WCAP - 13795

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AP600 UNCERTAINTY ANALYSIS

Westinghouse Energy Systems

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WCAP - 13795 [redacted]

AP600 UNCERTAINTY ANALYSIS

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AP600 UNCERTAINTY ANALYSIS

Anoop Kapoor

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1.0 INTRODUCTION

Uncertainty analysis is a simulation methodology to perform repeated evaluations of the top event using Monte Carlo technique or Latin Hypercube Sampling. The sampling results are then used to compute various estimators for the occurrence of the top event. The estimators typically include the mean, median, and quantiles (e.g., 5 percentile, 25 percentile, 75 percentile, 95 percentile, etc.). Such distributions are obtained for various plant damage states for the AP600 level 1 PRA. Additionally, the contributions to core damage from various initiating events are also obtained in terms of distribution rather than a point estimate or mean. Finally, various plots of the frequency distributions for all plant damage states and the core damage frequency are provided.

2.0 METHODOLOGY FOR UNCERTAINTY ANALYSIS

In order to perform the uncertainty analysis, the Westinghouse uncertainty analysis code WUNCERT (Reference 10) is used. The code consists of Latin Hypercube Sampling (WLHS) and Top Event Matrix Analysis Code (WTEMAC) and the Westinghouse Risk Code (WRISK).

The level 1 PRA fault tree and core damage frequency output files containing the information of the initiating events and minimal cut sets are used as input files. In addition, a data base file called WUNCERT.DB is also used containing the uncertainty distribution information for all the basic and initiating events. A list file AP600.LST containing the list of all the input files is used for running the code in batch mode. These files are then processed using the uncertainty code. The input files are processed by WRISK to prepare the input files for WLHS and WTEMAC in the required format. For example, WLHS requires .001 and .999 quantiles to be provided as input for all the basic events. WRISK makes those computations based on the distributions and parameters of the basic and initiating events.

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The Latin Hypecube Sampling is a constrained sampling technique used to produce samples corresponding to a given distribution and parameters. WTEMAC is a code for estimating risk and performing uncertainty and sensitivity analyses with a Boolean expression. WRISK is used to produce the Boolean expressions and other intermediate files for further processing.

WUNCERT is used to generate the probability distribution of plant damage states and the core damage frequency. These distributions are then plotted. A table is prepared to provide a summary of the distribution of the various plant damage states. The tables include parameters like mean, median and 90% confidence intervals. The contribution of various initiating and basic events is tabulated in terms of the uncertainty intervals. Finally, an analysis is performed for the uncertainty importance for the various events. The uncertainty importance provides the information of the relative impact on the variance of the top event by the distributions of various initiating and basic events.

3.0 UNCERTAINTY ANALYSIS

In this section, the discussion and results of the uncertainty analysis are provided. The plant damage states which provide any significant contribution to various release categories are defined in Section 3.1. This is followed by establishing a data base for failure probabilities and frequencies in Section 3.2. The uncertainty distributions of various plant damage states are evaluated and discussed in Section 3.3. The contribution from the dominant initiating event categories is computed in terms of uncertainty intervals are outlined in Section 3.4. In Section 3.5, the risk reduction by various basic events is discussed. The uncertainty importance, a measure of contribution to variance of the top event by various initiating and basic events is discussed in Section 3.6.

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3.1 Definition of Plant Damage States

Based on the analysis performed for Westinghouse AP600 probabilistic risk assessment (References 1 and 2), six plant damage states are the main contributors to various release categories. The six plant damage states (PDS) are as follows:

1. PDS I-A
2. PDS I-AP
3. PDS III-BE
4. PDS III-BR
5. PDS III-C
6. PDS III-D

A description of the above plant damage states is provided in Table 3-1. For example, the PDS III-BR is a state of core damage following LOCA or other events with full RCS depressurization, but CMT and accumulator failed. Each of the plant damage states consists of a multitude of minimal cut sets leading to the damage state. A typical cut set consists of an initiating event as the first element followed by various basic events (operator actions, component failures, etc.).

3.2 Data Base for Failure Probabilities and Frequencies

In order to perform the uncertainty analysis the distributions of all the initiating and basic events contained in the minimal cut sets of various plant damage states are required. Various sources are used to determine such distributions, which include References 1 through 9. A listing of all event i.d.s, their descriptions, the parameters of distributions and sources are provided in Table 3-2. For example, the event i.d. ATW-MAN03 defines the operator failure to trip reactor by de-energizing the M/G sets. The Reference 1, Appendix D provides the parameters of distribution. Here, the mean and variance have been used to define the lognormal

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distribution. This is done for the sake of compatibility with the input requirements of the codes used in the analysis. Similarly, other events are defined in Table 3-2.

3.3 Uncertainty Distribution for Plant Damage States

At the conclusion of uncertainty analysis, a distribution of the plant damage state annual frequencies is determined. The output of the WTEMAC segment of Westinghouse uncertainty analysis code WUNCERT code for the distribution of plant damage state provides a discrete distribution. Based on the discrete distribution, the mean, 5 percentile, 95 percentile, and median are estimated. A large sample size (500 for each basic and initiating event) is used. This results in the sample mean for the plant damage state in close agreement with the true mean. The results of uncertainty distributions for the plant damage states are presented in Table 3-3. The plant damage states III-BE, and III-BR appear to have larger frequencies (1.5E-07 and 1.7E-07) than plant damage states I-A, I-AP, III-C, and III-D (6.5 E-08, 5.5E-08, 7.6E-08, and 7.3E-08 respectively). The uncertainty intervals vary significantly from one plant damage state to the other. For example, for plant damage state I-A the median is 2.6E-09 per year, and the 5/95 percentile uncertainty interval is [7.3E-11, 1.4E-07]; while for the plant damage state III-D the median is 7.3E-07 per year and 5/95 percentile uncertainty interval is [1.9E-08, 7.3E-07]. The mean for both plant damage states, however, are 6.5E-08 and 7.3E-08 respectively, which are relatively close to each other. The AP600 core damage frequency (CDF) is 3.3E-07 per year with 5 and 95 percentiles uncertainty interval as [1.9E-08, 7.3E-07].

Histograms were prepared for each of the plant damage states described above. An effort was made to establish the underlying distribution for various plant damage states. Commercially available Statgraphics software was used to aid the curve fitting process. The fitted curves were compared with the histograms. Once it was established that the fitted curves closely resemble the histograms, the curve depicting the probability density function was plotted. Figures 3-1 and 3-2 show the probability density functions for various plant damage states. Figure 3-3 shows all the damage states in one plot. Even though this figure is busy, it was included to provide an overview of all the plant damage states.

3.4 Dominant Initiating Event Categories

In this section, an effort is made to determine which initiating event frequencies are responsible for the major numerical portion of the frequencies of the various plant damage states. The contributions from various initiating event frequencies are computed and tabulated in Tables 3-4 through 3-9. An individual table is prepared for each plant damage state.

For plant damage state I-A the major contributors for the frequencies of occurrence are turbine/ reactor trip/ L. RCS flow initiating event IEV-TT and loss of feed water to steam generator initiating event (IEV-TF). In fact, these two initiating events contribute more than 90% of the total frequency for release category I-A. Each of the other initiating events contributes less than 5% for the plant damage state I-A. The Table 3-4 lists all these contributions. This table also lists the uncertainty intervals for the contributions of various initiating events. For example, the mean contribution for initiating event IEV-TS (spurious S-signal initiating event) is 2.3E-09 per year. The 5 and 95 percentiles for the contribution by this initiating event are 7.5E-13 and 3.6E-09 respectively.

More than two-thirds of the frequency of plant damage state I-AP is contributed by the passive RHR tube rupture initiating event (IEV-S2P). The least contribution for this plant damage state is from the initiating event IEV-S2S (very small LOCA initiating event). Its contribution is 5.0E-09 per year with 5 and 95 percentile uncertainty intervals as [2.0E-11, 1.3E-08]. Refer to Table 3-5 for more details.

For plant damage state III-BE (core damage following large LOCAs or other event with full depressurization), more than 85% of the contribution is from the initiating events IEV-S1S (safety injection line break), IEV-S2P (passive RHR tube rupture), and IEV-A (Large LOCA

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initiating event). Each of the other initiating events contributes less than 5% to plant damage state III-BE. Refer to Table 3-6 for details on the uncertainty intervals for the contributions of various initiating events leading to plant damage state III-BE.

For plant damage state III-BR, more than 90% of contribution is from initiating events IEV-S1S, IEV-S2P, IEV-S2, and IEV-A. Table 3-7 provides more details. There are two major initiating event contributors to plant damage state III-C (Core damage following vessel rupture). These events are IEV-TFA (loss of feedwater without scram) and IEV-VR (vessel rupture initiating event). Refer to the Table 3-8 for more details including the summary of the uncertainty intervals for the contributions of the two initiating events.

Finally, Table 3-9 summarizes the contributions from various initiating events to plant damage state III-D. The major contributors are: IEV-S2P (Passive RHR tube rupture initiating event) and IEV-T (Turbine/ reactor trip/ L. RCS flow initiating event). These two initiating events contribute more than 75% to the plant damage state III-D. Table 3-28 provides the contribution of initiating events to core damage frequency.

3.5 Dominant Basic Events

The frequency of occurrence of top events, i.e., the plant damage states depends on the frequency of occurrence of the initiating events and basic events included in the minimal cut sets for the plant damage state. The risk reduction by a basic event is defined as the reduction in the frequency of the top event if the probability of that basic event can be forced to zero. For example, if a basic event is defined as "operator fails to trip reactor by de-energizing the M/G set", then the risk reduction for this basic event is obtained by reducing the probability of operator failure to zero; and then evaluating the reduction in the occurrence of frequency of the top event. In this section the dominant basic events contributing to various plant damage states are discussed. The uncertainty intervals for the risk reduction will also be computed and tabulated.

Table 3-10 summarizes the risk reduction by basic events for plant damage state I-A. It is observed that main contributors to the risk are common cause failures like CCX-DAS (common cause failure within DAS and DIS), and CCX-40EAI (M40, EAI cards CCF: 84 hours test), etc. The uncertainty interval for the risk reduction can be very wide. For example the risk reduction by the basic event CCX-DAS is 5.1E-08 per year for the plant damage state I-A. The uncertainty interval for the risk reduction is [3.4E-11, 1.3E-07]. Refer to Table 3-10 for a summary of risk reduction and the corresponding 5 and 95 percentile uncertainty intervals.

The risk reduction by basic events of other plant damage states are summarized in Tables 3-11 through 3-15. These tables also summarize the 5 and 95 percentile uncertainty intervals for the risk reduction. Refer to Table 3-29 for a summary of risk reduction by basic events for core damage frequency.

3.6 Uncertainty Importance by Initiating Events and Basic Events

The uncertainty in the estimates of the initiating event frequencies and basic event probabilities results in the uncertainty of the estimates of occurrence of plant damage states. The uncertainty or variance of the top event (plant damage state) can be reduced by reducing the uncertainty associated with the initiating and basic events. The uncertainty importance for an initiating event is a measure of the expected reduction in the variance or uncertainty of top event due to ascertaining the value of the initiating event under consideration. The same definition of uncertainty importance is applicable to the uncertainty importance of basic events.

Tables 3-16 through 3-21 summarize the results of uncertainty importance computations by initiating events for various plant damage states. These tables also provide average percentage reduction of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event. The tables also provide the percentage changes in the variance of the top event frequencies taken at the minimum and maximum values of initiating

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events. Similarly Tables 3-22 through 3-27 summarize the results of the uncertainty importance by basic events for various plant damage states. For example, the average percentage reduction by the initiating event IEV-S1S for plant damage state III-BR is 35.4%. The uncertainty importance for IEV-S1S (safety injection line break initiating event) is 1.5E-07. This provides a measure of the expected reduction in the frequency of occurrence of plant damage state III-BR due to ascertaining the value of the initiating event IEV-S1S. The percentage change in the variance of top event frequency taken at minimum and maximum values of the initiating event IEV-S1S is -54.5 and 20007.6 respectively. Refer to Tables 3-16 through 3-27 for more details of uncertainty importance analysis of other events for various plant damage states. Tables 3-30 and 3-31 summarize the uncertainty importance by initiating and basic events for core damage frequency.

4.0 SUMMARY AND CONCLUSIONS

The uncertainty analysis is able to provide not only the mean values for the frequency, but the associated uncertainty intervals as well. For example, the AP600 mean core damage frequency is 3.3E-07 per year and associated 5 and 95 percentile uncertainty interval is [1.9E-08, 7.3E-07]. The failure rates of the components, human error probabilities and initiating event frequencies are not cast in concrete and almost always have a certain degree of uncertainty associated with those. The uncertainty analysis is able to propagate these uncertainties to the top event (core damage frequency, plant damage states) and provide the uncertainty intervals for the occurrence of top events. Such information is of value to the decision maker. The uncertainty importance analysis provides information of those components, human errors, common cause failures, and initiating events, that contribute significantly to the variance or uncertainty of the top event. For example, for the plant damage state III-BE, the basic event IWX-CV-AO (common cause failure of gravity injection check valves to open: 8 of 8) is the main contributor to the uncertainty of this plant damage state. The average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known with certainty is more than 60% in this case. If with more

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testing and data the uncertainty interval for the this failure is reduced, the uncertainty for the occurrence of the plant damage state III-BE can be significantly reduced.

It should be noted that the ranking of initiating or basic events' contribution based on the mean values some times may be different than the ranking based on the uncertainty importance. If a component or initiating event has a very high variance associated with its distribution, it may show higher up based on the uncertainty importance ranking as compared to the rankings based on the mean values. During the decision making process, both the rankings must be considered to reduce the risk of plant operation based on the mean values as well as the tail end frequencies.

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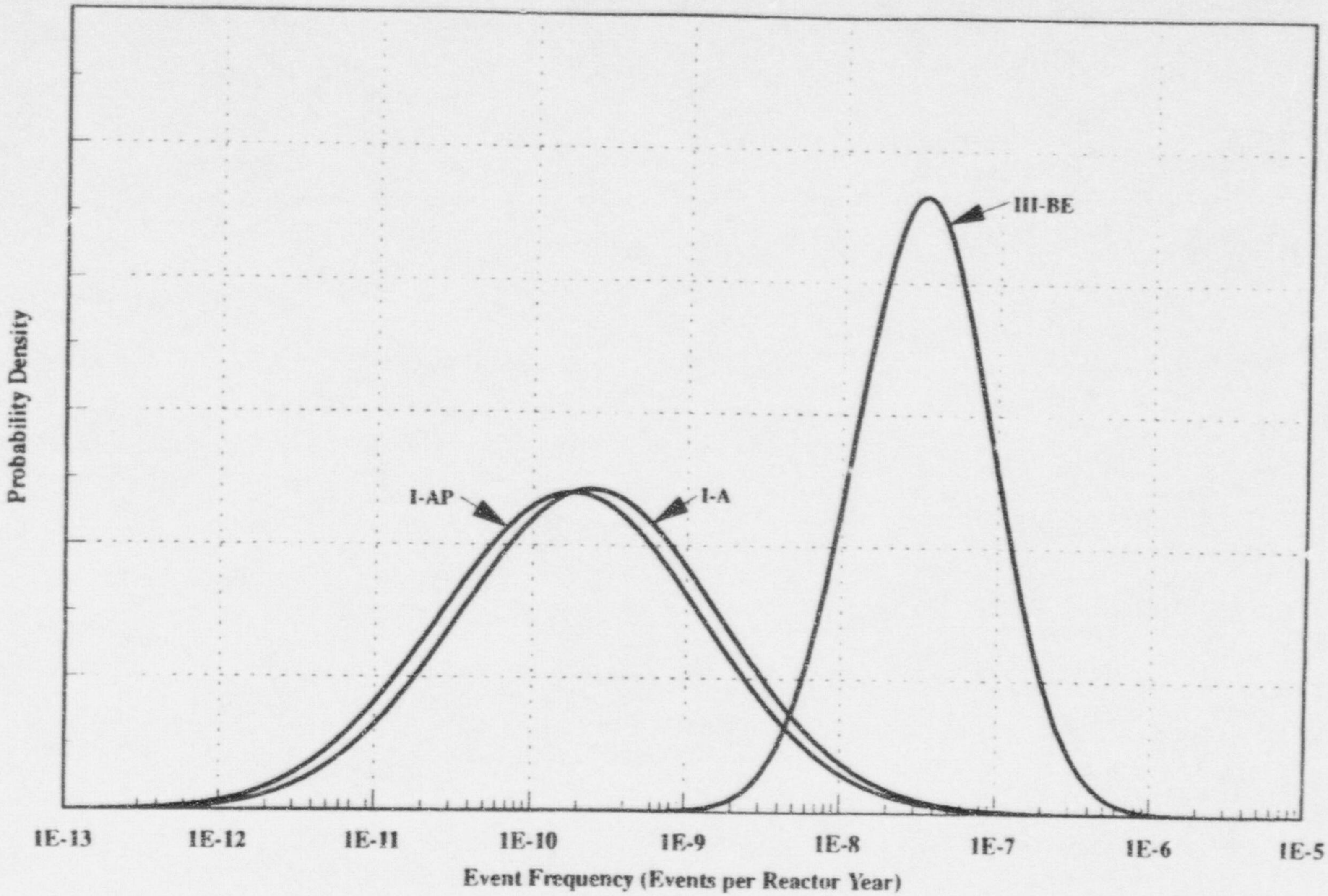

Figure 3-1
Uncertainty Distribution for Plant Damage States
(I-A, I-B, and III-BE)

[redacted]

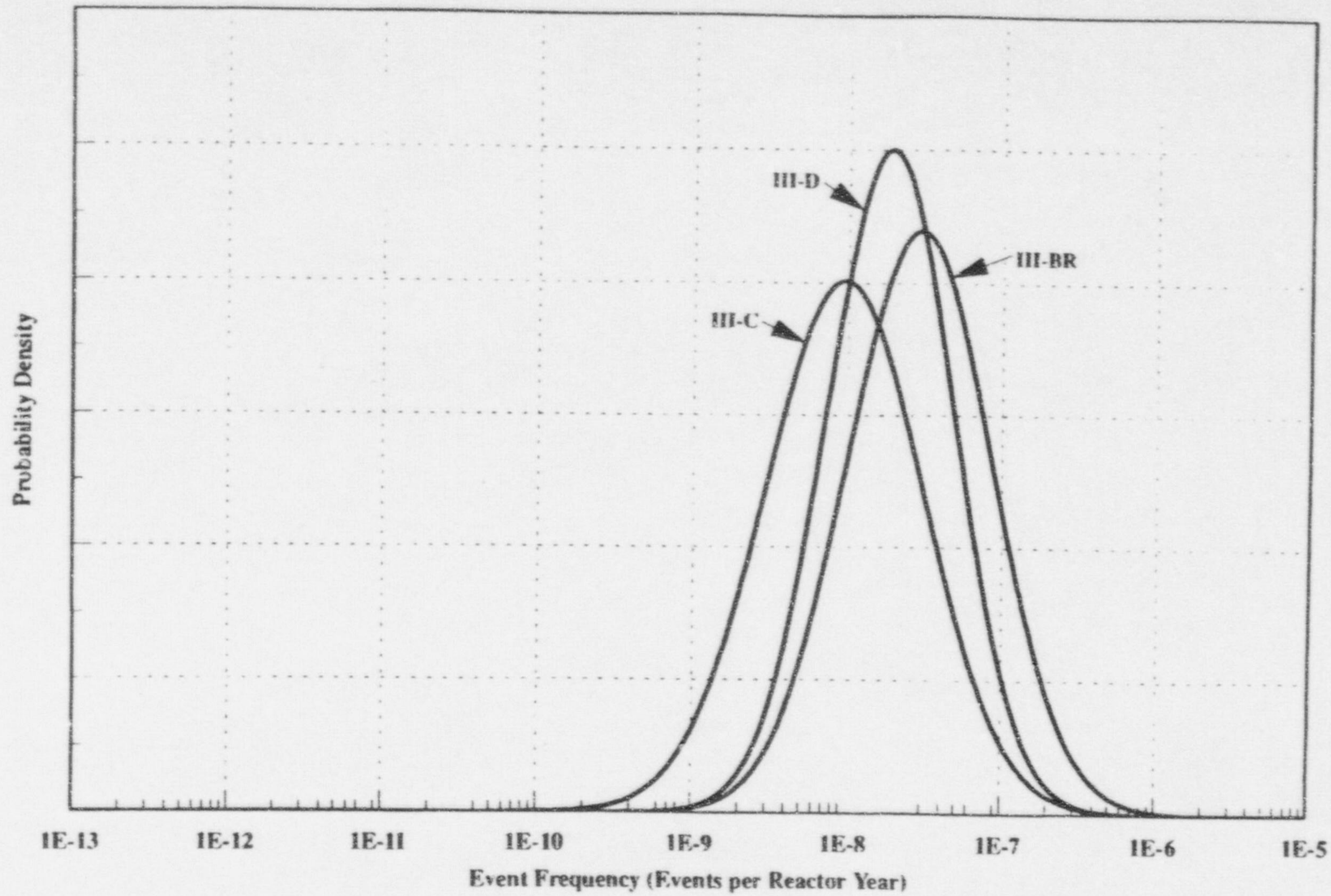

Figure 3-2
Uncertainty Distribution for Plant Damage States
(III-BR, III-C, and III-D)

[redacted]

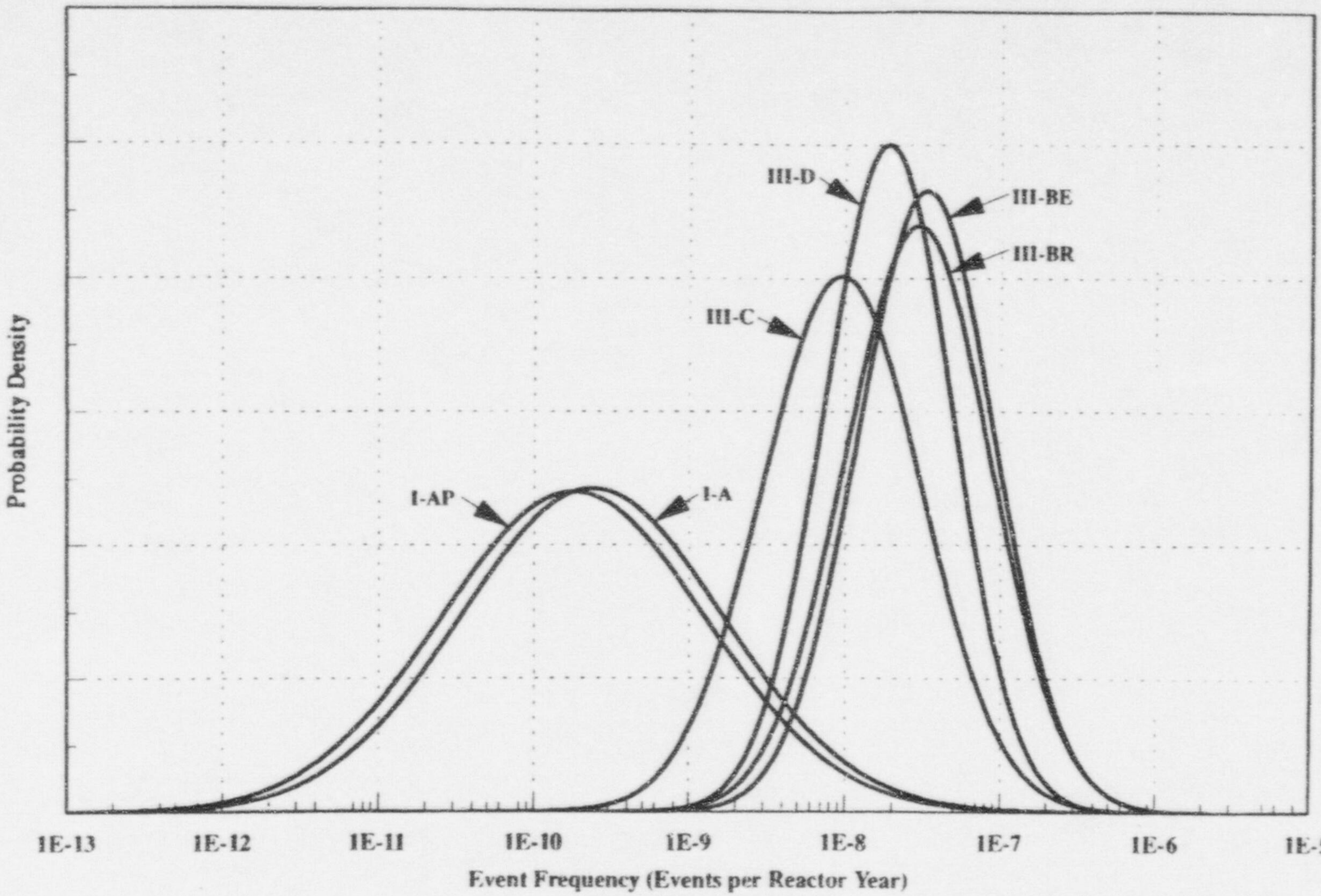

Figure 3-3
Uncertainty Distribution for Plant Damage States
(All Plant Damage States)

[redacted]

Table 3-1: Definition of Plant Damage States

No.	Plant Damage State	Description
1.	I - A	Core damage with reactor coolant system at high pressure following transient or very small LOCA.
2.	I - AP	Core damage following small LOCA and very small LOCA with no depressurization but with passive residual heat removal operating.
3.	III -BE	Core damage following large LOCAs or other event with full depressurization.
4.	III - BR	Core damage following LOCA or other events with full RCS depressurization, but CMT and accumulator failed.
5.	III - C	Core damage following vessel rupture.
6.	III - D	Core damage following LOCA (except large) with partial depressurization.

[redacted]

Table 3-2: Distribution of Failure Probabilities and Frequencies of Basic and Initiating Events

No.	EVENT I.D.	DESCRIPTION OF EVENT	TYPE OF DISTRIBUTION	SOURCE[3]	PARAMETERS OF DISTRIBUTION[1,2]	
					PARAM1	PARAM2
1.	ATW-MAN03	Operator fails to trip reactor by de-energizing the M/G sets	Lognormal E.F. = 10	Ref. 1, App. D, p. 17	1.53E-02	1.43E-03
2.	CCX-03XTS	M03, XTS boards CCF (Monthly tested)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	1.80E-05	2.30E-08
3.	CCX-19-SA	M19 boards CCF (Monthly test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	1.10E-05	8.58E-09
4.	CCX-19-YA	M19 boards CCF (84 hours test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	3.00E-06	6.38E-10
5.	CCX-40EAI	M40, EAI cards CCF (84 hours test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	1.40E-05	1.39E-08

[redacted]

6.	CCX-4828M	M48, M28 boards CCF (Monthly test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	1.50E-05	1.59E-08
7.	CCX-51EHX	M51, EHX boards CCF (84 hours test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	5.30E-06	1.99E-09
8.	CCX-AV-LA	Common Cause Failure of four AOVS to open	Lognormal E.F. = 30	Ref.1, App. E, p. PE-50	6.20E-05	2.72E-07
9.	CCX-BY-PN	Common Cause Failure of battery	Lognormal E.F. = 30	CMTOT.WLK	3.90E-05	1.08E-07
10.	CCX-DAS	CCF within DAS and DIS	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	1.00E-03	7.09E-05
11.	CCX-DU-SA	DLU board CCF	Lognormal E.F. = 30	Ref.1, App. E, p. PE-52	7.30E-05	3.78E-07
12.	CCX-EEMM12	IEEE bus, MDM, M12 boards CCF (84 hours test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	3.20E-06	7.26E-10
13.	CCX-EP-SA	CCF to operate the EPO boards	Lognormal E.F. = 30	Ref.1, App. E, p. PE-52	4.40E-06	1.37E-09

[redacted]

14.	CCX-ESF	M56, ERX cards CCF (Monthly test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	1.20E-05	1.02E-08
15.	CCX-FU-RQ	Common cause of fuse disconnect switches to open spuriously	Lognormal E.F. = 30	Ref.1, App. E, p. PE-44	2.80E-07	5.56E-12
16.	CCX-HARD1	IEEE bus, M51, EHX, MDM, M12 boards CCF (Monthly Test)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	3.30E-05	7.72E-08
17.	CCX-PW-SA	EPC power converter CCF	Lognormal E.F. = 30	Ref.1, App. E, p. PE-52	7.20E-06	3.67E-09
18.	CCX-SFTW	Software CCF within all cards	Lognormal E.F. = 30	Ref.1, App. E, p. PE-52	1.20E-06	1.02E-10
19.	CCX-TT-UF	CCF of temperature transimitterw continuously interfacing high tempr.	Lognormal E.F. = 30	Ref.1, App. E, p. PE-46	1.40E-04	1.39E-06
20.	CCX-XMTR	CCF of safety transmitters continuously interfacing high pressure	Lognormal E.F. = 30	Ref.1, App. E, p. PE-45	2.40E-04	4.08E-06

21.	CCX-XMTR195	CCF of pressurizer level transmitters	Lognormal E.F. = 30	Ref.1, App. E, p. PE-51	2.10E-06	3.13E-10
22.	DAS	Unavailability goal for DAS	Lognormal E.F. = 30	Ref.2	9.00E-03	5.74E-03
23.	DIS	Unavailability goal for DIS	Lognormal E.F. = 30	Ref.2	9.00E-03	5.74E-03
24.	EC1BS001TM	Unavailablity of bus ECS ES 1 due to unscheduled maintenance	Lognormal E. F. = 10	Ref.3, p. A-24	2.70E-03	4.44E-05
25.	EC2BS002TM	Unavailablity of bus ECS ES 2 due to unscheduled maintenance	Lognormal E. F. = 10	Ref.3, p. A-24	2.70E-03	4.44E-05
26.	ECX-CB-GO	Common cause failure of 4KV breakers to open	Lognormal E.F. = 30	Ref.1, App. E, p. PE-50	5.50E-04	2.14E-05
27.	ED3BS001TM	Distribution panel unavailable dur to test or corr. maintenace	Lognormal E. F. = 10	Ref.3, p. A-24	3.00E-04	5.48E-07
28.	ED3MOD03	Battery DB1 unavailable	Lognormal E. F. = 10	CMTOT.WLK	2.70E-03	4.44E-05

[redacted]

29.	IDABSDS2TM	Bus unavailable due to test or corrective maintenance	Lognormal E. F. = 10	Ref.3, p. A-24	3.00E-04	5.48E-07
30.	IDBBSDS2TM	Bus unavailable due to test or corrective maintenance	Lognormal E. F. = 10	Ref.3, p. A-24	3.00E-04	5.48E-07
31.	IDCBSDS2TM	Bus unavailable due to test or corrective maintenance	Lognormal E. F. = 10	Ref.3, p. A-24	3.00E-04	5.48E-07
32.	IDDBSDS2TM	Bus unavailable due to test or corrective maintenance	Lognormal E. F. = 10	Ref.3, p. A-24	3.00E-04	5.48E-07
33.	IEV-A	Large LOCA initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	9.70E-05	5.73E-08
34.	IEV-S1	Medium LOCA initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	5.60E-04	1.91E-06
35.	IEV-S1C	CMT line break initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	1.30E-04	1.03E-07
36.	IEV-S1S	Safety injection line break initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	1.20E-04	8.78E-08

37.	IEV-S2	Small LOCA initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	5.20E-04	1.65E-06
38.	IEV-S2P	Passive RHR tube rupture initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	5.00E-03	1.52E-04
39.	IEV-S2S	Very small LOCA initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	5.50E-04	1.84E-06
40.	IEV-TCA	Loss of compressor air system initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	1.44E-02	1.26E-03
41.	IEV-TF	Loss of FW to steam generator initiating event occurs	Lognormal E. F. = 3	Ref. 2, App. B	5.06E-01	1.44E-01
42.	IEV-TFA	Loss of feedwater without scram initiating event occurs	Lognormal E. F. = 3	Ref. 2, App. B	5.30E-01	1.58E-01
43.	IEV-TM	Secondary to primary side power mismatch initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	5.40E-02	1.78E-02
44.	IEV-TS	Spurious S-signal initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	8.50E-02	4.40E-02

[redacted]

45.	IEV-TSW	Loss of service water system initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	2.62E-02	4.18E-03
46.	IEV-TT	Turbine/ reactor trip/L. RCS flow initiating event occurs	Lognormal E. F. = 3	Ref. 2, App. B	1.40E+00	1.10E+00
47.	IEV-V2	Steam generator tube rupture initiating event occurs	Lognormal E. F. = 10	Ref. 2, App. B	5.20E-03	1.65E-04
48.	IEV-VR	Vessel rupture initiating event occurs	Lognormal E. F. = 30	Ref. 2, App. B	3.00E-08	6.38E-14
49.	IWA-PLUG	IRWST discharge line "A" plugged	Lognormal E. F. = 10	CMTOT.WLK	5.00E-05	1.52E-08
50.	IWACV122AO	Check valve 122A fails to open	Lognormal E. F. = 10	CMTOT.WLK	8.76E-03	4.68E-04
51.	IWACV123AO	Check valve 123A fails to open	Lognormal E. F. = 10	CMTOT.WLK	8.76E-03	4.68E-04
52.	IWACV124AO	Check valve 124A fails to open	Lognormal E. F. = 10	CMTOT.WLK	8.76E-03	4.68E-04

[redacted]

53.	IWACV125AO	Check valve 125A fails to open	Lognormal E. F. = 10	CMTOT.WLK	8.76E-03	4.68E-04
54.	IWX-CV-AO	CCF of gravity injection check valves to open (8 of 8)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-45	1.50E-04	1.59E-06
55.	IWX-CV1-AO	CCF of gravity injection check valves to open (4 of 4)	Lognormal E.F. = 30	Ref.1, App. E, p. PE-44	6.00E-05	2.55E-07
56.	IWX-PLUG	Plugging of both IRWST discharge lines	Lognormal E.F. = 30	Ref.1, App. E, p. PE-46	5.00E-06	1.77E-09
57.	LPM-MAN01	Operator fails to recognize need for ADS manual actuation	Lognormal E. F. = 10	Ref.2, App. D	2.20E-03	2.95E-05
58.	LPM-MAN03	Operator fails to recognize need for ADS manual actuation	Lognormal E. F. = 3	Ref.2, App. D	8.30E-02	3.87E-03
59.	LPM-MAN04	Operator fails to recognize need for ADS manual actuation	Lognormal E. F. = 3	Ref.2, App. D	8.30E-02	3.87E-03
60.	MGSET	MG set fails to de-energize	Lognormal E. F. = 10	CMTOT.WLK	8.74E-03	4.66E-04

[redacted]

61.	OTH-PM	Failure of MSL SV or PORV to reclose (2 SVs opened)	Lognormal E. F. = 10	CN-PRRA-92-347-R0	1.10E-02	7.37E-04
62.	OTH-PM1	Failure of MSL SV or PORV to reclose (4 SVs opened)	Lognormal E. F. = 10	CN-PRRA-92-347-R0	2.10E-02	2.69E-03
63.	OTH-SGTR		Lognormal E. F. = 10	CN-PRRA-92-347-R0	1.60E-02	1.56E-03
64.	OTH-SGTR1		Lognormal E. F. = 10	CN-PRRA-92-347-R0	8.00E-03	3.90E-04
65.	OTH-VAL3	Fraction of power mismatch events in which SFW is also lost	Lognormal E. F. = 10	CN-PRRA-92-347-R0	8.33E-02	4.23E-02
66.	OTH-VAL4	Fraction of spurious S signal events in which SFW is also lost	Lognormal E. F. = 10	CN-PRRA-92-347-R0	5.26E-02	1.69E-02
67.	PMX-ESFAC	Software CCF within ESFAC subsystems	Lognormal E.F. = 30	Ref.1, App. E, p. PE-52	1.10E-05	8.58E-09

[redacted]

68.	PMX-PLC	Software CCF within PLC boards	Lognormal E.F. = 30	Ref.1, App. E, p. PE-52	1.10E-05	8.58E-09
69.	RCX-RB-FA	Reactor trip breakers CCF	Lognormal E.F. = 30	Ref.1, App. E, p. PE-48	1.80E-04	2.30E-06
70.	REAMV117GO	Hardware failure cause recirc MOV 117A fails to open	Lognormal E.F. = 10	Ref.3, App.A	1.10E-02	7.37E-04
71.	REAMV118GO	Hardware failure cause recirc MOV 118A fails to open	Lognormal E.F. = 10	Ref.3, App.A	1.10E-02	7.37E-04
72.	REG-MAN00	Failure of manual valves V069 & V070 to cntrl flow to SG	Lognormal E.F. = 10	Ref.3, App.A	2.10E-01	2.69E-01
73.	RNNMOD05	Hardware failure to open MOV V022	Lognormal E.F. = 10	Ref.3, App.A	1.14E-02	7.92E-04
74.	RNNMOD08	Hardware failure of isol. valves on the common discharge header	Lognormal E.F. = 10	Ref.3, App.A	1.16E-02	8.20E-04
75.	RNX-MV-GO	CCF to open the motor operated vaives	Lognormal E.F. = 30	Ref.1, App. E, p. PE-47	4.40E-03	1.37E-03

[redacted]

76.	TIME-CVSNO	Time fraction during which CVS is in standby in normal operation	Lognormal E.F. = 3	CMTOT.WLK	9.85E-01	5.45E-01

NOTES:

1. PARAM1 and PARAM2 for NORMAL and LOGNORMAL distributions are MEAN and VARIANCE.

2. PARAM1 and PARAM2 for UNIFORM and LOGUNIFORM distributions are LOWER and UPPER limits.

3. The guidelines provided in reference 9 are used to establish error factors for lognormal distributions whenever other sources did not provide this information.

[redacted]

Table 3-3: Plant Damage State Frequencies and Uncertainties

No.	Plant Damage State	Mean	5%le	Median	95%le
1.	I - A	6.5E-08	7.3E-11	2.6E-09	1.4E-07
2.	I - AP	5.5E-08	9.3E-10	9.3E-09	1.4E-07
3.	III - BE	1.5E-07	4.0E-09	4.0E-08	4.3E-07
4.	III - BR	1.7E-07	7.4E-09	4.7E-08	3.7E-07
5.	III - C	7.6E-08	5.2E-10	9.4E-09	1.8E-07
6.	III - D	7.3E-08	1.9E-08	1.1E-7	7.3E-07

[redacted]

Table 3-4: Contribution of Initiating Events to Plant Damage State I-A

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-TT	3.7E-8	2.5E-11	1.1E-7	67.1	67.1
IEV-TF	1.4E-8	8.1E-12	3.7E-8	25.4	92.5
IEV-TS	2.3E-9	7.5E-13	3.6E-9	< 5.0	
IEV-TM	1.4E-9	4.1E-13	2.6E-9	< 5.0	
IEV-TCA	4.1E-10	4.0E-14	6.1E-10	< 5.0	

Table 3-5: Contribution of Initiating Events to Plant Damage State I-AP

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-S2P	3.1E-8	1.9E-10	9.3E-8	64.6	64.6
IEV-S2	1.3E-8	1.2E-10	4.1E-8	27.1	91.7
IEV-S2S	4.0E-9	2.0E-11	1.3E-8	8.3	100.0

[redacted]

Table 3-6: Contribution of Initiating Events to Plant Damage State III-BE

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-S1S	6.9E-8	6.8E-10	2.6E-7	52.6	52.6
IEV-S2P	3.1E-8	1.7E-10	9.5E-8	23.6	76.2
IEV-A	1.5E-8	2.1E-11	3.9E-8	11.4	87.6
IEV-S2	6.5E-9	2.1E-11	2.2E-8	< 5.0	
IEV-S2S	6.4E-9	1.8E-11	1.6E-8	< 5.0	
IEV-S1	2.9E-9	8.5E-12	7.2E-9	< 5.0	
IEV-S1C	3.6E-10	1.9E-13	1.0E-9	< 5.0	

[redacted]

Table 3-7: Contribution of Initiating Events to Plant Damage State III-BR

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-S1S	6.9E-8	6.3E-10	2.4E-7	47.6	47.6
IEV-S2P	3.1E-8	1.5E-10	8.6E-8	21.4	69.0
IEV-S2	1.7E-8	1.4E-10	5.0E-8	11.7	80.7
IEV-A	1.5E-8	2.0E-11	3.0E-8	10.3	91.0
IEV-S2S	8.1E-9	3.8E-11	2.2E-8	5.6	96.6
IEV-S1	2.9E-9	9.9E-12	1.3E-8	< 5.0	
IEV-TM	6.1E-10	5.1E-14	8.5E-10	< 5.0	
IEV-TS	6.1E-10	2.8E-14	6.3E-10	< 5.0	
IEV-TCA	4.1E-10	5.0E-14	6.6E-10	< 5.0	
IEV-S1C	3.6E-10	2.3E-13	1.0E-9	< 5.0	

[redacted]

Table 3-8: Contribution of Initiating Events to Plant Damage State III-C

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-TFA	4.2E-8	3.7E-11	9.9E-8	58.3	58.3
IEV-VR	3.0E-8	1.2E-10	1.1E-7	41.7	100.0

[redacted]

Table 3-9: Contribution of Initiating Events to Plant Damage State III-D

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-S2P	3.3E-8	2.2E-10	1.0E-7	61.3	61.3
IEV-TT	8.1E-9	1.8E-12	1.9E-8	15.0	78.3
IEV-S1	2.9E-9	8.0E-12	9.7E-9	5.4	83.7
IEV-TF	2.7E-9	3.0E-13	4.2E-9	5.0	88.7
IEV-S2	2.7E-9	7.1E-12	8.7E-9	5.0	93.7
IEV-S2S	2.3E-9	3.7E-12	6.4E-9	< 5.0	
IEV-S1S	1.4E-9	9.6E-13	5.6E-9	< 5.0	
IEV-TSW	3.7E-10	7.4E-15	3.5E-10	< 5.0	
IEV-S1C	3.6E-10	2.3E-13	1.1E-9	< 5.0	

[redacted]

Table 3-10: Risk Reduction by Basic Events for Plant Damage State I-A

Base Event	Risk Reduction	5%le	95%le
CCX-DAS	5.1E-8	3.4E-11	1.3E-7
CCX-40EAI	3.1E-8	4.7E-12	6.5E-8
CCX-51EHX	1.1E-8	1.1E-12	1.9E-8
CCX-EEMM12	6.1E-9	5.1E-13	9.8E-9
CCX-19-YA	5.7E-9	4.0E-13	1.0E-8
DAS	2.2E-9	5.8E-15	9.7E-10
DIS	1.6E-9	5.8E-15	9.7E-10
LPM-MAN01	1.6E-9	4.7E-13	3.1E-9
CCX-AV-LA	6.1E-10	4.7E-13	3.1E-9
OTH-VAL3	6.1E-10	5.3E-14	8.9E-10
OTH-VAL4	4.1E-10	3.8E-14	7.2E-10
REG-MAN00	4.1E-10	4.0E-14	6.1E-10

[redacted]

Table 3-11: Risk Reduction by Basic Events for Plant Damage State I-AP

Base Event	Risk Reduction	5%le	95%le
LPM-MAN03	4.1E-8	6.5E-10	1.2E-7
CCX-HARD1	1.8E-8	1.6E-11	4.5E-8
CCX-03XTS	9.9E-9	1.1E-11	3.0E-8
CCX-TT-UF	6.7E-9	2.8E-12	1.8E-8
DIS	3.0E-9	7.4E-13	5.2E-9
CCX-XMTR195	2.3E-9	3.3E-12	6.2E-9
CCX-51EHX	2.2E-9	1.0E-12	5.1E-9
CCX-EP-SA	1.8E-9	7.9E-13	4.0E-9
CCX-EEMM12	1.3E-9	8.9E-13	4.5E-9
CCX-19-YA	1.2E-9	6.6E-13	2.9E-9
CCX-19-SA	9.8E-10	8.3E-13	3.5E-9
CCX-4828M	6.5E-10	2.6E-13	1.4E-9
LPM-MAN01	6.3E-10	4.5E-12	2.5E-9
ECX-CB-GO	6.3E-10	4.5E-12	2.5E-9
CCX-SFTW	5.0E-10	2.6E-13	1.2E-9
PMX-PLC	4.8E-10	2.4E-13	1.4E-9
PMX-ESFAC	4.8E-10	2.7E-13	1.1E-9

[redacted]

Table 3-12: Risk Reduction by Basic Event for Plant Damage State III-BE

Base Event	Risk Reduction	5%le	95%le
IWX-CV-AO	4.1E-8	6.1E-11	1.1E-7
LPM-MAN03	3.3E-8	3.3E-10	1.2E-7
CCX-HARD1	2.0E-8	3.1E-11	6.1E-8
IWACV123AO	1.8E-8	3.4E-11	5.3E-8
IWACV124AO	1.8E-8	4.1E-11	6.1E-8
IWACV125AO	1.8E-8	3.5E-11	5.4E-8
IWACV122AO	1.8E-8	3.4E-11	7.1E-8
CCX-03XTS	1.1E-8	1.1E-11	3.3E-8
IWX-CV1-AO	7.2E-9	4.9E-12	2.1E-8
IWA-PLUG	6.0E-9	4.3E-11	3.0E-8
LPM-MAN04	4.6E-9	3.4E-11	1.4E-8
DIS	2.3E-9	1.9E-13	2.9E-9
CCX-51EHX	2.2E-9	1.0E-12	6.9E-9
RNNMOD08	1.9E-9	3.3E-13	3.9E-9
RNNMOD05	1.8E-9	5.5E-13	4.8E-9
CCX-EP-SA	1.8E-9	1.0E-12	5.2E-9
REAMV118GO	1.8E-9	4.5E-13	2.7E-9
REAMV117GO	1.8E-9	4.0E-13	3.1E-9
CCX-TT-UF	1.4E-9	7.6E-13	3.1E-9
CCX-EEMM12	1.3E-9	7.0E-13	2.9E-9
CCX-19-YA	1.2E-9	4.2E-13	3.4E-9
PMX-PLC	9.9E-10	1.1E-12	2.5E-9
RNX-MV-GO	7.1E-10	4.5E-14	1.3E-9
CCX-SFTW	5.0E-10	3.3E-13	1.2E-9
IWX-PLUG	4.9E-10	2.9E-13	1.3E-9

Table 3-13: Risk Reduction by Basic Events for Plant Damage State III-BR

Base Event	Risk Reduction	5%le	95%le
LPM-MAN03	4.1E-8	5.9E-10	1.1E-7
IWX-CV-AO	4.1E-8	7.0E-11	1.2E-7
CCX-HARD1	2.0E-8	2.5E-11	5.5E-8
IWACV123AO	1.8E-8	3.4E-11	5.5E-8
IWACV125AO	1.8E-8	3.4E-11	4.9E-8
IWACV124AO	1.8E-8	4.0E-11	8.1E-8
IWACV122AO	1.8E-8	3.4E-11	5.3E-8
CCX-03XTS	1.1E-8	1.6E-11	2.7E-8
CCX-TT-UF	8.1E-9	8.4E-12	2.3E-8
IWX-CV1-AO	7.2E-9	5.2E-12	1.6E-8
IWA-PLUG	6.0E-9	3.1E-11	2.4E-8
LPM-MAN04	4.6E-9	3.3E-11	2.0E-8
DIS	3.0E-9	5.5E-13	4.5E-9
LPM-MAN01	2.3E-9	8.8E-12	6.3E-9
CCX-XMTR195	2.3E-9	2.1E-12	7.4E-9
CCX-51EHX	2.2E-9	8.3E-13	4.5E-9
RNNMOD08	1.9E-9	6.1E-13	3.1E-9
RNNMOD05	1.8E-9	5.0E-13	4.0E-0
CCX-EP-SA	1.8E-9	8.1E-13	4.6E-9
REAMV117GO	1.8E-9	5.0E-13	4.8E-9
REAMV118GO	1.8E-9	5.5E-13	3.9E-9
CCX-AV-LA	1.6E-9	3.6E-13	2.9E-9
CCX-EEMM12	1.3E-9	6.5E-13	3.4E-9
CCX-19-YA	1.2E-9	5.5E-13	3.3E-9
PMX-PLC	9.9E-10	1.4E-12	3.5E-9

[redacted]

Table 3-13 (Continued)

Base Event	Risk Reduction	5%le	95%le
CCX-19-SA	9.8E-10	9.4E-13	3.0E-9
RNX-MV-GO	7.1E-10	3.3E-13	6.6E-10
CCX-4828M	6.5E-10	3.2E-13	1.6E-9
ECX-CB-GO	6.3E-10	3.3E-12	2.0E-9
OTH-VAL3	6.1E-10	5.1E-14	8.5E-10
OTH-VAL4	6.1E-10	2.8E-14	6.3E-10
CCX-SFTW	5.0E-10	2.4E-13	1.5E-9
IWX-PLUG	4.9E-10	4.1E-13	1.5E-9
PMX-ESFAC	4.8E-10	3.2E-13	1.5E-9
REG-MAN00	4.1E-10	5.0E-14	6.6E-10

[redacted]

Table 3-14: Risk Reduction by Basic Events for Plant Damage State III-C

Base Event	Risk Reduction	5%le	95%le
DAS	3.6E-8	7.8E-12	7.1E-8
ATW-MAN03	2.7E-8	1.1E-11	5.0E-8
RCX-RB-FA	2.4E-8	2.2E-12	3.4E-8
MGSET	1.5E-8	7.1E-12	2.8E-8
CCX-DU-SA	9.3E-9	6.7E-13	1.1E-8
CCX-HARD1	4.9E-9	8.1E-13	5.7E-9
CCX-DAS	3.2E-9	3.0E-13	6.3E-9
CCX-4828M	1.7E-9	5.8E-14	1.4E-9
CCX-ESF	1.4E-9	3.7E-14	1.2E-9
ED3MOD03	1.1E-9	2.1E-13	2.4E-9
CCX-PW-SA	5.3E-10	8.0E-15	4.9E-10
ED3BS001TM	4.4E-10	4.1E-14	5.8E-10
CCX-XMTR	3.5E-10	5.0E-15	2.7E-10

[redacted]

Table 3-15: Risk Reduction by Basic Events for Plant Damage State III-D

Base Event	Risk Reduction	5%le	95%le
LPM-MAN03	3.4E-8	3.4E-10	1.1E-7
CCX-HARD1	2.0E-8	2.5E-11	5.0E-8
CCX-51EHX	1.2E-8	6.1E-12	3.5E-8
CCX-DAS	1.1E-8	4.2E-12	2.5E-8
CCX-03XTS	1.1E-8	1.5E-11	2.8E-8
LPM-MAN04	4.6E-9	3.5E-11	1.8E-8
DIS	2.3E-9	2.2E-13	2.7E-9
CCX-EP-SA	1.8E-9	6.9E-13	4.0E-9
CCX-EEMM12	1.7E-9	1.1E-12	5.0E-9
CCX-19-YA	1.6E-9	1.1E-12	4.3E-9
CCX-TT-UF	1.4E-9	9.6E-13	5.6E-9
CCX-BY-PN	1.1E-9	2.7E-13	2.8E-9
PMX-PLC	9.9E-10	1.1E-12	3.4E-9
IDABSDS2TM	9.0E-10	2.0E-12	3.2E-9
IDDBSDS2TM	9.0E-10	1.4E-12	3.4E-9
IDCBSDS2TM	9.0E-10	1.8E-12	2.5E-9
IDBBSDS2TM	9.0E-10	1.4E-12	2.9E-9
EC2BS002TM	5.3E-10	8.6E-14	9.6E-10
EC1BS001TM	5.3E-10	1.1E-13	1.5E-9
CCX-SFTW	5.0E-10	3.1E-13	1.2E-9
CCX-40EAI	3.7E-10	7.4E-15	3.5E-10

[redacted]

Table 3-16: Uncertainty Importance by Initiating Events for Plant Damage State I-A

Initiating Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of initiating event	Maximum value of initiating event
IEV-TT	2.7E-8	0.4	-90.1	465.1
IEV-TF	1.0E-8	0.1	-24.5	136.4
IEV-TS	4.8E-8	0.0	- 0.9	109.5
IEV-TM	2.7E-9	0.0	- 0.3	40.0
IEV-TCA	8.6E-10	0.0	- 0.2	1.6

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-17: Uncertainty Importance by Initiating Events for Plant Damage State I-AP

Initiating Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of initiating event	Maximum value of initiating event
IEV-S2P	6.1E-8	2.7	-92.2	5153.6
IEV-S2	2.7E-8	0.5	- 7.3	2745.9
IEV-S2S	8.4E-9	0.1	- 2.5	189.5

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-18: Uncertainty Importance by Initiating Event for Plant Damage State III-BE

Initiating Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of initiating event	Maximum value of initiating event
IEV-S1S	1.4E-7	44.2	-51.0	24433.4
IEV-S2P	6.1E-8	9.0	-20.1	7085.4
IEV-A	3.2E-8	2.5	-30.3	6720.5
IEV-S2	1.4E-8	0.5	-14.2	778.2
IEV-S2S	1.4E-8	0.4	- 2.0	893.7
IEV-S1	5.6E-9	0.1	- 0.8	90.6
IEV-S1C	7.5E-10	0.0	- 0.1	8.0

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-19:Uncertainty Importance by Initiating Event for Plant Damage State III-BR

Initiating Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of initiating event	Maximum value of initiating event
IEV-S1S	1.5E-7	35.4	-54.5	20007.6
IEV-S2P	6.4E-8	6.6	- 8.6	5144.2
IEV-S2	3.6E-8	2.1	- 8.4	1100.3
IEV-A	3.0E-8	1.5	-42.5	5229.0
IEV-S2S	1.6E-8	0.4	-10.9	413.4
IEV-S1	6.1E-9	0.1	- 0.8	104.3
IEV-TS	1.3E-9	0.0	- 0.1	28.7
IEV-TM	1.3E-9	0.0	- 0.0	196.1
IEV-TCA	8.5E-10	0.0	- 0.1	3.9
IEV-S1C	6.8E-10	0.0	- 0.1	8.6

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-20: Uncertainty Importance by Initiating Events for Plant Damage State III-C

			% change in the variance of the top event frequency taken at the: **	
Initiating Event	Uncertainty Importance	Average % reduction*	Minimum value of initiating event	Meximum value of initiating event
IEV-VR	1.0E-7	65.1	-64.4	-64.4
IEV-TFA	3.1E-8	6.0	-34.6	1167.7

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-21: Uncertainty Importance by Initiating Event for Plant Damage State III-D

Initiating Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of initiating event	Maximum value of initiating event
IEV-S2P	6.9E-8	62.4	-75.7	32103.9
IEV-S1	6.2E-9	0.5	-12.5	1057.2
IEV-TT	6.0E-9	0.5	- 7.5	189.6
IEV-S2	5.5E-9	0.4	- 6.0	568.2
IEV-S2S	4.9E-9	0.3	-17.2	456.8
IEV-S1S	2.8E-9	0.1	- 0.7	309.4
IEV-TF	2.0E-9	0.1	- 2.0	27.6
IEV-TSW	7.8E-10	0.0	- 0.1	21.5
IEV-S1C	7.4E-10	0.0	- 0.5	65.5

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-22: Uncertainty Importance by Basic Events for Plant Damage State I-A

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
CCX-DAS	2.0E-7	22.5	-99.9	29670.2
CCX-40EAI	1.1E-7	6.9	-23.3	67682.7
CCX-51EHX	4.0E-8	0.9	-68.2	9437.0
CCX-EEMM12	2.2E-8	0.3	-41.1	3670.9
CCX-19-YA	1.9E-8	0.2	- 0.4	3559.8
DAS	8.9E-9	0.0	0.0	57.6
DIS	8.6E-9	0.0	0.0	635.9
CCX-AV-LA	5.6E-9	0.0	- 0.1	383.5
LPM-MAN01	3.5E-9	0.0	- 0.1	10.9
OTH-VAL4	9.7E-10	0.0	0.0	1.3
OTH-VAL3	7.0E-10	0.0	0.0	1.5
REG-MAN00	2.4E-10	0.0	- 0.1	0.3

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

[redacted]

Table 3-23: Uncertainty Importance by Basic Events for Plant Damage State I-AP

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
CCX-HARD1	7.2E-8	3.8	-90.2	4995.2
CCX-03XTS	3.3E-8	0.8	- 3.3	1636.3
LPM-MAN03	3.1E-8	0.7	-99.3	1502.9
CCX-TT-UF	2.8E-8	0.6	- 6.5	769.3
DIS	1.2E-8	0.1	- 0.7	3128.1
CCX-51EHX	8.5E-9	0.0	- 0.2	160.7
CCX-XMTR195	7.7E-9	0.0	- 0.2	47.3
CCX-EP-SA	7.5E-9	0.0	0.0	116.8
CCX-EEMM12	4.8E-9	0.0	- 0.2	68.8
CCX-19-YA	4.7E-9	0.0	- 0.5	61.4
CCX-19-SA	3.5E-9	0.0	- 0.1	14.4
CCX-4828M	2.2E-9	0.0	0.0	14.7
PMX-ESFAC	2.0E-9	0.0	- 0.1	9.4
CCX-SFTW	2.0E-9	0.0	- 0.1	16.0
PMX-PLC	1.9E-9	0.0	- 0.2	9.1
LPM-MAN01	1.2E-9	0.0	0.0	2.7
ECX-CB-GO	4.3E-15	0.0	0.0	0.0

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

[redacted]

Table 3-24:Uncertainty Importance by Basic Event for Plant Damage State III-BE

Base Event	Uncertainty Importance	Average % reduction *	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
IWX-CV-AO	1.6E-7	60.9	-43.9	27775.3
CCX-HARD1	7.3E-8	12.9	-18.7	13613.8
IWACV123AO	4.0E-8	3.8	-10.6	3037.4
IWACV122AO	3.9E-8	3.7	-17.9	2974.5
IWACV124AO	3.8E-8	3.5	-11.7	6962.3
IWACV125AO	3.7E-8	3.4	-17.1	6876.2
CCX-03XTS	3.6E-8	3.1	- 1.5	4268.4
IWX-CV1-AO	2.8E-8	1.9	- 7.7	2578.5
LPM-MAN03	2.5E-8	1.5	-20.0	572.8
IWA-PLUG	1.2E-8	0.3	- 9.9	340.5
DIS	9.2E-9	0.2	- 1.1	785.2
CCX-51-EHX	8.3E-9	0.2	- 0.4	253.2
CCX-EP-SA	7.1E-9	0.1	- 0.6	181.1
CCX-TT-UF	5.6E-9	0.1	- 0.7	354.0
CCX-EEMM12	4.6E-9	0.1	- 0.4	105.0
CCX--19-YA	4.4E-9	0.0	- 0.2	94.4
PMX-PLC	4.0E-9	0.0	- 0.5	33.5
RNNMOD08	3.9E-9	0.0	- 0.7	603.9
RNNMOD05	3.9E-9	0.0	- 1.3	586.1
REAMV118GO	3.6E-9	0.0	- 6.3	520.5
LPM-MAN04	3.5E-9	0.0	- 1.5	23.6
REAMV117GO	3.4E-9	0.0	- 1.9	545.4

[redacted]

Table 3-24 (Continued)

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
RNX-MV-GO	2.8E-9	0.0	- 5.9	513.3
CCX-SFTW	2.0E-9	0.0	- 0.1	23.1
IWX-PLUG	42.0E-9	0.0	0.0	22.2

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

[redacted]

Table 3-25: Uncertainty Importance by Basic Events for Plant Damage State III-BR

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
IWX-CV-AO	1.7E-7	47.2	-56.0	20138.7
CCX-HARD1	8.0E-8	10.4	- 5.8	22766.5
IWACV122AO	3.9E-8	2.5	-14.7	2831.1
IWACV123AO	3.9E-8	2.4	- 9.9	2827.0
IWACV125AO	3.8E-8	2.4	- 9.0	5760.5
CCX-03XTS	3.6E-8	2.1	- 2.4	6960.1
IWACV124AO	3.5E-8	2.0	-18.2	5430.1
LPM-MAN03	3.1E-8	1.5	- 9.7	301.6
IWX-CV1-AO	3.0E-8	1.4	-13.0	2032.6
CCX-TT-UF	2.8E-8	1.2	- 0.7	2517.3
IWA-PLUG	1.3E-8	0.3	- 2.8	271.6
DIS	1.0E-8	0.2	- 0.8	280.4
CCX-XMTR195	9.2E-9	0.1	- 0.1	114.9
CCX-51EHX	8.5E-9	0.1	- 0.5	588.3
CCX-EP-SA	7.3E-9	0.1	- 0.2	415.2
CCX-AV-LA	6.0E-9	0.1	- 0.1	241.2
CCX-EEMM12	5.5E-9	0.0	- 0.2	231.7
LPM-MAN01	4.8E-9	0.0	- 0.2	170.0
CCX-19-YA	4.7E-9	0.0	- 1.4	203.8
PMX-PLC	4.1E-9	0.0	- 0.1	35.7
RNNMOD08	3.9E-9	0.0	- 4.4	271.6
REAMV118GO	3.8E-9	0.0	- 6.7	245.0

[redacted]

Table 3-25: (Continued)

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
RNNMOD05	3.6E-9	0.0	- 1.8	275.9
REAMV117GO	3.5E-9	0.0	- 1.4	264.3
CCX-19-SA	3.5E-9	0.0	- 0.3	48.7
LPM-MAN04	3.4E-9	0 0	- 1.0	17.5
RNX-MV-GO	2.8E-9	0.0	- 3.9	251.7
CCX-4828M	2.2E-9	0.0	- 0.1	38.6
CCX-SFTW	2.1E-9	0.0	- 0.1	43.6
IWX-PLUG	1.9E-9	0.0	0.0	9.1
PMX-ESFAC	1.6E-9	0.0	- 0.2	22.3
OTH-VAL4	9.4E-10	0.0	- 0.1	7.1
OTH-VAL3	7.0E-10	0.0	0.0	2.6
REG-MAN00	2.4E-10	0.0	0.0	0.5
ECX-CB-GO	1.6E-14	0.0	0.0	0.0

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

[redacted]

Table 3-26: Uncertainty Importance by Basic Event for Plant Damage State III-C

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
DAS	1.5E-7	133.3	-31.7	4110383.0
RCX-RB-FA	8.4E-8	45.0	-23.1	89382.8
ATW-MAN03	5.2E-8	17.0	-30.1	34534.1
CCX-DU-SA	3.2E-8	6.4	- 9.3	14651.9
MGSET	3.1E-8	6.1	-11.2	11372.9
CCX-HARD1	1.8E-8	2.0	- 2.2	3779.0
CCX-DAS	1.2E-8	0.9	- 8.5	51303.9
CCX-4828M	6.1E-9	0.2	- 2.0	736.2
CCX-ESF	5.3E-9	0.2	- 0.5	499.9
ED3MOD03	2.2E-9	0.0	- 1.0	330.2
CCX-PW-SA	2.2E-9	0.0	- 0.6	158.2
CCX-XMTR	1.4E-9	0.0	- 0.4	2301.1
ED3BS001TM	9.3E-10	0.0	- 1.7	662.6

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

[redacted]

Table 3-27: Uncertainty Importance by Basic Events for Plant Damage State III-D

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
CCX-HARD1	8.0E-8	84.0	-46.7	131296.5
CCX-51EHX	4.2E-8	23.5	-10.6	135874.8
CCX-DAS	4.1E-8	21.9	- 8.2	60340.5
CCX-03XTS	3.6E-8	16.7	-37.6	39686.1
LPM-MAN03	2.5E-8	8.1	-86.1	1784.8
DIS	9.4E-9	1.2	- 6.0	1906.8
CCX-EP-SA	7.3E-9	0.7	- 1.0	2527.8
CCX-EEMM12	7.0E-9	0.6	- 5.6	1899.7
CCX-19-YA	5.7E-9	0.4	- 6.9	1692.7
CCX-TT-UF	4.8E-9	0.3	- 0.7	621.3
PMX-PLC	4.1E-9	0.2	- 0.4	178.6
CCX-BY-PN	4.1E-9	0.2	- 1.7	508.8
LPM-MAN04	3.4E-9	0.2	-12.9	85.6
CCX-SFTW	2.1E-9	0.1	- 0.2	269.9
IDDBSDS2TM	1.9E-9	0.0	- 2.6	114.7
IDBBSDS2TM	1.9E-9	0.0	- 2.8	157.7
IDABSDS2TM	1.8E-9	0.0	- 2.3	166.3
IDCBSDS2TM	1.7E-9	0.0	- 2.6	117.4
CCX-40EAI	1.4E-9	0.0	- 0.1	22272.2
EC2BS002TM	1.1E-9	0.0	- 1.1	289.8
EC1BS001TM	1.0E-9	0.0	- 0.8	287.3

[redacted]

Table 3-27 (Continued)

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

Table 3-28: Contribution of Initiating Events to Core Damage Frequency

Initiating Event	Contribution	5%le	95%le	%age	Cumulative %age
IEV-S1S	6.9E-8	7.7E-10	2.2E-7	24.6	24.6
IEV-TFA	4.2E-8	2.4E-11	7.5E-8	15.0	39.6
IEV-TT	3.9E-8	6.4E-11	6.9E-8	13.9	53.5
IEV-S2P	3.3E-8	2.5E-10	1.3E-7	11.8	65.3
IEV-VR	3.0E-8	1.2E-10	1.1E-7	10.7	76.0
IEV-S2	1.7E-8	1.5E-10	6.3E-8	6.0	83.0
IEV-A	1.5E-8	2.2E-11	3.4E-8	5.4	88.4
IEV-TF	1.4E-8	1.9E-11	2.5E-8	5.0	93.4
IEV-S2S	8.1E-9	3.7E-11	2.1E-8	< 5.0	
IEV-S1	7.0E-9	3.4E-11	1.9E-8	< 5.0	
IEV-TS	2.3E-9	7.4E-13	3.2E-9	< 5.0	
IEV-V2	1.4E-9	1.1E-12	3.6E-9	< 5.0	
IEV-TM	1.4E-9	3.4E-13	2.4E-9	< 5.0	
IEV-TCA	4.1E-10	3.5E-14	7.0E-10	< 5.0	
IEV-TSW	3.7E-10	1.1E-14	3.1E-10	< 5.0	
IEV-S1C	3.6E-10	1.8E-13	1.1E-9	< 5.0	

[redacted]

Table 3-29: Risk Reduction by Basic Events for Core Damage Frequency

Base Event	Risk Reduction	5%le	95%le
CCX-DAS	5.5E-8	4.6E-11	1.1E-7
IWX-CV-AO	4.5E-8	7.2E-11	1.4E-7
LPM-MAN03	4.3E-8	6.6E-10	1.4E-7
DAS	3.9E-8	6.7E-12	5.1E-8
CCX-40EAI	3.1E-8	3.3E-12	6.1E-8
ATW-MAN03	2.7E-8	9.3E-12	4.6E-8
CCX-HARD1	2.6E-8	4.1E-11	7.0E-8
RCX-RB-FA	2.4E-8	3.0E-12	3.0E-8
IWACV125AO	1.8E-8	2.8E-11	4.8E-8
IWACV123AO	1.8E-8	3.2E-11	4.5E-8
IWACV124AO	1.8E-8	3.0E-11	5.2E-8
IWACV122AO	1.8E-8	3.2E-11	4.9E-8
MGSET	1.5E-8	4.7E-12	2.2E-8
CCX-51EHX	1.3E-8	4.5E-12	2.8E-8
CCX-03XTS	1.1E-8	1.5E-11	4.3E-8
CCX-DU-SA	9.3E-9	7.5E-13	1.1E-8
CCX-TT-UF	8.1E-9	7.1E-12	1.8E-8
CCX-EEMM12	7.4E-9	3.1E-12	1.8E-8
IWX-CV1-AO	7.2E-9	6.5E-12	2.3E-8
CCX-19-YA	7.0E-9	2.5E-12	9.8E-9
IWA-PLUG	6.0E-9	4.2E-11	2.6E-8
DIS	5.1E-9	8.3E-13	3.9E-9
LPM-MAN04	4.6E-9	3.5E-11	1.5E-8

[redacted]

Table 3-29 (Continued)

Base Event	Risk Reduction	5%le	95%le
RNNMOD08	2.8E-9	8.8E-13	7.0E-9
RNNMOD05I	2.8E-9	1.3E-12	6.2E-9
REAMV117GO	2.7E-9	1.1E-12	8.2E-9
REAMV118GO	2.7E-9	7.2E-13	6.1E-9
CCX-4828M	2.4E-9	8.7E-13	3.3E-9
LPM-MAN01	2.3E-9	9.2E-12	5.2E-9
CCX-XMTR195	2.3E-9	2.9E-12	7.0E-9
CCX-EP-SA	1.8E-9	9.6E-13	4.6E-9
CCX-AV-LA	1.6E-9	3.6E-13	3.0E-9
OTH-SGTR	1.5E-9	5.6E-13	3.2E-9
TIME-CVSNO	1.4E-9	1.1E-12	3.6E-9
CCX-FU-RQ	1.4E-9	1.1E-12	3.6E-9
OTH-PM	1.4E-9	4.6E-13	3.4E-9
CCX-ESF	1.4E-9	4.1E-14	1.2E-9
ED3MOD03	1.1E-9	1.8E-13	3.2E-9
RNX-MV-GO	1.1E-9	5.9E-14	2.0E-9
CCX-BY-PN	1.1E-9	4.0E-13	1.9E-9
PMX-PLC	9.9E-10	1.1E-12	3.1E-9
CCX-19-SA	9.8E-10	1.1E-12	2.7E-9
IDCBSDS2TM	9.0E-10	1.5E-12	2.4E-9
IDBBSDS2TM	9.0E-10	1.4E-12	2.2E-9
IDABSDS2TM	9.0E-10	1.7E-12	2.3E-9
IDDBSDS2TM	9.0E-10	1.6E-12	2.4E-9

[redacted]

Table 3-29 (Continued)

Base Event	Risk Reduction	5%le	95%le
ECX-CB-GO	6.3E-10	3.3E-12	2.4E-9
OTH-VAL3	6.1E-10	5.8E-14	1.1E-9
OTH-VAL4	6.1E-10	3.7E-14	8.3E-10
EC2BS002TM	5.3E-10	9.0E-14	9.9E-10
EC1BS001TM	5.3E-10	9.7E-14	1.0E-9
CCX-PW-SA	5.3E-10	1.2E-14	4.4E-10
CCX-SFTW	5.0E-10	2.4E-13	1.5E-9
IWX-PLUG	4.9E-10	3.3E-13	1.3E-9
PMX-ESFAC	4.8E-10	3.6E-13	1.5E-9
OTH-PM1	4.7E-10	3.5E-14	8.1E-10
ED3BS001TM	4.4E-10	5.3E-14	9.0E-10
REG-MAN00	4.1E-10	3.5E-14	7.0E-10
CCX-XMTR	3.5E-10	5.3E-15	2.8E-10
OTH-SGTR1	3.4E-10	3.0E-14	6.1E-10

[redacted]

Table 3-30: Uncertainty Importance by Initiating Events for Core Damage Frequency

Initiating Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of initiating event	Maximum value of initiating event
IEV-S1S	1.4E-7	2.4	- 6.6	1603.5
IEV-VR	1.1E-7	1.5	- 1.0	- 1.0
IEV-S2P	6.5E-8	0.5	- 0.6	444.9
IEV-S2	3.2E-8	0.1	-89.8	340.6
IEV-A	3.2E-8	0.1	- 0.8	396.6
IEV-TFA	3.0E-8	0.1	- 1.1	44.7
IEV-TT	2.8E-8	0.1	- 4.1	117.0
IEV-S2S	1.7E-8	0.0	- 0.3	77.9
IEV-S1	1.5E-8	0.0	- 1.5	67.8
IEV-TF	1.0E-8	0.0	- 1.2	23.8
IEV-TS	4.7E-9	0.0	- 0.1	11.1
IEV-V2	2.9E-9	0.0	- 0.0	3.0
IEV-TM	2.7E-9	0.0	- 0.0	2.3
IEV-TCA	8.2E-10	0.0	- 0.0	0.0
IEV-TSW	7.6E-10	0.0	- 0.0	1.0
IEV-S1C	7.5E-10	0.0	- 0.0	0.4

* Average percentage reduction in the variance of the top event frequency taken over the range of the initiating event, given that the value of the initiating event is known. The actual percentage reduction is dependent on the specific value of the initiating event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the initiating event in question.

[redacted]

Table 3-31: Uncertainty Importance by Basic Events for Core Damage Frequency

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
CCX-DAS	2.3E-7	6.4	-5.3	10106.3
IWX-CV-AO	1.8E-7	4.1	-3.3	1834.8
DAS	1.5E-7	2.9	-0.5	5521.5
CCX-40EAI	1.2E-7	1.8	-1.2	8076.4
CCX-HARD1	1.1E-7	1.4	-0.6	1666.7
RCX-RB-FA	8.6E-8	0.9	-1.0	26276.9
CCX-51EHX	5.2E-8	0.3	-1.3	1133.2
ATW-MAN03	5.2E-8	0.3	-0.6	682.3
CCX-03XTS	4.0E-8	0.2	-0.4	223.0
IWACV125AO	3.9E-8	0.2	-1.5	664.3
IWACV124AO	3.8E-8	0.2	-2.1	688.9
IWACV122AO	3.8E-8	0.2	-1.2	154.6
IWACV123AO	3.6E-8	0.2	-2.5	146.7
CCX-TT-UF	3.4E-8	0.1	-88.3	265.5
LPM-MAN03	3.2E-8	0.1	-47.3	287.6
CCX-DU-SA	3.2E-8	0.1	-0.1	4408.4
MGSET	3.0E-8	0.1	-0.6	219.1
CCX-EEMM12	3.0E-8	0.1	-1.3	419.1
IWX-CV1-AO	3.0E-8	0.1	-0.1	158.3
CCX-19-YA	2.4E-8	0.1	-2.4	370.4
DIS	2.0E-8	0.1	-76.8	320.1

[redacted]

Table 3-31 (Continued)

Base Event	Uncertainty Importance	Average % reduction*	% change in the variance of the top event frequency taken at the: **	
			Minimum value of base event	Maximum value of base event
IWA-PLUG	1.2E-8	0.0	-0.1	24.5
CCX-4828M	8.6E-9	0.0	-0.2	208.2
CCX-XMTR195	8.2E-9	0.0	0.0	17.1
CCX-AV-LA	6.5E-9	0.0	0.0	18.5
CCX-EP-SA	6.2E-9	0.0	0.0	11.2
RNNMOD08	6.1E-9	0.0	-0.7	106.8
CCX-ESF	5.7E-9	0.0	0.0	129.4
RNNMOD05	5.5E-9	0.0	-1.3	102.2
REAMV117GO	5.4E-9	0.0	-0.4	99.0
REAMV118GO	5.3E-9	0.0	-0.6	98.4
CCX-FU-RQ	5.1E-9	0.0	0.0	5.4
LPM-MAN01	4.4E-9	0.0	0.0	4.7
RNX-MV-GO	4.4E-9	0.0	-0.1	99.9
CCX-BY-PN	4.2E-9	0.0	0.0	21.7
PMX-PLC	4.0E-9	0.0	-0.1	9.3
CCX-19-SA	3.7E-9	0.0	-0.1	10.1
LPM-MAN04	3.4E-9	0.0	-2.0	18.6
OTH-SGTR	3.1E-9	0.0	0.0	3.6
OTH-PM	2.9E-9	0.0	0.0	3.7
ED3MOD03	2.2E-9	0.0	0.0	7.9
CCX-SFTW	2.1E-9	0.0	0.0	1.2

[redacted]

Table 3-31 (Continued)

			% change in the variance of the top event frequency taken at the: **	
Base Event	Uncertainty Importance	Average % reduction*	Minimum value of base event	Maximum value of base event
IDBBSDS2TM	1.9E-9	0.0	0.0	1.2
IDCBSDS2TM	1.9E-9	0.0	0.0	1.4
PMX-ESFAC	1.9E-9	0.0	0.0	8.3
IDDBSDS2TM	1.9E-9	0.0	0.0	1.4
IDABSDS2TM	1.9E-9	0.0	0.0	1.1
CCX-PW-SA	1.7E-9	0.0	-0.3	40.2
IWX-PLUG	1.6E-9	0.0	0.0	0.7
CCX-XMTR	1.4E-9	0.0	0.0	0.8
EC2BS002TM	1.1E-9	0.0	0.0	0.8
EC1BS001TM	1.1E-9	0.0	0.0	0.8
OTH-VAL4	9.6E-10	0.0	0.0	0.9
ED3BS001TM	9.2E-10	0.0	0.0	0.2
OTH-PM1	9.0E-10	0.0	0.0	0.4
OTH-SGTR1	7.3E-10	0.0	0.0	0.4
OTH-VAL3	7.2E-10	0.0	0.0	0.1
REG-MAN00	2.5E-10	0.0	0.0	0.0
TIME-CVSNO	7.0E-12	0.0	0.0	0.0
ECX-CB-GO	4.8E-14	0.0	0.0	0.0

* Average percentage reduction in the variance of the top event frequency taken over the range of the base event, given that the value of the base event is known. The actual percentage reduction is dependent on the specific value of the base event.

** The minimum and maximum values are the endpoints of the range used in generating the sample values for the base event in question.

[redacted]

REFERENCES

1. Westinghouse AP600 Probabilistic Risk Assessment, Proprietary version, DE-AC03-90SF18495, June 26, 1992.

2. Westinghouse AP600 Probabilistic Risk Assessment, Non-proprietary version, DE-AC03-90SF18495, June 26, 1992.

3. "AP600 Plant Probability Safety Study Guidebooks," WCAP-12699, Rev. 1, June 1992.

4. USNRC NUREG/CR-4550, SAND86-2084, "Analysis of Core Damage Frequency: Internal Events Methodology," Vol. 1, Rev. 1

5. USNRC NUREG/CR-2728, SAND82-1100, "Interim Reliability Evaluation Program Procedures Guide," January 1983.

6. USNRC NUREG/CR-2815, BNL-NUREG-51559, "Probabilistic Safety Analysis Procedures Guide," Vol. 1, Rev. 1.

7. USNRC NUREG/CR-1278, SAND80-0200, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," Final Report.

8. "Advanced Light Water Reactor Utility Requirements Documents," Volume III, Chapter 1, Appendix A, PRA Key Assumptions and Groundrules, Rev. 3, May 1992.

9. "Guidelines for Assessing the Variance of Lognormal Distributions," CN-PRRA-93-123, Westinghouse Electric Corporation, June 1993.

10. "User Manual for Westinghouse Uncertainty Analysis Software: WUNCERT," WCAP-13302, May 1992.

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DCP/NRC1413
NSD-NRC-98-5757
Docket No.: 52-003

August 14, 1998

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. Quay

SUBJECT: RESPONSE TO NRC LETTERS CONCERNING REQUEST FOR WITHHOLDING INFORMATION

Reference:

1. Letter, Sebrosky to McIntyre, "Request for withholding information from public disclosure for Westinghouse AP600 design letter of October 20, 1993," dated June 18, 1998.
2. Letter, Sebrosky to McIntyre, "Request for withholding information from public disclosure for Westinghouse AP600 design letter of January 17, 1994," dated June 18, 1998.
3. Letter, Sebrosky to McIntyre, "Request for withholding information from public disclosure for Westinghouse AP600 letters of September 20, 1993, January 21, 1994, and February 3, 1994," dated July 10, 1998.
4. Letter, Sebrosky to McIntyre, "Request for withholding proprietary information for Westinghouse letters dated April 18, 1995," dated July 15, 1998.
5. Letter, Huffman to McIntyre, "Request for withholding information from public disclosure of Westinghouse report on AP600 function based task analysis," dated July 17, 1998.

Dear Mr. Quay:

Reference 1 provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated October 20, 1993, that contained the response to a staff request for additional information regarding the AP600 probabilistic risk assessment. The NRC assessment was that the material was similar to material that exists in the current (1998) nonproprietary version of the AP600 probabilistic risk assessment (PRA) report. In addition, the staff indicated the material was used by the staff in the development of the AP600 draft safety evaluation report and therefore should remain on the docket. At the time this request for additional information response was provided to the

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NRC technical staff, the information was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse. If this request for additional information response was indeed used by the staff in development of the AP600 draft final safety evaluation report in November 30, 1994, then at this time, almost five years later, this information is no longer considered to be proprietary by Westinghouse.

Reference 2 provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated January 17, 1994, that contained the response to a staff request for additional information regarding the AP600 instrumentation and control system. The NRC assessment was that the material was similar to material that exists in the current (1998) nonproprietary version of the AP600 standard safety analysis report. In addition, the staff indicated the material was used by the staff in the development of the AP600 draft safety evaluation report and therefore should remain on the docket. At the time this request for additional information response was provided to the NRC technical staff, the information was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse. If this request for additional information response was indeed used by the staff in development of the AP600 draft final safety evaluation report in November 30, 1994, then at this time, over four years later, this information is no longer considered to be proprietary by Westinghouse.

Reference 3 provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated September 20, 1993, that contained information related to the AP600 PRA and WCAP-13795, which provided the PRA uncertainty analysis. The NRC assessment was that the material was similar to material that exists in the current (1998) nonproprietary version of the AP600 probabilistic risk assessment (PRA) report. In addition, the staff indicated the material was used by the staff in the development of the AP600 draft safety evaluation report and therefore should remain on the docket. At the time this information was provided to the NRC technical staff, it was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse. If the information transmitted by the Westinghouse September 20, 1993, letter was indeed used by the staff in development of the AP600 draft final safety evaluation report in November 30, 1994, then at this time, almost five years later, this information is no longer considered to be proprietary by Westinghouse.

Reference 3 also provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated January 21, 1994, that contained WCAP-13913, "Framework for AP600 Severe Accident Management Guidance" (SAMG). The NRC assessment was that the material was similar to material that exists in current (1998) nonproprietary AP600 documents (e.g., WCAP-13914, "Framework for AP600 Severe Accident Management Guidance"). In addition, the staff indicated the material was used by the staff in the development of the AP600 draft safety evaluation report and therefore should remain on the docket. At the time this Framework for SAMG was provided to the NRC technical staff, the information was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse. At this time, over four years later, this information is no longer considered to be proprietary by Westinghouse.

Reference 3 also provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated February 3, 1994, that contained additional copies of WCAP-13913, "Framework for AP600 Severe Accident Management Guidance" (SAMG). The NRC assessment was that the material was similar to material that exists in current (1998) nonproprietary AP600 documents (e.g., WCAP-13914, "Framework for AP600 Severe Accident Management Guidance"). In addition, the staff indicated the material was used by the staff in the development of the AP600 draft safety evaluation report and therefore should remain on the docket. At the time this Framework for SAMG was provided to the NRC technical staff, the information was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse. At this time, over four years later, this information is no longer considered to be proprietary by Westinghouse.

Reference 4 provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated April 18, 1995, that contained information for a MAAP4/RELAP comparison for the AP600 in response to a staff request for additional information. The NRC assessment was that the Westinghouse cover letter indicated that Enclosure 2 is a non-proprietary version of Enclosure 3, however, the staff could not find any portion of the enclosures marked as proprietary. The staff assessment further states the conventional bracketed-superscript notation also appears to be missing. Finally, the NRC assessment states the staff could not determine which part of the material enclosed with the Westinghouse letter was Enclosure 1, 2, or 3. It should be noted that the Westinghouse April 18, 1995, cover letter states "Enclosures 2 (nonproprietary) and 3 (proprietary) provide the requested information." The letter does not indicate that enclosure 2 was a duplicate of enclosure 3 minus the proprietary information. A cover sheet was provided just prior to each of the enclosures to the Westinghouse letter. The enclosures contained the following: Enclosure 1 provided a copy of the NRC's two-page request for information for the MAAP-RELAP comparison. Enclosure 2 provided the requested information, and was titled "Requested Information for AP600 MAAP4/RELAP Comparison." Under section 4, Initial Conditions, of Enclosure 2 it states the initial conditions information (which was proprietary) is provided in Enclosure 3 of the subject Westinghouse letter. Finally, Enclosure 3 contained the list of initial conditions. The information provided in Enclosure 3 was labeled as Westinghouse Proprietary Class 2 at the top of the page, however, the specific proprietary information was not indicated by the bracketed-superscripted notation. In addition to the initial conditions, a mark-up of AP600 PRA Figure K-1 was provided in Enclosure 3. Again, the information was labeled as Westinghouse Proprietary Class 2 at the top of the page, however, the specific proprietary information was not indicated by the bracketed-superscripted notation. At the time the information provided in Enclosure 3 of the subject Westinghouse letter was provided to the NRC technical staff, the information was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse. At this time, over three years later, this information is no longer considered to be proprietary by Westinghouse.

Reference 5 provided the NRC assessment of the Westinghouse claim that proprietary information was provided in a letter dated February 8, 1994, provided a copy of WCAP-13957, "AP600 Reactor Coolant System Mass Inventory: Function Based Risk Analysis." The NRC assessment was that the material was not "information that the staff customarily accepts as proprietary." In addition, the staff indicated the material was used by the staff in the development of the AP600 final safety evaluation report and therefore should remain on the docket. At the time this report was prepared, the information was considered to be proprietary by Westinghouse since it contained information that had commercial value to Westinghouse and was of the type of information that was customarily held in confidence by Westinghouse. That the material was not information that the staff customarily accepts as proprietary is not relevant to making the proprietary determination. However, in an effort to expedite the issuance of the AP600 Final Safety Evaluation Report and Final Design Approval, Westinghouse agrees to no longer consider this information to be proprietary.

In a telephone call on July 8, 1998, the staff informed Westinghouse of a concern related to WCAP-13288 and WCAP-13289, which were associated with the AP600 check valve testing specification. The concern was that the proprietary report had no proprietary information identified and the nonproprietary report had been placed in the public document room. Westinghouse has reviewed these reports and, at this time, considers none of the information to be proprietary.

This response addresses the proprietary issues delineated in the references.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

cc: J. W. Roe - NRC/NRR/DRPM
J. M. Sebrosky - NRC/NRR/DRPM
W. C. Huffman - NRC/NRR/DRPM
H. A. Sepp - Westinghouse

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