right hand of the tabulation indicates for the 1 Hz analysis, the median capacity used was Am = 0.245g and the composite βc was 0.27.

Columns A and B, containing the Hazard Curve Accelerations and Annual Exceedance Frequency are identical to the values presented here under 4. above.

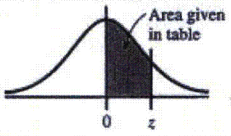
Given the Z value, EXCEL calculated the Conditional Probabilities of failure, tabulated in Column G, using the NORMDIST Z function. A verification of two of the entries is presented below.

Table E The Standard Normal Distribution

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545

Where the table entries represent the area under the curve from the mean to the Z value:

Source: Frederick Mosteller and Robert E. K. Rourke, *Sturdy Statistics*, Table A–1 (Reading, Mass.: Addison-Wesley, 1973). Reprinted with permission of the copyright owners.



For the Z value of -0.315, which is entered for the row showing the acceleration of 0.1757g, we round the value to -0.30 and the area in the table above is 0.1179. Therefore, the conditional probability of failure, which is the area starting from the left tail of the normal distribution to the Z-value, is 0.5, the area under the left half of the distribution plus the tabulated value, less 0.1179 which equals 0.3821. This compares favorably with the NORMDIST Z value of 0.376 (calculated for a z-value of -0.315 rather than 0.30).

For the Z value of 1.262, shown in the row for acceleration 0.2743g, the area from the Normal Distribution Table above is shown as 0.4032. Thus, the conditional probability of failure, (i.e., the area under the normal distribution curve from the left tail to the Z-value) is 0.5 + 0.4032 = 0.9032, which compares favorably to the NORMDIST Z value calculated as 0.89658.

On a different note, the summation of all Probability of Failure entries calculated under Column H for all accelerations under Column A., or 2.57E-05, represents the Total Probability of Failure, or SCDF, for PNPS when considering the USGS 1 Hz Hazard Curve modified for soil conditions. Given the limited number of discretization points for the Hazard Curve, the value differs from the SCDF calculated in the NRC Report (Ref. 1) which, as shown in the excerpt below, is 2.4E-05 for the 1.0 Hz Hazard Curve.

Table D-1. Seismic Core-Damage Frequencies Using 2008 USGS Seismic Hazard Curves.

		Updated USGS								
Plant Name	Docket Number	PGA	10 Hz	5 Hz	1 Hz	max	controlling curve	simple average	IPEEE weighted average	weakest link model
Pilgrim 1	05000293	4.3E-05	6.9E-05	6.2E-05	2.4E-05	6.9E-05	10 Hz	4.9E-05	5.0E-05	6.9E-05

6. Use the methodology and derived parameters and perform risk analyses that duplicate the NRC Report SCDFs for PNPS.

The methodology developed for estimating SCDF given Hazard Curves for different frequencies and the parameters derived under 5. above, were used in conjunction with the USGS Hazard Curves for which the acceleration interval was refined using a log-log interpolation between the raw acceleration data points for a 0.001g interval. Excerpts from the SCDF analyses for the PGA, 10 Hz, 5 Hz, and 1Hz Hazard curves showing the 0.001g discretization and the Total Probability of Failure for each Hazard Curve are presented in Attachment 3.

A summary of the results obtained using the methodology described above, against those reported in the NRC Report, shows full agreement:

PNPS Comparison of Seismic CDF Results with NRC Estimates			
Hazard Curve Frequency	Median Capacity (g)	Seismic CDF	
		NRC (Table D-1)	Simplified Methodology
PGA	0.49	4.3E-05	4.26E-05
10Hz	0.7595	6.9E-05	6.88E-05
5Hz	0.8134	6.2E-05	6.19E-05
1Hz	0.245	2.4E-05	2.40E-05

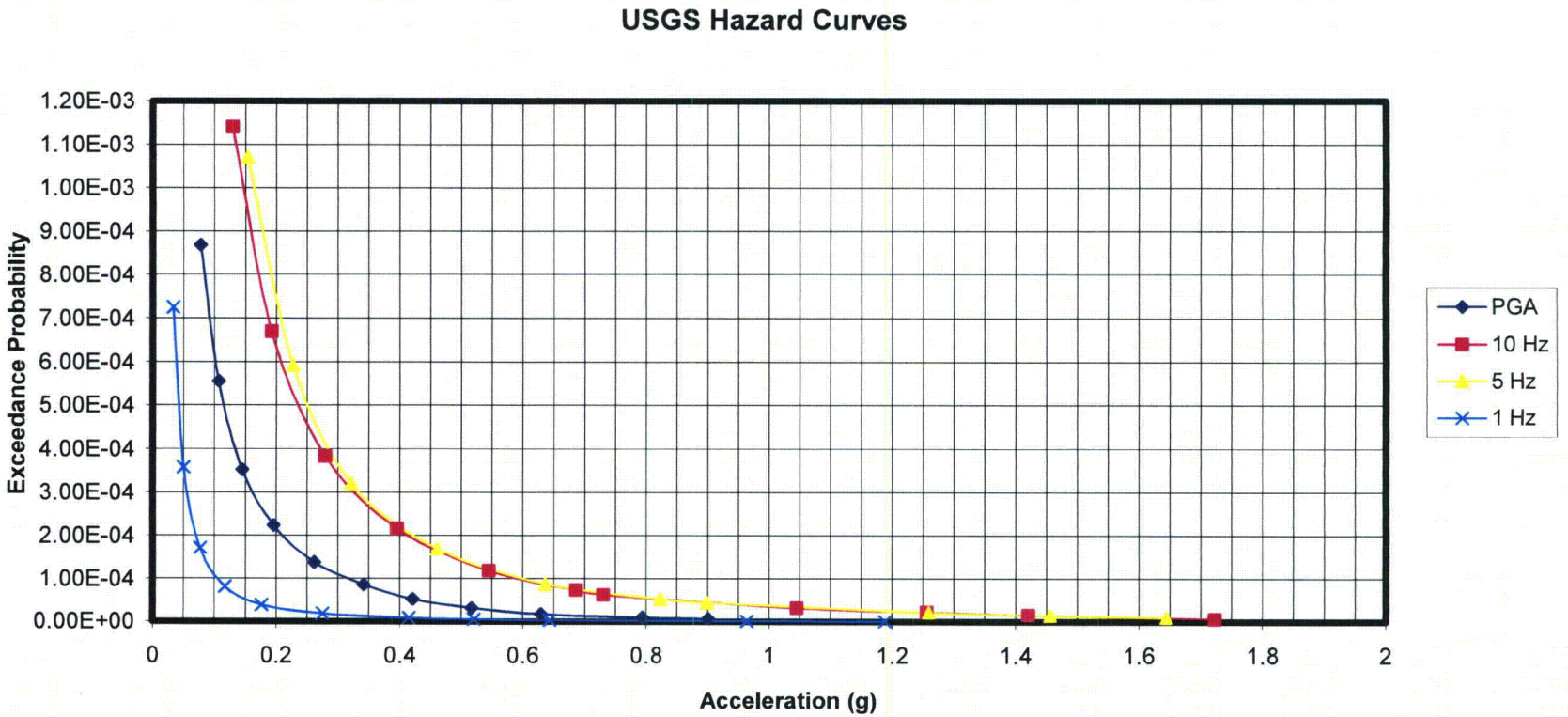
Excerpts from the EXCEL analyses using the USGS Hazard Curves for PGA, 10 Hz, 5 Hz, and 1 Hz are provided in Attachment 2. Due to the rather small acceleration interval of 0.001g, the number of rows is excessive and, as such, only a limited number of acceleration values are excerpted.

The headings of the tabulations list the frequency of the Hazard Curve used (which was discretized to 0.001g intervals), the calculated SCDF for the specific Hazard Curve, and the plant level Median Capacity and βc used.

References:

1. NRC, "Safety/Risk Assessment Results for Generic Issue (GI) 199, Implications of Updated Probabilistic Hazard Estimates in Central and Eastern United States on Existing Plants," dated September 2, 2010 (ADAMS Accession Number ML 100270582)
2. Pilgrim Individual Plant Examination of External Events Report, July 1994.

Attachment 1
USGS Hazard Curves for PNPS


USGS Hazard Curves
Exceedance Probability
1.20E-03
1.10E-03
1.00E-03
9.00E-04
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Acceleration (g)
PGA
10 Hz
5 Hz
1 Hz

ATTACHMENT 2

Excerpts from SCDF Calculations for Various USGS Hazard Curve Frequencies

PGA USGS Hazard Curve 0.001g Intervals			
Total Seismic Core Damage Frequency =			4.26E-05
Plant Median Capacity	0.49		
Plant Composite Uncertainty, βc	0.27		
Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.015	6.76E-03	9.21E-38	5.14E-41
0.016	6.21E-03	1.76E-36	7.34E-40
0.017	5.79E-03	2.71E-35	9.93E-39
0.018	5.42E-03	3.42E-34	1.11E-37
0.019	5.10E-03	3.63E-33	1.06E-36
0.020	4.81E-03	3.31E-32	5.96E-36
0.021	4.63E-03	2.63E-31	8.71E-35
0.022	4.30E-03	1.85E-30	4.12E-34
0.023	4.07E-03	1.16E-29	2.35E-33
0.024	3.87E-03	6.61E-29	1.22E-32
0.025	3.69E-03	3.43E-28	5.80E-32
0.026	3.52E-03	1.64E-27	2.54E-31
0.027	3.36E-03	7.22E-27	1.04E-30
0.028	3.22E-03	2.97E-26	3.06E-30
0.029	3.12E-03	1.15E-25	1.81E-29
0.030	2.96E-03	4.16E-25	4.92E-29
0.031	2.84E-03	1.43E-24	1.57E-28
0.032	2.73E-03	4.65E-24	4.77E-28
0.033	2.63E-03	1.44E-23	1.38E-27
0.034	2.53E-03	4.28E-23	3.84E-27
0.035	2.44E-03	1.22E-22	1.02E-26
0.036	2.36E-03	3.33E-22	2.63E-26
0.037	2.28E-03	8.76E-22	6.52E-26
0.038	2.20E-03	2.23E-21	1.56E-25
0.039	2.13E-03	5.48E-21	4.08E-25
0.040	2.06E-03	1.31E-20	7.34E-25
0.041	2.00E-03	3.03E-20	1.85E-24
0.042	1.94E-03	6.82E-20	3.95E-24
0.043	1.88E-03	1.50E-19	8.21E-24
0.044	1.83E-03	3.20E-19	1.67E-23
0.045	1.78E-03	6.69E-19	3.31E-23

Last rows of the EXCEL spreadsheet are below:

1.870	6.05E-07	1.00E+00	1.26E-09
1.871	6.04E-07	1.00E+00	1.26E-09
1.872	6.02E-07	1.00E+00	1.26E-09
1.873	6.01E-07	1.00E+00	1.75E-09
1.874	5.99E-07	1.00E+00	5.99E-07

10 Hz USGS Hazard Curve 0.001g Intervals	
Total Seismic Core Damage Frequency =	**6.88E-05**

Plant Median Capacity	0.7595
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.018	1.04E-02	2.25E-43	1.48E-46
0.019	9.78E-03	3.28E-42	1.56E-45
0.020	9.31E-03	4.03E-41	1.74E-44
0.021	8.88E-03	4.26E-40	1.67E-43
0.022	8.48E-03	3.93E-39	1.41E-42
0.023	8.13E-03	3.20E-38	1.05E-41
0.024	7.80E-03	2.33E-37	7.08E-41
0.025	7.49E-03	1.54E-36	4.31E-40
0.026	7.21E-03	9.23E-36	1.35E-39
0.027	7.07E-03	5.08E-35	1.94E-38
0.028	6.68E-03	2.59E-34	6.25E-38
0.029	6.44E-03	1.23E-33	2.76E-37
0.030	6.22E-03	5.43E-33	1.14E-36
0.031	6.01E-03	2.26E-32	4.44E-36
0.032	5.81E-03	8.87E-32	1.63E-35
0.033	5.63E-03	3.30E-31	5.71E-35
0.034	5.45E-03	1.17E-30	1.90E-34
0.035	5.29E-03	3.93E-30	6.05E-34
0.036	5.14E-03	1.27E-29	1.84E-33
0.037	4.99E-03	3.92E-29	5.39E-33
0.038	4.85E-03	1.17E-28	1.83E-32
0.039	4.70E-03	3.34E-28	3.41E-32
0.040	4.59E-03	9.25E-28	1.14E-31
0.041	4.47E-03	2.48E-27	2.89E-31
0.042	4.36E-03	6.43E-27	7.15E-31
0.043	4.24E-03	1.62E-26	1.71E-30
0.044	4.14E-03	3.97E-26	4.00E-30
0.045	4.04E-03	9.46E-26	9.12E-30
0.046	3.94E-03	2.20E-25	2.02E-29
0.047	3.85E-03	4.99E-25	4.40E-29
0.048	3.76E-03	1.11E-24	9.33E-29

Last rows of the EXCEL spreadsheet are shown below

3.996	7.35E-08	1.00E+00	9.85E-11
3.997	7.34E-08	1.00E+00	9.83E-11
3.998	7.33E-08	1.00E+00	9.82E-11
3.999	7.32E-08	1.00E+00	9.80E-11
4.000	7.31E-08	1.00E+00	7.31E-08

5 Hz USGS Hazard Curve 0.001g Intervals

Total Seismic Core Damage Frequency =	6.19E-05

Plant Median Capacity	0.8134
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.021	1.31E-02	1.42E-41	5.12E-45
0.022	1.28E-02	1.36E-40	8.33E-44
0.023	1.21E-02	1.16E-39	6.45E-43
0.024	1.16E-02	8.77E-39	4.48E-42
0.025	1.11E-02	6.00E-38	2.82E-41
0.026	1.06E-02	3.73E-37	1.62E-40
0.027	1.02E-02	2.13E-36	8.53E-40
0.028	9.77E-03	1.12E-35	4.16E-39
0.029	9.40E-03	5.48E-35	1.89E-38
0.030	9.05E-03	2.50E-34	8.07E-38
0.031	8.73E-03	1.07E-33	3.17E-37
0.032	8.44E-03	4.34E-33	1.34E-36
0.033	8.13E-03	1.66E-32	4.70E-36
0.034	7.85E-03	6.03E-32	1.60E-35
0.035	7.58E-03	2.09E-31	5.21E-35
0.036	7.33E-03	6.91E-31	1.62E-34
0.037	7.10E-03	2.19E-30	4.85E-34
0.038	6.87E-03	6.68E-30	1.40E-33
0.039	6.67E-03	1.96E-29	3.87E-33
0.040	6.47E-03	5.56E-29	1.04E-32
0.041	6.28E-03	1.52E-28	2.70E-32
0.042	6.10E-03	4.04E-28	6.79E-32
0.043	5.94E-03	1.04E-27	1.66E-31
0.044	5.78E-03	2.60E-27	3.96E-31
0.045	5.62E-03	6.34E-27	9.18E-31
0.046	5.48E-03	1.50E-26	2.72E-30
0.047	5.30E-03	3.48E-26	3.35E-30
0.048	5.20E-03	7.87E-26	1.07E-29
0.049	5.07E-03	1.74E-25	2.26E-29
0.050	4.94E-03	3.77E-25	4.67E-29
0.051	4.81E-03	7.99E-25	9.47E-29

Last rows of the EXCEL spreadsheet are shown below:

3.932	6.72E-08	1.00E+00	7.70E-11
3.933	6.71E-08	1.00E+00	7.69E-11
3.934	6.70E-08	1.00E+00	7.68E-11
3.935	6.69E-08	1.00E+00	7.67E-11
3.936	6.69E-08	1.00E+00	6.69E-08

Attachment 3

Revised SCDF for PNPS Using USGS & EPRI Hazard Curves

Re-assessment of Pilgrim Seismic Core Damage Frequency

Prepared by: Paul Baughman, PE

Reviewed by: Dan Nuta, PE
John Bretti

Assessment of the Effect of Identified Conservatisms on the SCDF Estimates Obtained Using the USGS Hazard Curves.

Seismic core damage frequency analyses using the 2008 USGS Seismic Hazard Curves used by NRC for 1 Hz, 5 Hz, 10 Hz, and PGA, discretized to acceleration intervals of 0.001g by log-log interpolation, were performed using fragilities adjusted for identified conservatisms. The analyses consist of convolving the USGS Hazard Curves for different frequencies with the various fragilities.

A description of the analyses performed is as follows:

Analyses Series 1 - NRC plant-level fragility, Am = 0.49g and $\beta c = 0.27$, with $m_{10} = 1.55$, $m_5 = 1.66$, and $m_1 = 0.5$.

Analyses Series 2 - Entergy revised fragility, Am = 0.57g, and $\beta c = 0.23$. This fragility reflects changes in the plant model, plant modifications and removal of conservatism in fragilities.

Analyses Series 3 - Entergy SHIP-adjusted revised fragility, Am = 0.63g, and $\beta c = 0.34$. This fragility reflects adjustment of the Entergy revised plant-level fragility so that the SCDF using the PGA hazard curve matches the SHIP-calculated SCDF.

Results from the analyses are presented below.

Analysis Series →		1	2	3
Hazard Curve Frequency	NRC Reported SCDF Estimates	Entergy SCDFs Am = .49g βc = .27	Entergy SCDFs Am = .57g βc = .23	Entergy SCDFs Am = .63g βc = .23
PGA	4.3E-05	4.26E-05	2.78E-05	2.14E-05
10 Hz	6.9E-04	6.88E-04	4.88E-05	3.98E-05
5 Hz	6.2E-05	6.19E-05	4.36E-05	3.53E-05
1 Hz	2.4E-05	2.40E-05	1.79E-05	1.49E-06

Assessment of the Effect of Identified Conservatisms on the SCDF Estimates Obtained Using the EPRI Updated Hazard Curves.

Seismic core damage frequency analyses using updated hazard curves developed by EPRI for 1 Hz, 10 Hz, and PGA, discretized to acceleration intervals of 0.001g by log-log interpolation, were performed using fragilities adjusted for identified conservatisms. The analyses consist of convolving the EPRI updated hazard curves for different frequencies with the various fragilities

A description of the analyses performed is as follows:

Analyses Series 1 - NRC fragility values, Am = 0.49g and $\beta c = 0.27$, with $m_{10} = 1.55$, $m_5 = 1.66$, and $m_1 = 0.5$.

Analyses Series 2 - Entergy revised fragility, Am = 0.57g, and $\beta c = 0.23$. This fragility reflects changes in the plant model, plant modifications and removal of conservatism in fragilities.

Analyses Series 3 - Entergy SHIP-adjusted revised fragility, Am = 0.82g, and $\beta c = 0.34$. This fragility reflects adjustment of the Entergy revised plant-level fragility so that the SCDF using the PGA hazard curve matches the SHIP-calculated SCDF.

Results from the analyses are presented below.

Analysis Series →		1	2	3
Hazard Curve Frequency	NRC Reported SCDF USGS-Based Estimates	Entergy SCDFs Am = .49 βc = .27	Entergy SCDFs Am = .57 βc = .23	Entergy SCDFs Am = .82g βc = .23
PGA	4.3E-05	3.11E-05	2.54E-05	1.46E-05
10 Hz	6.9E-04	2.74E-05	2.20E-05	1.22E-05
5 Hz	6.2E-05	n/a	n/a	n/a
1 Hz	2.4E-05	1.87E-06	1.29E-06	5.57E-07

Attachment 4

Revised Calculations for Identified Low Capacity Components

Revised Calculations for Identified Low Capacity Components

Prepared by: Paul Baughman

Reviewed by: Dragos Nuta

This attachment shows the calculations done in revising the fragilities of identified low capacity components.

Background

The low capacity components to be examined for conservatism in the fragilities were identified by running the SHIP program and successively increasing the median capacity of each component to 2g, well above the surrogate element capacity. Note that the term "component" refers to a component event of the SPRA systems model, not necessarily a component in the plant.

For each component in the list, the basis for fragility is examined, to the extent possible in a limited amount of time, for excess conservatism in the median capacity. The median capacity will then will be revised to account for the removal of the conservatism.

The table below shows the components that were identified for investigation, ranked by potential reduction in risk. The table gives the fragility values used in the original SPRA. Median refers to the median capacity of the component in terms of peak ground acceleration. Beta-c refers to the composite variability. HCLPF refers to the high confidence of low probability of failure capacity.

Revised Calculations for Identified Low Capacity Components

Number	Name	Median	Beta-C	HCLPF	Component Description
5	ELOSPXXXXZ	0.35	0.55	0.141	LOSS OF OFFSITE POWER
28	EFN204ABXZ	0.61	0.46	0.286	QUAD ROOM COOLER FANs 204A/B FAILURE
29	EFN204CDXZ	0.61	0.46	0.286	QUAD ROOM COOLER FANs 204C/D FAILURE
3	ERE18781IZ	0.25	0.597	0.065	SEISMICALLY INDUCED CHATTER OF RELAY 187-801A
6	ERE132X9IZ	0.55	0.597	0.142	SEISMICALLY CORRELATED RELAY CHATTER OF 132-509 AND 609
7	ERE159X9IZ	0.55	0.597	0.142	SEISMICALLY CORRELATED RELAY CHATTER OF 159-509 AND 609 (1 AND 2)
36	EBW209/0XZ	0.82	0.46	0.384	BLOCK WALL 209.0 FAILS
35	EBDDGBLDXZ	0.77	0.46	0.36	DIESEL GENERATOR BUILDING FAILS
45	EBW45/3XXZ	1.07	0.46	0.501	BLOCK WALL 45.3 FAILS
33	EBSA8XXXXZ	0.96	0.47	0.323	A8 BUS FAILURE
37	EBSB2XXXXZ	0.84	0.46	0.393	SEISMICALLY INDUCED FAILURE OF BUS B2
43	EPM184AXXZ	1.05	0.46	0.492	BODG FUEL OIL PUMP P184 FAILURE
13	ERE16059IZ	0.89	0.597	0.23	SEISMICALLY CORRELATED RELAY CHATTER OF 160-509
14	ERE18159IZ	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF RELAY 181-509
15	ERE18759IZ	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF RELAY 187-509
16	ERE27A5XIZ	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF RELAY 127-A5X
32	EDLGEABXXZ	1.39	0.654	0.32	SEISMICALY INDUCED DIESEL GENERATOR A/B CORELATED FAILURE
42	EFN207A-DZ	1.01	0.46	0.473	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY
23	ERE15169IZ	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF 151V-609/A,B,C
24	ERE16069IZ	1.04	0.597	0.269	SEISMICALLY CORRELATED RELAY CHATTER OF 160-609
25	ERE18169IZ	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF RELAY 181-609
26	ERE18769IZ	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF RELAY 187-609
27	ERE27A6XIZ	1.04	0.597	0.269	SEISMICALLY INDUCED CHATTER OF RELAY 127-A6X
44	EFNDWCOOLZ	1.06	0.46	0.496	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS
17	ERE32801IZ	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 132-801A
18	ERE51N81IZ	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 151N-801A
19	ERE51NG8IZ	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 151NG-801A
20	ERE51V81IZ	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 151V-801A
21	ERE59801IZ	1	0.597	0.258	SEISMICALLY INDUCED CHATTER OF RELAY 159-801A
31	ERE2352XIZ	1.2	0.597	0.31	SEISMICALLY CORRELATED RELAY CHATTER OF 23A-K52A AND B
46	EFN201ABXZ	1.23	0.46	0.576	HPCI ROOM COOLING FANs VAC201A/B FAILURE
47	EFN202ABXZ	1.23	0.46	0.576	VAC202A&B FAIL RBCCW PRESSURE BOUNDARY
48	EFN203ABXZ	1.23	0.46	0.576	CRD QUAD ROOM COOLING FANS VAC 203A/B FAILURE
49	ECMK103ABZ	1.28	0.46	0.599	DIESEL STARTING AIR COMPRESSORS K103A/B CORRELATED FAILURE
50	EPM141ABXZ	1.28	0.46	0.599	DIESEL FUEL OIL PUMPS P-141A/B FAILURE
51	EVPEABXXXZ	1.28	0.46	0.599	DG A & B SEIS CORREL FUEL OIL PRESSURE REG VALVE E FAILURE
52	EVRCABXXXZ	1.28	0.46	0.599	DG A & B SEISMICALLY CORRELATED FUEL OIL RELIEF VALVE C FAIL
53	EVS4565CDZ	1.28	0.46	0.599	DIESEL AIR PSV4565C AND D SEISMIC CORRELATION FAILURE
22	ERE12769IZ	1.04	0.597	0.269	SEISMICALLY CORRELATED CHATTER OF RELAY 127-609 AND 159N-609
30	ERE1425BIZ	1.14	0.597	0.295	SEISMICALLY INDUCED CHATTER OF 420-1846
34	ERE18681IZ	1.34	0.597	0.346	SEISMICALLY INDUCED CHATTER OF RELAY 186-801A
38	ERE2759XIZ	1.55	0.597	0.401	SEISMICALLY INDUCED CHATTER OF 127-509X
39	ETKT105ABZ	0.94	0.46	0.44	CSTs T105A/B FAILURE
40	EBW210/0XZ	1.65	0.572	0.441	BLOCK WALL 210.0 FAILS
41	EBW195/23Z	1	0.46	0.468	BLOCKWALL 195.23 FAILS
4	ETK105ABNZ	0.16	0.46	0.075	CST 105 A/B FAILS DUE TO N2 TANK INTERACTION
8	ERE40801IZ	0.67	0.597	0.173	SEISMICALLY INDUCED CHATTER OF RELAY 140-801A
9	ERE46801IZ	0.67	0.597	0.173	SEISMICALLY INDUCED CHATTER OF RELAY 146-801A
10	ERE1865XIZ	0.73	0.597	0.189	SEISMICALLY INDUCED CHATTER OF RELAY 181-5X
12	ERE15159IZ	0.89	0.597	0.23	SEISMICALLY INDUCED CHATTER OF 151V-509/A,B,C
1	EISLOCACSZ	0	0.46	0	SEISMICALLY INDUCED CORE SPRAY PIPE RUPTURE
2	EISLOCRHRZ	0	0.46	0	SEISMICALLY INDUCED RHR PIPING RUPTURE
11	ERE12759IZ	0.89	0.597	0.23	SEISMICALLY CORRELATED CHATTER OF RELAY 127-509 AND 159N-509
54	EBW198/1XZ	3.43	0.792	0.607	BLOCK WALL 198.1 FAILS
55	EBW198/2XZ	3.43	0.792	0.607	BLOCK WALL 198.2 FAILS

Identification of Conservatism

There are four groups of components in the table above whose median capacities can be modified:

1. Component failures that can be eliminated from the model
2. Relay chatter failures
3. Block wall failures
4. Other component failures

Component Failures that can be Eliminated from the Model

The first component in the table above, LOSS OF OFFSITE POWER, cannot be changed without further research. The next two components, QUAD ROOM COOLER FANs 204A/B FAILURE and QUAD ROOM COOLER FANs 204C/D FAILURE are no longer required to be in the model due to systems consideration. EFN201ABXZ and EFN203ABXZ—CRD, quad coolers and HPCI room coolers, are also not required. EKT105ABNZ, CST 105 A/B fails due to N2 tank interaction, is also not required because the N2 tank anchorage has been upgraded, eliminating the interaction. These components are not examined further. The median capacities of these components are set to 2g in order to effectively eliminate them from contribution to risk.

Relay Chatter Failures

Two relay fragilities were revised, ERE132X9!Z and ERE159X9!Z. The relay fragility calculations are documented in C-015 (Stevenson & Associates, C-015: Relay Fragility Analysis for Seismic PRA (BECo SUDDS/RF 94-10)).

ERE132X9!Z (Relays 132-509 and 132-609):

The properties of ERE132X9!Z (132-509 and 132-609) from C-015 are shown below (from C-015). 132-609 is the same.

Relay #	Basic Event	Panel	Loc.	Mfgr	Model #	GERS Values (g) Peak	above 33	Median Fragility (Peak) - g	Median Fragility (ZPA) - g	Lesser Fragility (g)
DCFT1(A)	EREDCFTA!Z	C101	DG 23	Agastat	2412PD	12.5	5	2.76	2.79	2.76
132-509	ERE13259!Z	C101	DG 23	West	CRN-1	Use A-46 demand	Use A-46 demand	0.55	0.55	0.55

Revised Calculations for Identified Low Capacity Components

The fragility for relay 132-509 was not based on a GERS (Generic Equipment Ruggedness Spectrum, from EPRI NP-7147-SL, "Seismic Ruggedness of Relays," August 1991, and supplements); rather, it was based on just meeting the A-46 (NRC, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," Generic Letter 87-03, February 1987) capacity requirement. A GERS now exists for the Westinghouse CRN-1 relay. It is in Group 18 of EPRI NP-7147-SL, "Seismic Ruggedness of Relays," V2, Addendum 2. The GERS data for Group 18 is presented below. Fragility level refers to the spectra acceleration in the 4-16 Hz range for which the relay contacts will not chatter. There are four relay contact states: non-operate (de-energized) and operate (energized), and, for each of those, NO (normally open) and NC (normally closed). The GERS fragility level is given for each contact state. The ZPA acceleration is 60% of the 4-16 Hz acceleration per EPRI NP-7147-SL.

Table 2-1
Test Fragility Levels for Relay Test Groups 13 through 20 (continued)

Test Group 16 - Model[2]		Fragility[1] Level			
		Non-Operate		Operate	
		NO	NC	NO	NC
GE	12IAC68K HDI	10	NA	2	NA
	STDI	7	NA	7	NA
	INTOC	5	NA	10	NA
ASCO	214A	10	10	10	10
GE	CR120C	10	10	10	10
PB	JR	10	10	10	10
GE	12HGA14B	6	NR	4	10
GE	12HFA151A (250 VDC)	8	NA	NA	NA
GE	12JCV51	8	NA	10	NA
Test Group 17 - Model[2]					
Micro	RYCA40	5	NA	10	NA
WL	4471	4	NA	10	NA
CH	D40	10	10	10	10
W	CV-2	NA	8	NA	8
W	CV-5	8	NA	8	NA
AEMCO	156	10	10	10	10
Test Group 18 - Model[2]					
GE	12IAV59L	10	7	2	10
W	CRN-1	7	NA	5	NA
SQD	9060-B	10	10	10	10
ASCO	2506	9	NA	10	NA
PB	CS	10	10	10	10
AB	849	10	10	10	10

The entry for these relays from the A-46 Essential Relay List is shown below. The far right columns give the operational state.

118	132-509	C101	ES	OL2	DG A	23'0"	Westinghouse	CRN-1	589 E40/E7	A509	NO	No
119	132-609	C102	ES	OL2	DG B	23'0"	Westinghouse	CRN-1	590 E40/E7	A609	NO	No

The list above shows the relay state is normally open (NO) and de-energized (No in far right column). Therefore, the GERS fragility level is 7g. The ZPA level is 60% of this, or 4.2g.

The GERS accelerations are converted to median capacities for Pilgrim using scale factors. The table of scale factor from C-015 is shown below.

	SPRA @ 0.4g				MCC Type		Control Benchboard		Switchgear Type	
Location	EW Peak	EW ZPA	NS Peak	NS ZPA	Peak	ZPA	Peak	ZPA	Peak	ZPA
DG23	0.782	0.320	0.802	0.305	0.262	0.657	0.222	0.557	0.167	0.418
GND23	0.724	0.400	0.724	0.400	0.290	0.525	0.246	0.446	0.185	0.334
RB23	0.318	0.211	0.330	0.195	0.692	1.083	0.587	0.919	0.441	0.689
RW23	0.517	0.214	0.489	0.207	0.442	1.068	0.375	0.906	0.281	0.679
RW37	0.530	0.216	0.497	0.259	0.431	0.882	0.366	0.748	0.274	0.561
TB23	0.538	0.268	0.483	0.267	0.425	0.852	0.360	0.723	0.270	0.542
TB37	0.629	0.276	0.611	0.281	0.363	0.813	0.309	0.690	0.231	0.517

The panel C101 is a control benchboard at location DG23. Therefore, the median capacity, per the table above, is the lesser of 0.222 times the 4-16 Hz spectral acceleration or 0.557 times the ZPA acceleration. Considering the GERS for the Westinghouse CRN-1 these calculations are:

0.222 x 7.0g = 1.55g
0.557 x 4.2g = 2.34g

Therefore, the median capacity of ERE132X9!Z is 1.55g.

ERE159X9!Z (Relays 159-509 and 159-609):

The panel and location of the 159-509 and 160-509 are shown below (from C-015):

Relay #	Basic Event	Panel	Loc.	Mfgr	Model #	GERS Values (g) Peak	above 33	Median Fragility (Peak) - g	Median Fragility (ZPA) - g	Lesser Fragility (g)
DCFT1(A)	EREDCFTA!Z	C101	DG 23	Agastat	2412PD	12.5	5	2.78	2.79	2.78
132-509	ERE13259!Z	C101	DG 23	West	CRN-1	Use A-46 demand	Use A-46 demand	0.55	0.55	0.55
159-509 1&2	ERE15959!Z	C101	DG 23	GE	SV	Use A-46 demand	Use A-46 demand	0.55	0.55	0.55
DCFT1(B)	EREDCFTB!Z	C102	DG 23	Agastat	2412PD	12.5	5	2.78	2.79	2.78
132-609	ERE13269!Z	C102	DG 23	West	CRN-1	Use A-46 demand	Use A-46 demand	0.55	0.55	0.55
159-609 1&2	ERE15969!Z	C102	DG 23	GE	SV	Use A-46 demand	Use A-46 demand	0.55	0.55	0.55

As reported by PNPS personnel, ERE159X9!Z has been changed to a ABB 59N relay. This relay has been qualified by ABB Report RC 5139-B (BECo SUDDS/RF 96-16).

Revised Calculations for Identified Low Capacity Components

The cover of the seismic qualification report is shown below.

ASEA BROWN BOVERI	SEISMIC QUALIFICATION REPORT	Number: RC-5539
		Page: 1 of 4
Title: 27N UNDERVOLTAGE RELAY		Date: 10/19/89
		Prep. by: R. Conrad

Test Model : Cat. # 211T4175

Test Procedure : Per ABB Specification RC-2051-B to meet the requirements of ANSI C37.98 (IEEE-501-1978).

Test Facility : NTS, Acton Division, Acton, Mass.

Documentation : NTS/ACTON report 18333-83N
Relay Settings and Status Monitoring (Page 2)
Test Response Spectra (Page 3)

Testing : A broad-band, multi-frequency vibration, of 30 seconds duration, imposed biaxial at 45°, in four orientations:

1) Left-to-right
2) Front-to-back
3) Right-to-left
4) Back-to-front

For each orientation, the relay status is tested and monitored in three functional states:

1) Non-operating (i.e. not picked up, etc.)
2) Operated (i.e. tripped, etc.)
3) Transitional

The required combinations total 12 full-level tests.

Results : No fragility or mis-operation was found within the 6g ZPA limitation of the actuator.

Notes : The biaxial motion produces an acceleration with equal vertical and horizontal components, thus yielding a total ZPA of 8.5g at 45°. The TRS shows the vertical component, as analyzed at one third octave intervals between 1 and 100 Hz. The analysis is shown for damping factors of 5, 3, 2, and 1%.

Generic : Other relays qualified by this test series:

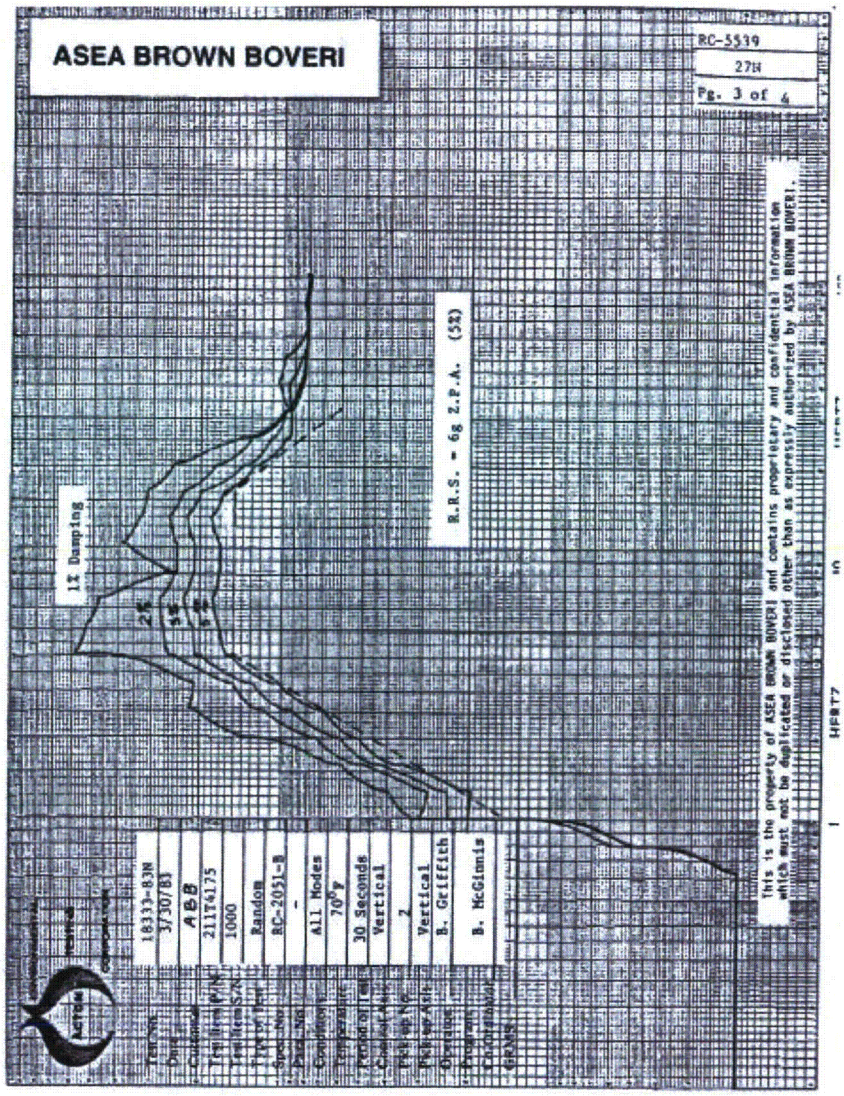
All ABB type 27N relays, series 211T
All ABB type 59N relays, series 211U

Test case models are also qualified by this report in conjunction with supplementary tests (Acton 24839-89N, 5/25/88), using test levels equal to or greater than the TRS shown on page 3 of this report:

All ABB type 27N relays, series 411T
All ABB type 59N relays, series 411U

Revised Calculations for Identified Low Capacity Components

The Test Response Spectra are shown below:



The ZPA of the TRS is 6g and the 4-16 Hz range is 2.5 x 6g = 15g. This applies to all operating states.

To be conservative, the 4-16 Hz range will be taken as 10g and used to obtain the median capacity. The 5%-damped TRS plot shown in the report has a peak spectral acceleration of 15g, but the test was a bi-axial test performed with the specimen mounted at 45 degrees. It is not clear if the TRS has been adjusted for this, so be conservative it is de-rated by a factor of 1.4, giving about 10g. The ZPA will likewise be de-rated to 4g. This is sufficient to give a good median capacity.

The panel and location of the 159-509 and 160-509 are (from C-015) C101 and C102. These are control benchboards located at DG23. The median capacity is lesser of 0.222 times the 4-16 Hz acceleration of 10g, or 0.557 times the ZPA.

0.222 x 10g = 2.22g
0.557 x 4g = 2.23g

Therefore, the median capacity is 2.22g.

Block Wall Failures

The fragility calculations for block walls are documented in Stevenson & Associates, C-017: Estimated Fragilities for Blockwalls for Pilgrim Station Seismic PRA (BECo SUDDS/RF 94-10).

The following summary of results is from C-017:

Summary of Results

Building	Elevation	Wall No.	Initial Estimation A_m(SSE)[1]	Seismic Fragility (A_m)
Intake Structure	21'-6"	45.01	0.67 g	0.67 g
	21'-6"	45.02	0.66 g	2.39 g
	21'-6"	45.03	0.66 g	1.07 g
Reactor Building	51'-0"	64.05	0.65 g	0.72 g
	51'-0"	65.06	0.65 g	3.82 g
	74'-3"	66.22	0.49 g	2.92 g
	74'-3"	66.24	0.49 g	2.92 g
Reactor Aux. Bay	3'-0"	185.01	0.86 g	1.41 g
Radwaste Building	23'-0"	194.22	0.49 g	3.33 g
	37'-0"	195.23	0.42 g	1.0 g
Diesel Generator Building	23'-0"	198.00	0.32 g	2.29 g
	23'-0"	198.01	0.32 g	0.55 g*
	23'-0"	198.02	0.32 g	0.56 g*
	23'-0"	198.03	0.32 g	2.29 g
Turbine Building	23'-0"	209.00	0.49 g	0.82 g
	23'-0"	209.01	0.49 g	1.72 g
	37'-0"	210.00	0.42 g	0.54 g*
	37'-0"	210.01	0.42 g	1.84 g*
	37'-0"	210.02	0.42 g	2.35 g
	37'-0"	210.03	0.42 g	0.54 g

NOTE: Fragility analysis for blockwalls 198.01, 198.02, 210.00 and 210.01 superseded by detailed fragility analysis in calculation 91C2672-C012

Block walls 45.03, 209.00 and 195.23 had fragilities obtained by factoring the IE 80-11 (NRC, "Masonry Wall Design," IE Bulletin 80-11, May 1980) results. Note that these walls are labeled 45.3, 209.0 and 195.23 in SPRA fragility table.

The block walls 45.03, 210.00 and 195.23 have fragilities calculated by factoring the A-46 anchorage calculation. The following is from C-017:

> To convert a $HCLPF_{84}$ value to a median capacity two variables $\beta_c = 0.40$ and $\beta_m = 0.20$ are used as discussed on pages 3-4, 5-5, 5-6 of Ref. 3. Then the median capacity (Ac) is calculated according to pages 2-22 and 2-23 of Ref. 3:
>
> $$A_c = (HCLPF_{84}) \frac{e^{2.33\beta_c}}{e^{2.33\beta_m}} \times \text{Amplification Factor} \qquad \text{EQ 1}$$
> $$= 0.15g \times 2.1 \times 2.1 = 0.66\ g$$
>
> S&A performed Soil Structure Interaction for the Pilgrim Station using a reference peak ground acceleration of 0.4g (Ref. 1). The resulting floor spectra from this analysis establish the relationship between spectral accelerations on building floors, and a 0.4g PGA seismic input using the SPRA spectral shape. On the basis of this analysis, the median fragilities of blockwalls (i.e. the A_m values) can be calculated by ratioing the spectral ordinate $S_{a(SPRA)}$ of the appropriate response spectrum anchored to SPRA PGA = 0.4 g to the median capacity A_c = 0.66 g:
>
> $$A_m(SSE) = \frac{Ac}{S_{a(SPRA)}} \times 0.4g \qquad \text{EQ 2}$$

The 2.1 Amplification Factor is explained below:

> For conservative estimation of the $HLCPF_{84}$ values for the blockwalls the factor of 2.1 is employed. This factor represents approximation of the ratio of spectral peak acceleration over ZPA value at ground level.

C-017 contains a table of amplification factors based on building and elevation, shown below:

Location	7% Damped Peak	Amplification Factor
Diesel Generator El 23'-0"	0.39g	2.60
Intake Structure El 21'-6"	1.23g	8.20
Reactor Building El 51'-0"	1.48g	9.87
Reactor Building El 3'-0"	0.61g	4.07
Radwaste El 23'-0"	1.35g	9.00
Radwaste El 37'-0"	0.67g	4.47
Turbine Building El 23'-0"	1.35g	9.00
Turbine Building El 37'-0"	1.89g	12.60

Wall 45.03 is at Intake Structure El. 21'6". The amplification factor is 8.20. Wall 195.23 is at Radwaste Building El. 37'-0". The amplification factor is 4.47. Wall 209.00 is at Turbine Building El. 23'-0". The amplification factor is 9.00. These amplification factors could have been used instead of 2.1.

The initial median capacity Am(SSE) was calculated assuming the wall had a capacity/demand ration of 1.0 under the SSE seismic demand in the 80-11 evaluation. The final seismic fragility median capacity Am was calculated by factoring the initial capacity by the actual capacity/demand ratio in the 80-11 calculation. These calculations are shown in C-017. No excess conservatism was noted in the 80-11 capacity/demand factor.

There are two sources of conservatism in these block wall fragilities. The first is the reduction for the peak-to-valley variability in the ground response spectra. For the block walls, this factor is 1/1.35. The USGS and updated EPRI Hazard Curves include this variability; therefore, it should not be included in the fragility calculation. This means that the median capacities can be increased by 35%. The second source is the building amplification factor. A multiplying factor of 2.1 was used for all of the walls in C-017, yet table of building amplification factors on Page 5 of C-017 gives amplification factors between 2.6 and 12.6. For the three block walls 45.03, 209.00 and 195.23 the building amplification factors vary from 4.47 to 9.00, which are 2.12 and 4.29, respectively, times the 2.1 factor used in the fragility calculation. Thus, the median capacities can be multiplied by a factor of at least 2. Multiplying the C-017 fragilities by 2, and also by 1.35, results in median capacities for the three block walls above 2g. For the purpose of this evaluation a median capacity of 2g is used.

Other Component Failures

There are many components with a composite variability of 0.46. This indicates that the fragility was derived by factoring the USI A-46 anchorage capacity. These components are candidates for removing conservatism. Fragilities of components with composite uncertainty different than 0.46 were obtained by full fragility analysis. These are not examined for conservatism. Note that the standard composite uncertainty for relays is 0.597 rather than 0.46.

The following components had median capacities based on factoring the A-46 anchorage calculations.

Revised Calculations for Identified Low Capacity Components

Number	Name	Median	Beta-C	HCLPF	Component Description
35	EBDDGBLDXZ	0.77	0.46	0.36	DIESEL GENERATOR BUILDING FAILS
37	EBSB2XXXXZ	0.84	0.46	0.393	SEISMICALLY INDUCED FAILURE OF BUS B2
43	EPM184AXXZ	1.05	0.46	0.492	BODG FUEL OIL PUMP P184 FAILURE
42	EFN207A-DZ	1.01	0.46	0.473	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY
44	EFNDWCOOLZ	1.06	0.46	0.496	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS
49	ECMK103ABZ	1.28	0.46	0.599	DIESEL STARTING AIR COMPRESSORS K103A/B CORRELATED FAILURE
50	EPM141ABXZ	1.28	0.46	0.599	DIESEL FUEL OIL PUMPS P-141A/B FAILURE
51	EVPEABXXXZ	1.28	0.46	0.599	DG A & B SEIS CORREL FUEL OIL PRESSURE REG VALVE E FAILURE
52	EVRCABXXXZ	1.28	0.46	0.599	DG A & B SEISMICALLY CORRELATED FUEL OIL RELIEF VALVE C FAIL
53	EVS4565CDZ	1.28	0.46	0.599	DIESEL AIR PSV4565C AND D SEISMIC CORRELATION FAILURE
39	ETKT105ABZ	0.94	0.46	0.44	CSTs T105A/B FAILURE

The following excerpt from section 3.1.4.2 of the PNPS IPEEE submittal describes the process of factoring up a HLPLF to get the median capacity. The process used a factor of 1.35 to account for peak-to-valley variability. This can be removed if the seismic hazard analysis accounts for this, which the 2008 USGS and 2010 EPRI seismic hazard analyses do.

Using these conservative seismic capacities in median fragility analysis requires a two step process using the recommendations of Ref. 3-10. The first step adjusts for the variability of the definition of the seismic ground motion input. The seismic margins approach uses a ground motion spectral shape that represents an 84% non-exceedance level, whereas seismic fragility analysis uses a median or 50% non-exceedance level. The first conversion adjusts an SMA HCLPF (a $HCLPF_{84}$) to median equivalent (a $HCLPF_{50}$) as:

$$HCLPF_{50} = \frac{HCLPF_{84}}{e^{\beta_{rs}}} \cong \frac{HCLPF_{84}}{1.35}$$

where:

β_{rs} = Response spectrum logarithmic standard deviation (taken at 0.3 for East Coast sites).

The resulting value of the $HCLPF_{50}$ corresponds to the 5% probability of failure on the 95% confidence interval. The second conversion moves from the $HCLPF_{50}$ to the median capacity point, or the 50% probability of failure on the 50% confidence interval as:

$$C_m = \frac{HCLPF_{50}}{e^{-2.3\beta_c}} = \frac{HCLPF_{50}}{0.35}$$

Where:

C_m = Median in-structure seismic capacity
β_c = Combined uncertainty = 0.46 for this project.

Combining these two steps into a single equation results in the direct relationship between $HCLPF_{84}$ and median capacity as:

$$C_m = \frac{HCLPF_{84}}{e^{\beta_{rs}-2.3\beta_c}} \cong 2.1 \times HCLPF_{84}$$

Seismic capacities (A_m) are expressed in terms of a Peak Ground Acceleration normalizing the in-structure seismic capacity as:

$$A_m = \frac{C_m}{IRS} \times 0.4g$$

Where:

A_m = Median PGA seismic capacity of a specific component
IRS = Peak of the in-structure response spectra at or above f_n for the specific component
0.4g = PGA of the ground response spectrum used to generate the IRS

All of the median capacities for the components in the table above can be increased by a factor of 1.35. This is done in the table below.

Revised Calculations for Identified Low Capacity Components

Number	Name	Original Median	Beta-rs Factor	Revised Median	Component Description
35	EBDDGBLDXZ	0.77	1.35	1.04	DIESEL GENERATOR BUILDING FAILS
37	EBSB2XXXXZ	0.84	1.35	1.13	SEISMICALLY INDUCED FAILURE OF BUS B2
43	EPM184AXXZ	1.05	1.35	1.42	BODG FUEL OIL PUMP P184 FAILURE
42	EFN207A-DZ	1.01	1.35	1.36	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY
44	EFNDWCOOLZ	1.06	1.35	1.43	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS
49	ECMK103ABZ	1.28	1.35	1.73	DIESEL STARTING AIR COMPRESSORS K103A/B CORRELATED FAILURE
50	EPM141ABXZ	1.28	1.35	1.73	DIESEL FUEL OIL PUMPS P-141A/B FAILURE
51	EVPEABXXXZ	1.28	1.35	1.73	DG A & B SEIS CORREL FUEL OIL PRESSURE REG VALVE E FAILURE
52	EVRCABXXXZ	1.28	1.35	1.73	DG A & B SEISMICALLY CORRELATED FUEL OIL RELIEF VALVE C FAIL
53	EVS4565CDZ	1.28	1.35	1.73	DIESEL AIR PSV4565C AND D SEISMIC CORRELATION FAILURE
39	ETKT105ABZ	0.94	1.35	1.27	CSTs T105A/B FAILURE

Summary of Results

The following table presents a summary of the revised fragilities for the identified low-capacity components.

	Component	Revised Fragility			
Number	Name	Median	Beta-C	Comment	Component Description
5	ELOSPXXXZ				LOSS OF OFFSITE POWER
28	EFN204ABXZ	2.00	0.46	Not needed	QUAD ROOM COOLER FANs 204A/B FAILURE
29	EFN204CDXZ	2.00	0.46	Not needed	QUAD ROOM COOLER FANs 204C/D FAILURE
3	ERE18781IZ	0.25	0.60		SEISMICALLY INDUCED CHATTER OF RELAY 187-801A
6	ERE132X9IZ	1.50	0.60	Found GERS	SEISMICALLY CORRELATED RELAY CHATTER OF 132-509 AND 609
7	ERE159X9IZ	2.22	0.60	Replaced - ABB 59N	SEISMICALLY CORRELATED RELAY CHATTER OF 159-509 AND 609 (1 AND 2
36	EBW209/0XZ	2.00	0.46	Limited to 2.00	BLOCK WALL 209.0 FAILS
35	EBDDGBLDXZ	1.04	0.46	Brs	DIESEL GENERATOR BUILDING FAILS
45	EBW45/3XXZ	2.00	0.46	Limited to 2.00	BLOCK WALL 45.3 FAILS
33	EBSA8XXXXZ			Full fragility analysis	A8 BUS FAILURE
37	EBSB2XXXXZ	1.13	0.46	Brs	SEISMICALLY INDUCED FAILURE OF BUS B2
43	EPM184AXXZ	1.42	0.46	Brs	BODG FUEL OIL PUMP P184 FAILURE
13	ERE16059IZ				SEISMICALLY CORRELATED RELAY CHATTER OF 160-509
14	ERE18159IZ				SEISMICALLY INDUCED CHATTER OF RELAY 181-509
15	ERE18759IZ				SEISMICALLY INDUCED CHATTER OF RELAY 187-509
16	ERE27A5XIZ				SEISMICALLY INDUCED CHATTER OF RELAY 127-A5X
32	EDLGEABXXZ				SEISMICALY INDUCED DIESEL GENERATOR A/B CORELATED FAILURE
42	EFN207A-DZ	1.36	0.46	Brs	VAC207A-D FAILS RBCCW PRESSURE BOUNDARY
23	ERE15169IZ.				SEISMICALLY INDUCED CHATTER OF 151V-609/A,B,C
24	ERE16069IZ				SEISMICALLY CORRELATED RELAY CHATTER OF 160-609
25	ERE18169IZ				SEISMICALLY INDUCED CHATTER OF RELAY 181-609
26	ERE18769IZ				SEISMICALLY INDUCED CHATTER OF RELAY 187-609
27	ERE27A6XIZ				SEISMICALLY INDUCED CHATTER OF RELAY 127-A6X
44	EFNDWCOOLZ	1.43	0.46	Brs	FAILURE OF VAC205 OR 206 FAMILY OF FAN COOLERS
17	ERE32801IZ				SEISMICALLY INDUCED CHATTER OF RELAY 132-801A
18	ERE51N81IZ				SEISMICALLY INDUCED CHATTER OF RELAY 151N-801A
19	ERE51NG8IZ				SEISMICALLY INDUCED CHATTER OF RELAY 151NG-801A
20	ERE51V81IZ				SEISMICALLY INDUCED CHATTER OF RELAY 151V-801A
21	ERE59801IZ				SEISMICALLY INDUCED CHATTER OF RELAY 159-801A
31	ERE2352XIZ				SEISMICALLY CORRELATED RELAY CHATTER OF 23A-K52A AND B
46	EFN201ABXZ	2.00	0.46	Not needed	HPCI ROOM COOLING FANs VAC201A/B FAILURE
47	EFN202ABXZ	2.00	0.46	Not needed	VAC202A&B FAIL RBCCW PRESSURE BOUNDARY
48	EFN203ABXZ	2.00	0.46	Not needed	CRD QUAD ROOM COOLING FANS VAC 203A/B FAILURE
49	ECMK103ABZ	1.73	0.46	Brs	DIESEL STARTING AIR COMPRESSORS K103A/B CORRELATED FAILURE
50	EPM141ABXZ	1.73	0.46	Brs	DIESEL FUEL OIL PUMPS P-141A/B FAILURE
51	EVPEABXXXZ	1.73	0.46	Brs	DG A & B SEIS CORREL FUEL OIL PRESSURE REG VALVE E FAILURE
52	EVRCABXXXZ	1.73	0.46	Brs	DG A & B SEISMICALLY CORRELATED FUEL OIL RELIEF VALVE C FAIL
53	EVS4565CDZ	1.73	0.46	Brs	DIESEL AIR PSV4565C AND D SEISMIC CORRELATION FAILURE
22	ERE12769IZ				SEISMICALLY CORRELATED CHATTER OF RELAY 127-609 AND 159N-609
30	ERE1425BIZ				SEISMICALLY INDUCED CHATTER OF 420-1846
34	ERE18681IZ				SEISMICALLY INDUCED CHATTER OF RELAY 186-801A
38	ERE2759XIZ				SEISMICALLY INDUCED CHATTER OF 127-509X
39	ETKT105ABZ	1.27	0.46	Brs	CSTs T105A/B FAILURE
40	EBW210/0XZ			Full fragility analysis	BLOCK WALL 210.0 FAILS
41	EBW195/23Z	2.00	0.46	Limited to 2.00	BLOCKWALL 195.23 FAILS
4	ETK105ABNZ	2.00	0.46	Interaction fixed	CST 105 A/B FAILS DUE TO N2 TANK INTERACTION
8	ERE40801IZ				SEISMICALLY INDUCED CHATTER OF RELAY 140-801A
9	ERE46801IZ				SEISMICALLY INDUCED CHATTER OF RELAY 146-801A
10	ERE1865XIZ				SEISMICALLY INDUCED CHATTER OF RELAY 186-5X
12	ERE15159IZ				SEISMICALLY INDUCED CHATTER OF 151V-509/A,B,C
1	EISLOCACSZ				SEISMICALLY INDUCED CORE SPRAY PIPE RUPTURE
2	EISLOCRHRZ				SEISMICALLY INDUCED RHR PIPING RUPTURE
11	ERE12759IZ				SEISMICALLY CORRELATED CHATTER OF RELAY 127-509 AND 159N-509
54	EBW198/1XZ			Full fragility analysis	BLOCK WALL 198.1 FAILS
55	EBW198/2XZ			Full fragility analysis	BLOCK WALL 198.2 FAILS

Attachment 5

SCDF Calculations Using Plant-Level Fragility

Prepared by: Paul Baughman Reviewed by: Dragos Nuta

Background

The plant seismic core damage frequency (SCDF) from the Pilgrim Individual Plant Examination of External Events (IPEEE) Report Seismic Probabilistic Assessment (SPRA) was calculated from the systems model using the SHIP (Seismic Hazard Integration Package) code. The model incorporated seismic fragilities for components into event trees and fault trees. These resulted in sequences where system-induced failures could lead to core damage. The fragilities in the model are in terms of peak ground acceleration (PGA). Therefore, the seismic hazard curve used must also be in terms of PGA.

In the GI-199 SRA the NRC used hazard curves for PGA, 10 Hz, 5 Hz and 1 Hz. The method used for computing the SCDF for each curve is develop a plant-level fragility P(a) and convolve it with the hazard curve H(a), where a is acceleration. The plant-level fragility for PGA is developed from the IPEEE SCDF, median capacity and HCLPF. For use with other hazard curves, the median capacity is modified using m factors. This process is explained in the GI-199 SRA.

The SCDF is calculated as:

$$SCDF = \int_0^\infty P(a) * \left[-\frac{dH(a)}{da} \right] da$$

where P(a) is the plant-level fragility function and H(a) is the seismic hazard curve.

The above equation can be evaluated numerically. Entergy developed spreadsheets that perform the numerical integration. The failure probability, p(a), at each acceleration level is calculated as follows:

$$p(a) = \Phi\left[\frac{\ln(a / Am)}{\beta c} \right]$$

where

$\Phi[\ ]$	=	Standard normal cumulative distribution function
a	=	Seismic acceleration (g)
Am	=	Plant/component median capacity (g)
β_C	=	Logarithmic composite standard deviation (uncertainty) of the response and fragility

The seismic risk frequency is estimated by convoluting the hazard curve with the component failure probability using the following expression:

$$Risk = \sum_i^n p\left(\frac{a_i + a_{i+1}}{2}\right) \times [f(a)_i - f(a)_{i+1}]$$

where $p(a)$ = Component failure probability evaluated at the average seismic acceleration for the interval i to i+1

$f(a)_i$ = Seismic frequency of exceedance for i^{th} acceleration

$f(a)_{i+1}$ = Seismic frequency of exceedance for $(i+1)^{th}$ acceleration

In other words, the overall seismic risk frequency can be estimated by multiplying the plant/component failure probability (which is evaluated at the average acceleration of each interval) by the corresponding frequency of exceedance for that interval and summing the results over the entire range of the seismic hazard curve. The accuracy of the seismic CDF is dependent on the size of the interval used in the convolution, with smaller convolution intervals resulting in more accurate estimates of the seismic core damage frequency (SCDF). The spreadsheets developed by Entergy to estimate the SCDF use a convolution interval of 0.001g, with values in between known data points derived using a log-log interpolation.

Calculations

This attachment contains the spreadsheets for the various SCDF calculations.

1. NRC GI-199 SRA Fragility with 2008 USGS Hazard (PGA, 10 Hz, 5 Hz, 1 Hz)
2. Entergy Fragility with 2008 USGS Hazard (PGA, 10 Hz, 5 Hz, 1 Hz)
3. Entergy Fragility – SHIP Adjusted with 2008 USGS Hazard (PGA, 10 Hz, 5 Hz, 1 Hz)
4. NRC GI-199 SRA Fragility with 2010 EPRI Hazard (PGA, 10 Hz, 1 Hz)
5. Entergy Fragility with 2010 EPRI Hazard (PGA, 10 Hz, 1 Hz)
6. Entergy Fragility – SHIP Adjusted with 2010 EPRI Hazard (PGA, 10 Hz, 1 Hz)

NRC GI-199 SRA Fragility with 2008 USGS Hazard (PGA)

Total Seismic Core Damage Frequency =	4.26E-05

Plant Median Capacity	0.49
Plant HCLPF	0.26
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.015	6.76E-03	9.21E-38	5.14E-41
0.016	6.21E-03	1.76E-36	7.34E-40
0.017	5.79E-03	2.71E-35	9.93E-39
0.018	5.42E-03	3.42E-34	1.11E-37
0.019	5.10E-03	3.63E-33	1.06E-36
0.020	4.81E-03	3.31E-32	5.96E-36
0.021	4.63E-03	2.63E-31	8.71E-35
0.022	4.30E-03	1.85E-30	4.12E-34
0.023	4.07E-03	1.16E-29	2.35E-33
0.024	3.87E-03	6.61E-29	1.22E-32
0.025	3.69E-03	3.43E-28	5.80E-32
0.026	3.52E-03	1.64E-27	2.54E-31
0.027	3.36E-03	7.22E-27	1.04E-30
0.028	3.22E-03	2.97E-26	3.06E-30
0.029	3.12E-03	1.15E-25	1.81E-29
0.030	2.96E-03	4.16E-25	4.92E-29
0.031	2.84E-03	1.43E-24	1.57E-28
0.032	2.73E-03	4.65E-24	4.77E-28
0.033	2.63E-03	1.44E-23	1.38E-27
0.034	2.53E-03	4.28E-23	3.84E-27
0.035	2.44E-03	1.22E-22	1.02E-26
0.036	2.36E-03	3.33E-22	2.63E-26
0.037	2.28E-03	8.76E-22	6.52E-26
0.038	2.20E-03	2.23E-21	1.56E-25
0.039	2.13E-03	5.48E-21	4.08E-25
0.040	2.06E-03	1.31E-20	7.34E-25
0.041	2.00E-03	3.03E-20	1.85E-24
0.042	1.94E-03	6.82E-20	3.95E-24
0.043	1.88E-03	1.50E-19	8.21E-24
0.044	1.83E-03	3.20E-19	1.67E-23

Acceleration (g)	Annual Frequency of Exceedance
0.015	6.76E-03
0.021	4.63E-03
0.029	3.12E-03
0.040	2.06E-03
0.056	1.34E-03
0.077	8.68E-04
0.106	5.55E-04
0.145	3.52E-04
0.196	2.23E-04
0.261	1.38E-04
0.341	8.57E-05
0.420	5.23E-05
0.516	3.11E-05
0.628	1.77E-05
0.794	9.51E-06
0.900	7.08E-06
1.046	4.65E-06
1.383	1.96E-06
1.874	5.99E-07

Last EXCEL spreadsheet rows are shown below:

1.872	6.02E-07	1.00E+00	1.26E-09
1.873	6.01E-07	1.00E+00	1.75E-09
1.874	5.99E-07	1.00E+00	5.99E-07

NRC GI-199 SRA Fragility with 2008 USGS Hazard (10Hz)

Total Seismic Core Damage Frequency =	6.88E-05

Plant Median Capacity	0.7595
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.018	1.04E-02	2.25E-43	1.48E-46
0.019	9.78E-03	3.28E-42	1.56E-45
0.020	9.31E-03	4.03E-41	1.74E-44
0.021	8.88E-03	4.26E-40	1.67E-43
0.022	8.48E-03	3.93E-39	1.41E-42
0.023	8.13E-03	3.20E-38	1.05E-41
0.024	7.80E-03	2.33E-37	7.08E-41
0.025	7.49E-03	1.54E-36	4.31E-40
0.026	7.21E-03	9.23E-36	1.35E-39
0.027	7.07E-03	5.08E-35	1.94E-38
0.028	6.68E-03	2.59E-34	6.25E-38
0.029	6.44E-03	1.23E-33	2.76E-37
0.030	6.22E-03	5.43E-33	1.14E-36
0.031	6.01E-03	2.26E-32	4.44E-36
0.032	5.81E-03	8.87E-32	1.63E-35
0.033	5.63E-03	3.30E-31	5.71E-35
0.034	5.45E-03	1.17E-30	1.90E-34
0.035	5.29E-03	3.93E-30	6.05E-34
0.036	5.14E-03	1.27E-29	1.84E-33
0.037	4.99E-03	3.92E-29	5.39E-33
0.038	4.85E-03	1.17E-28	1.83E-32
0.039	4.70E-03	3.34E-28	3.41E-32
0.040	4.59E-03	9.25E-28	1.14E-31
0.041	4.47E-03	2.48E-27	2.89E-31
0.042	4.36E-03	6.43E-27	7.15E-31
0.043	4.24E-03	1.62E-26	1.71E-30
0.044	4.14E-03	3.97E-26	4.00E-30
0.045	4.04E-03	9.46E-26	9.12E-30
0.046	3.94E-03	2.20E-25	2.02E-29
0.047	3.85E-03	4.99E-25	4.40E-29

Acceleration (g)	Annual Frequency of Exceedance
0.018	1.04E-02
0.027	7.07E-03
0.039	4.70E-03
0.058	3.03E-03
0.087	1.88E-03
0.129	1.14E-03
0.192	6.69E-04
0.279	3.83E-04
0.396	2.15E-04
0.544	1.18E-04
0.686	7.37E-05
0.730	6.26E-05
1.045	3.20E-05
1.256	2.21E-05
1.421	1.54E-05
1.723	6.74E-06
2.190	2.52E-06
2.624	7.00E-07
4.000	7.31E-08

Last EXCEL spreadsheet rows are shown below:

3.998	7.33E-08	1.00E+00	9.82E-11
3.999	7.32E-08	1.00E+00	9.80E-11
4.000	7.31E-08	1.00E+00	7.31E-08

NRC GI-199 SRA Fragility with 2008 USGS Hazard (5Hz)

Total Seismic Core Damage Frequency =	6.19E-05

Plant Median Capacity	0.8134
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.021	1.31E-02	1.42E-41	5.12E-45
0.022	1.28E-02	1.36E-40	8.33E-44
0.023	1.21E-02	1.16E-39	6.45E-43
0.024	1.16E-02	8.77E-39	4.48E-42
0.025	1.11E-02	6.00E-38	2.82E-41
0.026	1.06E-02	3.73E-37	1.62E-40
0.027	1.02E-02	2.13E-36	8.53E-40
0.028	9.77E-03	1.12E-35	4.16E-39
0.029	9.40E-03	5.48E-35	1.89E-38
0.030	9.05E-03	2.50E-34	8.07E-38
0.031	8.73E-03	1.07E-33	3.17E-37
0.032	8.44E-03	4.34E-33	1.34E-36
0.033	8.13E-03	1.66E-32	4.70E-36
0.034	7.85E-03	6.03E-32	1.60E-35
0.035	7.58E-03	2.09E-31	5.21E-35
0.036	7.33E-03	6.91E-31	1.62E-34
0.037	7.10E-03	2.19E-30	4.85E-34
0.038	6.87E-03	6.68E-30	1.40E-33
0.039	6.67E-03	1.96E-29	3.87E-33
0.040	6.47E-03	5.56E-29	1.04E-32
0.041	6.28E-03	1.52E-28	2.70E-32
0.042	6.10E-03	4.04E-28	6.79E-32
0.043	5.94E-03	1.04E-27	1.66E-31
0.044	5.78E-03	2.60E-27	3.96E-31
0.045	5.62E-03	6.34E-27	9.18E-31
0.046	5.48E-03	1.50E-26	2.72E-30
0.047	5.30E-03	3.48E-26	3.35E-30
0.048	5.20E-03	7.87E-26	1.07E-29
0.049	5.07E-03	1.74E-25	2.26E-29
0.050	4.94E-03	3.77E-25	4.67E-29

Acceleration (g)	Annual Frequency of Exceedance
0.021	1.31E-02
0.032	8.44E-03
0.047	5.30E-03
0.070	3.21E-03
0.104	1.88E-03
0.154	1.07E-03
0.227	5.92E-04
0.321	3.20E-04
0.461	1.69E-04
0.636	8.74E-05
0.823	5.26E-05
0.899	4.41E-05
1.259	2.14E-05
1.456	1.44E-05
1.644	9.77E-06
1.913	4.03E-06
2.190	1.44E-06
2.624	4.16E-07
3.936	6.69E-08

Last EXCEL spreadsheet rows are shown below:

3.934	6.70E-08	1.00E+00	7.68E-11
3.935	6.69E-08	1.00E+00	7.67E-11
3.936	6.69E-08	1.00E+00	6.69E-08

NRC GI-199 SRA Fragility with 2008 USGS Hazard (1Hz)

Total Seismic Core Damage Frequency =	2.40E-05

Plant Median Capacity	0.245
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.004	1.16E-02	6.86E-50	1.74E-52
0.005	9.10E-03	3.29E-45	5.64E-48
0.006	7.39E-03	1.71E-41	2.04E-44
0.007	6.19E-03	1.92E-38	1.76E-41
0.008	5.27E-03	7.09E-36	5.62E-39
0.009	4.48E-03	1.14E-33	5.60E-37
0.010	3.99E-03	9.48E-32	4.47E-35
0.011	3.52E-03	4.70E-30	1.79E-33
0.012	3.14E-03	1.52E-28	4.79E-32
0.013	2.82E-03	3.47E-27	8.87E-31
0.014	2.57E-03	5.88E-26	1.50E-29
0.015	2.31E-03	7.76E-25	1.62E-28
0.016	2.10E-03	8.24E-24	1.48E-27
0.017	1.92E-03	7.26E-23	1.12E-26
0.018	1.77E-03	5.42E-22	7.32E-26
0.019	1.63E-03	3.51E-21	4.16E-25
0.020	1.52E-03	2.00E-20	2.27E-24
0.021	1.40E-03	1.01E-19	8.71E-24
0.022	1.32E-03	4.64E-19	3.93E-23
0.023	1.23E-03	1.94E-18	1.47E-22
0.024	1.15E-03	7.44E-18	5.10E-22
0.025	1.09E-03	2.65E-17	1.64E-21
0.026	1.02E-03	8.80E-17	4.96E-21
0.027	9.68E-04	2.74E-16	1.41E-20
0.028	9.16E-04	8.06E-16	3.79E-20
0.029	8.69E-04	2.25E-15	9.69E-20
0.030	8.26E-04	5.97E-15	2.36E-19
0.031	7.87E-04	1.51E-14	5.53E-19
0.032	7.50E-04	3.67E-14	9.71E-19
0.033	7.24E-04	8.58E-14	3.76E-18

Acceleration (g)	Annual Frequency of Exceedance
0.004	1.16E-02
0.006	7.39E-03
0.009	4.48E-03
0.014	2.57E-03
0.021	1.40E-03
0.033	7.24E-04
0.050	3.58E-04
0.076	1.71E-04
0.116	8.09E-05
0.176	3.81E-05
0.274	1.79E-05
0.415	8.21E-06
0.520	5.37E-06
0.643	3.55E-06
0.964	1.41E-06
1.188	8.42E-07
1.439	5.10E-07
2.165	1.59E-07
3.247	4.28E-08
4.871	8.57E-09

Last EXCEL spreadsheet rows are shown below:

4.869	8.58E-09	1.00E+00	6.99E-12
4.870	8.58E-09	1.00E+00	5.58E-12
4.871	8.57E-09	1.00E+00	8.57E-09

Entergy Fragility with 2008 USGS Hazard (PGA)

Total Seismic Core Damage Frequency =	2.78E-05

Plant Median Capacity	0.57
Plant HCLPF	0.33
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.015	6.76E-03	1.16E-55	6.46E-59
0.016	6.21E-03	8.03E-54	3.34E-57
0.017	5.79E-03	4.06E-52	1.49E-55
0.018	5.42E-03	1.56E-50	5.07E-54
0.019	5.10E-03	4.67E-49	1.36E-52
0.020	4.81E-03	1.13E-47	2.03E-51
0.021	4.63E-03	2.23E-46	7.38E-50
0.022	4.30E-03	3.71E-45	8.26E-49
0.023	4.07E-03	5.26E-44	1.06E-47
0.024	3.87E-03	6.46E-43	1.19E-46
0.025	3.69E-03	6.97E-42	1.18E-45
0.026	3.52E-03	6.66E-41	1.03E-44
0.027	3.36E-03	5.70E-40	8.17E-44
0.028	3.22E-03	4.41E-39	4.54E-43
0.029	3.12E-03	3.11E-38	4.93E-42
0.030	2.96E-03	2.01E-37	2.38E-41
0.031	2.84E-03	1.20E-36	1.32E-40
0.032	2.73E-03	6.66E-36	6.83E-40
0.033	2.63E-03	3.44E-35	3.30E-39
0.034	2.53E-03	1.67E-34	1.50E-38
0.035	2.44E-03	7.61E-34	6.40E-38
0.036	2.36E-03	3.28E-33	2.59E-37
0.037	2.28E-03	1.34E-32	9.96E-37
0.038	2.20E-03	5.20E-32	3.65E-36
0.039	2.13E-03	1.93E-31	1.43E-35
0.040	2.06E-03	6.82E-31	3.83E-35
0.041	2.00E-03	2.32E-30	1.42E-34
0.042	1.94E-03	7.56E-30	4.38E-34
0.043	1.88E-03	2.38E-29	1.30E-33
0.044	1.83E-03	7.21E-29	3.75E-33

Acceleration (g)	Annual Frequency of Exceedance
0.015	6.76E-03
0.021	4.63E-03
0.029	3.12E-03
0.040	2.06E-03
0.056	1.34E-03
0.077	8.68E-04
0.106	5.55E-04
0.145	3.52E-04
0.196	2.23E-04
0.261	1.38E-04
0.341	8.57E-05
0.420	5.23E-05
0.516	3.11E-05
0.628	1.77E-05
0.794	9.51E-06
0.900	7.08E-06
1.046	4.65E-06
1.383	1.96E-06
1.874	5.99E-07

Last EXCEL spreadsheet rows are shown below:

1.872	6.02E-07	1.00E+00	1.26E-09
1.873	6.01E-07	1.00E+00	1.75E-09
1.874	5.99E-07	1.00E+00	5.99E-07

Entergy Fragility with 2008 USGS Hazard (10Hz)

Total Seismic Core Damage Frequency =	4.88E-05

Plant Median Capacity	0.8835
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.018	1.04E-02	1.04E-63	6.84E-67
0.019	9.78E-03	4.83E-62	2.30E-65
0.020	9.31E-03	1.76E-60	7.59E-64
0.021	8.88E-03	5.17E-59	2.03E-62
0.022	8.48E-03	1.25E-57	4.49E-61
0.023	8.13E-03	2.54E-56	8.36E-60
0.024	7.80E-03	4.40E-55	1.33E-58
0.025	7.49E-03	6.59E-54	1.85E-57
0.026	7.21E-03	8.66E-53	1.27E-56
0.027	7.07E-03	1.01E-51	3.84E-55
0.028	6.68E-03	1.05E-50	2.52E-54
0.029	6.44E-03	9.79E-50	2.20E-53
0.030	6.22E-03	8.34E-49	1.75E-52
0.031	6.01E-03	6.49E-48	1.28E-51
0.032	5.81E-03	4.65E-47	8.58E-51
0.033	5.63E-03	3.09E-46	5.35E-50
0.034	5.45E-03	1.91E-45	3.11E-49
0.035	5.29E-03	1.10E-44	1.69E-48
0.036	5.14E-03	5.96E-44	8.66E-48
0.037	4.99E-03	3.04E-43	4.18E-47
0.038	4.85E-03	1.47E-42	2.30E-46
0.039	4.70E-03	6.71E-42	6.85E-46
0.040	4.59E-03	2.92E-41	3.59E-45
0.041	4.47E-03	1.21E-40	1.42E-44
0.042	4.36E-03	4.81E-40	5.35E-44
0.043	4.24E-03	1.83E-39	1.94E-43
0.044	4.14E-03	6.70E-39	6.76E-43
0.045	4.04E-03	2.36E-38	2.27E-42
0.046	3.94E-03	8.00E-38	7.36E-42
0.047	3.85E-03	2.62E-37	2.31E-41

Acceleration (g)	Annual Frequency of Exceedance
0.018	1.04E-02
0.027	7.07E-03
0.039	4.70E-03
0.058	3.03E-03
0.087	1.88E-03
0.129	1.14E-03
0.192	6.69E-04
0.279	3.83E-04
0.396	2.15E-04
0.544	1.18E-04
0.686	7.37E-05
0.730	6.26E-05
1.045	3.20E-05
1.256	2.21E-05
1.421	1.54E-05
1.723	6.74E-06
2.190	2.52E-06
2.624	7.00E-07
4.000	7.31E-08

Last EXCEL spreadsheet rows are shown below:

3.998	7.33E-08	1.00E+00	9.82E-11
3.999	7.32E-08	1.00E+00	9.80E-11
4.000	7.31E-08	1.00E+00	7.31E-08

Entergy Fragility with 2008 USGS Hazard (5Hz)

Total Seismic Core Damage Frequency =	4.36E-05

Plant Median Capacity	0.9462
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.021	1.31E-02	3.93E-61	1.42E-64
0.022	1.28E-02	1.01E-59	6.16E-63
0.023	1.21E-02	2.17E-58	1.21E-61
0.024	1.16E-02	3.96E-57	2.02E-60
0.025	1.11E-02	6.25E-56	2.94E-59
0.026	1.06E-02	8.62E-55	3.74E-58
0.027	1.02E-02	1.05E-53	4.21E-57
0.028	9.77E-03	1.14E-52	4.25E-56
0.029	9.40E-03	1.12E-51	3.87E-55
0.030	9.05E-03	9.96E-51	3.21E-54
0.031	8.73E-03	8.09E-50	2.38E-53
0.032	8.44E-03	6.04E-49	1.87E-52
0.033	8.13E-03	4.17E-48	1.18E-51
0.034	7.85E-03	2.67E-47	7.09E-51
0.035	7.58E-03	1.60E-46	3.99E-50
0.036	7.33E-03	8.97E-46	2.11E-49
0.037	7.10E-03	4.74E-45	1.05E-48
0.038	6.87E-03	2.37E-44	4.94E-48
0.039	6.67E-03	1.12E-43	2.21E-47
0.040	6.47E-03	5.03E-43	9.40E-47
0.041	6.28E-03	2.16E-42	3.82E-46
0.042	6.10E-03	8.82E-42	1.48E-45
0.043	5.94E-03	3.46E-41	5.53E-45
0.044	5.78E-03	1.30E-40	1.98E-44
0.045	5.62E-03	4.72E-40	6.83E-44
0.046	5.48E-03	1.65E-39	2.98E-43
0.047	5.30E-03	5.55E-39	5.34E-43
0.048	5.20E-03	1.81E-38	2.46E-42
0.049	5.07E-03	5.70E-38	7.40E-42
0.050	4.94E-03	1.74E-37	2.16E-41

Acceleration (g)	Annual Frequency of Exceedance
0.021	1.31E-02
0.032	8.44E-03
0.047	5.30E-03
0.070	3.21E-03
0.104	1.88E-03
0.154	1.07E-03
0.227	5.92E-04
0.321	3.20E-04
0.461	1.69E-04
0.636	8.74E-05
0.823	5.26E-05
0.899	4.41E-05
1.259	2.14E-05
1.456	1.44E-05
1.644	9.77E-06
1.913	4.03E-06
2.190	1.44E-06
2.624	4.16E-07
3.936	6.69E-08

Last EXCEL spreadsheet rows are shown below:

3.934	6.70E-08	1.00E+00	7.68E-11
3.935	6.69E-08	1.00E+00	7.67E-11
3.936	6.69E-08	1.00E+00	6.69E-08

Entergy Fragility with 2008 USGS Hazard (1Hz)

Total Seismic Core Damage Frequency =	1.79E-05

Plant Median Capacity	0.285
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.004	1.16E-02	5.03E-73	1.27E-75
0.005	9.10E-03	2.47E-66	4.22E-69
0.006	7.39E-03	5.13E-61	6.12E-64
0.007	6.19E-03	1.21E-56	1.12E-59
0.008	5.27E-03	5.93E-53	4.69E-56
0.009	4.48E-03	8.78E-50	4.32E-53
0.010	3.99E-03	5.13E-47	2.42E-50
0.011	3.52E-03	1.42E-44	5.43E-48
0.012	3.14E-03	2.16E-42	6.78E-46
0.013	2.82E-03	1.97E-40	5.05E-44
0.014	2.57E-03	1.19E-38	3.02E-42
0.015	2.31E-03	4.97E-37	1.04E-40
0.016	2.10E-03	1.53E-35	2.73E-39
0.017	1.92E-03	3.59E-34	5.55E-38
0.018	1.77E-03	6.66E-33	8.99E-37
0.019	1.63E-03	1.01E-31	1.19E-35
0.020	1.52E-03	1.26E-30	1.43E-34
0.021	1.40E-03	1.35E-29	1.16E-33
0.022	1.32E-03	1.24E-28	1.05E-32
0.023	1.23E-03	9.98E-28	7.59E-32
0.024	1.15E-03	7.13E-27	4.88E-31
0.025	1.09E-03	4.56E-26	2.83E-30
0.026	1.02E-03	2.64E-25	1.49E-29
0.027	9.68E-04	1.40E-24	7.18E-29
0.028	9.16E-04	6.80E-24	3.19E-28
0.029	8.69E-04	3.06E-23	1.32E-27
0.030	8.26E-04	1.28E-22	5.09E-27
0.031	7.87E-04	5.04E-22	1.84E-26
0.032	7.50E-04	1.86E-21	4.92E-26
0.033	7.24E-04	6.49E-21	2.84E-25

Acceleration (g)	Annual Frequency of Exceedance
0.004	1.16E-02
0.006	7.39E-03
0.009	4.48E-03
0.014	2.57E-03
0.021	1.40E-03
0.033	7.24E-04
0.050	3.58E-04
0.076	1.71E-04
0.116	8.09E-05
0.176	3.81E-05
0.274	1.79E-05
0.415	8.21E-06
0.520	5.37E-06
0.643	3.55E-06
0.964	1.41E-06
1.188	8.42E-07
1.439	5.10E-07
2.165	1.59E-07
3.247	4.28E-08
4.871	8.57E-09

Last EXCEL spreadsheet rows are shown below:

4.869	8.58E-09	1.00E+00	6.99E-12
4.870	8.58E-09	1.00E+00	5.58E-12
4.871	8.57E-09	1.00E+00	8.57E-09

Entergy Fragility – SHIP Adjusted with 2008 USGS Hazard (PGA)

Total Seismic Core Damage Frequency =	2.14E-05

Plant Median Capacity	0.63
Plant HCLPF	0.37
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.015	6.76E-03	1.12E-58	6.24E-62
0.016	6.21E-03	8.73E-57	3.63E-60
0.017	5.79E-03	4.94E-55	1.81E-58
0.018	5.42E-03	2.10E-53	6.84E-57
0.019	5.10E-03	6.95E-52	2.02E-55
0.020	4.81E-03	1.84E-50	3.31E-54
0.021	4.63E-03	3.99E-49	1.32E-52
0.022	4.30E-03	7.23E-48	1.61E-51
0.023	4.07E-03	1.11E-46	2.25E-50
0.024	3.87E-03	1.48E-45	2.73E-49
0.025	3.69E-03	1.72E-44	2.91E-48
0.026	3.52E-03	1.77E-43	2.75E-47
0.027	3.36E-03	1.62E-42	2.32E-46
0.028	3.22E-03	1.34E-41	1.38E-45
0.029	3.12E-03	1.01E-40	1.60E-44
0.030	2.96E-03	6.96E-40	8.24E-44
0.031	2.84E-03	4.41E-39	4.86E-43
0.032	2.73E-03	2.59E-38	2.66E-42
0.033	2.63E-03	1.42E-37	1.36E-41
0.034	2.53E-03	7.27E-37	6.52E-41
0.035	2.44E-03	3.50E-36	2.94E-40
0.036	2.36E-03	1.59E-35	1.26E-39
0.037	2.28E-03	6.82E-35	5.08E-39
0.038	2.20E-03	2.78E-34	1.95E-38
0.039	2.13E-03	1.08E-33	8.05E-38
0.040	2.06E-03	4.02E-33	2.26E-37
0.041	2.00E-03	1.43E-32	8.73E-37
0.042	1.94E-03	4.88E-32	2.82E-36
0.043	1.88E-03	1.60E-31	8.79E-36
0.044	1.83E-03	5.07E-31	2.64E-35

Acceleration (g)	Annual Frequency of Exceedance
0.015	6.76E-03
0.021	4.63E-03
0.029	3.12E-03
0.040	2.06E-03
0.056	1.34E-03
0.077	8.68E-04
0.106	5.55E-04
0.145	3.52E-04
0.196	2.23E-04
0.261	1.38E-04
0.341	8.57E-05
0.420	5.23E-05
0.516	3.11E-05
0.628	1.77E-05
0.794	9.51E-06
0.900	7.08E-06
1.046	4.65E-06
1.383	1.96E-06
1.874	5.99E-07

Last EXCEL spreadsheet rows are shown below:

1.872	6.02E-07	1.00E+00	1.26E-09
1.873	6.01E-07	1.00E+00	1.75E-09
1.874	5.99E-07	1.00E+00	5.99E-07

Entergy Fragility – SHIP Adjusted with 2008 USGS Hazard (10Hz)

Total Seismic Core Damage Frequency =	3.98E-05

Plant Median Capacity	0.9765
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.018	1.04E-02	6.17E-67	4.04E-70
0.019	9.78E-03	3.15E-65	1.50E-68
0.020	9.31E-03	1.26E-63	5.44E-67
0.021	8.88E-03	4.05E-62	1.59E-65
0.022	8.48E-03	1.07E-60	3.83E-64
0.023	8.13E-03	2.35E-59	7.75E-63
0.024	7.80E-03	4.41E-58	1.34E-61
0.025	7.49E-03	7.13E-57	2.00E-60
0.026	7.21E-03	1.01E-55	1.48E-59
0.027	7.07E-03	1.25E-54	4.78E-58
0.028	6.68E-03	1.39E-53	3.36E-57
0.029	6.44E-03	1.39E-52	3.13E-56
0.030	6.22E-03	1.26E-51	2.65E-55
0.031	6.01E-03	1.05E-50	2.05E-54
0.032	5.81E-03	7.95E-50	1.47E-53
0.033	5.63E-03	5.58E-49	9.67E-53
0.034	5.45E-03	3.64E-48	5.94E-52
0.035	5.29E-03	2.22E-47	3.41E-51
0.036	5.14E-03	1.27E-46	1.84E-50
0.037	4.99E-03	6.80E-46	9.35E-50
0.038	4.85E-03	3.45E-45	5.39E-49
0.039	4.70E-03	1.65E-44	1.69E-48
0.040	4.59E-03	7.55E-44	9.29E-48
0.041	4.47E-03	3.28E-43	3.83E-47
0.042	4.36E-03	1.36E-42	1.51E-46
0.043	4.24E-03	5.42E-42	5.74E-46
0.044	4.14E-03	2.07E-41	2.09E-45
0.045	4.04E-03	7.58E-41	7.31E-45
0.046	3.94E-03	2.68E-40	2.47E-44
0.047	3.85E-03	9.15E-40	8.05E-44

Acceleration (g)	Annual Frequency of Exceedance
0.018	1.04E-02
0.027	7.07E-03
0.039	4.70E-03
0.058	3.03E-03
0.087	1.88E-03
0.129	1.14E-03
0.192	6.69E-04
0.279	3.83E-04
0.396	2.15E-04
0.544	1.18E-04
0.686	7.37E-05
0.730	6.26E-05
1.045	3.20E-05
1.256	2.21E-05
1.421	1.54E-05
1.723	6.74E-06
2.190	2.52E-06
2.624	7.00E-07
4.000	7.31E-08

Last EXCEL spreadsheet rows are shown below:

3.998	7.33E-08	1.00E+00	9.82E-11
3.999	7.32E-08	1.00E+00	9.80E-11
4.000	7.31E-08	1.00E+00	7.31E-08

Entergy Fragility – SHIP Adjusted with 2008 USGS Hazard (5Hz)

Total Seismic Core Damage Frequency =	3.53E-05

Plant Median Capacity	1.0458
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.021	1.31E-02	2.71E-64	9.80E-68
0.022	1.28E-02	7.57E-63	4.63E-66
0.023	1.21E-02	1.76E-61	9.84E-65
0.024	1.16E-02	3.49E-60	1.78E-63
0.025	1.11E-02	5.94E-59	2.79E-62
0.026	1.06E-02	8.81E-58	3.82E-61
0.027	1.02E-02	1.15E-56	4.61E-60
0.028	9.77E-03	1.34E-55	4.98E-59
0.029	9.40E-03	1.40E-54	4.84E-58
0.030	9.05E-03	1.33E-53	4.27E-57
0.031	8.73E-03	1.14E-52	3.37E-56
0.032	8.44E-03	9.06E-52	2.80E-55
0.033	8.13E-03	6.62E-51	1.87E-54
0.034	7.85E-03	4.49E-50	1.19E-53
0.035	7.58E-03	2.83E-49	7.07E-53
0.036	7.33E-03	1.68E-48	3.93E-52
0.037	7.10E-03	9.32E-48	2.06E-51
0.038	6.87E-03	4.89E-47	1.02E-50
0.039	6.67E-03	2.42E-46	4.79E-50
0.040	6.47E-03	1.14E-45	2.14E-49
0.041	6.28E-03	5.13E-45	9.08E-49
0.042	6.10E-03	2.19E-44	3.69E-48
0.043	5.94E-03	8.99E-44	1.44E-47
0.044	5.78E-03	3.53E-43	5.37E-47
0.045	5.62E-03	1.33E-42	1.93E-46
0.046	5.48E-03	4.85E-42	8.78E-46
0.047	5.30E-03	1.70E-41	1.64E-45
0.048	5.20E-03	5.76E-41	7.83E-45
0.049	5.07E-03	1.89E-40	2.45E-44
0.050	4.94E-03	6.00E-40	7.44E-44

Acceleration (g)	Annual Frequency of Exceedance
0.021	1.31E-02
0.032	8.44E-03
0.047	5.30E-03
0.070	3.21E-03
0.104	1.88E-03
0.154	1.07E-03
0.227	5.92E-04
0.321	3.20E-04
0.461	1.69E-04
0.636	8.74E-05
0.823	5.26E-05
0.899	4.41E-05
1.259	2.14E-05
1.456	1.44E-05
1.644	9.77E-06
1.913	4.03E-06
2.190	1.44E-06
2.624	4.16E-07
3.936	6.69E-08

Last EXCEL spreadsheet rows are shown below:

3.934	6.70E-08	1.00E+00	7.68E-11
3.935	6.69E-08	1.00E+00	7.67E-11
3.936	6.69E-08	1.00E+00	6.69E-08

Entergy Fragility – SHIP Adjusted with 2008 USGS Hazard (1Hz)

Total Seismic Core Damage Frequency =	1.49E-05

Plant Median Capacity	0.315
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.004	1.16E-02	1.74E-76	4.42E-79
0.005	9.10E-03	1.25E-69	2.14E-72
0.006	7.39E-03	3.56E-64	4.25E-67
0.007	6.19E-03	1.10E-59	1.02E-62
0.008	5.27E-03	6.82E-56	5.40E-59
0.009	4.48E-03	1.25E-52	6.13E-56
0.010	3.99E-03	8.78E-50	4.14E-53
0.011	3.52E-03	2.89E-47	1.10E-50
0.012	3.14E-03	5.13E-45	1.61E-48
0.013	2.82E-03	5.43E-43	1.39E-46
0.014	2.57E-03	3.73E-41	9.48E-45
0.015	2.31E-03	1.77E-39	3.70E-43
0.016	2.10E-03	6.12E-38	1.10E-41
0.017	1.92E-03	1.61E-36	2.49E-40
0.018	1.77E-03	3.31E-35	4.47E-39
0.019	1.63E-03	5.52E-34	6.54E-38
0.020	1.52E-03	7.62E-33	8.65E-37
0.021	1.40E-03	8.88E-32	7.64E-36
0.022	1.32E-03	8.89E-31	7.54E-35
0.023	1.23E-03	7.77E-30	5.91E-34
0.024	1.15E-03	6.00E-29	4.12E-33
0.025	1.09E-03	4.14E-28	2.57E-32
0.026	1.02E-03	2.58E-27	1.45E-31
0.027	9.68E-04	1.46E-26	7.52E-31
0.028	9.16E-04	7.61E-26	3.57E-30
0.029	8.69E-04	3.66E-25	1.58E-29
0.030	8.26E-04	1.63E-24	6.47E-29
0.031	7.87E-04	6.80E-24	2.49E-28
0.032	7.50E-04	2.66E-23	7.04E-28
0.033	7.24E-04	9.82E-23	4.30E-27

Acceleration (g)	Annual Frequency of Exceedance
0.004	1.16E-02
0.006	7.39E-03
0.009	4.48E-03
0.014	2.57E-03
0.021	1.40E-03
0.033	7.24E-04
0.050	3.58E-04
0.076	1.71E-04
0.116	8.09E-05
0.176	3.81E-05
0.274	1.79E-05
0.415	8.21E-06
0.520	5.37E-06
0.643	3.55E-06
0.964	1.41E-06
1.188	8.42E-07
1.439	5.10E-07
2.165	1.59E-07
3.247	4.28E-08
4.871	8.57E-09

Last EXCEL spreadsheet rows are shown below:

4.869	8.58E-09	1.00E+00	6.99E-12
4.870	8.58E-09	1.00E+00	5.58E-12
4.871	8.57E-09	1.00E+00	8.57E-09

NRC GI-199 SRA Fragility with 2010 EPRI Hazard (PGA)

Total Seismic Core Damage Frequency =	3.11E-05

Plant Median Capacity	0.49
Plant HCLPF	0.261
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	1.11E-108	0.00E+00
0.0015	1.15E-04	5.06E-97	0.00E+00
0.002	1.15E-04	2.12E-85	0.00E+00
0.003	1.15E-04	3.96E-75	1.61E-94
0.004	1.15E-04	6.77E-68	-2.75E-87
0.005	1.15E-04	2.17E-62	8.83E-82
0.006	1.15E-04	5.47E-58	-2.22E-77
0.007	1.15E-04	2.38E-54	9.68E-74
0.008	1.15E-04	2.88E-51	0.00E+00
0.009	1.15E-04	1.32E-48	-5.37E-68
0.010	1.15E-04	2.84E-46	1.15E-65
0.011	1.15E-04	3.33E-44	0.00E+00
0.012	1.15E-04	2.37E-42	0.00E+00
0.013	1.15E-04	1.12E-40	0.00E+00
0.014	1.15E-04	3.72E-39	-1.51E-58
0.015	1.15E-04	9.21E-38	3.74E-57
0.016	1.15E-04	1.76E-36	0.00E+00
0.017	1.15E-04	2.71E-35	0.00E+00
0.018	1.15E-04	3.42E-34	0.00E+00
0.019	1.15E-04	3.63E-33	-1.48E-52
0.020	1.15E-04	3.31E-32	1.35E-51
0.021	1.15E-04	2.63E-31	0.00E+00
0.022	1.15E-04	1.85E-30	0.00E+00
0.023	1.15E-04	1.16E-29	0.00E+00
0.024	1.15E-04	6.61E-29	0.00E+00
0.025	1.15E-04	3.43E-28	0.00E+00
0.026	1.15E-04	1.64E-27	0.00E+00
0.027	1.15E-04	7.22E-27	0.00E+00
0.028	1.15E-04	2.97E-26	0.00E+00
0.029	1.15E-04	1.15E-25	-4.66E-45

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.15E-04
0.005	1.15E-04
0.007	1.15E-04
0.01	1.15E-04
0.015	1.15E-04
0.02	1.15E-04
0.03	1.15E-04
0.05	1.15E-04
0.07	1.11E-04
0.1	1.02E-04
0.15	8.59E-05
0.2	7.20E-05
0.3	5.22E-05
0.5	2.99E-05
0.7	1.83E-05
1	9.54E-06
1.5	3.98E-06
2	1.95E-06
3	6.19E-07
5	1.10E-07
7	2.92E-08
10	5.97E-09

Last EXCEL spreadsheet rows are shown below:

9.998	5.98E-09	1.00E+00	2.66E-12
9.999	5.97E-09	1.00E+00	2.66E-12
10.000	5.97E-09	1.00E+00	5.97E-09

NRC GI-199 SRA Fragility with 2010 EPRI Hazard (10Hz)

Total Seismic Core Damage Frequency =	2.74E-05

Plant Median Capacity	0.7595
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	7.15E-125	0.00E+00
0.0015	1.15E-04	2.44E-112	0.00E+00
0.002	1.15E-04	8.70E-100	0.00E+00
0.003	1.15E-04	1.22E-88	4.97E-108
0.004	1.15E-04	9.42E-81	-3.83E-100
0.005	1.15E-04	1.01E-74	4.09E-94
0.006	1.15E-04	6.90E-70	-2.80E-89
0.007	1.15E-04	7.07E-66	2.88E-85
0.008	1.15E-04	1.81E-62	0.00E+00
0.009	1.15E-04	1.62E-59	-6.57E-79
0.010	1.15E-04	6.33E-57	2.57E-76
0.011	1.15E-04	1.28E-54	0.00E+00
0.012	1.15E-04	1.50E-52	0.00E+00
0.013	1.15E-04	1.12E-50	0.00E+00
0.014	1.15E-04	5.72E-49	-2.32E-68
0.015	1.15E-04	2.11E-47	8.57E-67
0.016	1.15E-04	5.87E-46	0.00E+00
0.017	1.15E-04	1.28E-44	0.00E+00
0.018	1.15E-04	2.25E-43	0.00E+00
0.019	1.15E-04	3.28E-42	-1.33E-61
0.020	1.15E-04	4.03E-41	1.64E-60
0.021	1.15E-04	4.26E-40	0.00E+00
0.022	1.15E-04	3.93E-39	0.00E+00
0.023	1.15E-04	3.20E-38	0.00E+00
0.024	1.15E-04	2.33E-37	0.00E+00
0.025	1.15E-04	1.54E-36	0.00E+00
0.026	1.15E-04	9.23E-36	0.00E+00
0.027	1.15E-04	5.08E-35	0.00E+00
0.028	1.15E-04	2.59E-34	0.00E+00
0.029	1.15E-04	1.23E-33	-4.99E-53

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.15E-04
0.005	1.15E-04
0.007	1.15E-04
0.01	1.15E-04
0.015	1.15E-04
0.02	1.15E-04
0.03	1.15E-04
0.05	1.15E-04
0.07	1.13E-04
0.1	1.09E-04
0.15	9.93E-05
0.2	8.84E-05
0.3	6.94E-05
0.5	4.43E-05
0.7	2.98E-05
1	1.76E-05
1.5	8.47E-06
2	4.65E-06
3	1.80E-06
5	4.59E-07
7	1.68E-07
10	5.28E-08

Last EXCEL spreadsheet rows are shown below:

9.998	5.28E-08	1.00E+00	1.71E-11
9.999	5.28E-08	1.00E+00	1.71E-11
10.000	5.28E-08	1.00E+00	5.28E-08

NRC GI-199 SRA Fragility with 2010 EPRI Hazard (1Hz)

Total Seismic Core Damage Frequency =	1.87E-06

Plant Median Capacity	0.245
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.27

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	2.12E-85	0.00E+00
0.0015	1.15E-04	3.96E-75	0.00E+00
0.002	1.15E-04	5.64E-65	5.64E-71
0.003	1.14E-04	4.34E-56	7.38E-62
0.004	1.12E-04	6.86E-50	8.93E-56
0.005	1.11E-04	3.29E-45	9.01E-51
0.006	1.08E-04	1.71E-41	3.86E-47
0.007	1.06E-04	1.92E-38	6.63E-44
0.008	1.03E-04	7.09E-36	2.10E-41
0.009	9.96E-05	1.14E-33	2.93E-39
0.010	9.70E-05	9.48E-32	3.49E-37
0.011	9.33E-05	4.70E-30	1.52E-35
0.012	9.01E-05	1.52E-28	4.38E-34
0.013	8.72E-05	3.47E-27	8.95E-33
0.014	8.46E-05	5.88E-26	1.37E-31
0.015	8.23E-05	7.76E-25	2.38E-30
0.016	7.92E-05	8.24E-24	2.29E-29
0.017	7.65E-05	7.26E-23	1.83E-28
0.018	7.39E-05	5.42E-22	1.25E-27
0.019	7.16E-05	3.51E-21	7.46E-27
0.020	6.95E-05	2.00E-20	5.36E-26
0.021	6.68E-05	1.01E-19	2.49E-25
0.022	6.44E-05	4.64E-19	1.05E-24
0.023	6.21E-05	1.94E-18	4.06E-24
0.024	6.00E-05	7.44E-18	1.45E-23
0.025	5.80E-05	2.65E-17	4.79E-23
0.026	5.62E-05	8.80E-17	1.48E-22
0.027	5.45E-05	2.74E-16	4.33E-22
0.028	5.30E-05	8.06E-16	1.19E-21
0.029	5.15E-05	2.25E-15	3.13E-21

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.14E-04
0.005	1.11E-04
0.007	1.06E-04
0.01	9.70E-05
0.015	8.23E-05
0.02	6.95E-05
0.03	5.01E-05
0.05	2.81E-05
0.07	1.74E-05
0.1	9.61E-06
0.15	4.49E-06
0.2	2.49E-06
0.3	1.02E-06
0.5	2.99E-07
0.7	1.24E-07
1	4.52E-08
1.5	1.29E-08
2	4.90E-09
3	1.12E-09
5	1.41E-10

Last EXCEL spreadsheet rows are shown below:

4.998	1.41E-10	1.00E+00	1.15E-13
4.999	1.41E-10	1.00E+00	1.14E-13
5.000	1.41E-10	1.00E+00	1.41E-10

Entergy Fragility with 2010 EPRI Hazard (PGA)

Total Seismic Core Damage Frequency =	2.54E-05

Plant Median Capacity	0.57
Plant HCLPF	0.334
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	2.02E-156	0.00E+00
0.0015	1.15E-04	5.98E-140	0.00E+00
0.002	1.15E-04	1.68E-123	0.00E+00
0.003	1.15E-04	6.10E-109	2.48E-128
0.004	1.15E-04	1.14E-98	-4.62E-118
0.005	1.15E-04	7.68E-91	3.12E-110
0.006	1.15E-04	1.42E-84	-5.76E-104
0.007	1.15E-04	2.17E-79	8.84E-99
0.008	1.15E-04	5.44E-75	0.00E+00
0.009	1.15E-04	3.44E-71	-1.40E-90
0.010	1.15E-04	7.42E-68	3.02E-87
0.011	1.15E-04	6.75E-65	0.00E+00
0.012	1.15E-04	3.03E-62	0.00E+00
0.013	1.15E-04	7.59E-60	0.00E+00
0.014	1.15E-04	1.16E-57	-4.70E-77
0.015	1.15E-04	1.16E-55	4.70E-75
0.016	1.15E-04	8.03E-54	0.00E+00
0.017	1.15E-04	4.06E-52	0.00E+00
0.018	1.15E-04	1.56E-50	0.00E+00
0.019	1.15E-04	4.67E-49	-1.90E-68
0.020	1.15E-04	1.13E-47	4.57E-67
0.021	1.15E-04	2.23E-46	0.00E+00
0.022	1.15E-04	3.71E-45	0.00E+00
0.023	1.15E-04	5.26E-44	0.00E+00
0.024	1.15E-04	6.46E-43	0.00E+00
0.025	1.15E-04	6.97E-42	0.00E+00
0.026	1.15E-04	6.66E-41	0.00E+00
0.027	1.15E-04	5.70E-40	0.00E+00
0.028	1.15E-04	4.41E-39	0.00E+00
0.029	1.15E-04	3.11E-38	-1.27E-57

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.15E-04
0.005	1.15E-04
0.007	1.15E-04
0.01	1.15E-04
0.015	1.15E-04
0.02	1.15E-04
0.03	1.15E-04
0.05	1.15E-04
0.07	1.11E-04
0.1	1.02E-04
0.15	8.59E-05
0.2	7.20E-05
0.3	5.22E-05
0.5	2.99E-05
0.7	1.83E-05
1	9.54E-06
1.5	3.98E-06
2	1.95E-06
3	6.19E-07
5	1.10E-07
7	2.92E-08
10	5.97E-09

Last EXCEL spreadsheet rows are shown below:

9.998	5.98E-09	1.00E+00	2.66E-12
9.999	5.97E-09	1.00E+00	2.66E-12
10.000	5.97E-09	1.00E+00	5.97E-09

Entergy Fragility with 2010 EPRI Hazard (10Hz)

Total Seismic Core Damage Frequency =	2.20E-05

Plant Median Capacity	0.8835
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	2.87E-179	0.00E+00
0.0015	1.15E-04	1.38E-161	0.00E+00
0.002	1.15E-04	7.38E-144	0.00E+00
0.003	1.15E-04	4.34E-128	1.76E-147
0.004	1.15E-04	6.46E-117	-2.63E-136
0.005	1.15E-04	2.29E-108	9.31E-128
0.006	1.15E-04	1.68E-101	-6.84E-121
0.007	1.15E-04	8.42E-96	3.42E-115
0.008	1.15E-04	5.93E-91	0.00E+00
0.009	1.15E-04	9.40E-87	-3.82E-106
0.010	1.15E-04	4.63E-83	1.88E-102
0.011	1.15E-04	8.94E-80	0.00E+00
0.012	1.15E-04	8.00E-77	0.00E+00
0.013	1.15E-04	3.78E-74	0.00E+00
0.014	1.15E-04	1.04E-71	-4.22E-91
0.015	1.15E-04	1.80E-69	7.32E-89
0.016	1.15E-04	2.10E-67	0.00E+00
0.017	1.15E-04	1.72E-65	0.00E+00
0.018	1.15E-04	1.04E-63	0.00E+00
0.019	1.15E-04	4.83E-62	-1.97E-81
0.020	1.15E-04	1.76E-60	7.16E-80
0.021	1.15E-04	5.17E-59	0.00E+00
0.022	1.15E-04	1.25E-57	0.00E+00
0.023	1.15E-04	2.54E-56	0.00E+00
0.024	1.15E-04	4.40E-55	0.00E+00
0.025	1.15E-04	6.59E-54	0.00E+00
0.026	1.15E-04	8.66E-53	0.00E+00
0.027	1.15E-04	1.01E-51	0.00E+00
0.028	1.15E-04	1.05E-50	0.00E+00
0.029	1.15E-04	9.79E-50	-3.98E-69

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.15E-04
0.005	1.15E-04
0.007	1.15E-04
0.01	1.15E-04
0.015	1.15E-04
0.02	1.15E-04
0.03	1.15E-04
0.05	1.15E-04
0.07	1.13E-04
0.1	1.09E-04
0.15	9.93E-05
0.2	8.84E-05
0.3	6.94E-05
0.5	4.43E-05
0.7	2.98E-05
1	1.76E-05
1.5	8.47E-06
2	4.65E-06
3	1.80E-06
5	4.59E-07
7	1.68E-07
10	5.28E-08

Last EXCEL spreadsheet rows are shown below:

9.998	5.28E-08	1.00E+00	1.71E-11
9.999	5.28E-08	1.00E+00	1.71E-11
10.000	5.28E-08	1.00E+00	5.28E-08

Entergy Fragility with 2010 EPRI Hazard (1Hz)

Total Seismic Core Damage Frequency =	1.29E-06

Plant Median Capacity	0.285
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	1.68E-123	0.00E+00
0.0015	1.15E-04	6.10E-109	0.00E+00
0.002	1.15E-04	1.61E-94	1.61E-100
0.003	1.14E-04	7.21E-82	1.22E-87
0.004	1.12E-04	5.03E-73	6.54E-79
0.005	1.11E-04	2.47E-66	6.75E-72
0.006	1.08E-04	5.13E-61	1.16E-66
0.007	1.06E-04	1.21E-56	4.21E-62
0.008	1.03E-04	5.93E-53	1.76E-58
0.009	9.96E-05	8.78E-50	2.26E-55
0.010	9.70E-05	5.13E-47	1.88E-52
0.011	9.33E-05	1.42E-44	4.60E-50
0.012	9.01E-05	2.16E-42	6.20E-48
0.013	8.72E-05	1.97E-40	5.10E-46
0.014	8.46E-05	1.19E-38	2.77E-44
0.015	8.23E-05	4.97E-37	1.52E-42
0.016	7.92E-05	1.53E-35	4.23E-41
0.017	7.65E-05	3.59E-34	9.06E-40
0.018	7.39E-05	6.66E-33	1.54E-38
0.019	7.16E-05	1.01E-31	2.14E-37
0.020	6.95E-05	1.26E-30	3.39E-36
0.021	6.68E-05	1.35E-29	3.32E-35
0.022	6.44E-05	1.24E-28	2.81E-34
0.023	6.21E-05	9.98E-28	2.09E-33
0.024	6.00E-05	7.13E-27	1.39E-32
0.025	5.80E-05	4.56E-26	8.25E-32
0.026	5.62E-05	2.64E-25	4.46E-31
0.027	5.45E-05	1.40E-24	2.21E-30
0.028	5.30E-05	6.80E-24	1.01E-29
0.029	5.15E-05	3.06E-23	4.26E-29

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.14E-04
0.005	1.11E-04
0.007	1.06E-04
0.01	9.70E-05
0.015	8.23E-05
0.02	6.95E-05
0.03	5.01E-05
0.05	2.81E-05
0.07	1.74E-05
0.1	9.61E-06
0.15	4.49E-06
0.2	2.49E-06
0.3	1.02E-06
0.5	2.99E-07
0.7	1.24E-07
1	4.52E-08
1.5	1.29E-08
2	4.90E-09
3	1.12E-09
5	1.41E-10

Last EXCEL spreadsheet rows are shown below:

4.998	1.41E-10	1.00E+00	1.15E-13
4.999	1.41E-10	1.00E+00	1.14E-13
5.000	1.41E-10	1.00E+00	1.41E-10

Entergy Fragility – SHIP Adjusted with 2010 EPRI Hazard (PGA)

Total Seismic Core Damage Frequency =	1.46E-05

Plant Median Capacity	0.82
Plant HCLPF	0.480
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	2.87E-175	0.00E+00
0.0015	1.15E-04	8.57E-158	0.00E+00
0.002	1.15E-04	2.78E-140	0.00E+00
0.003	1.15E-04	1.02E-124	4.14E-144
0.004	1.15E-04	1.06E-113	-4.32E-133
0.005	1.15E-04	2.84E-105	1.16E-124
0.006	1.15E-04	1.65E-98	-6.71E-118
0.007	1.15E-04	6.75E-93	2.75E-112
0.008	1.15E-04	3.99E-88	0.00E+00
0.009	1.15E-04	5.41E-84	-2.20E-103
0.010	1.15E-04	2.31E-80	9.41E-100
0.011	1.15E-04	3.93E-77	0.00E+00
0.012	1.15E-04	3.13E-74	0.00E+00
0.013	1.15E-04	1.33E-71	0.00E+00
0.014	1.15E-04	3.30E-69	-1.34E-88
0.015	1.15E-04	5.20E-67	2.12E-86
0.016	1.15E-04	5.55E-65	0.00E+00
0.017	1.15E-04	4.20E-63	0.00E+00
0.018	1.15E-04	2.35E-61	0.00E+00
0.019	1.15E-04	1.01E-59	-4.11E-79
0.020	1.15E-04	3.43E-58	1.40E-77
0.021	1.15E-04	9.43E-57	0.00E+00
0.022	1.15E-04	2.14E-55	0.00E+00
0.023	1.15E-04	4.09E-54	0.00E+00
0.024	1.15E-04	6.68E-53	0.00E+00
0.025	1.15E-04	9.47E-52	0.00E+00
0.026	1.15E-04	1.18E-50	0.00E+00
0.027	1.15E-04	1.30E-49	0.00E+00
0.028	1.15E-04	1.28E-48	0.00E+00
0.029	1.15E-04	1.15E-47	-4.66E-67

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.15E-04
0.005	1.15E-04
0.007	1.15E-04
0.01	1.15E-04
0.015	1.15E-04
0.02	1.15E-04
0.03	1.15E-04
0.05	1.15E-04
0.07	1.11E-04
0.1	1.02E-04
0.15	8.59E-05
0.2	7.20E-05
0.3	5.22E-05
0.5	2.99E-05
0.7	1.83E-05
1	9.54E-06
1.5	3.98E-06
2	1.95E-06
3	6.19E-07
5	1.10E-07
7	2.92E-08
10	5.97E-09

Last EXCEL spreadsheet rows are shown below:

9.998	5.98E-09	1.00E+00	2.66E-12
9.999	5.97E-09	1.00E+00	2.66E-12
10.000	5.97E-09	1.00E+00	5.97E-09

Entergy Fragility – SHIP Adjusted with 2010 EPRI Hazard (10Hz)

Total Seismic Core Damage Frequency =	1.22E-05

Plant Median Capacity	1.271
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	2.01E-199	0.00E+00
0.0015	1.15E-04	9.73E-181	0.00E+00
0.002	1.15E-04	6.04E-162	0.00E+00
0.003	1.15E-04	3.57E-145	1.45E-164
0.004	1.15E-04	2.99E-133	-1.21E-152
0.005	1.15E-04	4.20E-124	1.71E-143
0.006	1.15E-04	9.69E-117	-3.94E-136
0.007	1.15E-04	1.29E-110	5.27E-130
0.008	1.15E-04	2.15E-105	0.00E+00
0.009	1.15E-04	7.31E-101	-2.97E-120
0.010	1.15E-04	7.16E-97	2.91E-116
0.011	1.15E-04	2.58E-93	0.00E+00
0.012	1.15E-04	4.09E-90	0.00E+00
0.013	1.15E-04	3.27E-87	0.00E+00
0.014	1.15E-04	1.47E-84	-5.97E-104
0.015	1.15E-04	4.02E-82	1.63E-101
0.016	1.15E-04	7.18E-80	0.00E+00
0.017	1.15E-04	8.84E-78	0.00E+00
0.018	1.15E-04	7.84E-76	0.00E+00
0.019	1.15E-04	5.21E-74	-2.12E-93
0.020	1.15E-04	2.67E-72	1.09E-91
0.021	1.15E-04	1.09E-70	0.00E+00
0.022	1.15E-04	3.59E-69	0.00E+00
0.023	1.15E-04	9.82E-68	0.00E+00
0.024	1.15E-04	2.26E-66	0.00E+00
0.025	1.15E-04	4.46E-65	0.00E+00
0.026	1.15E-04	7.62E-64	0.00E+00
0.027	1.15E-04	1.14E-62	0.00E+00
0.028	1.15E-04	1.52E-61	0.00E+00
0.029	1.15E-04	1.80E-60	-7.31E-80

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.15E-04
0.005	1.15E-04
0.007	1.15E-04
0.01	1.15E-04
0.015	1.15E-04
0.02	1.15E-04
0.03	1.15E-04
0.05	1.15E-04
0.07	1.13E-04
0.1	1.09E-04
0.15	9.93E-05
0.2	8.84E-05
0.3	6.94E-05
0.5	4.43E-05
0.7	2.98E-05
1	1.76E-05
1.5	8.47E-06
2	4.65E-06
3	1.80E-06
5	4.59E-07
7	1.68E-07
10	5.28E-08

Last EXCEL spreadsheet rows are shown below:

9.998	5.28E-08	1.00E+00	1.71E-11
9.999	5.28E-08	1.00E+00	1.71E-11
10.000	5.28E-08	1.00E+00	5.28E-08

Entergy Fragility – SHIP Adjusted with 2010 EPRI Hazard (1Hz)

Total Seismic Core Damage Frequency =	5.57E-07

Plant Median Capacity	0.41
Plant HCLPF	n/a
Plant Composite Uncertainty, βc	0.23

Seismic Level (g)	Frequency of Exceedance	Failure Probability	Delta Risk at g level
0.001	1.15E-04	2.78E-140	0.00E+00
0.0015	1.15E-04	1.02E-124	0.00E+00
0.002	1.15E-04	3.11E-109	3.11E-115
0.003	1.14E-04	1.40E-95	2.37E-101
0.004	1.12E-04	5.46E-86	7.10E-92
0.005	1.11E-04	1.06E-78	2.90E-84
0.006	1.08E-04	6.92E-73	1.57E-78
0.007	1.06E-04	4.37E-68	1.51E-73
0.008	1.03E-04	5.02E-64	1.49E-69
0.009	9.96E-05	1.59E-60	4.10E-66
0.010	9.70E-05	1.85E-57	6.78E-63
0.011	9.33E-05	9.55E-55	3.09E-60
0.012	9.01E-05	2.56E-52	7.36E-58
0.013	8.72E-05	3.97E-50	1.02E-55
0.014	8.46E-05	3.88E-48	9.07E-54
0.015	8.23E-05	2.57E-46	7.86E-52
0.016	7.92E-05	1.21E-44	3.36E-50
0.017	7.65E-05	4.25E-43	1.07E-48
0.018	7.39E-05	1.15E-41	2.67E-47
0.019	7.16E-05	2.50E-40	5.31E-46
0.020	6.95E-05	4.41E-39	1.18E-44
0.021	6.68E-05	6.51E-38	1.60E-43
0.022	6.44E-05	8.17E-37	1.85E-42
0.023	6.21E-05	8.86E-36	1.86E-41
0.024	6.00E-05	8.41E-35	1.63E-40
0.025	5.80E-05	7.07E-34	1.28E-39
0.026	5.62E-05	5.33E-33	8.99E-39
0.027	5.45E-05	3.63E-32	5.73E-38
0.028	5.30E-05	2.25E-31	3.33E-37
0.029	5.15E-05	1.28E-30	1.78E-36

Acceleration (g)	Annual Frequency of Exceedance
0.001	1.15E-04
0.0015	1.15E-04
0.002	1.15E-04
0.003	1.14E-04
0.005	1.11E-04
0.007	1.06E-04
0.01	9.70E-05
0.015	8.23E-05
0.02	6.95E-05
0.03	5.01E-05
0.05	2.81E-05
0.07	1.74E-05
0.1	9.61E-06
0.15	4.49E-06
0.2	2.49E-06
0.3	1.02E-06
0.5	2.99E-07
0.7	1.24E-07
1	4.52E-08
1.5	1.29E-08
2	4.90E-09
3	1.12E-09
5	1.41E-10

Last EXCEL spreadsheet rows are shown below:

4.998	1.41E-10	1.00E+00	1.15E-13
4.999	1.41E-10	1.00E+00	1.14E-13
5.000	1.41E-10	1.00E+00	1.41E-10

Attachment 6

Email from Martin Stutzke (USNRC) to John Bretti (Entergy)

Prepared by: Clem Yeh

Reviewed by: John Bretti

The 2008 USGS Seismic Hazard Curves for the Entergy plants were transmitted to Entergy by the NRC is the following email.

From: Stutzke, Martin [mailto:Martin.Stutzke@nrc.gov]
Sent: Thursday, April 07, 2011 1:18 PM
To: Bretti, John F
Subject: RE: Pilgrim Seismic Hazard Curves used in GI-199

John –

Please find attached an EXCEL spreadsheet that provides the seismic hazard curves used in GI-199 based on the 2008 U.S. Geological Survey (USGS) hard rock seismic hazard estimates, adjusted for site soil conditions using the EPRI/SOG site amplification functions (EPRI NP-6395-D). I've provided information for all Entergy sites, just in case you have a use for it or wish to share with others at Entergy. Please note that these are mean values; the USGS has not issued uncertainty information (fractiles, medians, etc.) for the 2008 estimates. You can use www.earthquake.usgs.gov to get more information, including the final report (click on "Hazards").

Regards,

Marty
From: Bretti, John F [mailto:JBretti@entergy.com]
Sent: Thursday, April 07, 2011 11:35 AM
To: Stutzke, Martin
Subject: Pilgrim Seismic Hazard Curves used in GI-199

Martin,

About a week ago, you had provided Dragos (Dan) Nuta with tabulated exceedance frequencies for the USGS hazard curves that were used for the Indian Point site. I was wondering if you could provide me with the corresponding hazard curve data used in GI-199 for Pilgrim Station.

Sincerely,

John Bretti
Senior Lead Engineer
Entergy Nuclear
914-272-3433

Seismic Hazard Curves Used in GI-199

Basis: 2008 USGS adjusted for site soil conditions using EPRI/SOG site amplification functions (EPRI NP-6395-D)

	PGA		10 Hz		5 Hz		1 Hz	
Site Name	acceleration (g's)	exceedence frequency (per year)	acceleration (g's)	exceedence frequency (per year)	acceleration (g's)	exceedence frequency (per year)	acceleration (g's)	exceedence frequency (per year)
Arkansas	0.0070	8.42E-03	0.0075	1.30E-02	0.0075	1.64E-02	0.0037	1.35E-02
	0.0098	5.98E-03	0.0113	8.81E-03	0.0113	1.07E-02	0.0056	9.17E-03
	0.0137	4.33E-03	0.0169	6.03E-03	0.0169	7.01E-03	0.0084	6.21E-03
	0.0192	3.19E-03	0.0253	4.21E-03	0.0253	4.65E-03	0.0127	4.23E-03
	0.0269	2.36E-03	0.0380	2.99E-03	0.0380	3.17E-03	0.0190	2.95E-03
	0.0376	1.67E-03	0.0570	2.09E-03	0.0570	2.17E-03	0.0285	2.05E-03
	0.0527	1.07E-03	0.0854	1.34E-03	0.0854	1.38E-03	0.0427	1.34E-03
	0.0738	6.09E-04	0.1280	7.48E-04	0.1280	7.45E-04	0.0641	7.55E-04
	0.1030	3.13E-04	0.1920	3.60E-04	0.1920	3.35E-04	0.0961	3.50E-04
	0.1450	1.45E-04	0.2880	1.51E-04	0.2880	1.27E-04	0.1440	1.32E-04
	0.2030	6.33E-05	0.3900	7.34E-05	0.3900	5.61E-05	0.2160	4.11E-05
	0.2840	2.68E-05	0.4320	5.68E-05	0.4320	4.19E-05	0.3240	1.07E-05
	0.3970	1.14E-05	0.6490	1.94E-05	0.6490	1.23E-05	0.4000	4.83E-06
	0.5560	5.00E-06	0.8000	1.09E-05	0.8000	6.39E-06	0.4870	2.15E-06
	0.7780	2.23E-06	0.9730	6.31E-06	0.9730	3.37E-06	0.7300	3.08E-07
	0.9000	1.58E-06	1.4600	1.92E-06	1.4600	8.71E-07	0.9000	1.19E-07
	1.0900	9.71E-07	2.1900	5.16E-07	2.1900	2.37E-07	1.0900	5.53E-08
	1.5200	3.82E-07	3.2800	1.17E-07	3.2800	5.79E-08	1.6400	1.33E-08
	2.1300	1.09E-07	5.0000	1.01E-08	4.9200	7.72E-09	2.4600	2.59E-09
							3.6900	3.16E-10
Fitzpatrick	0.0070	9.06E-03	0.0075	1.60E-02	0.0075	2.04E-02	0.0037	1.52E-02
	0.0098	5.63E-03	0.0113	9.77E-03	0.0113	1.24E-02	0.0056	9.66E-03
	0.0137	3.38E-03	0.0169	5.72E-03	0.0169	7.17E-03	0.0084	5.85E-03
	0.0192	1.96E-03	0.0253	3.17E-03	0.0253	3.89E-03	0.0127	3.32E-03
	0.0269	1.10E-03	0.0380	1.67E-03	0.0380	1.98E-03	0.0190	1.78E-03
	0.0376	6.04E-04	0.0570	8.39E-04	0.0570	9.60E-04	0.0285	8.83E-04
	0.0527	3.23E-04	0.0854	4.08E-04	0.0854	4.42E-04	0.0427	4.05E-04
	0.0738	1.71E-04	0.1280	1.92E-04	0.1280	1.94E-04	0.0641	1.70E-04
	0.1030	9.16E-05	0.1920	8.96E-05	0.1920	8.21E-05	0.0961	6.58E-05
	0.1450	4.91E-05	0.2880	4.19E-05	0.2880	3.46E-05	0.1440	2.40E-05
	0.2030	2.73E-05	0.3900	2.40E-05	0.3900	1.83E-05	0.2160	8.50E-06
	0.2840	1.55E-05	0.4320	1.99E-05	0.4320	1.48E-05	0.3240	3.04E-06
	0.3970	8.81E-06	0.6490	9.39E-06	0.6490	6.44E-06	0.4000	1.80E-06
	0.5560	4.87E-06	0.8000	6.32E-06	0.8000	4.17E-06	0.4870	1.10E-06
	0.7780	2.57E-06	0.9730	4.31E-06	0.9730	2.75E-06	0.7300	3.95E-07
	0.9000	1.90E-06	1.4600	1.83E-06	1.4600	1.09E-06	0.9000	2.28E-07
	1.0900	1.23E-06	2.1900	6.72E-07	2.1900	3.81E-07	1.0900	1.36E-07
	1.5200	5.18E-07	3.2800	1.85E-07	3.2800	1.09E-07	1.6400	4.16E-08
	2.1300	1.57E-07	5.0000	1.91E-08	4.9200	1.74E-08	2.4600	1.10E-08
							3.6900	2.17E-09

Seismic Hazard Curves Used in GI-199

Basis: 2008 USGS adjusted for site soil conditions using EPRI/SOG site amplification functions (EPRI NP-6395-D)

	PGA		10 Hz		5 Hz		1 Hz	
Grand Gulf	0.0097	5.03E-03	0.0125	7.25E-03	0.0140	9.60E-03	0.0080	1.03E-02
	0.0135	3.65E-03	0.0188	5.02E-03	0.0210	6.31E-03	0.0120	6.95E-03
	0.0188	2.63E-03	0.0277	3.54E-03	0.0313	4.23E-03	0.0179	4.69E-03
	0.0259	1.80E-03	0.0412	2.43E-03	0.0466	2.83E-03	0.0269	3.16E-03
	0.0360	1.12E-03	0.0612	1.53E-03	0.0695	1.77E-03	0.0401	2.11E-03
	0.0500	6.34E-04	0.0906	8.69E-04	0.1032	9.79E-04	0.0596	1.31E-03
	0.0696	3.31E-04	0.1349	4.47E-04	0.1529	4.70E-04	0.0863	7.03E-04
	0.0937	1.67E-04	0.1920	2.13E-04	0.2189	2.03E-04	0.1276	3.11E-04
	0.1246	8.48E-05	0.2707	9.74E-05	0.3110	8.19E-05	0.1893	1.15E-04
	0.1610	4.32E-05	0.3715	4.36E-05	0.4406	3.26E-05	0.2621	3.65E-05
	0.2071	2.33E-05	0.4563	2.40E-05	0.5577	1.66E-05	0.3715	1.05E-05
	0.2442	1.30E-05	0.4795	1.96E-05	0.6005	1.33E-05	0.5346	2.91E-06
	0.3176	7.43E-06	0.5906	8.70E-06	0.7528	5.52E-06	0.6400	1.54E-06
	0.4448	4.23E-06	0.6640	5.70E-06	0.7840	3.53E-06	0.7792	8.75E-07
	0.6224	2.32E-06	0.7784	3.81E-06	0.8757	2.35E-06	1.1680	3.23E-07
	0.7200	1.74E-06	1.1680	1.63E-06	1.1680	9.62E-07	1.4400	1.93E-07
	0.8502	1.15E-06	1.7520	6.14E-07	1.7520	3.47E-07	1.7440	1.17E-07
	1.1552	4.96E-07	2.6240	1.71E-07	2.6240	1.01E-07	2.6240	3.68E-08
	1.5762	1.53E-07	4.0000	1.69E-08	3.9360	1.63E-08	3.9360	9.90E-09
							5.9040	1.94E-09
Indian Point	0.0070	8.02E-03	0.0075	1.20E-02	0.0075	1.47E-02	0.0037	1.27E-02
	0.0098	5.72E-03	0.0113	8.43E-03	0.0113	9.73E-03	0.0056	8.13E-03
	0.0137	4.04E-03	0.0169	5.86E-03	0.0169	6.37E-03	0.0084	4.98E-03
	0.0192	2.82E-03	0.0253	3.98E-03	0.0253	4.07E-03	0.0127	2.89E-03
	0.0269	1.95E-03	0.0380	2.62E-03	0.0380	2.52E-03	0.0190	1.63E-03
	0.0376	1.34E-03	0.0570	1.69E-03	0.0570	1.53E-03	0.0285	8.78E-04
	0.0527	9.06E-04	0.0854	1.06E-03	0.0854	9.08E-04	0.0427	4.61E-04
	0.0738	6.09E-04	0.1280	6.49E-04	0.1280	5.26E-04	0.0641	2.37E-04
	0.1030	4.07E-04	0.1920	3.87E-04	0.1920	2.97E-04	0.0961	1.21E-04
	0.1450	2.65E-04	0.2880	2.23E-04	0.2880	1.62E-04	0.1440	6.10E-05
	0.2030	1.71E-04	0.3900	1.44E-04	0.3900	1.01E-04	0.2160	3.04E-05
	0.2840	1.07E-04	0.4320	1.24E-04	0.4320	8.52E-05	0.3240	1.47E-05
	0.3970	6.46E-05	0.6490	6.45E-05	0.6490	4.23E-05	0.4000	9.79E-06
	0.5560	3.69E-05	0.8000	4.49E-05	0.8000	2.87E-05	0.4870	6.57E-06
	0.7780	1.97E-05	0.9730	3.13E-05	0.9730	1.95E-05	0.7300	2.68E-06
	0.9000	1.46E-05	1.4600	1.37E-05	1.4600	8.09E-06	0.9000	1.61E-06
	1.0900	9.58E-06	2.1900	5.12E-06	2.1900	2.91E-06	1.0900	9.81E-07
	1.5200	4.05E-06	3.2800	1.42E-06	3.2800	8.50E-07	1.6400	3.08E-07
	2.1300	1.24E-06	5.0000	1.42E-07	4.9200	1.38E-07	2.4600	8.23E-08
							3.6900	1.60E-08
Palisades	0.0148	3.93E-03	0.0178	6.02E-03	0.0215	8.05E-03	0.0040	9.78E-03
	0.0207	2.48E-03	0.0266	3.82E-03	0.0320	4.97E-03	0.0060	6.30E-03
	0.0288	1.46E-03	0.0392	2.28E-03	0.0473	2.89E-03	0.0092	3.97E-03
	0.0401	8.12E-04	0.0584	1.28E-03	0.0698	1.55E-03	0.0140	2.39E-03

Seismic Hazard Curves Used in GI-199

Basis: 2008 USGS adjusted for site soil conditions using EPRI/SOG site amplification functions (EPRI NP-6395-D)

	PGA		10 Hz		5 Hz		1 Hz	
	0.0560	4.40E-04	0.0870	6.90E-04	0.1037	7.69E-04	0.0211	1.32E-03
	0.0771	2.37E-04	0.1294	3.61E-04	0.1539	3.66E-04	0.0328	6.22E-04
	0.1065	1.26E-04	0.1922	1.82E-04	0.2272	1.67E-04	0.0495	2.47E-04
	0.1446	6.76E-05	0.2790	8.82E-05	0.3213	7.30E-05	0.0763	8.30E-05
	0.1957	3.69E-05	0.3955	4.12E-05	0.4608	3.11E-05	0.1163	2.47E-05
	0.2610	2.04E-05	0.5443	1.89E-05	0.6365	1.31E-05	0.1757	7.03E-06
	0.3410	1.17E-05	0.6864	1.05E-05	0.8229	6.92E-06	0.2743	1.96E-06
	0.4203	6.81E-06	0.7301	8.63E-06	0.8986	5.61E-06	0.4147	6.61E-07
	0.5161	3.90E-06	1.0449	3.97E-06	1.2591	2.43E-06	0.5200	3.98E-07
	0.6283	2.13E-06	1.2560	2.64E-06	1.4560	1.57E-06	0.6428	2.44E-07
	0.7936	1.08E-06	1.4206	1.77E-06	1.6444	1.01E-06	0.9636	8.34E-08
	0.9000	7.86E-07	1.7228	7.12E-07	1.9126	3.74E-07	1.1880	4.57E-08
	1.0464	4.97E-07	2.1900	2.39E-07	2.1900	1.17E-07	1.4388	2.55E-08
	1.3832	1.97E-07	2.6240	5.81E-08	2.6240	2.91E-08	2.1648	6.43E-09
	1.8744	5.63E-08	4.0000	5.05E-09	3.9360	3.95E-09	3.2472	1.31E-09
							4.8708	1.65E-10
Pilgrim	0.0148	6.76E-03	0.0178	1.04E-02	0.0215	1.31E-02	0.0040	1.16E-02
	0.0207	4.63E-03	0.0266	7.07E-03	0.0320	8.44E-03	0.0060	7.39E-03
	0.0288	3.12E-03	0.0392	4.70E-03	0.0473	5.30E-03	0.0092	4.48E-03
	0.0401	2.06E-03	0.0584	3.03E-03	0.0698	3.21E-03	0.0140	2.57E-03
	0.0560	1.34E-03	0.0870	1.88E-03	0.1037	1.88E-03	0.0211	1.40E-03
	0.0771	8.68E-04	0.1294	1.14E-03	0.1539	1.07E-03	0.0328	7.24E-04
	0.1065	5.55E-04	0.1922	6.69E-04	0.2272	5.92E-04	0.0495	3.58E-04
	0.1446	3.52E-04	0.2790	3.83E-04	0.3213	3.20E-04	0.0763	1.71E-04
	0.1957	2.23E-04	0.3955	2.15E-04	0.4608	1.69E-04	0.1163	8.09E-05
	0.2610	1.38E-04	0.5443	1.18E-04	0.6365	8.74E-05	0.1757	3.81E-05
	0.3410	8.57E-05	0.6864	7.37E-05	0.8229	5.26E-05	0.2743	1.79E-05
	0.4203	5.23E-05	0.7301	6.26E-05	0.8986	4.41E-05	0.4147	8.21E-06
	0.5161	3.11E-05	1.0449	3.20E-05	1.2591	2.14E-05	0.5200	5.37E-06
	0.6283	1.77E-05	1.2560	2.21E-05	1.4560	1.44E-05	0.6428	3.55E-06
	0.7936	9.51E-06	1.4206	1.54E-05	1.6444	9.77E-06	0.9636	1.41E-06
	0.9000	7.08E-06	1.7228	6.74E-06	1.9126	4.03E-06	1.1880	8.42E-07
	1.0464	4.65E-06	2.1900	2.52E-06	2.1900	1.44E-06	1.4388	5.10E-07
	1.3832	1.96E-06	2.6240	7.00E-07	2.6240	4.16E-07	2.1648	1.59E-07
	1.8744	5.99E-07	4.0000	7.31E-08	3.9360	6.69E-08	3.2472	4.28E-08
							4.8708	8.57E-09
River Bend	0.0056	4.07E-03	0.0080	5.73E-03	0.0138	7.19E-03	0.0104	8.20E-03
	0.0078	2.87E-03	0.0121	4.05E-03	0.0206	4.88E-03	0.0157	5.56E-03
	0.0110	1.91E-03	0.0181	2.73E-03	0.0304	3.22E-03	0.0235	3.75E-03
	0.0154	1.17E-03	0.0271	1.70E-03	0.0450	1.96E-03	0.0353	2.47E-03
	0.0215	6.76E-04	0.0407	9.82E-04	0.0638	1.08E-03	0.0524	1.54E-03
	0.0301	3.87E-04	0.0604	5.45E-04	0.0946	5.52E-04	0.0784	8.39E-04
	0.0422	2.22E-04	0.0897	2.96E-04	0.1401	2.73E-04	0.1153	3.88E-04
	0.0590	1.29E-04	0.1280	1.56E-04	0.1920	1.32E-04	0.1654	1.53E-04

Seismic Hazard Curves Used in GI-199

Basis: 2008 USGS adjusted for site soil conditions using EPRI/SOG site amplification functions (EPRI NP-6395-D)

	PGA		10 Hz		5 Hz		1 Hz	
	0.0824	7.57E-05	0.1766	8.06E-05	0.2534	6.26E-05	0.2153	5.38E-05
	0.1160	4.44E-05	0.2592	4.05E-05	0.3168	2.93E-05	0.2261	1.82E-05
	0.1624	2.63E-05	0.3198	2.37E-05	0.3705	1.65E-05	0.2484	6.43E-06
	0.2272	1.55E-05	0.3499	1.98E-05	0.3974	1.35E-05	0.2592	2.43E-06
	0.3176	8.99E-06	0.5192	9.38E-06	0.5257	6.16E-06	0.3200	1.53E-06
	0.4448	4.97E-06	0.6400	6.33E-06	0.6400	4.06E-06	0.3896	9.98E-07
	0.6224	2.59E-06	0.7784	4.32E-06	0.7784	2.72E-06	0.5840	3.90E-07
	0.7200	1.90E-06	1.1680	1.84E-06	1.1680	1.10E-06	0.7200	2.31E-07
	0.8720	1.23E-06	1.7520	6.76E-07	1.7520	3.89E-07	0.8720	1.39E-07
	1.2160	5.10E-07	2.6240	1.88E-07	2.6240	1.12E-07	1.3120	4.28E-08
	1.7040	1.55E-07	4.0000	1.97E-08	3.9360	1.82E-08	1.9680	1.13E-08
							2.9520	2.21E-09
Vermont Yankee	0.0070	1.02E-02	0.0075	1.70E-02	0.0075	2.07E-02	0.0037	1.51E-02
	0.0098	6.67E-03	0.0113	1.11E-02	0.0113	1.32E-02	0.0056	9.73E-03
	0.0137	4.23E-03	0.0169	6.94E-03	0.0169	7.99E-03	0.0084	5.99E-03
	0.0192	2.58E-03	0.0253	4.12E-03	0.0253	4.59E-03	0.0127	3.49E-03
	0.0269	1.53E-03	0.0380	2.31E-03	0.0380	2.49E-03	0.0190	1.93E-03
	0.0376	8.88E-04	0.0570	1.24E-03	0.0570	1.28E-03	0.0285	9.99E-04
	0.0527	5.00E-04	0.0854	6.34E-04	0.0854	6.30E-04	0.0427	4.83E-04
	0.0738	2.77E-04	0.1280	3.13E-04	0.1280	2.94E-04	0.0641	2.16E-04
	0.1030	1.53E-04	0.1920	1.51E-04	0.1920	1.32E-04	0.0961	9.01E-05
	0.1450	8.35E-05	0.2880	7.20E-05	0.2880	5.79E-05	0.1440	3.55E-05
	0.2030	4.67E-05	0.3900	4.13E-05	0.3900	3.12E-05	0.2160	1.35E-05
	0.2840	2.64E-05	0.4320	3.43E-05	0.4320	2.53E-05	0.3240	5.11E-06
	0.3970	1.49E-05	0.6490	1.61E-05	0.6490	1.10E-05	0.4000	3.06E-06
	0.5560	8.15E-06	0.8000	1.08E-05	0.8000	7.11E-06	0.4870	1.89E-06
	0.7780	4.25E-06	0.9730	7.30E-06	0.9730	4.66E-06	0.7300	6.76E-07
	0.9000	3.14E-06	1.4600	3.06E-06	1.4600	1.83E-06	0.9000	3.88E-07
	1.0900	2.04E-06	2.1900	1.11E-06	2.1900	6.34E-07	1.0900	2.30E-07
	1.5200	8.51E-07	3.2800	3.05E-07	3.2800	1.81E-07	1.6400	6.95E-08
	2.1300	2.58E-07	5.0000	3.15E-08	4.9200	2.87E-08	2.4600	1.83E-08
							3.6900	3.62E-09
Waterford	0.0056	3.62E-03	0.0060	5.15E-03	0.0120	6.35E-03	0.0087	7.46E-03
	0.0078	2.48E-03	0.0090	3.58E-03	0.0181	4.28E-03	0.0132	5.04E-03
	0.0110	1.60E-03	0.0135	2.34E-03	0.0270	2.73E-03	0.0197	3.37E-03
	0.0154	9.80E-04	0.0202	1.44E-03	0.0397	1.61E-03	0.0292	2.17E-03
	0.0215	5.92E-04	0.0304	8.58E-04	0.0570	8.91E-04	0.0422	1.29E-03
	0.0301	3.60E-04	0.0456	5.00E-04	0.0804	4.78E-04	0.0613	6.59E-04
	0.0422	2.19E-04	0.0683	2.84E-04	0.1179	2.51E-04	0.0820	2.90E-04
	0.0590	1.33E-04	0.1024	1.57E-04	0.1562	1.29E-04	0.1199	1.12E-04
	0.0824	8.14E-05	0.1536	8.34E-05	0.1843	6.42E-05	0.1634	4.13E-05
	0.1160	4.91E-05	0.2304	4.33E-05	0.2362	3.14E-05	0.1872	1.56E-05
	0.1624	2.98E-05	0.3120	2.61E-05	0.3120	1.82E-05	0.1793	6.20E-06
	0.2272	1.79E-05	0.3456	2.20E-05	0.3456	1.51E-05	0.2592	2.66E-06

Seismic Hazard Curves Used in GI-199

Basis: 2008 USGS adjusted for site soil conditions using EPRI/SOG site amplification functions (EPRI NP-6395-D)

	PGA		10 Hz		5 Hz		1 Hz	
	0.3176	1.05E-05	0.5192	1.09E-05	0.5192	7.18E-06	0.3200	1.73E-06
	0.4448	5.95E-06	0.6400	7.46E-06	0.6400	4.81E-06	0.3896	1.14E-06
	0.6224	3.18E-06	0.7784	5.17E-06	0.7784	3.25E-06	0.5840	4.49E-07
	0.7200	2.36E-06	1.1680	2.25E-06	1.1680	1.33E-06	0.7200	2.66E-07
	0.8720	1.55E-06	1.7520	8.33E-07	1.7520	4.70E-07	0.8720	1.61E-07
	1.2160	6.52E-07	2.6240	2.30E-07	2.6240	1.35E-07	1.3120	4.96E-08
	1.7040	1.99E-07	4.0000	2.35E-08	3.9360	2.14E-08	1.9680	1.31E-08
							2.9520	2.53E-09

Attachment 7

SHIP Model Input and Output

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Reviewed by: Clem Yeh

Background

The plant seismic core damage frequency (SCDF) from the Pilgrim Individual Plant Examination of External Events (IPEEE) Report Seismic Probabilistic Assessment (SPRA) was calculated from the systems model using the SHIP (Seismic Hazard Integration Package) code. The model incorporated seismic fragilities for components into event trees and fault trees. These resulted in sequences where system-induced failures could lead to core damage. The effect on plant SCDF of changing the fragility of a given component (structure, system or equipment) is determined by changing the fragility parameters in the model and re-running it using the SHIP software.

This attachment describes the specific SHIP evaluations performed in re-evaluating the Pilgrim SCDF based on revised seismic capacity of important seismic components, update of random failure data for significant non-seismic components, realistic consideration of operator action failure probability to align suppression pool cooling given ground acceleration greater than 0.5g, and latest success criteria on impact of loss of quad room cooling for the RHR, Core Spray, CRD, and HPCI systems.

The Pilgrim IPEEE Report gives a point estimate SCDF of 5.82E-05/year.

In the Pilgrim SPRA seismic sequence quantification entailed the integration of the seismic hazard curve, component fragilities and the seismic system logic model to evaluate the frequency of system failure. The seismic hazard curve used was the 1989 Electric Power Research Institute (EPRI) PGA (peak ground acceleration) curve. The quantification was performed in three steps using the seismic component fragilities and SHIP computer code to determine the seismic sequences frequencies and plant fragilities along with the seismic point estimate core damage frequencies. The steps were:

1. The SPRA logic model was initially quantified, using the current version of SAIC's CAFTA (computer aided fault tree analysis) software, to produce seismic initiated accident sequence cutsets at three PGA levels (i.e., 0.2g, 0.4g, and 0.6g). The cutsets were provided as input to the initial risk quantification over the entire spectrum of the seismic hazard curve. The cutsets were also used to rank important seismic and non-seismic failures for subsequent sensitivity analyses. The results of the initial quantification, and the importance rankings were used to determine which seismic failures required more detailed fragility analysis. These results were also used to determine the need for more detailed fragility and human reliability analysis

2. Re-quantified the SPRA logic models with revised inputs to produce seismic initiated accident sequence cutsets at three seismic hazard levels (i.e., 0.2g, 0.4g, and 0.6g). The

re-quantified cutsets were provided as input for final importance ranking and quantification.

3. Quantify the Pilgrim SPRA model using the SHIP software package. The SHIP program integrates the SPRA logic model cutsets, the site seismic hazard curve, random failures, operator actions and the individual component seismic fragilities over the full range of seismic risk. The SHIP quantification results include the estimate of the plant core damage frequency and the plant level fragility curve.

Two initiating events (loss-of-offsite power and small break LOCA) and 13 seismic sequences were identified and solved for the SPRA. The 13 seismic sequences were quantified using the EPRI hazard curves and best-estimate seismic fragilities and random failure frequencies. The total SCDF is the sum of the SCDFs for each sequence. The contribution of each sequence to the SCDF is equal to its SCDF divided by the total SCDF.

Of the 13 seismic-induced accident sequences, the top six dominant accident sequences leading to core damage shown in the Pilgrim IPEEE contribute almost 98 percent of the total core damage frequency. The seismic sequences, ranked according to their contribution to core damage frequency, are listed below. .

Sequence	CDF Contribution		Description
	Rank	Percent	
SITQU	1	46.66	Loss of makeup at high RPV pressure
SITW	2	35.92	Loss of containment heat removal
SISL2	3	5.25	Small LOCA with high pressure makeup failure
SISL1	4	4.88	Small LOCA with containment control failure
SURROGATE	5	2.81	Surrogate element to represent all "screened out" components
SIVR1	6	2.6	Vessel Rupture
SIATWS1	7	1.01	ATWS
SIAOUT1	8	0.5	Large LOCA outside containment
SISORV2	9	0.13	SORV with successful HP injection but with LP injection failure
SISORV1	10	0.1	SORV with successful HP injection but containment control failure
SISORV4	11	0.09	SORV with HP and LP injection failure
SISORV3	12	0.03	SORV with successful LP injection but containment control failure
SIISL1	13	0	Interfacing system LOCAs

Although, it is not possible, at this time, to change the CAFTA logic model use to generate the seismic sequences cutsets use as inputs to the model. The capability exists to run SHIP and hence, examined the impact on SCDF. Specifically, five runs were performed.

1. Predict the change in SCDF based on revised SPRA model and use of the original EPRI hazard curves. The revised SPRA model reflect realistic changes in systems, structures, and components seismic capacity, random failure rates, success criteria, and operator

actions. This removes some inherent conservatism from the IPEEE SPRA model (for example low seismic fragilities and outdated plant failure data).

2. Predict the change in SCDF based on the original IPEEE SPRA model and use of USGS hazard curves. This provides some perspective regarding the potential conservatism in the NRC's seismic hazard.

3. Determine SCDF contribution for seismic components only based on the original IPEEE SPRA model and use of USGS hazard curves.

4. Predict the change in SCDF based on the revised SPRA model (as described in item #1 above) and use of the USGS hazard curves.

5. Determine SCDF contribution for seismic only components based on the revised SPRA model (as described in item #1 above) and use of USGS hazard curves.

6. Predict the change in SCDF based on the original IPEEE SPRA model and use of the updated EPRI hazard curves. This provides some perspective regarding the impact of the updated EPRI hazards curves versus the IPEEE EPRI hazard curves and the 2008 USGS hazard curves.

7. Determine SCDF contribution for seismic only components based on the original IPEEE SPRA model and use of the updated EPRI hazard curves.

8. Predict the change in SCDF based on the revised SPRA model (as described in item #1 as above) and use of the updated EPRI hazard curves.

9. Determine SCDF contribution for seismic only components based on the revised SPRA model (as described in item #1 as above) and use of the updated EPRI hazard curves.

The salient results from these runs are summarized in Table A-1.

Table A-1 Summary of SHIP Results

Ship Run #1	**EPRI Original Curves (revised model)**	**Seismic and Non-Seismic**
	Seismic Core Damage Frequency	2.85E-5/year
	Median Capacity	0.57g
	HCLPF	0.33g
Ship Run #2	**2008 USGS Curves**	**Seismic and Non-Seismic**
	Seismic Core Damage Frequency	3.78E-05/year
	Median Capacity	0.48g
	HCLPF	0.25g
Ship Run #3	**2008 USGS Curves**	**Seismic Only**
	Seismic Core Damage Frequency	2.33E-05/year
	Median Capacity	0.56g
	HCLPF	0.32g
Ship Run #4	**2008 USGS Curves (revised model)**	**Seismic and Non-Seismic**
	Seismic Core Damage Frequency	2.14E-05/year
	Median Capacity	0.57g
	HCLPF	0.33g
Ship Run #5	**2008 USGS Curves (revised model)**	**Seismic Only**
	Seismic Core Damage Frequency	1.20E-05/year
	Median Capacity	0.69g
	HCLPF	0.38g
Ship Run #6	**Updated EPRI Curves**	**Seismic and Non-Seismic**
	Seismic Core Damage Frequency	2.15E-05/year
	Median Capacity	0.49g
	HCLPF	0.25g
Ship Run #7	**Updated EPRI Curves**	**Seismic Only**
	Seismic Core Damage Frequency	1.56E-05/year
	Median Capacity	0.57g
	HCLPF	0.32g

Table A-1 Summary of SHIP Results

Ship Run #8	**Updated EPRI Curves (revised model)**	**Seismic and Non-Seismic**
	Seismic Core Damage Frequency	1.44E-05/year
	Median Capacity	0.57g
	HCLPF	0.33g
Ship Run #9	**Updated EPRI Curves (revised model)**	**Seismic Only**
	Seismic Core Damage Frequency	8.97E-06/year
	Median Capacity	0.69g
	HCLPF	0.38g

SHIP Evaluation #1

Predict the change in SCDF based on revised SPRA model and use of the original EPRI hazard curves. The revised SPRA model reflect realistic changes in systems, structures, and components seismic capacity, random failure rates, success criteria, and operator actions. This removes some inherent conservatism from the IPEEE SPRA model (for example low seismic fragilities and outdated plant failure data).

List of SHIP input files:

i. Names File: PILCDF1.NAM (This file lists the names of all other data files to be used by SHIP for Case #1). [see page 22 for details]

ii. Basic Input File: PILCDF1.GEN (This file contains basic parameters relevant to the SHIP Case #1 application). [see page 22 for details]

iii. Basic Event Data File: PILCDF1.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #1). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 23 for details]

iv. System Data File: PILCDF1.SYS (This file contains a list of systems to be analyzed for SHIP for Case #1. Note that the cutsets for each system will be read from separate files). [see page 29 for details]

v. Sequence Data File: PILCDF1.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #1). [See page 29 for details]

vi. Hazard Data File: PILCDF1.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #1). [see page 29 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #1. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: SCDF1.BAS (This file represents the SHIP output for SHIP for Case #1. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 30 for details]

Results for SHIP Evaluation #1

$SCDF_{\text{(using IPEEE EPRI data)}} = 2.85E\text{-}5/\text{year}$

$\text{Median Capacity}_{\text{(using IPEEE EPRI data)}} = 0.57g$

$HCLPF_{\text{(using IPEEE EPRI data)}} = 0.33g$

SHIP Evaluation #2

Predict the change in SCDF based on the original IPEEE SPRA model and use of USGS hazard curves. This provides some perspective regarding the potential conservatism in the NRC's seismic hazard.

List of SHIP input files:

i. Names File: PILUSGS.NAM (This file lists the names of all other data files to be used by SHIP for Case #2). [see page 31 for details]

ii. Basic Input File: PILUSGS.GEN (This file contains basic parameters relevant to the SHIP Case #2 application). [see page 31 for details]

iii. Basic Event Data File: PILUSGS.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #2). [see page 32 for details]

iv. System Data File: PILUSGS.SYS (This file contains a list of systems to be analyzed for SHIP for Case #2. Note that the cutsets for each system will be read from separate files) [see page 38 for details]

v. Sequence Data File: PILUSGS.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #2). [See page 38 for details]

vi. Hazard Data File: PILUSGS.HAZ (This file contains data related to the 2008 USGS seismic hazard for the Pilgrim site for SHIP for Case #2). [see page 38 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #2. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: USGSCDF.BAS (This file represents the SHIP output for SHIP for Case #2. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 39 for details]

Results for SHIP Evaluation #2

$SCDF_{\text{(using Updated USGS data)}} = 3.78E\text{-}5/\text{year}$

$\text{Median Capacity}_{\text{(using Updated USGS data)}} = 0.49g$

$HCLPF_{\text{(using Updated USGS data)}} = 0.25g$

SHIP Evaluation #3

Determine SCDF contribution for seismic only components based on the original IPEEE SPRA model and use of USGS hazard curves.

List of SHIP input files:

i. Names File: PILRUN1.NAM (This file lists the names of all other data files to be used by SHIP for Case #3). [see page 40 for details]

ii. Basic Input File: PILRUN1.GEN (This file contains basic parameters relevant to the SHIP Case #3 application). [see page 40 for details]

iii. Basic Event Data File: PILRUN1.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #3). [see page 41 for details]

iv. System Data File: PILRUN1.SYS (This file contains a list of systems to be analyzed for SHIP for Case #3. Note that the cutsets for each system will be read from separate files) [see page 47 for details]

v. Sequence Data File: PILRUN1.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #3). [See page 47 for details]

vi. Hazard Data File: PILRUN1.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #3). [see page 47 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #3. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: RANOP0.BAS (This file represents the SHIP output for SHIP for Case #3. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 48 for details]

Results for SHIP Evaluation #3

$SCDF_{(\text{using USGS data})} = 2.33E\text{-}05/\text{year}$

$\text{Median Capacity}_{(\text{using USGS data})} = 0.56g$

$HCLPF_{(\text{using USGS data})} = 0.32g$

SHIP Evaluation #4

Predict the change in SCDF based on revised SPRA model and use of the 2008 USGS hazard curves. The revised SPRA model reflect realistic changes in systems, structures, and components seismic capacity, random failure rates, success criteria, and operator actions. This removes some inherent conservatism from the IPEEE SPRA model (for example low seismic fragilities and outdated plant failure data).

List of SHIP input files:

i. Names File: PILCDF2.NAM (This file lists the names of all other data files to be used by SHIP for Case #4). [see page 49 for details]

ii. Basic Input File: PILCDF2.GEN (This file contains basic parameters relevant to the SHIP Case #4 application). [see page 49 for details]

iii. Basic Event Data File: PILCDF2.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #4). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 50 for details]

iv. System Data File: PILCDF2.SYS (This file contains a list of systems to be analyzed for SHIP for Case #4. Note that the cutsets for each system will be read from separate files) [see page 56 for details]

v. Sequence Data File: PILCDF2.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #4). [See page 56 for details]

vi. Hazard Data File: PILCDF2.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #4). [see page 56 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #4. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: SCDF2.BAS (This file represents the SHIP output for SHIP for Case #4. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 57 for details]

Results for SHIP Evaluation #4

SCDF $_{(\text{using USGS data})}$ = 2.14E-05/year

Median Capacity $_{(\text{using USGS data})}$ = 0.57g

HCLPF $_{(\text{using USGS data})}$ = 0.33g

SHIP Evaluation #5

Determine SCDF contribution for seismic only components based on the revised SPRA model and use of USGS hazard curves. The revised SPRA model reflect realistic changes in systems, structures, and components seismic capacity, random failure rates, success criteria, and operator actions. This removes some inherent conservatism from the IPEEE SPRA model (for example low seismic fragilities and outdated plant failure data).

List of SHIP input files:

i. Names File: PILRUN1.NAM (This file lists the names of all other data files to be used by SHIP for Case #5). [see page 58 for details]

ii. Basic Input File: PILRUN1.GEN (This file contains basic parameters relevant to the SHIP Case #5 application). [see page 58 for details]

iii. Basic Event Data File: PILRUN1.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #5). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 59 for details]

iv. System Data File: PILRUN1.SYS (This file contains a list of systems to be analyzed for SHIP for Case #5. Note that the cutsets for each system will be read from separate files) [see page 65 for details]

v. Sequence Data File: PILRUN1.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #5). [See page 65 for details]

vi. Hazard Data File: PILRUN1.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #5). [see page 65 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #5. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: RANOP0.BAS (This file represents the SHIP output for SHIP for Case #5. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 66 for details]

Results for SHIP Evaluation #5

SCDF $_{(\text{using USGS data})}$ = 1.20E-05/year

Median Capacity $_{(\text{using USGS data})}$ = 0.69g

HCLPF $_{(\text{using USGS data})}$ = 0.38g

SHIP Evaluation #6

Predict the change in SCDF based on the original IPEEE SPRA model and use of the updated EPRI hazard curves. This provides some perspective regarding the impact of the updated EPRI hazards curves versus the IPEEE EPRI hazard curves and the 2008 USGS hazard curves.

List of SHIP input files:

i. Names File: PILEPRI1.NAM (This file lists the names of all other data files to be used by SHIP for Case #6). [see page 67 for details]

ii. Basic Input File: PILEPRI1.GEN (This file contains basic parameters relevant to the SHIP Case #6 application). [see page 67 for details]

iii. Basic Event Data File: PILEPRI1.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #6). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 68 for details]

iv. System Data File: PILEPRI1.SYS (This file contains a list of systems to be analyzed for SHIP for Case #6. Note that the cutsets for each system will be read from separate files) [see page 74 for details]

v. Sequence Data File: PILRUN1.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #6). [See page 74 for details]

vi. Hazard Data File: PILRUN1.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #6). [see page 74 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #6. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: EPRICDF1.BAS (This file represents the SHIP output for SHIP for Case #6. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 75 for details]

Results for SHIP Evaluation #6

SCDF $_{\text{(using updated EPRI data)}}$ = 2.15E-05/year

Median Capacity $_{\text{(using updated EPRI data)}}$ = 0.49g

HCLPF $_{\text{(using updated EPRI data)}}$ = 0.25g

SHIP Evaluation #7

Determine SCDF contribution for seismic only components based on the original IPEEE SPRA model and use of the updated EPRI hazard curves.

List of SHIP input files:

i. Names File: PILEPRI2.NAM (This file lists the names of all other data files to be used by SHIP for Case #7). [see page 76 for details]

ii. Basic Input File: PILEPRI2.GEN (This file contains basic parameters relevant to the SHIP Case #7 application). [see page 76 for details]

iii. Basic Event Data File: PILEPRI2.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #7). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 77 for details]

iv. System Data File: PILEPRI2.SYS (This file contains a list of systems to be analyzed for SHIP for Case #7. Note that the cutsets for each system will be read from separate files) [see page 83 for details]

v. Sequence Data File: PILRUN2.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #7). [See page 83 for details]

vi. Hazard Data File: PILRUN2.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #7). [see page 83 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #7. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: EPRICDF2.BAS (This file represents the SHIP output for SHIP for Case #7. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 84 for details]

Results for SHIP Evaluation #7

SCDF $_{\text{(using updated EPRI data)}}$ = 1.56E-05/year

Median Capacity $_{\text{(using updated EPRI data)}}$ = 0.57g

HCLPF $_{\text{(using updated EPRI data)}}$ = 0.32g

SHIP Evaluation #8

Predict the change in SCDF based on the revised SPRA model (as described in item #1 on page 3 of this attachment) and use of the updated EPRI hazard curves.

List of SHIP input files:

i. Names File: PILCDF1.NAM (This file lists the names of all other data files to be used by SHIP for Case #8). [see page 85 for details]

ii. Basic Input File: PILCDF1.GEN (This file contains basic parameters relevant to the SHIP Case #8 application). [see page 85 for details]

iii. Basic Event Data File: PILCDF1.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #8). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 86 for details]

iv. System Data File: PILCDF1.SYS (This file contains a list of systems to be analyzed for SHIP for Case #8. Note that the cutsets for each system will be read from separate files) [see page 92 for details]

v. Sequence Data File: PILCDF1.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #8). [See page 92 for details]

vi. Hazard Data File: PILCDF1.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #8). [see page 92 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #8. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: SCDF1.BAS (This file represents the SHIP output for SHIP for Case #8. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 93 for details]

Results for SHIP Evaluation #8

SCDF $_{\text{(using updated EPRI data)}}$ = 1.44E-05/year

Median Capacity $_{\text{(using updated EPRI data)}}$ = 0.57g

HCLPF $_{\text{(using updated EPRI data)}}$ = 0.33g

SHIP Evaluation #9

Determine SCDF contribution for seismic only components based on the revised SPRA model (as described in item #1 on page 3 of this attachment) and use of the updated EPRI hazard curves.

List of SHIP input files:

i. Names File: PILEPRI1.NAM (This file lists the names of all other data files to be used by SHIP for Case #9). [see page 94 for details]

ii. Basic Input File: PILEPRI1.GEN (This file contains basic parameters relevant to the SHIP Case #9 application). [see page 94 for details]

iii. Basic Event Data File: PILEPRI1.CMP (This file contains data pertaining to seismic fragilities, random failures, and operator actions for SHIP for Case #9). This file contains the revise data on plant components seismic fragilities, updated random failure rate, less conservative operator actions failure probability to align suppression pool cooling, and current system success criteria on quad rooms cooling. [see page 95 for details]

iv. System Data File: PILEPRI1.SYS (This file contains a list of systems to be analyzed for SHIP for Case #9. Note that the cutsets for each system will be read from separate files) [see page 101 for details]

v. Sequence Data File: PILEPRI1.SEQ (This file contains data regarding sequences and plant damage states for SHIP for Case #9). [See page 101 for details]

vi. Hazard Data File: PILEPRI1.HAZ (This file contains data related to the IPEEE EPRI seismic hazard for the Pilgrim site for SHIP for Case #9). [see page 101 for details]

vii. Cutset File: LMCDF.RPT (This file contains the cutsets for the systems to be analyzed for SHIP for Case #9. Note that for Pilgrim SPRA, the CDFALL system is the only system to be analyzed. These cutsets are contained in LMCDF.RPT).

viii. SHIP Output File: RANOP0.BAS (This file represents the SHIP output for SHIP for Case #9. This file contains information on names of all input files, information of all input files, and information on core damage frequency (overall and individual sequences), plant median capacity, and high confidence of a low probability of failure HCLPF] information). [See page 102 for details]

Results for SHIP Evaluation #9

SCDF $_{\text{(using updated EPRI data)}}$ = 8.87E-06/year

Median Capacity $_{\text{(using updated EPRI data)}}$ = 0.69g

HCLPF $_{\text{(using updated EPRI data)}}$ = 0.38g

List of SHIP Input Files

SHIP Evaluation #1

Names File for PILCDF1.NAM

PILCDF1.GEN
PILCDF1.SYS
PILCDF1.CMP
PILCDF1.SEQ
PIL.HAZ

PILCDF1.NAM
05-19-11

Basic Input File for PILCDF1.GEN

Pilgrim SPRA
Entergy Nuclear
FRAG&BE Data (EPRI)
SCDF1
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .01 0.98 1290
2

PILCDF1.GEN
05-19-11

Basic Event Data File for PILCDF1.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	1.04	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	1.13	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	2	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	2	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	2	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.73	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0

EDPC6XXXXZ	2.11	0.46	0	0
EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	2	0.46	0	0
EFN202ABXZ	2	0.46	0	0
EFN203ABXZ	2	0.46	0	0
EFN204ABXZ	2	0.46	0	0
EFN204CDXZ	2	0.46	0	0
EFN207A-DZ	2	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.73	0.46	0	0
EPM184AXXZ	1.42	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	1.5	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	2.22	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0

ERE27A6X!Z	1.04	0.31	0.51	0
ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	5	0.46	0	0
ETKT105ABZ	1.27	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.73	0.46	0	0
EVRCABXXXZ	1.73	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.73	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 2.5e-2	2.50E-02	2.50E-01	5.00E-01	5.00E-01
EDLGESBOXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 3.2e-3	3.20E-03	3.20E-02	5.00E-01	5.00E-01
ELPSPPRPLY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 4.0e-3	4.00E-03	4.00E-02	1.00E+00	1.00E+00
ESPCOOLXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 5.1e-4	5.10E-04	5.10E-03	5.00E-02	5.00E-02

ESPC36ABXY		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	5.0e-1	5.00E-01	5.00E-01	7.50E-01	7.50E-01
ERERESET!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	9.0E-2	9.00E-02	5.00E-01	5.00E-01	5.00E-01
EVMMO45X!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	6.6E-2	6.60E-02	5.00E-01	5.00E-01	5.00E-01
ACB152501F		1.49E-04	0.001		
ACB152509L		1.49E-04	0.001		
ACB152601F		1.49E-04	0.001		
ACB152609L		1.49E-04	0.001		
ACB152802F		1.49E-04	0.001		
ACB5605CCN		2.21E-05	0.001		
ACB5609CCC		8.86E-05	0.001		
ADLADL3CCR		2.64E-04	0.001		
ADLADLBCCR		2.64E-04	0.001		
ADLADLBCCS		4.90E-05	0.001		
ADLBDL3CCR		2.64E-04	0.001		
ADLG123CCR		1.32E-05	0.001		
ADLGEAXXXS		4.80E-03	0.001		
ADLGEAXXXU		1.18E-02	0.001		
ADLGEBXXXR		7.92E-03	0.001		
ADLGEBXXXU		1.09E-02	0.001		
ADLGESBOXS		4.80E-03	0.001		
ADLGESBOXU		1.42E-02	0.001		
ALOCALOOP		1.00E+00	0.001		
APM141AXXR		6.84E-04	0.001		
APM141BXXR		6.84E-04	0.001		
APM184AXXR		6.84E-04	0.001		
APM184AXXS		4.95E-04	0.001		
AVA452XCCN		4.00E-05	0.001		
BPM5XXXCCS		4.80E-05	0.001		
BPMBXXXXXU		1.09E-02	0.001		
BPMCXXXXXU		1.09E-02	0.001		
BPMEXXXXXU		1.09E-02	0.001		
BPMFXXXXXU		1.09E-02	0.001		
BVM3801XXC		1.65E-03	0.001		
BVM3805XXC		1.65E-03	0.001		
CM		7.50E-06	0.001		
CVC9AXXXXC		2.66E-04	0.001		
CVC9BXXXXC		2.66E-04	0.001		
DBC21XXCCR		1.57E-05	0.001		
DBCD11NORE		6.80E-01	0.001		
DBCD11XXXU		7.30E-04	0.001		
DBCD12NORE		6.80E-01	0.001		
DBCD12XXXU		7.30E-04	0.001		
EBCD11XXXR		2.98E-04	0.001		

EBCD12XXXR	2.98E-04	0.001
ECB152504F	1.49E-04	0.001
ECB152505N	1.99E-04	0.001
ECB152508L	1.49E-04	0.001
ECB152509C	7.97E-04	0.001
ECB152600L	1.49E-04	0.001
ECB152604F	1.49E-04	0.001
ECB152605N	1.99E-04	0.001
ECB152608L	1.49E-04	0.001
ECB152609C	7.97E-04	0.001
ECB152801C	1.99E-04	0.001
ECB152802N	1.99E-04	0.001
ECB5605AXY	1.00E+00	0.001
ECB5605DXY	1.00E+00	0.001
EDLGEAXXXR	7.92E-03	0.001
EDLGEBXXXS	4.80E-03	0.001
EDLGESBOXR	7.92E-03	0.001
EHX209AXXU	2.66E-02	0.001
EHX209BXXU	2.66E-02	0.001
ELOCAHPCIR	1.23E-04	0.001
ELOCARCICR	1.23E-04	0.001
EPM141AXXS	4.95E-04	0.001
EPM141BXXS	4.95E-04	0.001
EPM208AXXS	9.20E-03	0.001
EPM208BXXS	9.20E-03	0.001
EPM208EXXS	9.20E-03	0.001
EPTHPCIXXR	3.93E-03	0.001
EPTRCICXXR	9.78E-03	0.001
EVA4521XXN	1.60E-04	0.001
EVA4522XXN	1.60E-04	0.001
EVM130117C	1.65E-03	0.001
EVM23015XC	1.65E-03	0.001
HPMAUXOILS	3.33E-03	0.001
HPME205XXS	3.00E-03	0.001
HPTHPCIXXS	3.33E-03	0.001
HPTHPRCCCR	2.31E-07	0.001
HPTHPRCCCS	3.46E-05	0.001
HSYHPCIMNU	1.21E-02	0.001
HVMMO35XXN	1.65E-03	0.001
HVMMO36XXN	1.65E-03	0.001
HVMMO3XXXN	1.03E-03	0.001
HVMMO6XXXC	1.65E-03	0.001
HVMMO8XXXN	1.65E-03	0.001
ILPRCICMNU	8.74E-03	0.001
IPTRCICXXS	3.33E-03	0.001
IPVVACPMPS	3.00E-03	0.001
IVMINJVCCN	1.30E-04	0.001
IVMMO49XXN	1.50E-03	0.001
IVMMO60XXC	1.65E-03	0.001

IVMMO61XXN	1.50E-03	0.001
IVMMO62XXN	1.65E-03	0.001
P	6.80E-03	0.001
RHXE207AXU	5.00E-04	0.001
RHXE207BXU	5.00E-04	0.001
RLPSPCOLAU	3.00E-03	0.001
RLPSPCOLBU	3.00E-03	0.001
RPMABCDCCS	1.70E-05	0.001
RVC68AXXXC	2.66E-04	0.001
RVC68BXXXC	2.66E-04	0.001
RVM10ABCCN	1.30E-04	0.001
RVM3436CCN	1.30E-05	0.001
RVM34ABCCN	3.70E-05	0.001
RVM34AXXXN	1.50E-03	0.001
RVM34BXXXN	1.50E-03	0.001
RVM36ABCCN	3.70E-05	0.001
RVM36AXXXN	1.50E-03	0.001
RVM36BXXXN	1.50E-03	0.001
RVM4A6BCCN	3.70E-05	0.001
RVM4B6ACCN	3.70E-05	0.001
RVM60ABCCN	1.30E-04	0.001
SPMABXXCCS	2.60E-04	0.001
SPMALLXCCS	1.63E-05	0.001
SPMP208BXU	2.98E-02	0.001
SPMP208EXU	2.98E-02	0.001
SVC3880BXN	1.57E-03	0.001
SVC3880EXN	1.57E-03	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	1.20E-05	0.001
RVM29BXXXL	1.20E-05	0.001
EVM25BXXXL	1.20E-05	0.001
CVM25AXXXL	1.20E-05	0.001
JAF-INSERT	4.65E-03	0.001

System Data File for PILCDF1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILCDF1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: PILCDF1.HAZ

```
*********Pilgrim Hazard Curves*********                    ...HAZHEAD  (A40)
       1                                                    ...NHAZ
 7                                                          ...NPHAZ
1.0                                                         ...PWHAZ(I)
.009174    .09684     .1937     .3914     .5810     .7543     .9888  ACC
1.3e-02   1.4e-03   5.3e-04   9.6e-05   2.0e-05   5.7e-06   1.5e-06  HAZ
```

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)
1	ALL	2.85E-05	2	

No.	Sequence Name	Sequence Risk	% of Total
1	PIL-SEQ2	2.57E-05	90.21
2	PIL-SEQ1	2.79E-06	9.79
	Sum:	2.85E-05	100.00

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.401
.150	.470
.250	.495
.500	.572
.750	.685
.850	.754
.950	.889

HCLPF (See note) .326

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #2

Names File for PILUSGS.NAM

PILUSGS.GEN
PILUSGS.SYS
PILUSGS.CMP
PILUSGS.SEQ
PILUSGS.HAZ

PILUSGS.NAM
05-18-11

Basic Input File for PILUSGS.GEN

Pilgrim SPRA
Entergy Nuclear
USGS Base Case CDF
USGSCDF
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .02 0.98 1290
2

PILUSGS.GEN
05-18-11

Basic Event Data File for PILUSGS.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	0.77	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	0.84	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	1	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	0.82	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	1.07	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.28	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0

EDPC6XXXXZ	2.11	0.46	0	0
EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	1.23	0.46	0	0
EFN202ABXZ	1.23	0.46	0	0
EFN203ABXZ	1.23	0.46	0	0
EFN204ABXZ	0.61	0.46	0	0
EFN204CDXZ	0.61	0.46	0	0
EFN207A-DZ	1.01	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.28	0.46	0	0
EPM184AXXZ	1.05	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	0.55	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	0.55	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0

ERE27A6X!Z	1.04	0.31	0.51	0
ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	0.16	0.46	0	0
ETKT105ABZ	0.94	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.28	0.46	0	0
EVRCABXXXZ	1.28	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.28	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 2.5e-2	2.50E-02	2.50E-01	5.00E-01	5.00E-01
EDLGESBOXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 3.2e-3	3.20E-03	3.20E-02	5.00E-01	5.00E-01
ELPSPPRPLY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 4.0e-3	4.00E-03	4.00E-02	1.00E+00	1.00E+00
ESPCOOLXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 5.1e-4	5.10E-04	5.10E-03	5.00E-01	5.00E-01

ESPC36ABXY		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	5.0e-1	5.00E-01	5.00E-01	7.50E-01	7.50E-01
ERERESET!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	9.0E-2	9.00E-02	5.00E-01	5.00E-01	5.00E-01
EVMMO45X!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	6.6E-2	6.60E-02	5.00E-01	5.00E-01	5.00E-01
ACB152501F		1.49E-04	0.001		
ACB152509L		1.49E-04	0.001		
ACB152601F		1.49E-04	0.001		
ACB152609L		1.49E-04	0.001		
ACB152802F		1.49E-04	0.001		
ACB5605CCN		2.21E-05	0.001		
ACB5609CCC		8.86E-05	0.001		
ADLADL3CCR		2.64E-04	0.001		
ADLADLBCCR		2.64E-04	0.001		
ADLADLBCCS		4.90E-05	0.001		
ADLBDL3CCR		2.64E-04	0.001		
ADLG123CCR		1.32E-05	0.001		
ADLGEAXXXS		4.80E-03	0.001		
ADLGEAXXXU		1.18E-02	0.001		
ADLGEBXXXR		7.92E-03	0.001		
ADLGEBXXXU		1.18E-02	0.001		
ADLGESBOXS		4.80E-03	0.001		
ADLGESBOXU		1.14E-02	0.001		
ALOCALOOP		1.00E+00	0.001		
APM141AXXR		6.84E-04	0.001		
APM141BXXR		6.84E-04	0.001		
APM184AXXR		6.84E-04	0.001		
APM184AXXS		4.95E-04	0.001		
AVA452XCCN		4.00E-05	0.001		
BPM5XXXCCS		4.80E-05	0.001		
BPMBXXXXXU		1.09E-02	0.001		
BPMCXXXXXU		1.09E-02	0.001		
BPMEXXXXXU		1.09E-02	0.001		
BPMFXXXXXU		1.09E-02	0.001		
BVM3801XXC		1.65E-03	0.001		
BVM3805XXC		1.65E-03	0.001		
CM		7.50E-06	0.001		
CVC9AXXXXC		2.66E-04	0.001		
CVC9BXXXXC		2.66E-04	0.001		
DBC21XXCCR		1.57E-05	0.001		
DBCD11NORE		6.80E-01	0.001		
DBCD11XXXU		7.30E-04	0.001		
DBCD12NORE		6.80E-01	0.001		
DBCD12XXXU		7.30E-04	0.001		
EBCD11XXXR		2.98E-04	0.001		

EBCD12XXXR	2.98E-04	0.001	
ECB152504F	1.49E-04	0.001	
ECB152505N	1.99E-04	0.001	
ECB152508L	1.49E-04	0.001	
ECB152509C	7.97E-04	0.001	
ECB152600L	1.49E-04	0.001	
ECB152604F	1.49E-04	0.001	
ECB152605N	1.99E-04	0.001	
ECB152608L	1.49E-04	0.001	
ECB152609C	7.97E-04	0.001	
ECB152801C	1.99E-04	0.001	
ECB152802N	1.99E-04	0.001	
ECB5605AXY	1.00E+00	0.001	
ECB5605DXY	1.00E+00	0.001	
EDLGEAXXXR	7.92E-03	0.001	
EDLGEBXXXS	4.80E-03	0.001	
EDLGESBOXR	7.92E-03	0.001	
EHX209AXXU	2.66E-02	0.001	
EHX209BXXU	2.66E-02	0.001	
ELOCAHPCIR	1.23E-04	0.001	
ELOCARCICR	1.23E-04	0.001	
EPM141AXXS	4.95E-04	0.001	
EPM141BXXS	4.95E-04	0.001	
EPM208AXXS	9.20E-03	0.001	
EPM208BXXS	9.20E-03	0.001	
EPM208EXXS	9.20E-03	0.001	
EPTHPCIXXR	1.96E-02	0.001	
EPTRCICXXR	1.96E-02	0.001	
EVA4521XXN	1.60E-04	0.001	
EVA4522XXN	1.60E-04	0.001	
EVM130117C	1.65E-03	0.001	
EVM23015XC	1.65E-03	0.001	
HPMAUXOILS	3.00E-03	0.001	
HPME205XXS	3.00E-03	0.001	
HPTHPCIXXS	6.11E-03	0.001	
HPTHPRCCCR	3.56E-04	0.001	
HPTHPRCCCS	3.90E-04	0.001	
HSYHPCIMNU	2.54E-02	0.001	
HVMMO35XXN	1.65E-03	0.001	
HVMMO36XXN	1.65E-03	0.001	80
HVMMO3XXXN	1.30E-02	0.001	
HVMMO6XXXC	1.65E-03	0.001	
HVMMO8XXXN	1.65E-03	0.001	
ILPRCICMNU	3.55E-02	0.001	
IPTRCICXXS	3.33E-02	0.001	
IPVVACPMPS	3.00E-03	0.001	
IVMINJVCCN	1.30E-04	0.001	
IVMMO49XXN	1.50E-03	0.001	
IVMMO60XXC	1.65E-03	0.001	

IVMMO61XXN	1.50E-03	0.001
IVMMO62XXN	1.65E-03	0.001
P	6.80E-03	0.001
RHXE207AXU	5.00E-04	0.001
RHXE207BXU	5.00E-04	0.001
RLPSPCOLAU	3.00E-03	0.001
RLPSPCOLBU	3.00E-03	0.001
RPMABCDCCS	1.70E-05	0.001
RVC68AXXXC	2.66E-04	0.001
RVC68BXXXC	2.66E-04	0.001
RVM10ABCCN	1.30E-04	0.001
RVM3436CCN	1.30E-05	0.001
RVM34ABCCN	3.70E-05	0.001
RVM34AXXXN	1.50E-03	0.001
RVM34BXXXN	1.50E-03	0.001
RVM36ABCCN	3.70E-05	0.001
RVM36AXXXN	1.50E-03	0.001
RVM36BXXXN	1.50E-03	0.001
RVM4A6BCCN	3.70E-05	0.001
RVM4B6ACCN	3.70E-05	0.001
RVM60ABCCN	1.30E-04	0.001
SPMABXXCCS	2.60E-04	0.001
SPMALLXCCS	7.00E-04	0.001
SPMP208BXU	2.98E-02	0.001
SPMP208EXU	2.98E-02	0.001
SVC3880BXN	1.57E-03	0.001
SVC3880EXN	1.57E-03	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	1.20E-05	0.001
RVM29BXXXL	1.20E-05	0.001
EVM25BXXXL	1.20E-05	0.001
CVM25AXXXL	1.20E-05	0.001
JAF-INSERT	4.65E-03	0.001

PILRUN1.CMP
5/18/2011

System Data File for PILUSGS.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILUSGS.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: PILUSGS.HAZ

```
*Pilgrim 2008 USGS Hazard Curves*                                   ...HAZHEAD  (A40)
       1                                                            ...NHAZ
15                                                                  ...NPHAZ
1.0                                                                  ...PWHAZ(I)
0.0148   0.0288   0.0401   0.0771   0.1065   0.1957   0.2610
0.3410   0.5161   0.6283   0.7936   0.9000   1.0464   1.3832
1.8744
6.76E-03  3.12E-03  2.06E-03  8.68E-04  5.55E-04  2.23E-04  1.38E-04
8.57E-05  3.11E-05  1.77E-05  9.51E-06  7.08E-06  4.65E-06  1.96E-06
5.99E-07
```

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
				No.	Sequence Name	Sequence Risk	% of Total
1	ALL	3.78E-05	2	1	PIL-SEQ2	3.50E-05	92.44
				2	PIL-SEQ1	2.86E-06	7.56
					Sum:	3.78E-05	100.00

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.314
.150	.378
.250	.418
.500	.490
.750	.543
.850	.630
.950	.808

HCLPF (See note) .252

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #3

Names File for PILRUN1.NAM

PILRUN1.GEN
PILRUN1.SYS
PILRUN1.CMP
PILRUN1.SEQ
USGS.HAZ

PILRUN1.NAM
05-09-94

Basic Input File for PILRUN1.GEN

Pilgrim SPRA
Boston Edison Company
Level 1 PRA
RANOP0
1 1 2
1 1 1 1
1 1 1
1 129 7 121 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .02 0.98 1290
2

Basic Event Data File for PILRUN1.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	0.77	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	0.84	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	1	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	0.82	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	1.07	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.28	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0

EDPC6XXXXZ	2.11	0.46	0	0
EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	1.23	0.46	0	0
EFN202ABXZ	1.23	0.46	0	0
EFN203ABXZ	1.23	0.46	0	0
EFN204ABXZ	0.61	0.46	0	0
EFN204CDXZ	0.61	0.46	0	0
EFN207A-DZ	1.01	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.28	0.46	0	0
EPM184AXXZ	1.05	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	0.55	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	0.55	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0

ERE27A6X!Z	1.04	0.31	0.51	0
ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	0.16	0.46	0	0
ETKT105ABZ	0.94	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.28	0.46	0	0
EVRCABXXXZ	1.28	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.28	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
EDLGESBOXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ELPSPPRPLY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPCOOLXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			

ESPC36ABXY	1	
2 0.0000	2	
1.0 0.0000	0.00E+00	
ERERESET!Y	1	
2 0.0000	2	
1.0 0.0000	0.00E+00	
EVMMO45X!Y	1	
2 0.0000	2	
1.0 0.0000	0.00E+00	
ACB152501F	0.00E+00	0.001
ACB152509L	0.00E+00	0.001
ACB152601F	0.00E+00	0.001
ACB152609L	0.00E+00	0.001
ACB152802F	0.00E+00	0.001
ACB5605CCN	0.00E+00	0.001
ACB5609CCC	0.00E+00	0.001
ADLADL3CCR	0.00E+00	0.001
ADLADLBCCR	0.00E+00	0.001
ADLADLBCCS	0.00E+00	0.001
ADLBDL3CCR	0.00E+00	0.001
ADLG123CCR	0.00E+00	0.001
ADLGEAXXXS	0.00E+00	0.001
ADLGEAXXXU	0.00E+00	0.001
ADLGEBXXXR	0.00E+00	0.001
ADLGEBXXXU	0.00E+00	0.001
ADLGESBOXS	0.00E+00	0.001
ADLGESBOXU	0.00E+00	0.001
ALOCALOOP	0.00E+00	0.001
APM141AXXR	0.00E+00	0.001
APM141BXXR	0.00E+00	0.001
APM184AXXR	0.00E+00	0.001
APM184AXXS	0.00E+00	0.001
AVA452XCCN	0.00E+00	0.001
BPM5XXXCCS	0.00E+00	0.001
BPMBXXXXXU	0.00E+00	0.001
BPMCXXXXXU	0.00E+00	0.001
BPMEXXXXXU	0.00E+00	0.001
BPMFXXXXXU	0.00E+00	0.001
BVM3801XXC	0.00E+00	0.001
BVM3805XXC	0.00E+00	0.001
CM	0.00E+00	0.001
CVC9AXXXXC	0.00E+00	0.001
CVC9BXXXXC	0.00E+00	0.001
DBC21XXCCR	0.00E+00	0.001
DBCD11NORE	0.00E+00	0.001
DBCD11XXXU	0.00E+00	0.001
DBCD12NORE	0.00E+00	0.001
DBCD12XXXU	0.00E+00	0.001
EBCD11XXXR	0.00E+00	0.001

EBCD12XXXR	0.00E+00	0.001
ECB152504F	0.00E+00	0.001
ECB152505N	0.00E+00	0.001
ECB152508L	0.00E+00	0.001
ECB152509C	0.00E+00	0.001
ECB152600L	0.00E+00	0.001
ECB152604F	0.00E+00	0.001
ECB152605N	0.00E+00	0.001
ECB152608L	0.00E+00	0.001
ECB152609C	0.00E+00	0.001
ECB152801C	0.00E+00	0.001
ECB152802N	0.00E+00	0.001
ECB5605AXY	0.00E+00	0.001
ECB5605DXY	0.00E+00	0.001
EDLGEAXXXR	0.00E+00	0.001
EDLGEBXXXS	0.00E+00	0.001
EDLGESBOXR	0.00E+00	0.001
EHX209AXXU	0.00E+00	0.001
EHX209BXXU	0.00E+00	0.001
ELOCAHPCIR	0.00E+00	0.001
ELOCARCICR	0.00E+00	0.001
EPM141AXXS	0.00E+00	0.001
EPM141BXXS	0.00E+00	0.001
EPM208AXXS	0.00E+00	0.001
EPM208BXXS	0.00E+00	0.001
EPM208EXXS	0.00E+00	0.001
EPTHPCIXXR	0.00E+00	0.001
EPTRCICXXR	0.00E+00	0.001
EVA4521XXN	0.00E+00	0.001
EVA4522XXN	0.00E+00	0.001
EVM130117C	0.00E+00	0.001
EVM23015XC	0.00E+00	0.001
HPMAUXOILS	0.00E+00	0.001
HPME205XXS	0.00E+00	0.001
HPTHPCIXXS	0.00E+00	0.001
HPTHPRCCCR	0.00E+00	0.001
HPTHPRCCCS	0.00E+00	0.001
HSYHPCIMNU	0.00E+00	0.001
HVMMO35XXN	0.00E+00	0.001
HVMMO36XXN	0.00E+00	0.001
HVMMO3XXXN	0.00E+00	0.001
HVMMO6XXXC	0.00E+00	0.001
HVMMO8XXXN	0.00E+00	0.001
ILPRCICMNU	0.00E+00	0.001
IPTRCICXXS	0.00E+00	0.001
IPVVACPMPS	0.00E+00	0.001
IVMINJVCCN	0.00E+00	0.001
IVMMO49XXN	0.00E+00	0.001
IVMMO60XXC	0.00E+00	0.001

IVMMO61XXN	0.00E+00	0.001
IVMMO62XXN	0.00E+00	0.001
P	0.00E+00	0.001
RHXE207AXU	0.00E+00	0.001
RHXE207BXU	0.00E+00	0.001
RLPSPCOLAU	0.00E+00	0.001
RLPSPCOLBU	0.00E+00	0.001
RPMABCDCCS	0.00E+00	0.001
RVC68AXXXC	0.00E+00	0.001
RVC68BXXXC	0.00E+00	0.001
RVM10ABCCN	0.00E+00	0.001
RVM3436CCN	0.00E+00	0.001
RVM34ABCCN	0.00E+00	0.001
RVM34AXXXN	0.00E+00	0.001
RVM34BXXXN	0.00E+00	0.001
RVM36ABCCN	0.00E+00	0.001
RVM36AXXXN	0.00E+00	0.001
RVM36BXXXN	0.00E+00	0.001
RVM4A6BCCN	0.00E+00	0.001
RVM4B6ACCN	0.00E+00	0.001
RVM60ABCCN	0.00E+00	0.001
SPMABXXCCS	0.00E+00	0.001
SPMALLXCCS	0.00E+00	0.001
SPMP208BXU	0.00E+00	0.001
SPMP208EXU	0.00E+00	0.001
SVC3880BXN	0.00E+00	0.001
SVC3880EXN	0.00E+00	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	0.00E+00	0.001
RVM29BXXXL	0.00E+00	0.001
EVM25BXXXL	0.00E+00	0.001
CVM25AXXXL	0.00E+00	0.001

System Data File for PILRUN1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILRUN1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: USGS.HAZ

```
*Pilgrim 2008 USGS Hazard Curves*                                   ...HAZHEAD (A40)
       1                                                            ...NHAZ
15                                                                  ...NPHAZ
1.0                                                                 ...PWHAZ(I)
0.0148   0.0288   0.0401   0.0771   0.1065   0.1957   0.2610
0.3410   0.5161   0.6283   0.7936   0.9000   1.0464   1.3832
1.8744
6.76E-03  3.12E-03  2.06E-03  8.68E-04  5.55E-04  2.23E-04  1.38E-04
8.57E-05  3.11E-05  1.77E-05  9.51E-06  7.08E-06  4.65E-06  1.96E-06
5.99E-07
```

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RANOP0.BAS
SHIP Basic Output

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
				No.	Sequence Name	Sequence Risk	% of Total
1	ALL	2.33E-05	2	1	PIL-SEQ2	2.05E-05	87.73
				2	PIL-SEQ1	2.86E-06	12.27
					Sum:	2.33E-05	100.00

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RANOP0.BAS
SHIP Basic Output

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.383
.150	.444
.250	.484
.500	.564
.750	.657
.850	.714
.950	.836
HCLPF (See note)	.321

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #4

Names File for PILCDF2.NAM

PILCDF2.GEN
PILCDF2.SYS
PILCDF2.CMP
PILCDF2.SEQ
USGS.HAZ

PILCDF2.NAM
05-19-11

Basic Input File for PILCDF2.GEN

Pilgrim SPRA
Entergy Nuclear
FRAG&BE Data (USGS)
SCDF2
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .02 0.98 1290
2

PILCDF2.GEN
05-19-11

Basic Event Data File for PILCDF2.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	1.04	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	1.13	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	2	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	2	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	2	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.73	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0
EDPC6XXXXZ	2.11	0.46	0	0
EDPC93023Z	2.28	0.46	0	0

EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	2	0.46	0	0
EFN202ABXZ	2	0.46	0	0
EFN203ABXZ	2	0.46	0	0
EFN204ABXZ	2	0.46	0	0
EFN204CDXZ	2	0.46	0	0
EFN207A-DZ	2	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.73	0.46	0	0
EPM184AXXZ	1.42	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	1.5	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	2.22	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0
ERE27A6X!Z	1.04	0.31	0.51	0
ERE32801!Z	1	0.31	0.51	0

ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	5	0.46	0	0
ETKT105ABZ	1.27	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.73	0.46	0	0
EVRCABXXXZ	1.73	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.73	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 2.5e-2	2.50E-02	2.50E-01	5.00E-01	5.00E-01
EDLGESBOXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 3.2e-3	3.20E-03	3.20E-02	5.00E-01	5.00E-01
ELPSPPRPLY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 4.0e-3	4.00E-03	4.00E-02	1.00E+00	1.00E+00
ESPCOOLXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 5.1e-4	5.10E-04	5.10E-03	5.00E-02	5.00E-02
ESPC36ABXY	1			
5 0.0000	0.15	0.4999	0.5	2

1.0	5.0e-1	5.00E-01	5.00E-01	7.50E-01	7.50E-01
ERERESET!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	9.0E-2	9.00E-02	5.00E-01	5.00E-01	5.00E-01
EVMMO45X!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	6.6E-2	6.60E-02	5.00E-01	5.00E-01	5.00E-01
ACB152501F		1.49E-04	0.001		
ACB152509L		1.49E-04	0.001		
ACB152601F		1.49E-04	0.001		
ACB152609L		1.49E-04	0.001		
ACB152802F		1.49E-04	0.001		
ACB5605CCN		2.21E-05	0.001		
ACB5609CCC		8.86E-05	0.001		
ADLADL3CCR		2.64E-04	0.001		
ADLADLBCCR		2.64E-04	0.001		
ADLADLBCCS		4.90E-05	0.001		
ADLBDL3CCR		2.64E-04	0.001		
ADLG123CCR		1.32E-05	0.001		
ADLGEAXXXS		4.80E-03	0.001		
ADLGEAXXXU		1.18E-02	0.001		
ADLGEBXXXR		7.92E-03	0.001		
ADLGEBXXXU		1.09E-02	0.001		
ADLGESBOXS		4.80E-03	0.001		
ADLGESBOXU		1.42E-02	0.001		
ALOCALOOP		1.00E+00	0.001		
APM141AXXR		6.84E-04	0.001		
APM141BXXR		6.84E-04	0.001		
APM184AXXR		6.84E-04	0.001		
APM184AXXS		4.95E-04	0.001		
AVA452XCCN		4.00E-05	0.001		
BPM5XXXCCS		4.80E-05	0.001		
BPMBXXXXXU		1.09E-02	0.001		
BPMCXXXXXU		1.09E-02	0.001		
BPMEXXXXXU		1.09E-02	0.001		
BPMFXXXXXU		1.09E-02	0.001		
BVM3801XXC		1.65E-03	0.001		
BVM3805XXC		1.65E-03	0.001		
CM		7.50E-06	0.001		
CVC9AXXXXC		2.66E-04	0.001		
CVC9BXXXXC		2.66E-04	0.001		
DBC21XXCCR		1.57E-05	0.001		
DBCD11NORE		6.80E-01	0.001		
DBCD11XXXU		7.30E-04	0.001		
DBCD12NORE		6.80E-01	0.001		
DBCD12XXXU		7.30E-04	0.001		
EBCD11XXXR		2.98E-04	0.001		
EBCD12XXXR		2.98E-04	0.001		
ECB152504F		1.49E-04	0.001		

ECB152505N	1.99E-04	0.001
ECB152508L	1.49E-04	0.001
ECB152509C	7.97E-04	0.001
ECB152600L	1.49E-04	0.001
ECB152604F	1.49E-04	0.001
ECB152605N	1.99E-04	0.001
ECB152608L	1.49E-04	0.001
ECB152609C	7.97E-04	0.001
ECB152801C	1.99E-04	0.001
ECB152802N	1.99E-04	0.001
ECB5605AXY	1.00E+00	0.001
ECB5605DXY	1.00E+00	0.001
EDLGEAXXXR	7.92E-03	0.001
EDLGEBXXXS	4.80E-03	0.001
EDLGESBOXR	7.92E-03	0.001
EHX209AXXU	2.66E-02	0.001
EHX209BXXU	2.66E-02	0.001
ELOCAHPCIR	1.23E-04	0.001
ELOCARCICR	1.23E-04	0.001
EPM141AXXS	4.95E-04	0.001
EPM141BXXS	4.95E-04	0.001
EPM208AXXS	9.20E-03	0.001
EPM208BXXS	9.20E-03	0.001
EPM208EXXS	9.20E-03	0.001
EPTHPCIXXR	3.93E-03	0.001
EPTRCICXXR	9.78E-03	0.001
EVA4521XXN	1.60E-04	0.001
EVA4522XXN	1.60E-04	0.001
EVM130117C	1.65E-03	0.001
EVM23015XC	1.65E-03	0.001
HPMAUXOILS	3.33E-03	0.001
HPME205XXS	3.00E-03	0.001
HPTHPCIXXS	3.33E-03	0.001
HPTHPRCCCR	2.31E-07	0.001
HPTHPRCCCS	3.46E-05	0.001
HSYHPCIMNU	1.21E-02	0.001
HVMMO35XXN	1.65E-03	0.001
HVMMO36XXN	1.65E-03	0.001
HVMMO3XXXN	1.03E-03	0.001
HVMMO6XXXC	1.65E-03	0.001
HVMMO8XXXN	1.65E-03	0.001
ILPRCICMNU	8.74E-03	0.001
IPTRCICXXS	3.33E-03	0.001
IPVVACPMPS	3.00E-03	0.001
IVMINJVCCN	1.30E-04	0.001
IVMMO49XXN	1.50E-03	0.001
IVMMO60XXC	1.65E-03	0.001
IVMMO61XXN	1.50E-03	0.001
IVMMO62XXN	1.65E-03	0.001

P	6.80E-03	0.001
RHXE207AXU	5.00E-04	0.001
RHXE207BXU	5.00E-04	0.001
RLPSPCOLAU	3.00E-03	0.001
RLPSPCOLBU	3.00E-03	0.001
RPMABCDCCS	1.70E-05	0.001
RVC68AXXXC	2.66E-04	0.001
RVC68BXXXC	2.66E-04	0.001
RVM10ABCCN	1.30E-04	0.001
RVM3436CCN	1.30E-05	0.001
RVM34ABCCN	3.70E-05	0.001
RVM34AXXXN	1.50E-03	0.001
RVM34BXXXN	1.50E-03	0.001
RVM36ABCCN	3.70E-05	0.001
RVM36AXXXN	1.50E-03	0.001
RVM36BXXXN	1.50E-03	0.001
RVM4A6BCCN	3.70E-05	0.001
RVM4B6ACCN	3.70E-05	0.001
RVM60ABCCN	1.30E-04	0.001
SPMABXXCCS	2.60E-04	0.001
SPMALLXCCS	1.63E-05	0.001
SPMP208BXU	2.98E-02	0.001
SPMP208EXU	2.98E-02	0.001
SVC3880BXN	1.57E-03	0.001
SVC3880EXN	1.57E-03	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	1.20E-05	0.001
RVM29BXXXL	1.20E-05	0.001
EVM25BXXXL	1.20E-05	0.001
CVM25AXXXL	1.20E-05	0.001
JAF-INSERT	4.65E-03	0.001

System Data File for PILCDF2.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILCDF2.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: USGS.HAZ

```
*Pilgrim 2008 USGS Hazard Curves*                                   ...HAZHEAD  (A40)
       1                                                            ...NHAZ
15                                                                  ...NPHAZ
1.0                                                                  ...PWHAZ(I)
0.0148   0.0288   0.0401   0.0771   0.1065   0.1957   0.2610
0.3410   0.5161   0.6283   0.7936   0.9000   1.0464   1.3832
1.8744
6.76E-03  3.12E-03  2.06E-03  8.68E-04  5.55E-04 2.23E-04  1.38E-04
8.57E-05  3.11E-05  1.77E-05  9.51E-06  7.08E-06 4.65E-06  1.96E-06
5.99E-07
```

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SCDF2.BAS
SHIP Basic Output

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
1	ALL	2.14E-05	2	No.	Sequence Name	Sequence Risk	% of Total
				1	PIL-SEQ2	1.85E-05	86.60
				2	PIL-SEQ1	2.86E-06	13.40
					Sum:	2.14E-05	100.00

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SCDF2.BAS
SHIP Basic Output

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.400
.150	.471
.250	.500
.500	.572
.750	.685
.850	.754
.950	.888
HCLPF (See note)	.326

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #5

Names File for PILRUN1.NAM

PILRUN1.GEN
PILRUN1.SYS
PILRUN1.CMP
PILRUN1.SEQ
USGS.HAZ

Basic Input File for PILRUN1.GEN

```
Pilgrim SPRA
Boston Edison Company
Level 1 PRA
RANOP0
1   1   2
1   1   1   1
1   1   1
1  129   7  122   1   2   1     nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
 PGA (g)
1  .04  .02  0.98  1290
2
```

Basic Event Data File for PILRUN1.CMP

ESISLXXXXZ	SISL				
EBAAXXXXXZ		2.11	0.46	0	0
EBABD3XXXZ		2.28	0.46	0	0
EBCD1145XZ		2.11	0.46	0	0
EBCD12-13Z		2.28	0.46	0	0
EBDDGBLDXZ		1.04	0.46	0	0
EBSA5XXXXZ		1.76	0.46	0	0
EBSA600XXZ		2.09	0.46	0	0
EBSA6XXXXZ		2.09	0.46	0	0
EBSA8XXXXZ		0.96	0.29	0.37	0
EBSB10XXXZ		2.24	0.46	0	0
EBSB1415XZ		1.51	0.46	0	0
EBSB1718XZ		2	0.46	0	0
EBSB1XXXXZ		2	0.46	0	0
EBSB2XXXXZ		1.13	0.46	0	0
EBSB6XXXXZ		2	0.46	0	0
EBSD16XXXZ		2.11	0.46	0	0
EBSD17XXXZ		2.28	0.46	0	0
EBSD4XXXXZ		2.11	0.46	0	0
EBSD5XXXXZ		2.28	0.46	0	0
EBSD7XXXXZ		2	0.46	0	0
EBSY34XXXZ		1.49	0.46	0	0
EBW185/1XZ		1.41	0.46	0	0
EBW195/23Z		2	0.46	0	0
EBW198/0XZ		2.29	0.46	0	0
EBW198/1XZ		3.43	0.33	0.72	0
EBW198/2XZ		3.43	0.33	0.72	0
EBW198/3XZ		2.29	0.46	0	0
EBW209/0XZ		2	0.46	0	0
EBW209/1XZ		1.72	0.46	0	0
EBW210/0XZ		1.65	0.34	0.46	0
EBW210/1XZ		1.84	0.46	0	0
EBW210/3XZ		2	0.46	0	0
EBW45/3XXZ		2	0.46	0	0
ECBD29XXXZ		2.23	0.46	0	0
ECBD30-31Z		2.28	0.46	0	0
ECMK103ABZ		1.73	0.46	0	0
ECONTLRODZ		1.55	0.46	0	0
ECOREPLATZ		2.9	0.46	0	0
EDLGEABXXZ		1.39	0.32	0.57	0
EDLGESBOXZ		2	0.46	0	0
EDP2233ABZ		1.49	0.46	0	0
EDPC2258XZ		2.13	0.46	0	0
EDPC5XXXXZ		2.11	0.46	0	0
EDPC6XXXXZ		2.11	0.46	0	0
EDPC93023Z		2.28	0.46	0	0

EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	2	0.46	0	0
EFN202ABXZ	2	0.46	0	0
EFN203ABXZ	2	0.46	0	0
EFN204ABXZ	2	0.46	0	0
EFN204CDXZ	2	0.46	0	0
EFN207A-DZ	2	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.73	0.46	0	0
EPM184AXXZ	1.42	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	1.5	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	2.22	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0
ERE27A6X!Z	1.04	0.31	0.51	0
ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0

ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	5	0.46	0	0
ETKT105ABZ	1.27	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.73	0.46	0	0
EVRCABXXXZ	1.73	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.73	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
EDLGESBOXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ELPSPPRPLY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPCOOLXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPC36ABXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ERERESET!Y	1			

2	0.0000	2	
1.0	0.0000	0.00E+00	
EVMMO45X!Y		1	
2	0.0000	2	
1.0	0.0000	0.00E+00	
ACB152501F		0.00E+00	0.001
ACB152509L		0.00E+00	0.001
ACB152601F		0.00E+00	0.001
ACB152609L		0.00E+00	0.001
ACB152802F		0.00E+00	0.001
ACB5605CCN		0.00E+00	0.001
ACB5609CCC		0.00E+00	0.001
ADLADL3CCR		0.00E+00	0.001
ADLADLBCCR		0.00E+00	0.001
ADLADLBCCS		0.00E+00	0.001
ADLBDL3CCR		0.00E+00	0.001
ADLG123CCR		0.00E+00	0.001
ADLGEAXXXS		0.00E+00	0.001
ADLGEAXXXU		0.00E+00	0.001
ADLGEBXXXR		0.00E+00	0.001
ADLGEBXXXU		0.00E+00	0.001
ADLGESBOXS		0.00E+00	0.001
ADLGESBOXU		0.00E+00	0.001
ALOCALOOP		0.00E+00	0.001
APM141AXXR		0.00E+00	0.001
APM141BXXR		0.00E+00	0.001
APM184AXXR		0.00E+00	0.001
APM184AXXS		0.00E+00	0.001
AVA452XCCN		0.00E+00	0.001
BPM5XXXCCS		0.00E+00	0.001
BPMBXXXXXU		0.00E+00	0.001
BPMCXXXXXU		0.00E+00	0.001
BPMEXXXXXU		0.00E+00	0.001
BPMFXXXXXU		0.00E+00	0.001
BVM3801XXC		0.00E+00	0.001
BVM3805XXC		0.00E+00	0.001
CM		0.00E+00	0.001
CVC9AXXXXC		0.00E+00	0.001
CVC9BXXXXC		0.00E+00	0.001
DBC21XXCCR		0.00E+00	0.001
DBCD11NORE		0.00E+00	0.001
DBCD11XXXU		0.00E+00	0.001
DBCD12NORE		0.00E+00	0.001
DBCD12XXXU		0.00E+00	0.001
EBCD11XXXR		0.00E+00	0.001
EBCD12XXXR		0.00E+00	0.001
ECB152504F		0.00E+00	0.001
ECB152505N		0.00E+00	0.001
ECB152508L		0.00E+00	0.001
ECB152509C		0.00E+00	0.001

ECB152600L	0.00E+00	0.001
ECB152604F	0.00E+00	0.001
ECB152605N	0.00E+00	0.001
ECB152608L	0.00E+00	0.001
ECB152609C	0.00E+00	0.001
ECB152801C	0.00E+00	0.001
ECB152802N	0.00E+00	0.001
ECB5605AXY	0.00E+00	0.001
ECB5605DXY	0.00E+00	0.001
EDLGEAXXXR	0.00E+00	0.001
EDLGEBXXXS	0.00E+00	0.001
EDLGESBOXR	0.00E+00	0.001
EHX209AXXU	0.00E+00	0.001
EHX209BXXU	0.00E+00	0.001
ELOCAHPCIR	0.00E+00	0.001
ELOCARCICR	0.00E+00	0.001
EPM141AXXS	0.00E+00	0.001
EPM141BXXS	0.00E+00	0.001
EPM208AXXS	0.00E+00	0.001
EPM208BXXS	0.00E+00	0.001
EPM208EXXS	0.00E+00	0.001
EPTHPCIXXR	0.00E+00	0.001
EPTRCICXXR	0.00E+00	0.001
EVA4521XXN	0.00E+00	0.001
EVA4522XXN	0.00E+00	0.001
EVM130117C	0.00E+00	0.001
EVM23015XC	0.00E+00	0.001
HPMAUXOILS	0.00E+00	0.001
HPME205XXS	0.00E+00	0.001
HPTHPCIXXS	0.00E+00	0.001
HPTHPRCCCR	0.00E+00	0.001
HPTHPRCCCS	0.00E+00	0.001
HSYHPCIMNU	0.00E+00	0.001
HVMMO35XXN	0.00E+00	0.001
HVMMO36XXN	0.00E+00	0.001
HVMMO3XXXN	0.00E+00	0.001
HVMMO6XXXC	0.00E+00	0.001
HVMMO8XXXN	0.00E+00	0.001
ILPRCICMNU	0.00E+00	0.001
IPTRCICXXS	0.00E+00	0.001
IPVVACPMPS	0.00E+00	0.001
IVMINJVCCN	0.00E+00	0.001
IVMMO49XXN	0.00E+00	0.001
IVMMO60XXC	0.00E+00	0.001
IVMMO61XXN	0.00E+00	0.001
IVMMO62XXN	0.00E+00	0.001
P	0.00E+00	0.001
RHXE207AXU	0.00E+00	0.001
RHXE207BXU	0.00E+00	0.001
RLPSPCOLAU	0.00E+00	0.001

RLPSPCOLBU	0.00E+00	0.001
RPMABCDCCS	0.00E+00	0.001
RVC68AXXXC	0.00E+00	0.001
RVC68BXXXC	0.00E+00	0.001
RVM10ABCCN	0.00E+00	0.001
RVM3436CCN	0.00E+00	0.001
RVM34ABCCN	0.00E+00	0.001
RVM34AXXXN	0.00E+00	0.001
RVM34BXXXN	0.00E+00	0.001
RVM36ABCCN	0.00E+00	0.001
RVM36AXXXN	0.00E+00	0.001
RVM36BXXXN	0.00E+00	0.001
RVM4A6BCCN	0.00E+00	0.001
RVM4B6ACCN	0.00E+00	0.001
RVM60ABCCN	0.00E+00	0.001
SPMABXXCCS	0.00E+00	0.001
SPMALLXCCS	0.00E+00	0.001
SPMP208BXU	0.00E+00	0.001
SPMP208EXU	0.00E+00	0.001
SVC3880BXN	0.00E+00	0.001
SVC3880EXN	0.00E+00	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	0.00E+00	0.001
RVM29BXXXL	0.00E+00	0.001
EVM25BXXXL	0.00E+00	0.001
CVM25AXXXL	0.00E+00	0.001
JAF-INSERT	4.65E-03	0.001

System Data File for PILRUN1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILRUN1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: USGS.HAZ

```
*Pilgrim 2008 USGS Hazard Curves*                                   ...HAZHEAD (A40)
       1                                                            ...NHAZ
15                                                                  ...NPHAZ
1.0                                                                 ...PWHAZ(I)
0.0148   0.0288   0.0401   0.0771   0.1065   0.1957   0.2610
0.3410   0.5161   0.6283   0.7936   0.9000   1.0464   1.3832
1.8744
6.76E-03  3.12E-03  2.06E-03  8.68E-04  5.55E-04  2.23E-04  1.38E-04
8.57E-05  3.11E-05  1.77E-05  9.51E-06  7.08E-06  4.65E-06  1.96E-06
5.99E-07
```

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RANOP0.BAS
SHIP Basic Output

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
				No.	Sequence Name	Sequence Risk	% of Total
1	ALL	1.20E-05	2	1	PIL-SEQ2	9.11E-06	76.09
				2	PIL-SEQ1	2.86E-06	23.91
					Sum:	1.20E-05	100.00

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RANOP0.BAS
SHIP Basic Output

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.466
.150	.546
.250	.595
.500	.693
.750	.797
.850	.859
.950	.965
HCLPF (See note)	.381

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #6

Names File for PILEPRI1.NAM

PILEPRI1.GEN
PILEPRI1.SYS
PILEPRI1.CMP
PILEPRI1.SEQ
PILEPRI1.HAZ

PILEPRI1.NAM
05-24-11

Basic Input File for PILEPRI1.GEN

Pilgrim SPRA
Entergy Nuclear
UPDATED EPRI Base CDF
EPRICDF1
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .02 0.98 1290
2

PILEPRI1.GEN
05-24-11

Basic Event Data File for PILEPRI1.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	0.77	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	0.84	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	1	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	0.82	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	1.07	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.28	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0
EDPC6XXXXZ	2.11	0.46	0	0

EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	1.23	0.46	0	0
EFN202ABXZ	1.23	0.46	0	0
EFN203ABXZ	1.23	0.46	0	0
EFN204ABXZ	0.61	0.46	0	0
EFN204CDXZ	0.61	0.46	0	0
EFN207A-DZ	1.01	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.28	0.46	0	0
EPM184AXXZ	1.05	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	0.55	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	0.55	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0
ERE27A6X!Z	1.04	0.31	0.51	0

ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	0.16	0.46	0	0
ETKT105ABZ	0.94	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.28	0.46	0	0
EVRCABXXXZ	1.28	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.28	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 2.5e-2	2.50E-02	2.50E-01	5.00E-01	5.00E-01
EDLGESBOXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 3.2e-3	3.20E-03	3.20E-02	5.00E-01	5.00E-01
ELPSPPRPLY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 4.0e-3	4.00E-03	4.00E-02	1.00E+00	1.00E+00
ESPCOOLXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 5.1e-4	5.10E-04	5.10E-03	5.00E-01	5.00E-01
ESPC36ABXY	1			

5	0.0000	0.15	0.4999	0.5	2
1.0	5.0e-1	5.00E-01	5.00E-01	7.50E-01	7.50E-01
ERERESET!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	9.0E-2	9.00E-02	5.00E-01	5.00E-01	5.00E-01
EVMMO45X!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	6.6E-2	6.60E-02	5.00E-01	5.00E-01	5.00E-01
ACB152501F		1.49E-04	0.001		
ACB152509L		1.49E-04	0.001		
ACB152601F		1.49E-04	0.001		
ACB152609L		1.49E-04	0.001		
ACB152802F		1.49E-04	0.001		
ACB5605CCN		2.21E-05	0.001		
ACB5609CCC		8.86E-05	0.001		
ADLADL3CCR		2.64E-04	0.001		
ADLADLBCCR		2.64E-04	0.001		
ADLADLBCCS		4.90E-05	0.001		
ADLBDL3CCR		2.64E-04	0.001		
ADLG123CCR		1.32E-05	0.001		
ADLGEAXXXS		4.80E-03	0.001		
ADLGEAXXXU		1.18E-02	0.001		
ADLGEBXXXR		7.92E-03	0.001		
ADLGEBXXXU		1.18E-02	0.001		
ADLGESBOXS		4.80E-03	0.001		
ADLGESBOXU		1.14E-02	0.001		
ALOCALOOP		1.00E+00	0.001		
APM141AXXR		6.84E-04	0.001		
APM141BXXR		6.84E-04	0.001		
APM184AXXR		6.84E-04	0.001		
APM184AXXS		4.95E-04	0.001		
AVA452XCCN		4.00E-05	0.001		
BPM5XXXCCS		4.80E-05	0.001		
BPMBXXXXXU		1.09E-02	0.001		
BPMCXXXXXU		1.09E-02	0.001		
BPMEXXXXXU		1.09E-02	0.001		
BPMFXXXXXU		1.09E-02	0.001		
BVM3801XXC		1.65E-03	0.001		
BVM3805XXC		1.65E-03	0.001		
CM		7.50E-06	0.001		
CVC9AXXXXC		2.66E-04	0.001		
CVC9BXXXXC		2.66E-04	0.001		
DBC21XXCCR		1.57E-05	0.001		
DBCD11NORE		6.80E-01	0.001		
DBCD11XXXU		7.30E-04	0.001		
DBCD12NORE		6.80E-01	0.001		
DBCD12XXXU		7.30E-04	0.001		
EBCD11XXXR		2.98E-04	0.001		
EBCD12XXXR		2.98E-04	0.001		

ECB152504F	1.49E-04	0.001
ECB152505N	1.99E-04	0.001
ECB152508L	1.49E-04	0.001
ECB152509C	7.97E-04	0.001
ECB152600L	1.49E-04	0.001
ECB152604F	1.49E-04	0.001
ECB152605N	1.99E-04	0.001
ECB152608L	1.49E-04	0.001
ECB152609C	7.97E-04	0.001
ECB152801C	1.99E-04	0.001
ECB152802N	1.99E-04	0.001
ECB5605AXY	1.00E+00	0.001
ECB5605DXY	1.00E+00	0.001
EDLGEAXXXR	7.92E-03	0.001
EDLGEBXXXS	4.80E-03	0.001
EDLGESBOXR	7.92E-03	0.001
EHX209AXXU	2.66E-02	0.001
EHX209BXXU	2.66E-02	0.001
ELOCAHPCIR	1.23E-04	0.001
ELOCARCICR	1.23E-04	0.001
EPM141AXXS	4.95E-04	0.001
EPM141BXXS	4.95E-04	0.001
EPM208AXXS	9.20E-03	0.001
EPM208BXXS	9.20E-03	0.001
EPM208EXXS	9.20E-03	0.001
EPTHPCIXXR	1.96E-02	0.001
EPTRCICXXR	1.96E-02	0.001
EVA4521XXN	1.60E-04	0.001
EVA4522XXN	1.60E-04	0.001
EVM130117C	1.65E-03	0.001
EVM23015XC	1.65E-03	0.001
HPMAUXOILS	3.00E-03	0.001
HPME205XXS	3.00E-03	0.001
HPTHPCIXXS	6.11E-03	0.001
HPTHPRCCCR	3.56E-04	0.001
HPTHPRCCCS	3.90E-04	0.001
HSYHPCIMNU	2.54E-02	0.001
HVMMO35XXN	1.65E-03	0.001
HVMMO36XXN	1.65E-03	0.001
HVMMO3XXXN	1.30E-02	0.001
HVMMO6XXXC	1.65E-03	0.001
HVMMO8XXXN	1.65E-03	0.001
ILPRCICMNU	3.55E-02	0.001
IPTRCICXXS	3.33E-02	0.001
IPVVACPMPS	3.00E-03	0.001
IVMINJVCCN	1.30E-04	0.001
IVMMO49XXN	1.50E-03	0.001
IVMMO60XXC	1.65E-03	0.001
IVMMO61XXN	1.50E-03	0.001

IVMMO62XXN	1.65E-03	0.001
P	6.80E-03	0.001
RHXE207AXU	5.00E-04	0.001
RHXE207BXU	5.00E-04	0.001
RLPSPCOLAU	3.00E-03	0.001
RLPSPCOLBU	3.00E-03	0.001
RPMABCDCCS	1.70E-05	0.001
RVC68AXXXC	2.66E-04	0.001
RVC68BXXXC	2.66E-04	0.001
RVM10ABCCN	1.30E-04	0.001
RVM3436CCN	1.30E-05	0.001
RVM34ABCCN	3.70E-05	0.001
RVM34AXXXN	1.50E-03	0.001
RVM34BXXXN	1.50E-03	0.001
RVM36ABCCN	3.70E-05	0.001
RVM36AXXXN	1.50E-03	0.001
RVM36BXXXN	1.50E-03	0.001
RVM4A6BCCN	3.70E-05	0.001
RVM4B6ACCN	3.70E-05	0.001
RVM60ABCCN	1.30E-04	0.001
SPMABXXCCS	2.60E-04	0.001
SPMALLXCCS	7.00E-04	0.001
SPMP208BXU	2.98E-02	0.001
SPMP208EXU	2.98E-02	0.001
SVC3880BXN	1.57E-03	0.001
SVC3880EXN	1.57E-03	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	1.20E-05	0.001
RVM29BXXXL	1.20E-05	0.001
EVM25BXXXL	1.20E-05	0.001
CVM25AXXXL	1.20E-05	0.001
JAF-INSERT	4.65E-03	0.001

PILRUN1.CMP
5/18/2011

System Data File for PILEPRI1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILEPRI1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: PILEPRI1.HAZ

```
*Pilgrim Updated EPRI Hazard Curves*     ..HAZHEAD  (A40)
       1                                 ...NHAZ
15                                       .NPHAZ
1.0                                      ..PWHAZ(I)
0.001    0.002    0.005    0.01     0.02    0.03     0.05
0.07     0.1      0.2      0.3      0.5     1.0      1.5
2.0
1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04
1.11E-04  1.02E-04  7.20E-05  5.22E-05  2.99E-05  9.54E-06  3.98E-06
1.95E-06
```

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
				No.	Sequence Name	Sequence Risk	% of Total
1	ALL	2.15E-05	2	1	PIL-SEQ2	1.90E-05	88.44
				2	PIL-SEQ1	2.49E-06	11.56
					Sum:	2.15E-05	100.00

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.314
.150	.378
.250	.418
.500	.490
.750	.543
.850	.630
.950	.808
HCLPF (See note)	.252

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #7

Names File for PILRUN1.NAM

PILRUN1.GEN
PILRUN1.SYS
PILRUN1.CMP
PILRUN1.SEQ
PILEPRI1.HAZ

PILRUN1.NAM
05-24-11

Basic Input File for PILRUN1.GEN

Pilgrim SPRA
Boston Edison Company
Level 1 PRA
RANOP0
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .01 0.98 1290
2

PILRUN1.GEN
5-24-11

Basic Event Data File for PILRUN1.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	1.04	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	1.13	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	2	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	2	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	2	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.73	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0
EDPC6XXXXZ	2.11	0.46	0	0

EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	2	0.46	0	0
EFN202ABXZ	2	0.46	0	0
EFN203ABXZ	2	0.46	0	0
EFN204ABXZ	2	0.46	0	0
EFN204CDXZ	2	0.46	0	0
EFN207A-DZ	2	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.73	0.46	0	0
EPM184AXXZ	1.42	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	1.5	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	2.22	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0
ERE27A6X!Z	1.04	0.31	0.51	0

ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	5	0.46	0	0
ETKT105ABZ	1.27	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.73	0.46	0	0
EVRCABXXXZ	1.73	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.73	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
EDLGESBOXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ELPSPPRPLY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPCOOLXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPC36ABXY	1			

2	0.0000	2	
1.0	0.0000	0.00E+00	
ERERESET!Y		1	
2	0.0000	2	
1.0	0.0000	0.00E+00	
EVMMO45X!Y		1	
2	0.0000	2	
1.0	0.0000	0.00E+00	
ACB152501F		0.00E+00	0.001
ACB152509L		0.00E+00	0.001
ACB152601F		0.00E+00	0.001
ACB152609L		0.00E+00	0.001
ACB152802F		0.00E+00	0.001
ACB5605CCN		0.00E+00	0.001
ACB5609CCC		0.00E+00	0.001
ADLADL3CCR		0.00E+00	0.001
ADLADLBCCR		0.00E+00	0.001
ADLADLBCCS		0.00E+00	0.001
ADLBDL3CCR		0.00E+00	0.001
ADLG123CCR		0.00E+00	0.001
ADLGEAXXXS		0.00E+00	0.001
ADLGEAXXXU		0.00E+00	0.001
ADLGEBXXXR		0.00E+00	0.001
ADLGEBXXXU		0.00E+00	0.001
ADLGESBOXS		0.00E+00	0.001
ADLGESBOXU		0.00E+00	0.001
ALOCALOOP		0.00E+00	0.001
APM141AXXR		0.00E+00	0.001
APM141BXXR		0.00E+00	0.001
APM184AXXR		0.00E+00	0.001
APM184AXXS		0.00E+00	0.001
AVA452XCCN		0.00E+00	0.001
BPM5XXXCCS		0.00E+00	0.001
BPMBXXXXXU		0.00E+00	0.001
BPMCXXXXXU		0.00E+00	0.001
BPMEXXXXXU		0.00E+00	0.001
BPMFXXXXXU		0.00E+00	0.001
BVM3801XXC		0.00E+00	0.001
BVM3805XXC		0.00E+00	0.001
CM		0.00E+00	0.001
CVC9AXXXXC		0.00E+00	0.001
CVC9BXXXXC		0.00E+00	0.001
DBC21XXCCR		0.00E+00	0.001
DBCD11NORE		0.00E+00	0.001
DBCD11XXXU		0.00E+00	0.001
DBCD12NORE		0.00E+00	0.001
DBCD12XXXU		0.00E+00	0.001
EBCD11XXXR		0.00E+00	0.001
EBCD12XXXR		0.00E+00	0.001

ECB152504F	0.00E+00	0.001
ECB152505N	0.00E+00	0.001
ECB152508L	0.00E+00	0.001
ECB152509C	0.00E+00	0.001
ECB152600L	0.00E+00	0.001
ECB152604F	0.00E+00	0.001
ECB152605N	0.00E+00	0.001
ECB152608L	0.00E+00	0.001
ECB152609C	0.00E+00	0.001
ECB152801C	0.00E+00	0.001
ECB152802N	0.00E+00	0.001
ECB5605AXY	0.00E+00	0.001
ECB5605DXY	0.00E+00	0.001
EDLGEAXXXR	0.00E+00	0.001
EDLGEBXXXS	0.00E+00	0.001
EDLGESBOXR	0.00E+00	0.001
EHX209AXXU	0.00E+00	0.001
EHX209BXXU	0.00E+00	0.001
ELOCAHPCIR	0.00E+00	0.001
ELOCARCICR	0.00E+00	0.001
EPM141AXXS	0.00E+00	0.001
EPM141BXXS	0.00E+00	0.001
EPM208AXXS	0.00E+00	0.001
EPM208BXXS	0.00E+00	0.001
EPM208EXXS	0.00E+00	0.001
EPTHPCIXXR	0.00E+00	0.001
EPTRCICXXR	0.00E+00	0.001
EVA4521XXN	0.00E+00	0.001
EVA4522XXN	0.00E+00	0.001
EVM130117C	0.00E+00	0.001
EVM23015XC	0.00E+00	0.001
HPMAUXOILS	0.00E+00	0.001
HPME205XXS	0.00E+00	0.001
HPTHPCIXXS	0.00E+00	0.001
HPTHPRCCCR	0.00E+00	0.001
HPTHPRCCCS	0.00E+00	0.001
HSYHPCIMNU	0.00E+00	0.001
HVMMO35XXN	0.00E+00	0.001
HVMMO36XXN	0.00E+00	0.001
HVMMO3XXXN	0.00E+00	0.001
HVMMO6XXXC	0.00E+00	0.001
HVMMO8XXXN	0.00E+00	0.001
ILPRCICMNU	0.00E+00	0.001
IPTRCICXXS	0.00E+00	0.001
IPVVACPMPS	0.00E+00	0.001
IVMINJVCCN	0.00E+00	0.001
IVMMO49XXN	0.00E+00	0.001
IVMMO60XXC	0.00E+00	0.001
IVMMO61XXN	0.00E+00	0.001

IVMMO62XXN	0.00E+00	0.001
P	0.00E+00	0.001
RHXE207AXU	0.00E+00	0.001
RHXE207BXU	0.00E+00	0.001
RLPSPCOLAU	0.00E+00	0.001
RLPSPCOLBU	0.00E+00	0.001
RPMABCDCCS	0.00E+00	0.001
RVC68AXXXC	0.00E+00	0.001
RVC68BXXXC	0.00E+00	0.001
RVM10ABCCN	0.00E+00	0.001
RVM3436CCN	0.00E+00	0.001
RVM34ABCCN	0.00E+00	0.001
RVM34AXXXN	0.00E+00	0.001
RVM34BXXXN	0.00E+00	0.001
RVM36ABCCN	0.00E+00	0.001
RVM36AXXXN	0.00E+00	0.001
RVM36BXXXN	0.00E+00	0.001
RVM4A6BCCN	0.00E+00	0.001
RVM4B6ACCN	0.00E+00	0.001
RVM60ABCCN	0.00E+00	0.001
SPMABXXCCS	0.00E+00	0.001
SPMALLXCCS	0.00E+00	0.001
SPMP208BXU	0.00E+00	0.001
SPMP208EXU	0.00E+00	0.001
SVC3880BXN	0.00E+00	0.001
SVC3880EXN	0.00E+00	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	0.00E+00	0.001
RVM29BXXXL	0.00E+00	0.001
EVM25BXXXL	0.00E+00	0.001
CVM25AXXXL	0.00E+00	0.001
JAF-INSERT	4.65E-03	0.001

PILRUN1.CMP
5/18/2011

System Data File for PILRUN1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILRUN1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: PILEPRI1.HAZ

```
*Pilgrim Updated EPRI Hazard Curves*     ..HAZHEAD  (A40)
       1                                 ...NHAZ
15                                       .NPHAZ
1.0                                      ..PWHAZ(I)
0.001    0.002    0.005    0.01    0.02    0.03    0.05
0.07     0.1      0.2      0.3     0.5     1.0     1.5
2.0
1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04
1.11E-04  1.02E-04  7.20E-05  5.22E-05  2.99E-05  9.54E-06  3.98E-06
1.95E-06
```

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
				No.	Sequence Name	Sequence Risk	% of Total
1	ALL	8.97E-06	2	1	PIL-SEQ2	6.57E-06	73.19
				2	PIL-SEQ1	2.41E-06	26.81
					Sum:	8.97E-06	100.00

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.466
.150	.546
.250	.595
.500	.693
.750	.798
.850	.858
.950	.962
HCLPF (See note)	.381

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #8

Names File for PILCDF1.NAM

PILCDF1.GEN
PILCDF1.SYS
PILCDF1.CMP
PILCDF1.SEQ
PILEPRI1.HAZ

PILCDF1.NAM
05-24-11

Basic Input File for PILCDF1.GEN

Pilgrim SPRA
Entergy Nuclear
FRAG&BE Data (EPRI)
SCDF1
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .01 0.98 1290
2

PILCDF1.GEN
05-24-11

Basic Event Data File for PILCDF1.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	1.04	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	1.13	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	2	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	2	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	2	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.73	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0

EDPC5XXXXZ	2.11	0.46	0	0
EDPC6XXXXZ	2.11	0.46	0	0
EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	2	0.46	0	0
EFN202ABXZ	2	0.46	0	0
EFN203ABXZ	2	0.46	0	0
EFN204ABXZ	2	0.46	0	0
EFN204CDXZ	2	0.46	0	0
EFN207A-DZ	2	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.73	0.46	0	0
EPM184AXXZ	1.42	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	1.5	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	2.22	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0

ERE27A5X!Z	0.89	0.31	0.51	0
ERE27A6X!Z	1.04	0.31	0.51	0
ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	5	0.46	0	0
ETKT105ABZ	1.27	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.73	0.46	0	0
EVRCABXXXZ	1.73	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.73	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 2.5e-2	2.50E-02	2.50E-01	5.00E-01	5.00E-01
EDLGESBOXY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 3.2e-3	3.20E-03	3.20E-02	5.00E-01	5.00E-01
ELPSPPRPLY	1			
5 0.0000	0.15	0.4999	0.5	2
1.0 4.0e-3	4.00E-03	4.00E-02	1.00E+00	1.00E+00
ESPCOOLXXY	1			
5 0.0000	0.15	0.4999	0.5	2

1.0	5.1e-4	5.10E-04	5.10E-03	5.00E-02	5.00E-02
ESPC36ABXY		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	5.0e-1	5.00E-01	5.00E-01	7.50E-01	7.50E-01
ERERESET!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	9.0E-2	9.00E-02	5.00E-01	5.00E-01	5.00E-01
EVMMO45X!Y		1			
5	0.0000	0.15	0.4999	0.5	2
1.0	6.6E-2	6.60E-02	5.00E-01	5.00E-01	5.00E-01
ACB152501F		1.49E-04	0.001		
ACB152509L		1.49E-04	0.001		
ACB152601F		1.49E-04	0.001		
ACB152609L		1.49E-04	0.001		
ACB152802F		1.49E-04	0.001		
ACB5605CCN		2.21E-05	0.001		
ACB5609CCC		8.86E-05	0.001		
ADLADL3CCR		2.64E-04	0.001		
ADLADLBCCR		2.64E-04	0.001		
ADLADLBCCS		4.90E-05	0.001		
ADLBDL3CCR		2.64E-04	0.001		
ADLG123CCR		1.32E-05	0.001		
ADLGEAXXXS		4.80E-03	0.001		
ADLGEAXXXU		1.18E-02	0.001		
ADLGEBXXXR		7.92E-03	0.001		
ADLGEBXXXU		1.09E-02	0.001		
ADLGESBOXS		4.80E-03	0.001		
ADLGESBOXU		1.42E-02	0.001		
ALOCALOOP		1.00E+00	0.001		
APM141AXXR		6.84E-04	0.001		
APM141BXXR		6.84E-04	0.001		
APM184AXXR		6.84E-04	0.001		
APM184AXXS		4.95E-04	0.001		
AVA452XCCN		4.00E-05	0.001		
BPM5XXXCCS		4.80E-05	0.001		
BPMBXXXXXU		1.09E-02	0.001		
BPMCXXXXXU		1.09E-02	0.001		
BPMEXXXXXU		1.09E-02	0.001		
BPMFXXXXXU		1.09E-02	0.001		
BVM3801XXC		1.65E-03	0.001		
BVM3805XXC		1.65E-03	0.001		
CM		7.50E-06	0.001		
CVC9AXXXXC		2.66E-04	0.001		
CVC9BXXXXC		2.66E-04	0.001		
DBC21XXCCR		1.57E-05	0.001		
DBCD11NORE		6.80E-01	0.001		
DBCD11XXXU		7.30E-04	0.001		
DBCD12NORE		6.80E-01	0.001		
DBCD12XXXU		7.30E-04	0.001		

EBCD11XXXR	2.98E-04	0.001
EBCD12XXXR	2.98E-04	0.001
ECB152504F	1.49E-04	0.001
ECB152505N	1.99E-04	0.001
ECB152508L	1.49E-04	0.001
ECB152509C	7.97E-04	0.001
ECB152600L	1.49E-04	0.001
ECB152604F	1.49E-04	0.001
ECB152605N	1.99E-04	0.001
ECB152608L	1.49E-04	0.001
ECB152609C	7.97E-04	0.001
ECB152801C	1.99E-04	0.001
ECB152802N	1.99E-04	0.001
ECB5605AXY	1.00E+00	0.001
ECB5605DXY	1.00E+00	0.001
EDLGEAXXXR	7.92E-03	0.001
EDLGEBXXXS	4.80E-03	0.001
EDLGESBOXR	7.92E-03	0.001
EHX209AXXU	2.66E-02	0.001
EHX209BXXU	2.66E-02	0.001
ELOCAHPCIR	1.23E-04	0.001
ELOCARCICR	1.23E-04	0.001
EPM141AXXS	4.95E-04	0.001
EPM141BXXS	4.95E-04	0.001
EPM208AXXS	9.20E-03	0.001
EPM208BXXS	9.20E-03	0.001
EPM208EXXS	9.20E-03	0.001
EPTHPCIXXR	3.93E-03	0.001
EPTRCICXXR	9.78E-03	0.001
EVA4521XXN	1.60E-04	0.001
EVA4522XXN	1.60E-04	0.001
EVM130117C	1.65E-03	0.001
EVM23015XC	1.65E-03	0.001
HPMAUXOILS	3.33E-03	0.001
HPME205XXS	3.00E-03	0.001
HPTHPCIXXS	3.33E-03	0.001
HPTHPRCCCR	2.31E-07	0.001
HPTHPRCCCS	3.46E-05	0.001
HSYHPCIMNU	1.21E-02	0.001
HVMMO35XXN	1.65E-03	0.001
HVMMO36XXN	1.65E-03	0.001
HVMMO3XXXN	1.03E-03	0.001
HVMMO6XXXC	1.65E-03	0.001
HVMMO8XXXN	1.65E-03	0.001
ILPRCICMNU	8.74E-03	0.001
IPTRCICXXS	3.33E-03	0.001
IPVVACPMPS	3.00E-03	0.001
IVMINJVCCN	1.30E-04	0.001
IVMMO49XXN	1.50E-03	0.001

IVMMO60XXC	1.65E-03	0.001
IVMMO61XXN	1.50E-03	0.001
IVMMO62XXN	1.65E-03	0.001
P	6.80E-03	0.001
RHXE207AXU	5.00E-04	0.001
RHXE207BXU	5.00E-04	0.001
RLPSPCOLAU	3.00E-03	0.001
RLPSPCOLBU	3.00E-03	0.001
RPMABCDCCS	1.70E-05	0.001
RVC68AXXXC	2.66E-04	0.001
RVC68BXXXC	2.66E-04	0.001
RVM10ABCCN	1.30E-04	0.001
RVM3436CCN	1.30E-05	0.001
RVM34ABCCN	3.70E-05	0.001
RVM34AXXXN	1.50E-03	0.001
RVM34BXXXN	1.50E-03	0.001
RVM36ABCCN	3.70E-05	0.001
RVM36AXXXN	1.50E-03	0.001
RVM36BXXXN	1.50E-03	0.001
RVM4A6BCCN	3.70E-05	0.001
RVM4B6ACCN	3.70E-05	0.001
RVM60ABCCN	1.30E-04	0.001
SPMABXXCCS	2.60E-04	0.001
SPMALLXCCS	1.63E-05	0.001
SPMP208BXU	2.98E-02	0.001
SPMP208EXU	2.98E-02	0.001
SVC3880BXN	1.57E-03	0.001
SVC3880EXN	1.57E-03	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	1.20E-05	0.001
RVM29BXXXL	1.20E-05	0.001
EVM25BXXXL	1.20E-05	0.001
CVM25AXXXL	1.20E-05	0.001
JAF-INSERT	4.65E-03	0.001

PILRUN1.CMP
5/18/2011

System Data File for PILCDF1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILCDF1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: PILEPRI1.HAZ

```
*Pilgrim Updated EPRI Hazard Curves*      ..HAZHEAD  (A40)
       1                                  ...NHAZ
15                                        .NPHAZ
1.0                                       ..PWHAZ(I)
0.001    0.002    0.005    0.01     0.02    0.03     0.05
0.07     0.1      0.2      0.3      0.5     1.0      1.5
2.0
1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04
1.11E-04  1.02E-04  7.20E-05  5.22E-05  2.99E-05  9.54E-06  3.98E-06
1.95E-06
```

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
1	ALL	1.44E-05	2	No.	Sequence Name	Sequence Risk	% of Total
				1	PIL-SEQ2	1.20E-05	83.34
				2	PIL-SEQ1	2.41E-06	16.66
					Sum:	1.44E-05	100.00

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.401
.150	.470
.250	.495
.500	.572
.750	.685
.850	.754
.950	.889
HCLPF (See note)	.326

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)

SHIP Evaluation #9

Names File for PILRUN1.NAM

PILRUN1.GEN
PILRUN1.SYS
PILRUN1.CMP
PILRUN1.SEQ
PILEPRI1.HAZ

PILRUN1.NAM
05-24-11

Basic Input File for PILRUN1.GEN

Pilgrim SPRA
Boston Edison Company
Level 1 PRA
RANOP0
1 1 2
1 1 1 1
1 1 1
1 129 7 122 1 2 1 nsupcmp,ncomps,ncmpnln,nr,nsys,nseq,ndmg
PGA (g)
1 .04 .01 0.98 1290
2

PILRUN1.GEN
5-24-11

Basic Event Data File for PILRUN1.CMP

ESISLXXXXZ	SISL			
EBAAXXXXXZ	2.11	0.46	0	0
EBABD3XXXZ	2.28	0.46	0	0
EBCD1145XZ	2.11	0.46	0	0
EBCD12-13Z	2.28	0.46	0	0
EBDDGBLDXZ	1.04	0.46	0	0
EBSA5XXXXZ	1.76	0.46	0	0
EBSA600XXZ	2.09	0.46	0	0
EBSA6XXXXZ	2.09	0.46	0	0
EBSA8XXXXZ	0.96	0.29	0.37	0
EBSB10XXXZ	2.24	0.46	0	0
EBSB1415XZ	1.51	0.46	0	0
EBSB1718XZ	2	0.46	0	0
EBSB1XXXXZ	2	0.46	0	0
EBSB2XXXXZ	1.13	0.46	0	0
EBSB6XXXXZ	2	0.46	0	0
EBSD16XXXZ	2.11	0.46	0	0
EBSD17XXXZ	2.28	0.46	0	0
EBSD4XXXXZ	2.11	0.46	0	0
EBSD5XXXXZ	2.28	0.46	0	0
EBSD7XXXXZ	2	0.46	0	0
EBSY34XXXZ	1.49	0.46	0	0
EBW185/1XZ	1.41	0.46	0	0
EBW195/23Z	2	0.46	0	0
EBW198/0XZ	2.29	0.46	0	0
EBW198/1XZ	3.43	0.33	0.72	0
EBW198/2XZ	3.43	0.33	0.72	0
EBW198/3XZ	2.29	0.46	0	0
EBW209/0XZ	2	0.46	0	0
EBW209/1XZ	1.72	0.46	0	0
EBW210/0XZ	1.65	0.34	0.46	0
EBW210/1XZ	1.84	0.46	0	0
EBW210/3XZ	2	0.46	0	0
EBW45/3XXZ	2	0.46	0	0
ECBD29XXXZ	2.23	0.46	0	0
ECBD30-31Z	2.28	0.46	0	0
ECMK103ABZ	1.73	0.46	0	0
ECONTLRODZ	1.55	0.46	0	0
ECOREPLATZ	2.9	0.46	0	0
EDLGEABXXZ	1.39	0.32	0.57	0
EDLGESBOXZ	2	0.46	0	0
EDP2233ABZ	1.49	0.46	0	0
EDPC2258XZ	2.13	0.46	0	0
EDPC5XXXXZ	2.11	0.46	0	0
EDPC6XXXXZ	2.11	0.46	0	0

EDPC93023Z	2.28	0.46	0	0
EDPC93912Z	2.28	0.46	0	0
EDRYWSUPPZ	2.62	0.46	0	0
EDWSHIELDZ	2.04	0.46	0	0
EFN201ABXZ	2	0.46	0	0
EFN202ABXZ	2	0.46	0	0
EFN203ABXZ	2	0.46	0	0
EFN204ABXZ	2	0.46	0	0
EFN204CDXZ	2	0.46	0	0
EFN207A-DZ	2	0.46	0	0
EFNDWCOOLZ	1.06	0.46	0	0
EFUAXXXXXZ	2.23	0.46	0	0
EFUBXXXXXZ	2.5	0.46	0	0
EFUD3XXXXZ	2.28	0.46	0	0
EFUELCHANZ	3.96	0.46	0	0
EINCORHOUZ	2.75	0.46	0	0
EINTKPANLZ	4.54	0.46	0	0
EISLOCACSZ	0	0.46	0	0
EISLOCRHRZ	0	0.46	0	0
ELOCAHPCIZ	2.5	0.46	0	0
ELOCARCICZ	2.5	0.46	0	0
EPM141ABXZ	1.73	0.46	0	0
EPM184AXXZ	1.42	0.46	0	0
EPM202A-FZ	2.13	0.46	0	0
EPM203A-DZ	2.33	0.46	0	0
EPM208A-EZ	2.32	0.46	0	0
EPTHPCIXXZ	2.33	0.46	0	0
EPTRCICXXZ	2.33	0.46	0	0
ERBTRKLOKZ	3.55	0.46	0	0
ERE12759!Z	0.89	0.31	0.51	0
ERE12769!Z	1.04	0.31	0.51	0
ERE132X9!Z	1.5	0.31	0.51	0
ERE1425B!Z	1.14	0.31	0.51	0
ERE15159!Z	0.89	0.31	0.51	0
ERE15169!Z	1.04	0.31	0.51	0
ERE159X9!Z	2.22	0.31	0.51	0
ERE16059!Z	0.89	0.31	0.51	0
ERE16069!Z	1.04	0.31	0.51	0
ERE18159!Z	0.89	0.31	0.51	0
ERE18169!Z	1.04	0.31	0.51	0
ERE1865X!Z	0.73	0.31	0.51	0
ERE18681!Z	1.34	0.31	0.51	0
ERE18759!Z	0.89	0.31	0.51	0
ERE18769!Z	1.04	0.31	0.51	0
ERE18781!Z	0.25	0.31	0.51	0
ERE2352X!Z	1.2	0.31	0.51	0
ERE2759X!Z	1.55	0.31	0.51	0
ERE27A5X!Z	0.89	0.31	0.51	0
ERE27A6X!Z	1.04	0.31	0.51	0

ERE32801!Z	1	0.31	0.51	0
ERE40801!Z	0.67	0.31	0.51	0
ERE46801!Z	0.67	0.31	0.51	0
ERE51N81!Z	1	0.31	0.51	0
ERE51NG8!Z	1	0.31	0.51	0
ERE51V81!Z	1	0.31	0.51	0
ERE59801!Z	1	0.31	0.51	0
ERINGGIRDZ	2.54	0.46	0	0
ERPVPEDESZ	3.27	0.46	0	0
ERPVSTABLZ	1.52	0.46	0	0
ERWCONCWLZ	1.93	0.46	0	0
ERXBLDDWLZ	3.57	0.46	0	0
ERXBLDFOUZ	1.76	0.46	0	0
ESHDSPGUSZ	2.54	0.46	0	0
ESURROGATZ	1	0.3	0	0
ETBCONCWLZ	3.89	0.46	0	0
ETK105ABNZ	5	0.46	0	0
ETKT105ABZ	1.27	0.46	0	0
ETKT124ABZ	4.81	0.65	0	0
ETKT126ABZ	1.44	0.46	0	0
ETKT201ABZ	2.1	0.46	0	0
ETOPGUIDEZ	2.56	0.46	0	0
ETVX21XXXZ	1.76	0.46	0	0
ETVX22XXXZ	2.77	0.46	0	0
ETVX55XXXZ	1.49	0.46	0	0
EUPLOFLORZ	1.4	0.46	0	0
EVA452122Z	2.9	0.46	0	0
EVESUPSKTZ	6.15	0.46	0	0
EVPEABXXXZ	1.73	0.46	0	0
EVRCABXXXZ	1.73	0.46	0	0
EVS4563ABZ	2.9	0.46	0	0
EVS4563CDZ	2.9	0.46	0	0
EVS4565CDZ	1.73	0.46	0	0
EVS4582ABZ	2.9	0.46	0	0
EVS4582CDZ	2.9	0.46	0	0
ELOSPXXXXZ	0.35	0.55	0	0
EBCD14XXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
EDLGESBOXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ELPSPPRPLY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPCOOLXXY	1			
2 0.0000	2			
1.0 0.0000	0.00E+00			
ESPC36ABXY	1			

2	0.0000	2	
1.0	0.0000	0.00E+00	
ERERESETIY		1	
2	0.0000	2	
1.0	0.0000	0.00E+00	
EVMMO45XIY		1	
2	0.0000	2	
1.0	0.0000	0.00E+00	
ACB152501F		0.00E+00	0.001
ACB152509L		0.00E+00	0.001
ACB152601F		0.00E+00	0.001
ACB152609L		0.00E+00	0.001
ACB152802F		0.00E+00	0.001
ACB5605CCN		0.00E+00	0.001
ACB5609CCC		0.00E+00	0.001
ADLADL3CCR		0.00E+00	0.001
ADLADLBCCR		0.00E+00	0.001
ADLADLBCCS		0.00E+00	0.001
ADLBDL3CCR		0.00E+00	0.001
ADLG123CCR		0.00E+00	0.001
ADLGEAXXXS		0.00E+00	0.001
ADLGEAXXXU		0.00E+00	0.001
ADLGEBXXXR		0.00E+00	0.001
ADLGEBXXXU		0.00E+00	0.001
ADLGESBOXS		0.00E+00	0.001
ADLGESBOXU		0.00E+00	0.001
ALOCALOOP		0.00E+00	0.001
APM141AXXR		0.00E+00	0.001
APM141BXXR		0.00E+00	0.001
APM184AXXR		0.00E+00	0.001
APM184AXXS		0.00E+00	0.001
AVA452XCCN		0.00E+00	0.001
BPM5XXXCCS		0.00E+00	0.001
BPMBXXXXXU		0.00E+00	0.001
BPMCXXXXXU		0.00E+00	0.001
BPMEXXXXXU		0.00E+00	0.001
BPMFXXXXXU		0.00E+00	0.001
BVM3801XXC		0.00E+00	0.001
BVM3805XXC		0.00E+00	0.001
CM		0.00E+00	0.001
CVC9AXXXXC		0.00E+00	0.001
CVC9BXXXXC		0.00E+00	0.001
DBC21XXCCR		0.00E+00	0.001
DBCD11NORE		0.00E+00	0.001
DBCD11XXXU		0.00E+00	0.001
DBCD12NORE		0.00E+00	0.001
DBCD12XXXU		0.00E+00	0.001
EBCD11XXXR		0.00E+00	0.001
EBCD12XXXR		0.00E+00	0.001

ECB152504F	0.00E+00	0.001
ECB152505N	0.00E+00	0.001
ECB152508L	0.00E+00	0.001
ECB152509C	0.00E+00	0.001
ECB152600L	0.00E+00	0.001
ECB152604F	0.00E+00	0.001
ECB152605N	0.00E+00	0.001
ECB152608L	0.00E+00	0.001
ECB152609C	0.00E+00	0.001
ECB152801C	0.00E+00	0.001
ECB152802N	0.00E+00	0.001
ECB5605AXY	0.00E+00	0.001
ECB5605DXY	0.00E+00	0.001
EDLGEAXXXR	0.00E+00	0.001
EDLGEBXXXS	0.00E+00	0.001
EDLGESBOXR	0.00E+00	0.001
EHX209AXXU	0.00E+00	0.001
EHX209BXXU	0.00E+00	0.001
ELOCAHPCIR	0.00E+00	0.001
ELOCARCICR	0.00E+00	0.001
EPM141AXXS	0.00E+00	0.001
EPM141BXXS	0.00E+00	0.001
EPM208AXXS	0.00E+00	0.001
EPM208BXXS	0.00E+00	0.001
EPM208EXXS	0.00E+00	0.001
EPTHPCIXXR	0.00E+00	0.001
EPTRCICXXR	0.00E+00	0.001
EVA4521XXN	0.00E+00	0.001
EVA4522XXN	0.00E+00	0.001
EVM130117C	0.00E+00	0.001
EVM23015XC	0.00E+00	0.001
HPMAUXOILS	0.00E+00	0.001
HPME205XXS	0.00E+00	0.001
HPTHPCIXXS	0.00E+00	0.001
HPTHPRCCCR	0.00E+00	0.001
HPTHPRCCCS	0.00E+00	0.001
HSYHPCIMNU	0.00E+00	0.001
HVMMO35XXN	0.00E+00	0.001
HVMMO36XXN	0.00E+00	0.001
HVMMO3XXXN	0.00E+00	0.001
HVMMO6XXXC	0.00E+00	0.001
HVMMO8XXXN	0.00E+00	0.001
ILPRCICMNU	0.00E+00	0.001
IPTRCICXXS	0.00E+00	0.001
IPVVACPMPS	0.00E+00	0.001
IVMINJVCCN	0.00E+00	0.001
IVMMO49XXN	0.00E+00	0.001
IVMMO60XXC	0.00E+00	0.001
IVMMO61XXN	0.00E+00	0.001

IVMMO62XXN	0.00E+00	0.001
P	0.00E+00	0.001
RHXE207AXU	0.00E+00	0.001
RHXE207BXU	0.00E+00	0.001
RLPSPCOLAU	0.00E+00	0.001
RLPSPCOLBU	0.00E+00	0.001
RPMABCDCCS	0.00E+00	0.001
RVC68AXXXC	0.00E+00	0.001
RVC68BXXXC	0.00E+00	0.001
RVM10ABCCN	0.00E+00	0.001
RVM3436CCN	0.00E+00	0.001
RVM34ABCCN	0.00E+00	0.001
RVM34AXXXN	0.00E+00	0.001
RVM34BXXXN	0.00E+00	0.001
RVM36ABCCN	0.00E+00	0.001
RVM36AXXXN	0.00E+00	0.001
RVM36BXXXN	0.00E+00	0.001
RVM4A6BCCN	0.00E+00	0.001
RVM4B6ACCN	0.00E+00	0.001
RVM60ABCCN	0.00E+00	0.001
SPMABXXCCS	0.00E+00	0.001
SPMALLXCCS	0.00E+00	0.001
SPMP208BXU	0.00E+00	0.001
SPMP208EXU	0.00E+00	0.001
SVC3880BXN	0.00E+00	0.001
SVC3880EXN	0.00E+00	0.001
ETRANSFLAG	1.00E+00	0.001
RVM29AXXXL	0.00E+00	0.001
RVM29BXXXL	0.00E+00	0.001
EVM25BXXXL	0.00E+00	0.001
CVM25AXXXL	0.00E+00	0.001
JAF-INSERT	4.65E-03	0.001

PILRUN1.CMP
5/18/2011

System Data File for PILRUN1.SYS

```
1    1    CDFALL          LMCDF
```

Sequence Data File: PILRUN1.SEQ

```
PIL-SEQ1        PIL-SEQ1
 1   1   1
 ESURROGATZ

PIL-SEQ2        PIL-SEQ2
 1   1   3
\ESURROGATZ      ELOSPXXXXZ      CDFALL

ALL             1
```

Hazard Data File: PILEPRI1.HAZ

```
*Pilgrim Updated EPRI Hazard Curves*      ..HAZHEAD  (A40)
       1                                  ...NHAZ
15                                        .NPHAZ
1.0                                       ..PWHAZ(I)
0.001    0.002    0.005    0.01     0.02    0.03     0.05
0.07     0.1      0.2      0.3      0.5     1.0      1.5
2.0
1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04  1.15E-04
1.11E-04  1.02E-04  7.20E-05  5.22E-05  2.99E-05  9.54E-06  3.98E-06
1.95E-06
```

No.	Damage State Name	Damage State Risk	No. of Sequences	Contributing Sequence Risks (in decreasing order of importance)			
				No.	Sequence Name	Sequence Risk	% of Total
1	ALL	8.97E-06	2	1	PIL-SEQ2	6.57E-06	73.19
				2	PIL-SEQ1	2.41E-06	26.81
					Sum:	8.97E-06	100.00

Summary of Plant Level Fragility

Conditional Probability of Failure	PGA (g)
.050	.466
.150	.546
.250	.595
.500	.693
.750	.798
.850	.858
.950	.962
HCLPF (See note)	.381

Note: Best Estimate Case HCLPF

HCLPF = Ground motion level for which there is a high confidence of a low probability of failure

= Amed * exp(-2.3 * Beta)
(Assuming the plant fragility is Lognormally distributed, the HCLPF corresponds to a 1.072% probability of failure)