TVA-BFN-TS-418
TVA-BFN-TS-431

March 31, 2006

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop: OWFN P1-35
Washington, D.C. 20555-0001

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

BROWNS FERRY NUCLEAR PLANT (BFN) – UNITS 1, 2, AND 3 – TECHNICAL SPECIFICATIONS (TS) CHANGES NOS. TS-418 AND TS-431 - REQUEST FOR EXTENDED POWER UPRATE OPERATION - RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION OF MARCH 7, 2006, REGARDING PROBABILISTIC RISK ANALYSES (TAC NOS. MC3812, MC3743, AND MC3744)

TVA submitted the BFN Unit 1 EPU application to the NRC by letter dated June 28, 2004 (ADAMS Accession No. ML041840109). TVA submitted the BFN Units 2 and 3 EPU application to the NRC by letter dated June 25, 2004 (ML041840301).

The enclosure to this letter provides the response to the NRC request for additional information from NRC letter dated March 7, 2006 (ML060610721) regarding Probabilistic Risk Analyses (PRA).

There are no new regulatory commitments associated with this submittal. If you have any questions concerning this letter, please contact me at (256) 729-2636.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 31st day of March, 2006.

Sincerely,

Original signed by:

William D. Crouch
Manager of Licensing
and Industry Affairs

Enclosure:

Response To NRC Request For Additional Information of March 7, 2006, Regarding Probabilistic Risk Analyses

cc: See page 3.

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s:lic/submit/TechSpec/TS 418 and 431 RAI - PRA.doc

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION OF MARCH 7, 2006, REGARDING PROBABILISTIC RISK ANALYSES

TVA submitted the BFN Unit 1 EPU application to the NRC by letter dated June 28, 2004 (ADAMS Accession No. ML041840109). TVA submitted the BFN Units 2 and 3 EPU application to the NRC by letter dated June 25, 2004 (ML041840301).

The enclosure to this letter provides the response to the NRC request for additional information of March 7, 2006, (ML060610721) regarding Probabilistic Risk Analyses (PRA).

NRC Request 1[a]

In its review of the Tennessee Valley Authority (TVA) responses to the U.S. Nuclear Regulatory Commission (NRC) requests for additional information (RAIs), the NRC staff noted some inconsistencies in the information provided. For example, the response to RAI SPSB-A.7 (References 1 and 2) for all three units is not complete, based on a comparison with the response to RAI SPSB-A.20 (Unit 1), and SPSB-A.22 (Units 2 and 3).

Table SPSB-A.7-1 for Unit 1 omitted event BE_HOAL2, which is the operator action with the second-highest Fussell-Vesely importance in the response to RAI SPSB-A.20.

Table SPSB-A.7-1 for Unit 2 has different Fussell-Vesely values for operator actions that correspond to those in the Unit 2 response to RAI SPSB-A.22. Table SPSB-A.7-1 includes event HRA_OBD_1, which is not in the SPSB-A.22 table, and is missing the following events that are important in the SPSB-A.22 table:

- U1FALLHUMAN
- OHL2
- U1FHXHUMAN
- OHC3
- BEIVR10

Table SPSB-A.7-1 for Unit 3 has different Fussell-Vesely values for operator actions that correspond to those in the Unit 3 response to RAI SPSB-A.22. Table SPSB-A.7-1 includes events BEHORVD2 and BEHORVD3, which are not in the SPSB-A.22 table, and is missing the following events that are important in the SPSB-A.22 table:

- HER_HPRVD1
- OHL2
- BEIVR10

Provide the following information for all three units:

a. Corrected and complete responses to RAI SPSB-A.7.

b. Corrected and complete responses to RAI SPSB-A.20 (Unit 1) and SPSB-A.22 (Units 2 and 3).

c. A description of the quality control measures that were used to ensure completeness and accuracy of the risk information provided in the license amendment request and in the responses to the RAIs that have been submitted to date, and that were used in answering these RAIs.

TVA Response to NRC Request 1[a]

Certain Fussell-Vesely and risk achievement worth (RAW) values that were previously provided in Tables SPSP-A.7-1 (all BFN units) and Table SPSB-A.20-1 (Unit 1) have been revised because of incorrect information. Tables SPSP-A-22-1 (Units 2 and 3) are unchanged.

Three problems have been identified regarding the preparation of Tables SPSP-A.7-1 and SPSB-A.20-1:

1. Table SPSB-A.20-1 (Unit 1) was generated using the RISKMAN® software. However, a different feature of RISKMAN® was used in the generation of this table than was used for Tables SPSP-A.22-1. Importance measures can be derived in RISKMAN® either from the sequence calculation process (as was used for Tables SPSB-A.22-1) or from a database of saved sequences (used for Table SPSB-A.20-1). Either method is technically correct; however, the former method provides greater accuracy in this case. The same method should have been chosen in calculating importance measures. The values in Table SPSB-A.20-1 are also used to generate Table SPSB-A.7-1.

2. Table SPSB-A.20-1 includes event OAL, which is redundant to top event OTAF. Originally used in the event trees as a placeholder for OTAF, OAL should have been deleted.

3. The wrong PRA model was selected when analyzing the human failure events in Tables SPSB-A.7-1 for Units 2 and 3. The PRA model with a boundary condition that assumed Unit 1 was in extended layup was incorrectly used. Instead, a boundary condition assuming Unit 1 at extended power uprate should have been used, as was the case in the generation of Tables SPSB-A.22-1. The contractor's preparation of the calculation was determined to be inadequate, and TVA's checking did not identify the inconsistency.

These problems have been corrected in the following tables. The PRA models remain valid, and the conclusions previously reached are unchanged. In addition, the response previously provided to RAI SPSB-A.22 (Units 2 and 3) was verified to be correct and was unaffected by these problems. TVA initiated a problem evaluation report (PER 99716) to document this issue in BFN's Corrective Action Program.

To enhance quality control, the probabilistic risk analysis contractor prepared and issued a new procedure to identify the key analysis parameters (such as those listed above). The procedure requires that these parameters be checked for their appropriateness and applicability for the calculation being performed. The parameters explicitly noted in the calculation file are:

1. Model of Record Name,
2. Description of Model of Record,
3. Source of Importance Measures (from calculation or sequence database),
4. Appropriateness of measures used,
5. Verification of appropriate master frequency file, and
6. Verification of appropriate sequence group

In this case, the risk information was developed by a preparer, reviewed and checked, and comments were resolved. The results were then submitted to TVA BFN for submittal to the NRC. For information of this nature, a TVA technical lead reviewed the information for completeness and checked for accuracy without identifying the processing problems identified above. The Licensing organization then processed the submittal per established guidelines, including a peer review.

The issues identified are unique to the contractor's calculation process, and the new contractor procedure should ensure accuracy and completeness in the future development of such information.

Table SPSB-A.7-1
BFN Unit 1[1] Significant[2] Human Failure Events

Event Name [4]	Fussell-Vesely Importance	Risk Achievement Worth	Event Description
HER_HPRVD1	2.80E-01	1.46E+03	Operator fails to initiate depressurization
HER_HPWWV1	2.32E-01	6.31E+00	Operator fails to align wetwell vent path
HER_HRSPC1	1.35E-01	2.23E+00	Operator fails local recovery of suppression pool cooling
BE_HOU11	2.73E-02	1.41E+00	Operators fail to align the RHR X-tie
HER_HPHPE1	2.33E-02	8.39E+00	Operators fail to control level with RCIC/HPCI(early - 6 hours)
HER_HPHPR1	1.80E-02	5.58E+00	Operators fail to recover and control RCIC/HPCI after L8
BE_HPTAF1	1.40E-02	2.05E+00	Operators fail to maintain level above top of active fuel (ATWS)
BE_HOSV1	1.07E-02	1.11E+00	Operators defeat MSIV interlock during ATWS
HER_HPSPC1	1.04E-02	1.79E+03	Operators fail to align RHR for suppression pool cooling (non-ATWS)
ORVD2[3]	6.46E-03	1.04E+00	Operators fail to initiate depressurization (OHPR=F)

Notes:

(1) All table entries were taken from RISKMAN® basic event importance reports except where indicated.
Model - U1050517: Unit 1 under EPU conditions; all three units in service. Master Frequency File: L2R0.
Sequence Group: CDF

(2) RAW greater than or equal to 2.0 or Fussell-Vesely (FV) Importance greater than or equal to 5.0E-03.

(3) Event ORVD2 and corresponding RAW and FV values taken from a RISKMAN® split fraction importance report.

(4) The following event appears in the basic event importance reports, but is intentionally omitted from Table SPSB-A.7-1 for Unit 1: Event BE_HOAL2 is a redundant action.

Table SPSB-A.7-1
BFN Unit 2[1] Significant[2] Human Failure Events

Event Name [4]	Fussell-Vesely Importance	Risk Achievement Worth	Event Description
HER_HPRVD1	2.93E-01	1.56E+03	Operator fails to depressurize given HPCI/RCIC hardware failed (OHPR=S)
OPERR_OLP2	1.36E-01	1.82E+00	Operator fails to open hardened wetwell vent - AC power avail - OP action to init SPC failed
OHL2	1.25E-01	2.86E+01	Operator fails long term control of HPCI and/or RCIC given OHC=F
ORVD2 [3]	1.25E-01	1.76E+00	Operator fails to depressurize given HPCI/RCIC hardware failed (OHPR=F)
OHC1	1.15E-01	1.09E+02	Operator fails to take early action to control HPCI/RCIC injection
OPERR_OSP1	7.33E-02	9.69E+02	Operator fails to align for suppression pool cooling
OSL1 [3]	3.84E-02	3.28E+00	Operator fails to start SLC, unisolated vessel
OU11	3.63E-02	2.96E+00	Operator fails to align U1 RHR loop II thru X-tie to U2 RHR loop
OU12	2.79E-02	1.61E+00	Operator fails to align RHRSW to Unit 2 RHR loop I
OSL2 [3]	1.97E-02	1.24E+00	Operator fails to start SLC, isolated vessel
OAD1 [3]	9.74E-03	3.00E+00	Operator fails to inhibit ADS, ATWS, unisolated vessel

Table SPSB-A.7-1 BFN Unit 2[1] Significant[2] Human Failure Events			
OLA1 [3]	6.29E-03	1.08E+00	Operator fails to maintain vessel level at top of active fuel with RHR/CS
OHC3	5.39E-03	8.32E+00	Operator fails to take early action to control RCIC injection
OPERR_OLP1	1.89E-03	1.08E+02	Operator fails to manually control LPCI/CS
OPERR_OSP3	4.81E-04	8.06E+00	Operator fails to align suppression pool cooling, one RHR loop available, non-ATWS
OHC2	4.71E-03	6.13E+00	Operator fails control of HPCI for level control
OF1 [3]	3.96E-03	2.51E+00	Operator fails control of vessel level with feedwater, auto-control=S, 1 feedpump

Notes:

(1) All table entries were taken from RISKMAN® basic event importance reports except where indicated. Model - U2050530: Unit 2 under EPU conditions; all three units in service. Master Frequency File: WU1. Sequence Group: CD

(2) RAW greater than or equal to 2.0 or Fussell-Vesely (FV) Importance greater than or equal to 5.0E-03.

(3) Events ORVD2, OSL1, OSL2, OAD1, OLA1, OF1 and corresponding RAW and FV values taken from a RISKMAN® split fraction importance report.

(4) Events U1FALLHUMAN and U1FHXHUMAN are omitted. These events represent conditional failure probabilities due to previous human action failures (specifically OU12 and OU11, to split fractions U11 and U13 of Top Event U1). The human action importance is accurately captured directly through basic event OU11 and OU12. Basic Events BEIVR10 and BEIVR1 have been omitted. These basic events (i.e., Top Event IVR - Invessel Recovery) have no impact on CDF. The FV values of greater than 5.0E-03 are an artifact of the sequence truncation in RISKMAN® (e.g., disproportionate number and frequency of sequences involving failure and success of the split fraction).

Table SPSB-A.7-1 BFN Unit 3[1] Significant[2] Human Failure Events			
Event Name [4]	**Fussell-Vesely Importance**	**Risk Achievement Worth**	**Event Description**
HER_HPRVD1	1.65E-01	8.64E+02	Operator fails to depressurize given HPCI/RCIC hardware failed (OHPR=S)
OPERR_OLP2	8.92E-02	1.53E+00	Operator fails to open hardened wetwell vent - AC power avail - OP action to init suppression pool cooling failed
ORVD2 [3]	7.01E-02	1.43E+00	Operator fails to depressurize given HPCI/RCIC hardware failed (OHPR=F)
OHL2	7.01E-02	1.65E+01	Operator fails long term control of HPCI and/or RCIC given OHC=F
OHC1	6.46E-02	6.18E+01	Operator fails to take early action to control HPCI/RCIC injection
OPERR_OSP1	5.40E-02	6.72E+02	Operator fails to align for suppression pool cooling
OU12	3.39E-02	1.77E+00	Operator fails to align Unit 2 RHR loop II
OU11	3.37E-02	3.07E+00	Operator fails to align Unit 2 RHR loop I
OSL1 [3]	2.12E-02	2.28E+00	Operator fails to start SLC, unisolated vessel
OSL2 [3]	1.13E-02	1.13E+00	Operator fails to start SLC, isolated vessel
OSV1 [3]	8.31E-03	1.09E+00	Operator fails to defeat MSIV closure interlocks during ATWS
OAD1 [3]	5.46E-03	2.12E+00	Operator fails to inhibit ADS, ATWS, unisolated vessel

Table SPSB-A.7-1 BFN Unit 3[1] Significant[2] Human Failure Events			
OHC3	2.99E-03	5.06E+00	Operator fails to take early action to control RCIC injection
OHC2	2.55E-03	3.78E+00	Operator fails to take early action to control HPCI injection
OPERR_OLP1	2.20E-03	1.18E+02	Operator fails to manually control LPCI/CS
OSW1 [3]	7.84E-04	2.08E+00	Operator fails to transfer mode switch to refuel/shutdown
OPERR_OSP3	2.17E-04	4.37E+00	Operator fails to align suppression pool cooling, one RHR loop available, non-ATWS

Notes:

(1) All table entries were taken from RISKMAN® basic event importance reports except where indicated. Model - U3050531: Unit 3 under EPU conditions; all three units in service. Master Frequency File: WU1. Sequence Group: CD

(2) RAW greater than or equal to 2.0 or Fussell-Vesely (FV) Importance greater than or equal to 5.0E-03.

(3) Events ORVD2, OSL1, OSL2, OSV1, OAD1, OSW1 and corresponding RAW and FV values were taken from a RISKMAN® split fraction importance report.

(4) Basic Event BEIVR10 has been omitted. This basic event (i.e., Top Event IVR - Invessel Recovery) has no impact on CDF. The FV value of greater than 5.0E-03 is an artifact of the sequence truncation in RISKMAN® (e.g., disproportionate number and frequency of sequences involving failure and success of the split fraction).

Table SPSB-A.20-1 BFN Unit 1 Significant Basic Events by Fussell-Veseley Importance Measure			
Rank	**Basic Event**	**Description**	**Fussell-Vesely Importance**
1	HER_HPRVD1	OPERATOR FAILS TO INITIATE DEPRESSURIZATION	2.80E-01
2	HER_HPWWV1	OPERATOR FAILS TO ALIGN WETWELL VENT PATH	2.32E-01
3	CONDENSER_2A2B2C	MAIN CONDENSER UNAVAILABLE AFTER PLANT TRIP	1.47E-01
4	[MOVFO1FCV0230034 MOVFO1FCV0230040 MOVFO1FCV0230046 MOVFO1FCV0230052] (Note 1)	Common Cause: RHR Heat Exchanger FCVs FAIL TO OPEN, 4/4	1.38E-01
5	HER_HRSPC1	OPERATOR LOCAL RECOVERY OF SP COOLING FAILURE	1.35E-01
6	PTSFS1PMP0730054	HPCI PUMP FAILS TO START ON DEMAND	1.01E-01
7	PTSFR1PMP71019_6	RCIC PUMP FAILS TO RUN	1.00E-01
8	GEL_SOV_CF_PSOVS	CCF 33% OR MORE HCU SCRAM PILOT SOVs OR BACKUP SOVs FAILS	8.27E-02
9	PTSFS1PMP0710019	RCIC PUMP FAILS TO START ON DEMAND	7.49E-02
10	PTSFR1PMP73054_6	HPCI PUMP FAILS DURING OPERATION	6.39E-02
11	RHR1CCF	FAILURE OF U2 RHR PUMPS AFTER ALL U1 PUMPS HAVE FAILED	6.16E-02
12	[DGFTS_1_DG3A]	COMMON CAUSE: UNIT 3 DIESEL GENERATOR 3A FAILS TO START	5.91E-02
13	[DGFTS_1_DGA]	COMMON CAUSE: UNIT 1/2 DIESEL GENERATOR A FAILS TO START	5.29E-02
14	[MOVFO1FCV0740057 MOVFO1FCV0740059 MOVFO1FCV0740071 MOVFO1FCV0740073]	Common Cause: RHR Suppression Pool Cooling Valves FAIL TO OPEN, 4/4	4.89E-02
15	[DGFTS_1_DGA DGFTS_1_DGB DGFTS_1_DGC DGFTS_1_DGD]	COMMON CAUSE: UNIT 1/2 DIESEL GENERATORS FAIL TO START, 4/4	3.85E-02
16	[DGFTS_1_DGB]	COMMON CAUSE: UNIT 1/2 DIESEL GENERATOR B FAILS TO START	3.56E-02
17	MOVFC1FCV0710034	VALVE 1-FCV-71-34 FAILS TO CLOSE ON DEMAND	2.96E-02
18	BE_HOU11	OPERATORS ALIGN THE RHR UNIT 1/UNIT 2 CROSSTIE	2.73E-02
19	[MOVFO1FCV0710008]	Common Cause: RCIC Steam Supply, 1/2	2.72E-02
20	[MOVFO1FCV0710039]	Common Cause: HPCI RCIC Pump Discharge MOV failure, 1/2	2.72E-02
21	[MOVFO1FCV0740073]	Common Cause: RHR Suppression Pool Cooling Valves, 1/4	2.48E-02
22	[MOVFO1FCV0740071]	Common Cause: RHR Suppression Pool Cooling Valves, 1/4	2.48E-02
23	PTSFS1CCF_RCIHPI	RCIC AND HPCI PUMPS COMMON CASUE FAILURE TO START	2.38E-02
24	HER_HPHPE1	OPERATOR FAILS TO CONTROL LEVEL WITH RCIC/HPCI (EARLY - 6 HOURS)	2.33E-02
25	MOVFO1FCV0730036	MOV 1-FCV-73-36 FAILS TO OPEN ON DEMAND	2.03E-02
26	[MOVXC1FCV0730036]	Common Cause: HPCI RCIC Return Lines MOVs 1/4	1.86E-02
27	MOVFO1FCV0730027	MOV 1-FCV-73-27 FAILS TO OPEN ON DEMAND	1.81E-02
28	MOVFO1FCV0730035	MOV 1-FCV-73-35 FAILS TO OPEN ON DEMAND	1.81E-02
29	MOVFO1FCV0730026	MOV 1-FCV-73-26 FAILS TO OPEN ON DEMAND	1.81E-02
30	MOVFC1FCV0730040	MOV 1-FCV-73-40 FAILS TO CLOSE ON DEMAND	1.81E-02
31	HER_HPHPR1	OPERATORS FAIL TO RECOVER AND CONTROL HPCI/RCIC AFTER L8	1.80E-02
32	[DGFTS_1_DGC]	DG C FAILS TO START; DG C FAILS TO RUN; DG C BREAKER 1818 FAILS	1.78E-02
33	PTSFR1PM73054_18	TURBINE DRIVEN PUMP FAILS TO RUN	1.69E-02
34	PTSFR1CCF_RCIHPI	RCIC AND HPCI PUMPS COMMON CAUSE FAILURE TO RUN	1.69E-02

Table SPSB-A.20-1 BFN Unit 1 Significant Basic Events by Fussell-Veseley Importance Measure			
Rank	**Basic Event**	**Description**	**Fussell-Vesely Importance**
35	[MOVFO1FCV0730016]	Common Cause: RCIC Steam Supply, 1/2	1.66E-02
36	[MOVFO1FCV0730044]	Common Cause: HPCI RCIC Pump Discharge MOV failure, 1/2	1.66E-02
37	[MOVXC1FCV0730035]	Common Cause: HPCI RCIC Return Lines MOVs 1/4	1.66E-02
38	[MOVFO1FCV0710008 MOVFO1FCV0730016]	Common Cause: RCIC Steam Supply, 2/2	1.64E-02
39	[MOVFO1FCV0710039 MOVFO1FCV0730044]	Common Cause: HPCI RCIC Pump Discharge MOV failure, 2/2	1.64E-02
40	PTSFR1PM71019_18	TURBINE DRIVEN PUMP FAILS TO RUN FOR 18 HOURS	1.50E-02
41	[MOVFO1FCV0230034]	Common Cause: RHR Heat Exchanger MOVs, 1/4	1.47E-02
42	BE_HPTAF1	OPERATORS LOWER LEVEL TO TAF AND TERMINATE MOST INJECTION UNISOL	1.40E-02
43	[PMSFS1PMP074001B]	Common Cause: RHR Pumps Fail to Start, 1/4	1.40E-02
44	[DGFTS_1_DGA DGFTS_1_DGB DGFTS_1_DGC]	Common Cause: Unit 1/2 Diesel Generators, 3/4	1.40E-02
45	[MOVFO1FCV0740059]	Common Cause: RHR Suppression Pool Cooling Valves, 1/4	1.33E-02
46	[MOVFO1FCV0740057]	Common Cause: RHR Suppression Pool Cooling Valves, 1/4	1.33E-02
47	[MOVFO1FCV0710034 MOVXC1FCV0710038 MOVXC1FCV0730035 MOVXC1FCV0730036]	MOV FAILURES RESULT IN FAIURE OF BOTH HPCI AND RCIC	1.27E-02
48	GEL_ROD_CF_CRD	CCF 33% OR MORE RODS FAIL TO INSERT	1.21E-02
49	BE_HOAL2	LOWER & CONTROL LEVEL DURING ATWS (UNISOLATED RPV)	1.10E-02
50	[MOVFO1FCV0740059 MOVFO1FCV0740071]	Common Cause: RHR Suppression Pool Cooling Valves, 2/4	1.09E-02
51	[MOVFO1FCV0740059 MOVFO1FCV0740073]	Common Cause: RHR Suppression Pool Cooling Valves, 2/4	1.09E-02
52	[MOVFO1FCV0740057 MOVFO1FCV0740071]	Common Cause: RHR Suppression Pool Cooling Valves, 2/4	1.09E-02
53	[MOVFO1FCV0740057 MOVFO1FCV0740073]	Common Cause: RHR Suppression Pool Cooling Valves, 2/4	1.09E-02
54	BE_HOSV1	OPERATORS DEFEAT MSIV INTERLOCK DURING ATWS	1.07E-02
55	HER_HPSPC1	OPERATOR FAILS TO ALIGN RHR FOR SUPPRESSION POOL COOLING (NON-ATWS)	1.04E-02
56	[DGFTS_1_DG3B]	COMMON CAUSE: UNIT 3 DG 3B FAILS TO START	9.77E-03
57	TBSFDST	TURBINE BYPASS SYSTEM UNAVAILABLE FOR SHORT TERM PRESSURE RELIEF	9.22E-03
58	BE_FRACT7	A MULTI UNIT INITIATOR AND U2 @ POWER	8.02E-03
59	FLTPL1___032AFLT	AFTERFILTER PLUGS	7.09E-03
60	FLTPL1__032PRFLT	PREFILTER PLUGS	7.09E-03
61	AOVFO1FCV0640222	FCV 64-222 FAILS TO OPEN ON DEMAND	6.70E-03
62	AOVFO1FCV0640221	FCV 64-221 FAILS TO OPEN ON DEMAND	6.70E-03
63	[FN2FR1ROOM74001A FN2FR1ROOM74001B FN2FR1ROOM74001C FN2FR1ROOM74001D]	Common Cause: RHR Room Coolers Fail to Run, 4/4	6.68E-03
64	GEL_ACC_CF_HCU	CCF 335 OR MORE HCU ACCUMULATORS FAIL	5.19E-03
65	SWYARD	OFFSITE GRID AND SWITCH YARD FAILURE	5.07E-03

Note 1: Basic events names in brackets indicate a common cause failure event.

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
1	GEL_SOV_CF_PSOVS	CCF 33% OR MORE HCU SCRAM PILOT SOVs OR BACKUP SOVs FAILS	4.79E+04
2	GEL_ACC_CF_HCU	CCF 335 OR MORE HCU ACCUMULATORS FAIL	4.79E+04
3	GEL_AOV_CF_HCU	CCF 33% OR MORE HCU SCRAM INLET/OUTLET AOVS FAIL TO OPEN	4.79E+04
4	GEL_ROD_CF_CRD	CCF 33% OR MORE RODS FAIL TO INSERT	4.79E+04
5	[PMSFR1PMP074001A PMSFR1PMP074001B PMSFR1PMP074001C PMSFR1PMP074001D] **Note 1**	Common Cause: Group RHR Pumps Fail to Run, 4/4	2.61E+03
6	[FN2FR1ROOM74001A FN2FR1ROOM74001B FN2FR1ROOM74001C FN2FR1ROOM74001D]	Common Cause: RHR Room Coolers Fail to Run, 4/4	2.61E+03
7	[PMSFS1PMP074001A PMSFS1PMP074001B PMSFS1PMP074001C PMSFS1PMP074001D]	Common Cause: Group RHR Pumps Fail to Start, 4/4	2.61E+03
8	[FN2FS1ROOM74001A FN2FS1ROOM74001B FN2FS1ROOM74001C FN2FS1ROOM74001D]	Common Cause: Group RHR Pump Room Coolers Fail to Start, 4/4	2.61E+03
9	HER_HPSPC1	OPERATOR FAILS TO ALIGN RHR FOR SUPPRESSION POOL COOLING (NON-ATWS)	1.79E+03
10	HER_HPRVD1	OPERATOR FAILS TO INITIATE DEPRESSURIZATION	1.46E+03
11	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 6/6	1.21E+03
12	[RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 5/6	1.21E+03
13	[RV2FO1PCV0010005 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 5/6	1.21E+03
14	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 5/6	1.21E+03
15	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 5/6	1.21E+03
16	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010034]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 5/6	1.21E+03
17	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group Safety Relief Valves Fail to Depressurize, 5/6	1.21E+03
18	[FN2FS1ROOM74001A FN2FS1ROOM74001B FN2FS1ROOM74001C]	Common Cause: Group RHR Pump Room Coolers Fail to Start, 3/4	1.20E+03
19	[PMSFS1PMP074001A PMSFS1PMP074001B PMSFS1PMP074001C]	Common Cause: Group RHR Pumps Fail to Start, 3/4	1.20E+03

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
20	[FN2FR1ROOM74001A FN2FR1ROOM74001B FN2FR1ROOM74001C]	Common Cause: Group RHR Room Coolers Fail to Run, 3/4	1.20E+03
21	[PMSFR1PMP074001A PMSFR1PMP074001B PMSFR1PMP074001C]	Common Cause: Group RHR Pumps Fail to Run, 3/4	1.20E+03
22	[MOVFO1FCV0230034 MOVFO1FCV0230040 MOVFO1FCV0230046 MOVFO1FCV0230052]	Common Cause: Group RHR Heat Exchangers, 4/4	9.48E+02
23	SWCS	CCF (FAILURE TO START) OF ALL RHRSW PUMP	6.08E+02
24	SWCR	CCF (FAILURE TO RUN) OF ALL RHRSW TRAINS	6.08E+02
25	FCOFTO_DGABCD	MOTOR OPERATED VENT. DAMPERS FAIL TO OPEN OR FANS FAIL TO START	2.80E+02
26	[DGFTS_1_DGA DGFTS_1_DGB DGFTS_1_DGC DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 4/4	2.80E+02
27	[MOVFO1FCV0740057 MOVFO1FCV0740059 MOVFO1FCV0740071 MOVFO1FCV0740073]	Common Cause: Group RHR Suppression Pool Cooling Valves, 4/4	2.10E+02
28	[MOVFO1FCV0740059 MOVFO1FCV0740071]	Common Cause: Group RHR Suppression Pool Cooling Valves, 2/4	2.10E+02
29	[MOVFO1FCV0740059 MOVFO1FCV0740073]	Common Cause: Group RHR Suppression Pool Cooling Valves, 2/4	2.10E+02
30	[MOVFO1FCV0740057 MOVFO1FCV0740071]	Common Cause: Group RHR Suppression Pool Cooling Valves, 2/4	2.10E+02
31	[MOVFO1FCV0740057 MOVFO1FCV0740073]	Common Cause: Group RHR Suppression Pool Cooling Valves, 2/4	2.10E+02
32	[RL1FD1___0010K14 RL1FD1___0010K16 RL1FD1___0010K51 RL1FD1___0010K52]	Common Cause: Group Relays for MSIV Closure, 4/4	1.39E+02
33	[RL1FD1___0010K16 RL1FD1___0010K51 RL1FD1___0010K52]	Common Cause: Group Relays for MSIV Closure, 3/4	1.39E+02
34	[RL1FD1___0010K14 RL1FD1___0010K16 RL1FD1___0010K51]	Common Cause: Group Relays for MSIV Closure, 3/4	1.39E+02
35	[RL1FD1___0010K51 RL1FD1___0010K52]	Common Cause: Group Relays for MSIV Closure, 2/4	1.39E+02
36	[RL1FD1___0010K14 RL1FD1___0010K51 RL1FD1___0010K52]	Common Cause: Group Relays for MSIV Closure, 3/4	1.39E+02
37	[RL1FD1___0010K14 RL1FD1___0010K16 RL1FD1___0010K52]	Common Cause: Group Relays for MSIV Closure, 3/4	1.39E+02
38	[RL1FD1___0010K14 RL1FD1___0010K16]	Common Cause: Group Relays for MSIV Closure, 2/4	1.39E+02
39	[RL1FD1___0010K14 RL1FD1___0010K52]	Common Cause: Group Relays for MSIV Closure, 2/4	1.39E+02
40	[AOVFC1FCV0010037 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 2/8	1.39E+02
41	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
42	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010051]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
43	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
44	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010037]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
45	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010027]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
46	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010026 AOVFC1FCV0010027 AOVFC1FCV0010037 AOVFC1FCV0010038 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 8/8	1.39E+02
47	[AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 2/8	1.39E+02
48	[AOVFC1FCV0010037 AOVFC1FCV0010038 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
49	[AOVFC1FCV0010037 AOVFC1FCV0010038 AOVFC1FCV0010051]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
50	[AOVFC1FCV0010038 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
51	[AOVFC1FCV0010037 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
52	[AOVFC1FCV0010027 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
53	[AOVFC1FCV0010014 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
54	[AOVFC1FCV0010015 AOVFC1FCV0010026 AOVFC1FCV0010027]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
55	[AOVFC1FCV0010026 AOVFC1FCV0010027]	Common Cause: MSIVS FAIL TO CLOSE, 2/8	1.39E+02
56	[AOVFC1FCV0010014 AOVFC1FCV0010037 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
57	[AOVFC1FCV0010027 AOVFC1FCV0010037 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
58	[AOVFC1FCV0010026 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
59	[AOVFC1FCV0010026 AOVFC1FCV0010027 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
60	[AOVFC1FCV0010026 AOVFC1FCV0010037 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
61	[AOVFC1FCV0010015 AOVFC1FCV0010037 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
62	[AOVFC1FCV0010015 AOVFC1FCV0010051 AOVFC1FCV0010052]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
63	[AOVFC1FCV0010026 AOVFC1FCV0010027 AOVFC1FCV0010038]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
64	[AOVFC1FCV0010026 AOVFC1FCV0010027 AOVFC1FCV0010037]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
65	[AOVFC1FCV0010014 AOVFC1FCV0010015]	Common Cause: MSIVS FAIL TO CLOSE, 2/8	1.39E+02
66	[RL1FD1___0010K16 RL1FD1___0010K51]	Common Cause: Group Relays for MSIV Closure, 2/4	1.39E+02
67	[AOVFC1FCV0010014 AOVFC1FCV0010015 AOVFC1FCV0010026]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
68	[AOVFC1FCV0010014 AOVFC1FCV0010026 AOVFC1FCV0010027]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02
69	[AOVFC1FCV0010026 AOVFC1FCV0010027 AOVFC1FCV0010051]	Common Cause: MSIVS FAIL TO CLOSE, 3/8	1.39E+02

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
70	[DGFTS_1_DGA DGFTS_1_DGB DGFTS_1_DGC]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 3/4	1.18E+02
71	[MOVFO1FCV0230034 MOVFO1FCV0230040 MOVFO1FCV0230046]	Common Cause: Group RHR Heat Exchangers MOVs, 3/4	1.01E+02
72	[PMSFR2___02300B1 PMSFR2___02300B2 PMSFR2___02300D1 PMSFR2___02300D2]	Common Cause: Group South Service Water Header RHRSW Pumps, 4/4	8.98E+01
73	[PMSFS2___02300B1 PMSFS2___02300B2 PMSFS2___02300D1 PMSFS2___02300D2]	Common Cause: Group South Service Water Header RHRSW Pumps 4/4	8.98E+01
74	[FN2FS1ROOM74001A FN2FS1ROOM74001C FN2FS1ROOM74001D]	Common Cause: Group RHR Pump Room Coolers Fail to Start, 3/4	7.19E+01
75	[PMSFS1PMP074001A PMSFS1PMP074001C PMSFS1PMP074001D]	Common Cause: Group RHR Pumps Fail to Start, 3/4	7.07E+01
76	[FN2FR1ROOM74001A FN2FR1ROOM74001C FN2FR1ROOM74001D]	Common Cause: RHR Room Coolers Fail to Run, 3/4	6.98E+01
77	[PMSFR1PMP074001A PMSFR1PMP074001C PMSFR1PMP074001D]	Common Cause: Group RHR Pumps Fail to Run, 3/4	6.86E+01
78	[FN2FS1ROOM74001A FN2FS1ROOM74001B FN2FS1ROOM74001D]	Common Cause: Group RHR Pump Room Coolers Fail to Start, 3/4	6.54E+01
79	[PMSFS1PMP074001A PMSFS1PMP074001B PMSFS1PMP074001D]	Common Cause: Group RHR Pumps Fail to Start, 3/4	6.42E+01
80	[FN2FS1ROOM74001B FN2FS1ROOM74001C FN2FS1ROOM74001D]	Common Cause: Group RHR Pump Room Coolers Fail to Start, 3/4	6.38E+01
81	[FN2FR1ROOM74001A FN2FR1ROOM74001B FN2FR1ROOM74001D]	Common Cause: RHR Room Coolers Fail to Run, 3/4	6.33E+01
82	[PMSFS1PMP074001B PMSFS1PMP074001C PMSFS1PMP074001D]	Common Cause: Group RHR Pumps Fail to Start, 3/4	6.26E+01
83	[PMSFR1PMP074001A PMSFR1PMP074001B PMSFR1PMP074001D]	Common Cause: Group RHR Pumps Fail to Run, 3/4	6.21E+01
84	[FN2FR1ROOM74001B FN2FR1ROOM74001C FN2FR1ROOM74001D]	Common Cause: Group RHR Room Coolers Fail to Run, 3/4	6.17E+01
85	[PMSFR1PMP074001B PMSFR1PMP074001C PMSFR1PMP074001D]	Common Cause: Group RHR Pumps Fail to Run, 3/4	6.05E+01
86	[CB1FO0BKR0571614 CB1FO0BKR0571616 CB1FO0BKR0571718]	Common Cause: BREAKERS FAIL TO OPEN, 3/4	5.11E+01
87	[CB1FO0BKR0571614 CB1FO0BKR0571616 CB1FO0BKR0571718 CB1FO0BKR0571724]	Common Cause: BREAKERS FAIL TO OPEN, 4/4	5.11E+01
88	HOVXC1HCV0740085	HCV-74-85 TRANSFERS CLOSED	5.09E+01
89	HOVXC1HCV0670565	VALVE 67-565 TRANSFERS CLOSED	5.09E+01
90	[FN2FS1ROOM74001A FN2FS1ROOM74001C]	Common Cause: Group RHR Pump Room Coolers Fail to Start, 2/4	4.92E+01
91	MOVXC1FCV0740007	FCV-74-7 TRANSFERS CLOSED	4.86E+01
92	[PMSFS1PMP074001A PMSFS1PMP074001C]	Common Cause: Group RHR Pumps Fail to Start, 2/4	4.84E+01

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
93	PTSFS1CCF_RCIHPI	RCIC AND HPCI PUMPS COMMON CASUE FAILURE TO START	4.82E+01
94	[MOVFO1FCV0710008 MOVFO1FCV0730016]	Common Cause: Group RCIC Steam Supply, 2/2	4.82E+01
95	[MOVFO1FCV0710039 MOVFO1FCV0730044]	Common Cause: Group HPCI RCIC Pump Discharge MOV failure, 2/2	4.82E+01
96	[MOVFO1FCV0710034 MOVXC1FCV0730035 MOVXC1FCV0730036]	Common Cause: Group HPCI RCIC Return Lines MOVs, 3/4	4.82E+01
97	[MOVFO1FCV0710034 MOVXC1FCV0710038 MOVXC1FCV0730035]	Common Cause: Group MOVFO, 3/4	4.82E+01
98	[MOVFO1FCV0710034 MOVXC1FCV0710038 MOVXC1FCV0730035 MOVXC1FCV0730036]	MOV FAILURES RESULT IN FAIURE OF BOTH HPCI AND RCIC	4.82E+01
99	[RL11RLY23A_K25 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 2/4	4.82E+01
100	[RL1FD123A_K21 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 2/4	4.82E+01
101	[RL11RLY23A_K25 RL1FD123A_K21 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 3/4	4.82E+01
102	[RL11RLY23A_K25 RL1FD123A_K22 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 3/4	4.82E+01
103	[RL1FD123A_K21 RL1FD123A_K22 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 3/4	4.82E+01
104	[RL11RLY23A_K25 RL1FD123A_K21 RL1FD123A_K22 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 4/4	4.82E+01
105	PTSFR1CCF_RCIHPI	RCIC AND HPCI PUMPS COMMON CAUSE FAILURE TO RUN	4.82E+01
106	[MOVFO1FCV0710034 MOVXC1FCV0710038 MOVXC1FCV0730036]	Common Cause: Group HPCI RCIC Return Lines MOVs 3/4	4.82E+01
107	[MOVFO1FCV0710034 MOVXC1FCV0730036]	Common Cause: Group HPCI RCIC Return Lines MOVs 2/4	4.82E+01
108	[RL1FD123A_K22 RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 2/4	4.82E+01
109	ECCS_SUPPLY_TRAN	INSUFFICIENT FLOW TO ECCS SUCTION RING HEADER DURING TRANSIENT	3.73E+01
110	ECCS_SUPPLY_LOST	INSUFFICIENT FLOW AVAILABLE TO RING HEADER DURING LOCA	3.70E+01
111	PRESS_SPRES_LOST	PSP FAILS TO QUENCH STEAM DURING LOCA BLOWDOWN	3.70E+01
112	[PMSFR1PMP074001A PMSFR1PMP074001C]	Common Cause: Group RHR Pumps Fail to Run, 2/4	3.67E+01
113	[FN2FR1ROOM74001A FN2FR1ROOM74001C]	Common Cause: FAN COOLERS FAIL TO RUN, 2/4	3.67E+01
114	[MOVFO1FCV0230034 MOVFO1FCV0230040 MOVFO1FCV0230052]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 3/4	3.48E+01
115	[FN2FR1FAN098601 FN2FR1FAN098602]	Common Cause: FAN COOLERS FAIL TO RUN, 2/2	3.38E+01
116	[FN2FS1ROOM74001A FN2FS1ROOM74001B]	Common Cause: FAN COOLERS FAIL TO START, 2/4	3.06E+01

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
117	[PMSFS1PMP074001A PMSFS1PMP074001B]	Common Cause: Group RHR Pumps Fail to Start, 2/4	3.02E+01
118	[FN2FR1ROOM74001A FN2FR1ROOM74001B]	Common Cause: FAN COOLERS FAIL TO RUN, 2/4	2.96E+01
119	[PMSFR1PMP074001A PMSFR1PMP074001B]	Common Cause: Group RHR Pumps Fail to Run, 2/4	2.96E+01
120	[FN2FS1ROOM74001B FN2FS1ROOM74001C]	Common Cause: FAN COOLERS FAIL TO START, 2/4	2.91E+01
121	[PMSFS1PMP074001B PMSFS1PMP074001C]	Common Cause: Group RHR Pumps Fail to Start, 2/4	2.87E+01
122	[FN2FR1ROOM74001B FN2FR1ROOM74001C]	Common Cause: FAN COOLERS FAIL TO RUN, 2/4	2.81E+01
123	[PMSFR1PMP074001B PMSFR1PMP074001C]	Common Cause: Group RHR Pumps Fail to Run, 2/4	2.81E+01
124	[DGFTS_1_DGA DGFTS_1_DGB DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 3/4	2.64E+01
125	[MOVFO1FCV0230034 MOVFO1FCV0230040]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 2/4	2.63E+01
126	HOVXC1HCV0740088	HCV-74-88 TRANSFERS CLOSED	2.37E+01
127	HOVXC1HCV0670606	VALVE 67-606 TRANSFERS CLOSED	2.32E+01
128	BUSFR1BUS057___1	BATTERY BD. 1 FAILS.	2.32E+01
129	MOVXC1FCV0740030	FCV-74-30 TRANSFERS CLOSED	2.27E+01
130	[FN2FS1ROOM74001B FN2FS1ROOM74001D]	Common Cause: FAN COOLERS FAIL TO START, 2/4	2.26E+01
131	[PMSFS1PMP074001B PMSFS1PMP074001D]	Common Cause: Group RHR Pumps Fail to Start, 2/4	2.22E+01
132	[RL1FD1___00358A2 RL1FD1___00358B2 RL1FD1___00358C2 RL1FD1___00358D2]	Common Cause: Group Low RX Level Output Relays, 4/4	2.15E+01
133	[RL1FD114A0750K7A RL1FD114A0750K7B]	Common Cause: Group Low RX Level Logic Relay (CSS), 2/4	2.15E+01
134	[RL1FD1___00358B2 RL1FD1___00358C2 RL1FD1___00358D2]	Common Cause: Group Low RX Level Output Relays, 3/4	2.15E+01
135	[RL1FD1___00358A2 RL1FD1___00358C2 RL1FD1___00358D2]	Common Cause: Group Low RX Level Output Relays, 3/4	2.15E+01
136	[RL1FD1___00358A2 RL1FD1___00358C2]	Common Cause: Group Low RX Level Output Relays, 2/4	2.15E+01
137	[RL1FD1___00358B2 RL1FD1___00358D2]	Common Cause: Group Low RX Level Output Relays, 2/4	2.15E+01
138	[RL1FD1___00358A2 RL1FD1___00358B2 RL1FD1___00358D2]	Common Cause: Group Low RX Level Output Relays, 3/4	2.15E+01
139	[RL1FD1___00358A2 RL1FD1___00358B2 RL1FD1___00358C2]	Common Cause: Group Low RX Level Output Relays, 3/4	2.15E+01
140	[RL1FD110A0740K7A RL1FD110A0740K7B RL1FD110A0740K8A RL1FD110A0740K8B]	Common Cause: Group RELAY3, 4/4	2.15E+01
141	[RL1FD110A074K36A RL1FD110A074K36B]	Common Cause: Group RELAY4, 2/2	2.15E+01
142	[SWDFD1_LS003058A SWDFD1_LS003058B SWDFD1_LS003058C SWDFD1_LS003058D]	Common Cause: Group Low RX Level Bistables, 4/4	2.15E+01
143	[SWDFD1_LS003058B SWDFD1_LS003058C SWDFD1_LS003058D]	Common Cause: Group Low RX Level Bistables, 3/4	2.15E+01
144	[SWDFD1_LS003058A SWDFD1_LS003058B SWDFD1_LS003058C]	Common Cause: Group Low RX Level Bistables, 3/4	2.15E+01

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
145	[SWDFD1_LS003058A SWDFD1_LS003058C SWDFD1_LS003058D]	Common Cause: Group Low RX Level Bistables, 3/4	2.15E+01
146	[SWDFD1_LS003058A SWDFD1_LS003058B SWDFD1_LS003058D]	Common Cause: Group Low RX Level Bistables, 3/4	2.15E+01
147	[RL1FD110A0740K7A RL1FD110A0740K8A RL1FD110A0740K8B]	Common Cause: Group Low RX Level Logic Relay (RHR), 3/4	2.15E+01
148	[RL1FD110A0740K7B RL1FD110A0740K8A RL1FD110A0740K8B]	Common Cause: Group Low RX Level Logic Relay (RHR), 3/4	2.15E+01
149	[RL1FD110A0740K7A RL1FD110A0740K7B]	Common Cause: Group Low RX Level Logic Relay (RHR), 2/4	2.15E+01
150	[RL1FD110A0740K7A RL1FD110A0740K7B RL1FD110A0740K8A]	Common Cause: Group Low RX Level Logic Relay (RHR), 3/4	2.15E+01
151	[RL1FD110A0740K7A RL1FD110A0740K7B RL1FD110A0740K8B]	Common Cause: Group Low RX Level Logic Relay (RHR), 3/4	2.15E+01
152	[RL1FD110A0740K8A RL1FD110A0740K8B]	Common Cause: Group Low RX Level Logic Relay (RHR), 2/4	2.15E+01
153	[SWDFD1_LS003058B SWDFD1_LS003058D]	Common Cause: Group Low RX Level Bistables, 2/4	2.15E+01
154	[SWDFD1_LS003058A SWDFD1_LS003058C]	Common Cause: Group Low RX Level Bistables, 2/4	2.15E+01
155	[RL1FD114A0750K7B RL1FD114A0750K8A RL1FD114A0750K8B]	Common Cause: Group Low RX Level Logic Relay (CSS), 3/4	2.15E+01
156	[RL1FD114A0750K7A RL1FD114A0750K7B RL1FD114A0750K8A RL1FD114A0750K8B]	Common Cause: Group Low RX Level Logic Relay (CSS), 4/4	2.15E+01
157	[RL1FD114A0750K8A RL1FD114A0750K8B]	Common Cause: Group Low RX Level Logic Relay (CSS), 2/4	2.15E+01
158	[RL1FD114A0750K7A RL1FD114A0750K7B RL1FD114A0750K8A]	Common Cause: Group Low RX Level Logic Relay (CSS), 3/4	2.15E+01
159	[RL1FD114A0750K7A RL1FD114A0750K7B RL1FD114A0750K8B]	Common Cause: Group Low RX Level Logic Relay (CSS), 3/4	2.15E+01
160	[RL1FD114A0750K7A RL1FD114A0750K8A RL1FD114A0750K8B]	Common Cause: Group Low RX Level Logic Relay (CSS), 3/4	2.15E+01
161	PMOFR3___027__CC	LOSS OF ALL UNIT 3 CCW PUMPS	2.05E+01
162	HOVXC2___0240500	UNIT 1 CCW INTAKE VALVE 2-24-500 TRANSFER CLOSED	2.05E+01
163	HOVXC1___0240504	CROSSTIE VALVE 1-24-504 TRANSFER CLOSED	2.05E+01
164	HOVXC1___0240500	UNIT 1 CCW INTAKE VALVE 1-24-500 TRANSFER CLOSED	2.05E+01
165	HOVXC2___0240521	RCW HEADER ISOLATION VALVE 2-24-521 TRANSFER CLOSED	2.05E+01
166	HOVXC2___0240524	RCW HEADER ISOLATION VALVE 2-24-524 TRANSFER CLOSED	2.05E+01
167	[PMOFR1___024001A PMOFR1___024001B PMOFR2___024002A PMOFR2___024002B PMOFR2___024002C PMOFR3___024003A PMOFR3___024003B]	Common Cause: Group PMPRUN, 7/7	2.05E+01
168	HOVXC3___0240500	UNIT 3 CCW INTAKE VALVE 3-24-500 TRANSFER CLOSED	2.05E+01
169	HOVXC2___0240594	RCW HEADER ISOLATION VALVE 2-24-594 TRANSFER CLOSED	2.05E+01
170	HOVXC2___0240515	CROSSTIE VALVE 2-24-515 TRANSFER CLOSED	2.05E+01

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
171	PMOFR1___027__CC	LOSS OF ALL UNIT 1 CCW PUMPS	2.05E+01
172	PMOFR2___027__CC	LOSS OF ALL UNIT 2 CCW PUMPS	2.05E+01
173	[CB1FO0BKR0571614 CB1FO0BKR0571616 CB1FO0BKR0571724]	Common Cause: BREAKERS FAIL TO OPEN, 3/4	1.87E+01
174	[CB1FO0BKR0571614 CB1FO0BKR0571616]	Common Cause: BREAKERS FAIL TO OPEN, 2/4	1.87E+01
175	[DGFTS_1_DGA DGFTS_1_DGC DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 3/4	1.82E+01
176	[PMSFR2___02300B1 PMSFR2___02300B2 PMSFR2___02300D2]	Common Cause: Group South Service Water Header RHRSW Pumps, 3/4	1.81E+01
177	[PMSFS2___02300B1 PMSFS2___02300B2 PMSFS2___02300D2]	Common Cause: Group South Service Water Header RHRSW Pumps 3/4	1.81E+01
178	[DGFTS_1_DGB DGFTS_1_DGC DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 3/4	1.77E+01
179	DIMFR1___002CODM	INSUFF FLOW THRU DEMIN FLOW PATH	1.77E+01
180	COVLK1___0020558	COND BOOSTER PUMP B DISCH CHECK VALVE 2-558 GROSS REVERSE LEAKAG	1.77E+01
181	[PMOFR1CBP002002A PMOFR1CBP002002B PMOFR1CBP002002C]	Common Cause: Group GROUP2, 3/3	1.77E+01
182	MOVXC1FCV0020041	OUTLET VALVE FCV 2-41 TRANSFERS CLOSED	1.77E+01
183	COVFT1___0020558	CONDENSATE BOOSTER PUMP B DISCH CHECK VALVE 2-558 FAILS TO RESEA	1.77E+01
184	COVLK1___0020517	CONDENSATE PUMP B DISCH CHECK VALVE 2-517 GROSS REVERSE LEAKAGE	1.77E+01
185	COVFT1___0020517	CONDENSATE PUMP B DISCH CHECK VALVE 2-517 FAILS TO RESEAT	1.77E+01
186	[PMOFR1_CP002002A PMOFR1_CP002002B PMOFR1_CP002002C]	Common Cause: Group GROUP1, 3/3	1.77E+01
187	MOVXC1FCV0020036	INLET VALVE FCV2-36 TRANSFERS CLOSED	1.77E+01
188	HXRPL1___002OFGA	EXCESSIVE LEAKAGE/RUPTURE OF OFF-GAS CONDENSER	1.77E+01
189	HXRPL1___002SJAE	EXCESSIVE LEAKAGE/RUPTURE (SJAE)	1.77E+01
190	HXRPL1___002EXHA	EXCESSIVE LEAKAGE/RUPTURE OF STEAM PACKING EXHAUSTER	1.77E+01
191	[DGFTS_1_DG3A DGFTS_1_DG3B DGFTS_1_DG3C DGFTS_1_DG3D]	Common Cause: UNIT 3 DIESELS FAIL TO START, 4/4	1.75E+01
192	FCOFTO_1_DG3ABCD	MOTOR OPERATED VENT. DAMPERS FAIL TO OPEN OR FANS FAIL TO START	1.75E+01
193	[DGFTS_1_DGA DGFTS_1_DGB]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 2/4	1.68E+01
194	[PMSFR2___02300B1 PMSFR2___02300B2 PMSFR2___02300D1]	Common Cause: Group PMR, 3/4	1.63E+01
195	[PMSFS2___02300B1 PMSFS2___02300B2 PMSFS2___02300D1]	Common Cause: Group South Service Water Header RHRSW Pumps 3/4	1.63E+01
196	SWYARD	OFFSITE GRID AND SWITCH YARD FAILURE	1.62E+01
197	COVFT1___0020526	CONDENSATE PUMP C DISCH CHECK VALVE 2-526 FAILS TO RESEAT	1.56E+01
198	COVFT1___0020550	CONDENSATE BOOSTER PUMP C DISCH CHECK VALVE 2-550 FAILS TO RESEA	1.56E+01

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
199	COVLK1___0020550	COND BOOSTER PUMP C DISCH CHECK VALVE 2-550 GROSS REVERSE LEAKAG	1.56E+01
200	COVLK1___0020526	CONDENSATE PUMP C DISCH CHECK VALVE 2-526 GROSS REVERSE LEAKAGE	1.56E+01
201	BUSFR0SHUTDNBRDA	SHUTDOWN BOARD A BUS FAULT	1.47E+01
202	E1VFD1FCV0470067	MASTER TRIP VALVE FCV 47-67 FAIL TO OPERATE ON DEMAND	1.42E+01
203	[MOVFO1FCV0230034 MOVFO1FCV0230046 MOVFO1FCV0230052]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 3/4	1.42E+01
204	[DGFTS_1_DG3A DGFTS_1_DG3B DGFTS_1_DG3C]	Common Cause: UNIT 3 DIESELS FAIL TO START, 3/4	1.27E+01
205	HOVXC1HCV0740033	HCV-74-33 TRANSFERS CLOSED	1.09E+01
206	HOVXC1ISV0670610	VALVE 67-610 TRANSFERS CLOSED	1.09E+01
207	HOVXC1HCV0670603	VALVE 67-603 TRANSFERS CLOSED	1.09E+01
208	HOVXC1ISV0670609	VALVE 67-609 TRANSFERS CLOSED	1.09E+01
209	HOVXC1ISV0670602	VALVE 67-602 TRANSFERS CLOSED	1.09E+01
210	HOVXC1ISV0670605	VALVE 67-605 TRANSFERS CLOSED	1.09E+01
211	HOVXC1HCV0740089	HCV-74-89 TRANSFERS CLOSED	1.09E+01
212	[PMSFR2___02300B1 PMSFR2___02300B2]	Common Cause: Group PMR, 2/4	1.08E+01
213	[PMSFS2___02300B1 PMSFS2___02300B2]	Common Cause: Group South Service Water Header RHRSW Pumps 2/4	1.08E+01
214	[MOVFO1FCV0230040 MOVFO1FCV0230046 MOVFO1FCV0230052]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 3/4	1.07E+01
215	MOVXC1FCV0740024	FCV-74-24 TRANSFERS CLOSED	1.06E+01
216	CKVFO1CKV074559B	CHECK VALVE 74-559B FAILS TO OPEN ON DEMAND	1.05E+01
217	CKVFO1CKV074560B	CHECK VALVE 74-560B FAILS TO OPEN ON DEMAND	1.05E+01
218	[FN2FS1ROOM74001B]	Common Cause: FAN COOLERS FAIL TO START, 1/4	1.05E+01
219	[PMSFR1PMP074001B]	Common Cause: Group PRUN, 1/4	1.04E+01
220	[PMSFS1PMP074001B]	Common Cause: Group PSTART, 1/4	1.04E+01
221	[FN2FR1ROOM74001B]	Common Cause: FAN COOLERS FAIL TO RUN, 1/4	1.04E+01
222	HXRRP1SEAL67001B	SEAL HEAT EXCHANGER 1B RUPTURES	1.03E+01
223	HXRRP1HEX074901B	HEAT EXCHANGER 1B RUPTURES	1.03E+01
224	HXRRP1HXR067001B	PUMP ROOM COOLER 1B (HEAT EXCHANGER DATA) RUPTURES	1.03E+01
225	COVXC0___0240563	CHECK VALVE 0-24-563 AND MANUAL VALVE 0-24-562 TRANSFER SHUT	9.48E+00
226	COVXC0___0240577	CHECK VALVE 0-24-577 AND MANUAL VALVE 0-24-578 TRANSFER SHUT	9.48E+00
227	HOVXC0___0240523	MANUAL VALVES 0-24-523, -554 TRANSFER SHUT	9.48E+00
228	COVPL1___0322171	CHECK VALVE 32-2171 PLUGS	9.43E+00
229	HOVXC0___0240681	MANUAL VALVE 0-24-681 TRANSFERS SHUT	9.43E+00
230	HOVXC0___0241052	MANUAL VALVE 0-24-1052 TRANSFERS SHUT	9.43E+00
231	COVPL1___0320243	CHECK VALVE 32-0243 PLUGS	9.43E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
232	R2VPO0___0320556	RELIEF VALVE 0-32-556 PREMATURE OPEN	9.43E+00
233	R2VPO0___0320551	RELIEF VALVE 0-32-551 PREMATURE OPEN	9.43E+00
234	HOVXC1___0320211	MANUAL VALVE 32-211 TRANSFERS SHUT	9.43E+00
235	HOVXC1___0322370	MANUAL VALVE 32-2370 TRANSFER SHUT	9.43E+00
236	HOVXC1___0322373	MANUAL VALVE 32-2373 TRANSFER SHUT	9.43E+00
237	R2VPO0___0320546	RELIEF VALVE 0-32-546 PREMATURE OPEN	9.43E+00
238	HOVXC1___0320975	MANUAL VALVE 032-975 TRANSFERS CLOSED	9.43E+00
239	FLTPL1___032AFLT	AFTERFILTER PLUGS	9.43E+00
240	RCVRP0__032RCVR1	AIR RECEIVER 1 RUPTURE	9.43E+00
241	RCVRP0__032RCVR2	AIR RECEIVER 2 RUPTURE	9.43E+00
242	RCVRP0__032RCVR3	AIR RECEIVER 3 RUPTURE	9.43E+00
243	FLTPL1__032PRFLT	PREFILTER PLUGS	9.43E+00
244	HOVXC0___0320549	VALVES 545 OR 549 TRANSFERS SHUT GIVEN RECEIVERS 2 AND 3 PATH	9.43E+00
245	[DGFTS_1_DGA DGFTS_1_DGC]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 2/4	8.64E+00
246	HER_HPHPE1	OPERATOR FAILS TO CONTROL LEVEL WITH RCIC/HPCI (EARLY - 6 HOURS)	8.39E+00
247	[DGFTS_1_DGB DGFTS_1_DGC]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 2/4	8.15E+00
248	[MOVFO1FCV0710008]	Common Cause: RCIC MOVS FAIL TO OPEN, 1/2	7.97E+00
249	[MOVFO1FCV0710039]	Common Cause: Group VLV1, 1/2	7.97E+00
250	MOVFC1FCV0710034	VALVE 1-FCV-71-34 FAILS TO CLOSE ON DEMAND	7.96E+00
251	[MOVFO1FCV0710034 MOVXC1FCV0710038]	Common Cause: Group MOVFO, 2/4	7.96E+00
252	[MOVFO1FCV0740053 MOVFO1FCV0740067]	Common Cause: Group FTO, 2/2	7.52E+00
253	[MOVFO1FCV0740071 MOVFO1FCV0740073]	Common Cause: Group SPMOV, 2/4	7.44E+00
254	[MOVFO1FCV0740073]	Common Cause: Group SPMOV, 1/4	7.42E+00
255	[MOVFO1FCV0740071]	Common Cause: Group SPMOV, 1/4	7.42E+00
256	[DGFTS_1_DG3A DGFTS_1_DG3B DGFTS_1_DG3D]	Common Cause: UNIT 3 DIESELS FAIL TO START, 3/4	7.28E+00
257	[MOVFO1FCV0710034 MOVXC1FCV0730035]	Common Cause: Group MOVFO, 2/4	7.03E+00
258	[DGFTS_1_DG3A DGFTS_1_DG3B]	Common Cause: UNIT 3 DIESELS FAIL TO START, 2/4	6.99E+00
259	RPDRP1RP71011A_6	INBOARD RUPTURE DISC 1-RPD-71-011A FAILURE	6.35E+00
260	HER_HPWWV1	OPERATOR FAILS TO ALIGN WETWELL VENT PATH	6.31E+00
261	CKVFO1CKV0710580	CHECK VALVE 1-CKV-71-580 FAILS TO OPEN ON DEMAND	6.26E+00
262	CKVFO1CKV0710499	CHECK VALVE 1-CKV-71-499 FAILS TO OPEN ON DEMAND	6.26E+00
263	CKVFO1CKV0030572	RFW LINE B INJECTION VALVE 1-CKV-3-572 FAILS TO OPEN ON DEMAND	6.26E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
264	CKVFO1FCV0710040	CHECK VALVE 1-FCV-71-40 FAILS TO OPEN ON DEMAND	6.26E+00
265	CKVFC1CKV0030568	CHECK VALVE 1-CKV-3-568 FAILS TO CLOSE ON DEMAND	6.26E+00
266	CKVLK1CK030568_6	CHECK VALVE 1-CKV-3-568 GROSS BACKLEAKAGE	6.25E+00
267	[RL1FD1RLY0710K22]	Common Cause: Group HPCI/RCIC Relays, 1/4	6.25E+00
268	CSVFO1HCV0710014	STOP CHECK VALVE 1-HCV-71-14 FAILS TO OPEN ON DEMAND	6.23E+00
269	MOVXC1FCV71037_6	VALVE 1-FCV-71-37 TRANSFERS CLOSED	6.20E+00
270	MOVXC1FCV71019_6	VALVE 1-FCV-71-19 TRANSFERS CLOSED	6.20E+00
271	MOVXC1FCV7102_6	VALVE 1-FCV-71-2 TRANSFERS CLOSED	6.20E+00
272	MOVXC1FCV07103_6	VALVE 1-FCV-71-3 TRANSFERS CLOSED	6.20E+00
273	MOVXO1FCV71038_6	VALVE 1-FCV-71-38 TRANSFERS OPEN	6.20E+00
274	SWLFD1_LS0710029	LEVEL SWITCH 1-LS-71-29 FAILS TO OPERATE ON DEMAND	6.18E+00
275	PTSFS1PMP0710019	RCIC PUMP FAILS TO START ON DEMAND	6.16E+00
276	PTSFR1PMP71019_6	RCIC PUMP FAILS TO RUN	6.11E+00
277	MOVXO1FCV71034_6	VALVE 1-FCV-71-34 TRANSFERS OPEN	5.99E+00
278	MOVXC1FCV07108_6	VALVE 1-FCV-71-8 TRANSFERS CLOSED	5.99E+00
279	MOVXC1FCV71039_6	VALVE 1-FCV-71-39 TRANSFERS CLOSED	5.99E+00
280	HOVXC1HCV3066_6	RFW LINE B VALVE 1-HCV-3-66 TRANSFERS CLOSED	5.97E+00
281	MOVXC1FCV0740071	VALVE FCV-74-71 TRANSFERS CLOSED	5.73E+00
282	MOVXC1FCV0740073	VALVE FCV-74-73 TRANSFERS CLOSED	5.73E+00
283	[MOVFO1FCV0230034 MOVFO1FCV0230046]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 2/4	5.72E+00
284	[MOVXC1FCV0730035 MOVXC1FCV0730036]	Common Cause: Group MOVFO, 2/4	5.69E+00
285	[MOVXC1FCV0710038 MOVXC1FCV0730036]	Common Cause: Group MOVFO, 2/4	5.69E+00
286	[MOVXC1FCV0710038 MOVXC1FCV0730035]	Common Cause: Group MOVFO, 2/4	5.69E+00
287	[MOVXC1FCV0730036]	Common Cause: Group MOVFO, 1/4	5.68E+00
288	MOVFO1FCV0730036	MOV 1-FCV-73-36 FAILS TO OPEN ON DEMAND	5.68E+00
289	[MOVXC1FCV0710038 MOVXC1FCV0730035 MOVXC1FCV0730036]	Common Cause: Group MOVFO, 3/4	5.67E+00
290	HER_HPHPR1	OPERATORS FAIL TO RECOVER AND CONTROL HPCI/RCIC AFTER L8	5.58E+00
291	CONDENSER_2A2B2C	MAIN CONDENSER UNAVAILABLE AFTER PLANT TRIP	5.51E+00
292	HOVXC1ISV0640737	LO MANUAL VALVE FCV-64-737 TRANSFERS CLOSED DURING OPERATION	5.36E+00
293	AOVFO1FCV0640222	FCV 64-222 FAILS TO OPEN ON DEMAND	5.36E+00
294	AOVFO1FCV0640221	FCV 64-221 FAILS TO OPEN ON DEMAND	5.36E+00
295	AOVXC1FCV0640222	FCV 64-222 TRANSFERS CLOSED DURING OPERATION	5.36E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
296	AOVXC1FCV0640221	FCV 64-221 TRANSFERS CLOSED DURING OPERATION	5.36E+00
297	HOVXC1__032_3754	MANUAL VALVE 32-3754 TRANSFERS CLOSED	5.36E+00
298	HOVXC1__032_2704	MANUAL VALVE 32-2704 TRANSFERS CLOSED	5.36E+00
299	HOVXC1__032_2703	MANUAL VALVE 32-2703 TRANSFERS CLOSED	5.36E+00
300	[PMOFR1_CP002002A PMOFR1_CP002002B]	Common Cause: Group GROUP1, 2/3	5.18E+00
301	[MOVFO1FCV0730016]	Common Cause: RCIC MOVS FAIL TO OPEN, 1/2	5.16E+00
302	[MOVFO1FCV0730044]	Common Cause: Group VLV1, 1/2	5.16E+00
303	[MOVXC1FCV0730035]	Common Cause: Group MOVFO, 1/4	5.16E+00
304	MOVFO1FCV0730027	MOV 1-FCV-73-27 FAILS TO OPEN ON DEMAND	5.16E+00
305	MOVFO1FCV0730035	MOV 1-FCV-73-35 FAILS TO OPEN ON DEMAND	5.16E+00
306	MOVFO1FCV0730026	MOV 1-FCV-73-26 FAILS TO OPEN ON DEMAND	5.16E+00
307	MOVFC1FCV0730040	MOV 1-FCV-73-40 FAILS TO CLOSE ON DEMAND	5.16E+00
308	[MOVFO1FCV0230034 MOVFO1FCV0230052]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 2/4	5.08E+00
309	CKVFO1CKV0730517	CHECK VALVE 1-CKV-73-517 FAILS TO OPEN ON DEMAND	4.89E+00
310	RHRDSGRUP0750000	RHR DISCHARGE FAILS TO REMAIN INTACT RUPTURE	4.88E+00
311	[MOVFO1FCV0230034]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 1/4	4.78E+00
312	MOVXC1FCV0020171	MOV 1-FCV-2-171 TRANSFERS CLOSED DURING OPERATION	4.75E+00
313	[PMSFR2___02300A1 PMSFR2___02300A2 PMSFR2___02300C1 PMSFR2___02300C2]	Common Cause: Group PMR, 4/4	4.74E+00
314	[PMSFS2___02300A1 PMSFS2___02300A2 PMSFS2___02300C1 PMSFS2___02300C2]	Common Cause: Group PMS, 4/4	4.74E+00
315	COVPL1___0760551	CHECK VALVE 076-0551 FAILS TO OPEN, PLUGGED, TRANSFERS CLOSED	4.73E+00
316	COVPL1___0760552	CHECK VALVE 076-0552 FAILS TO OPEN, PLUGGED, TRANSFERS CLOSED	4.73E+00
317	HOVXC1___0322515	MANUAL VALVES 32-2515,2520, 4011, 4009, 2529 TRANSFER SHUT	4.73E+00
318	COVPL1___0322516	CHECK VALVES 32-2516, 2528, AND 2521 FAIL TO OPEN, PLUGGED	4.73E+00
319	FLTPL1___032CFLT	DRYWELL LOADS (C) AIR FILTER PLUGGED	4.73E+00
320	COVPL1___0760405	CHECK VALVE 076-0405 FAILS TO OPEN, PLUGS, TRANSFERS CLOSED	4.73E+00
321	HOVXC1___0322253	MANUAL VALVES 32-2253,2160, 4010, 4008, 1736, TRANSFER SHUT	4.73E+00
322	COVPL1___0322163	CHECK VALVES 32-2163 AND 336 FAILS TO OPEN, PLUGGED, TRANFERS CLOSED	4.73E+00
323	FLTPL1___032BFLT	DRYWELL LOADS (B) AIR FILTER PLUGGED	4.73E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
324	HOVXC1___0760538	MANUAL VALVE 076-0538 TRANSFERS CLOSED	4.73E+00
325	HOVXC1___0760310	MANUAL VALVE 076-0310 TRANSFERS CLOSED	4.73E+00
326	CSVFO1HCV0730023	STOP CHECK VALVE 1-HCV-73-23 FAILS TO OPEN ON DEMAND	4.69E+00
327	TBSFDST	TURBINE BYPASS SYSTEM UNAVAILABLE FOR SHORT TERM PRESSURE RELIEF	4.69E+00
328	HOVXC1HCV0230031	VALVE HCV-23-31 TRANSFERS CLOSED	4.64E+00
329	CKVFO1CKV0230510	CHECK VALVE CKV-23-510 FAILS TO OPEN ON DEMAND	4.64E+00
330	HXRPL1HEX074900A	HEAT EXCHANGER 1A PLUGS	4.63E+00
331	[SWL1_LS073056A SWL1_LS073056B]	Common Cause: Group SWTCH, 2/2	4.63E+00
332	CKVXC1CKV0230510	CHECK VALVE CKV-23-510 TRANSFERS CLOSED	4.63E+00
333	MOVXC1FCV0230034	VALVE FCV-23-34 TRANSFERS CLOSED	4.63E+00
334	XR2FR1_C_1B_TS1B	TRANSFORMER TS1B FAILS DURING OPERATION	4.60E+00
335	BUSFR1_480VBRD1B	480V SHUTDOWN BUS 1B FAILS	4.60E+00
336	CB1XO04KV_BD_C20	INPUT BREAKER 20 TRANSFERS OPEN	4.60E+00
337	CB1XO1480BD1B_1C	OUTPUT BREAKER 1C TRANSFERS OPEN	4.60E+00
338	MOVXC1FCV73040_6	MOV 1-FCV-73-40 TRANSFERS CLOSED DURING OPERATION	4.59E+00
339	MOVXC1FCV73003_6	MOV 1-FCV-73-3 TRANSFERS CLOSED DURING OPERATION	4.59E+00
340	MOVXC1FCV73002_6	MOV 1-FCV-73-2 TRANSFERS CLOSED DURING OPERATION	4.59E+00
341	CKVFO1CKV0030558	RFW CHECK VALVE 1-CKV-3-558 FAILS TO OPEN ON DEMAND	4.59E+00
342	CKVFC1CKV0030554	FEEDWATER CHECK VALVE 1-CKV-3-554 FAILS TO CLOSE ON DEMAND	4.59E+00
343	CKVFO1CKV0730603	CHECK VALVE 1-CKV-73-603 FAILS TO OPEN ON DEMAND	4.59E+00
344	CKVFO1FCV0730045	TESTABLE CHECK VALVE 1-FCV-73-45 FAILS TO OPEN ON DEMAND	4.59E+00
345	CKVFO1CKV0730505	CHECK VALVE 1-CKV-73-505 FAILS TO OPEN ON DEMAND	4.59E+00
346	CKVFO1CKV0730566	CHECK VALVE 1-CKV-73-566 FAILS TO OPEN	4.59E+00
347	[RL1FD123A_K21]	Common Cause: Group RLYD2, 1/4	4.54E+00
348	[RL1FD123A_K22]	Common Cause: Group RLYD2, 1/4	4.54E+00
349	[RL11RLY23A_K25]	Common Cause: Group RLYD2, 1/4	4.54E+00
350	[RL11RLY23A_K25 RL1FD123A_K21]	Common Cause: Group RLYD2, 2/4	4.54E+00
351	[RL1FD123A_K21 RL1FD123A_K22]	Common Cause: Group RLYD2, 2/4	4.54E+00
352	[RL11RLY23A_K25 RL1FD123A_K22]	Common Cause: Group RLYD2, 2/4	4.54E+00
353	CKVLK1CKV30554_6	FEEDWATER CHECK VALVE 1-CKV-3-554 DEVELOPS GROSS REVERSE LEAKAGE	4.53E+00
354	[PMSFR2___02300B2 PMSFR2___02300D1 PMSFR2___02300D2]	Common Cause: Group PMR, 3/4	4.48E+00
355	[MOVFO1FCV0740057 MOVFO1FCV0740059]	Common Cause: Group SPMOV, 2/4	4.48E+00
356	PTSFS1PMP0730054	HPCI PUMP FAILS TO START ON DEMAND	4.46E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
357	[PMSFS2___02300B2 PMSFS2___02300D1 PMSFS2___02300D2]	Common Cause: Group PMS, 3/4	4.45E+00
358	[MOVFO1FCV0740059]	Common Cause: Group SPMOV, 1/4	4.45E+00
359	[MOVFO1FCV0740057]	Common Cause: Group SPMOV, 1/4	4.45E+00
360	PTSFR1PMP73054_6	HPCI PUMP FAILS DURING OPERATION	4.43E+00
361	MOVXC1FCV73044_6	MOV 1-FCV-73-44 TRANSFERS CLOSED DURING OPERATION	4.41E+00
362	MOVXC1FCV73027_6	MOV 1-FCV-73-27 TRANSFERS CLOSED DURING OPERATION	4.41E+00
363	MOVXC1FCV73026_6	MOV 1-FCV-73-26 TRANSFERS CLOSED DURING OPERATION	4.41E+00
364	MOVXO1FCV73040_6	MOV 1-FCV-73-40 TRANSFERS OPEN AFTER SWITCHOVER	4.41E+00
365	MOVXC1FCV73016_6	MOV 1-FCV-73-16 TRANSFERS CLOSED DURING OPERATION	4.41E+00
366	MOVXC1FCV73034_6	MOV 1-FCV-73-34 TRANSFERS CLOSED DURING OPERATION	4.41E+00
367	HOVXC1HCV73025_6	MANUAL VALVE 1-HCV-73-25 TRANSFERS CLOSED DURING OPERATION	4.37E+00
368	HOVXC1HC30067_6	RFW VALVE 1-HCV-3-67 TRANSFERS CLOSED	4.37E+00
369	[CB1FO3BKR0571334 CB1FO3BKR0571336 CB1FO3BKR0571338]	Common Cause: BREAKERS FAIL TO OPEN, 3/4	4.35E+00
370	[CB1FO3BKR0571334 CB1FO3BKR0571336 CB1FO3BKR0571338 CB1FO3BKR0571342]	Common Cause: BREAKERS FAIL TO OPEN, 4/4	4.35E+00
371	[RL11RLY23A_K25 RL1FD123A_K21 RL1FD123A_K22]	Common Cause: Group RLYD2, 3/4	4.35E+00
372	RPDRP1RP73020_6	INBOARD RUPTURE DISC 1-RPD-073- 020 RUPTURES CAUSING HPCI ISOLATE	4.34E+00
373	BUSFR1_UNITBRD1A	4KV UNIT BOARD 1A FAILS	4.04E+00
374	[PMSFR2___02300A1 PMSFR2___02300A2 PMSFR2___02300C2]	Common Cause: Group PMR, 3/4	4.03E+00
375	[PMSFS2___02300A1 PMSFS2___02300A2 PMSFS2___02300C2]	Common Cause: Group PMS, 3/4	4.03E+00
376	CSDSCGRUP0740000	CORE SPRAY DISCHARGE FAILS TO REMAIN INTACT RUPTURE	4.02E+00
377	CKVXC1CK30572_6	RFW LINE B INJECTION VALVE 1-CKV-3-572 TRANSFERS CLOSED	3.98E+00
378	CKVXC1CK710580_6	CHECK VALVE 1-CKV-71-580 TRANSFERS CLOSED	3.98E+00
379	CKVXC1FCV71040_6	CHECK VALVE 1-FCV-71-40 TRANSFERS CLOSED	3.98E+00
380	CKVXC1CK710499_6	CHECK VALVE 1-CKV-71-499 TRANSFERS CLOSED	3.98E+00
381	CSVXC1HCV71014_6	STOP CHECK VALVE 1-HCV-71-14 TRANSFERS CLOSED	3.97E+00
382	CB1XO1480SD1B_3B	FEEDER BRK 3B TRANSFERS OPEN DURING OPERATION.	3.97E+00
383	CB1XO1RMOV_1B_2D	BUS FEEDER BRK 2D TRANSFERS OPEN DURING OPERATION.	3.97E+00
384	BUSFR1480VRMOV1B	480V RMOV BD 1B BUS FAILS.	3.97E+00
385	[PMSFR2___02300A1 PMSFR2___02300A2 PMSFR2___02300C1]	Common Cause: Group PMR, 3/4	3.90E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
386	[PMSFS2___02300A1 PMSFS2___02300A2 PMSFS2___02300C1]	Common Cause: Group PMS, 3/4	3.89E+00
387	CKVXC1CK730603_6	CHECK VALVE 1-CKV-73-603 TRANSFERS CLOSED DURING OPERATION	3.83E+00
388	CKVXC1CK730505_6	CHECK VALVE 1-CKV-73-505 TRANSFERS CLOSED DURING OPERATION	3.83E+00
389	CKVXC1FCV73045_6	TESTABLE CHECK VALVE 1-FCV-73-45 TRANSFERS CLOSED	3.83E+00
390	CKVXC1CK030558_6	RFW CHECK VALVE 1-CKV-3-558 TRANSFERS CLOSED	3.83E+00
391	CKVXC1CKV0730566	CHECK VALVE 1-CKV-73-566 TRANSFERS CLOSED DURING OPERATION	3.83E+00
392	CKVXC1CK730517_6	CHECK VALVE 1-CKV-73-517 TRANSFERS CLOSED DURING OPERATION	3.83E+00
393	CB1XO2480BD2A_1C	OUTPUT BREAKER 1C TRANSFERS OPEN	3.82E+00
394	CB1XO04KV_BD_B_5	INPUT BREAKER 5 TRANSFERS OPEN	3.82E+00
395	BUSFR2_480VBRD2A	480V SHUTDOWN BUS 2A FAILS	3.82E+00
396	XR2FR2_B_2A_TS2A	TRANSFORMER TS2A FAILS DURING OPERATION	3.82E+00
397	CSVXC1HCV73023_6	STOP CHECK VALVE 1-HCV-73-23 TRANSFERS CLOSED	3.81E+00
398	[PMSFR2___02300A1 PMSFR2___02300A2]	Common Cause: Group PMR, 2/4	3.78E+00
399	[PMSFS2___02300A1 PMSFS2___02300A2]	Common Cause: Group PMS, 2/4	3.78E+00
400	[SWDFD1PIS003204B SWDFD1PIS003204C]	Common Cause: Group ATU, 2/4	3.70E+00
401	[SWDFD1PIS003204B SWDFD1PIS003204D]	Common Cause: Group ATU, 2/4	3.70E+00
402	[SWDFD1PIS003204A SWDFD1PIS003204C]	Common Cause: Group ATU, 2/4	3.70E+00
403	[SWDFD1PIS003204A SWDFD1PIS003204D]	Common Cause: Group ATU, 2/4	3.70E+00
404	[RL1FD1___003204A RL1FD1___003204C]	Common Cause: Group RELAY1, 2/4	3.70E+00
405	[RL1FD1___003204A RL1FD1___003204D]	Common Cause: Group RELAY1, 2/4	3.70E+00
406	[RL1FD1___003204B RL1FD1___003204C]	Common Cause: Group RELAY1, 2/4	3.70E+00
407	[RL1FD1___003204B RL1FD1___003204D]	Common Cause: Group RELAY1, 2/4	3.70E+00
408	[RL1FD1___003204A RL1FD1___003204B RL1FD1___003204C]	Common Cause: Group RELAY1, 3/4	3.70E+00
409	[RL1FD1___003204A RL1FD1___003204B RL1FD1___003204D]	Common Cause: Group RELAY1, 3/4	3.70E+00
410	[RL1FD1___003204A RL1FD1___003204C RL1FD1___003204D]	Common Cause: Group RELAY1, 3/4	3.70E+00
411	[RL1FD1___003204B RL1FD1___003204C RL1FD1___003204D]	Common Cause: Group RELAY1, 3/4	3.70E+00
412	[SWDFD1PIS003204B SWDFD1PIS003204C SWDFD1PIS003204D]	Common Cause: Group ATU, 3/4	3.70E+00
413	[SWDFD1PIS003204A SWDFD1PIS003204B SWDFD1PIS003204C SWDFD1PIS003204D]	Common Cause: Group ATU, 4/4	3.70E+00
414	[SWDFD1PIS003204A SWDFD1PIS003204B SWDFD1PIS003204C]	Common Cause: Group ATU, 3/4	3.70E+00
415	[SWDFD1PIS003204A SWDFD1PIS003204B SWDFD1PIS003204D]	Common Cause: Group ATU, 3/4	3.70E+00
416	[SWDFD1PIS003204A SWDFD1PIS003204C SWDFD1PIS003204D]	Common Cause: Group ATU, 3/4	3.70E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
417	[RL1FD1___00358C4 RL1FD1___00358C5]	Common Cause: Group RELAY2, 2/2	3.70E+00
418	[RL1FD1___003204A RL1FD1___003204B RL1FD1___003204C RL1FD1___003204D]	Common Cause: Group RELAY1, 4/4	3.70E+00
419	[CB1FO3BKR0571334 CB1FO3BKR0571336 CB1FO3BKR0571342]	Common Cause: BREAKERS FAIL TO OPEN, 3/4	3.61E+00
420	[CB1FO3BKR0571334 CB1FO3BKR0571336]	Common Cause: BREAKERS FAIL TO OPEN, 2/4	3.61E+00
421	BATFD1BAT057_SBA	BATTERY SB-A FAILS ON DEMAND.	3.42E+00
422	BUSFR1BUS057_SBA	SB-A BUS FAILS	3.42E+00
423	[PMSFR2___02300B1 PMSFR2___02300D1 PMSFR2___02300D2]	Common Cause: Group PMR, 3/4	3.42E+00
424	[MGSFR1RPSMGSET_A MGSFR1RPSMGSET_B]	Common Cause: MG SET FAILS DURING OPERATION, 2/2	3.41E+00
425	[PMSFS2___02300B1 PMSFS2___02300D1 PMSFS2___02300D2]	Common Cause: Group PMS, 3/4	3.40E+00
426	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
427	[RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
428	[RV2FO1PCV0010019 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
429	[RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
430	[RV2FO1PCV0010005 RV2FO1PCV0010022 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
431	[RV2FO1PCV0010005 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
432	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010030 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
433	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
434	[RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
435	[RV2FO1PCV0010005 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010034]	Common Cause: Group SRV, 4/6	3.37E+00
436	[RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031]	Common Cause: Group SRV, 4/6	3.37E+00
437	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010030 RV2FO1PCV0010031]	Common Cause: Group SRV, 4/6	3.37E+00
438	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010031]	Common Cause: Group SRV, 4/6	3.37E+00
439	[RV2FO1PCV0010005 RV2FO1PCV0010019 RV2FO1PCV0010022 RV2FO1PCV0010030]	Common Cause: Group SRV, 4/6	3.37E+00
440	[RV2FO1PCV0010005 RV2FO1PCV0010022 RV2FO1PCV0010030 RV2FO1PCV0010031]	Common Cause: Group SRV, 4/6	3.37E+00
441	[DGFTS_1_DG3A DGFTS_1_DG3C DGFTS_1_DG3D]	Common Cause: UNIT 3 DIESELS FAIL TO START, 3/4	3.32E+00
442	[DGFTS_1_DGA DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 2/4	3.19E+00
443	[MGSFR1RPSMGSET_A]	Common Cause: MG SET FAILS DURING OPERATION, 1/2	3.07E+00
444	BATFD1BAT057_SBC	BATTERY SB-C FAILS ON DEMAND.	3.07E+00
445	BUSFR1BUS057_SBC	SB-C BUS FAILS	3.07E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
446	BKRXO1RPSBUSA902	DIST. PNL. FEEDER BRK 902 TRANSFERS OPEN	3.07E+00
447	CTRXO1RPSBUSA1A1	PROTECTION CONTACTOR 1A1 TRANSFERS OPEN	3.07E+00
448	CTRXO1RPSBUSA1A2	PROTECTION CONTACTOR 1A2 TRANSFERS OPEN	3.07E+00
449	BUSFR1RPSBUS001A	RPS BUS A FAILS DURING OPERATION	3.07E+00
450	BKRXO1RMOV1A013A	480V RMOV BD 1A BREAKER 13A TRANSFERS OPEN	3.07E+00
451	FSWFR1M_B057__XC	CHARGER OUTPUT FUSE SWITCH-X FAILS OPEN.	3.03E+00
452	CB1FO1M_B05717B1	CHARGER INPUT BRK 17B1 FAILS OPEN.	3.03E+00
453	CHGFR1M_B057_SBC	CHARGER SB-C FAILS DURING OPERATION	3.03E+00
454	[DGFTS_1_DG3A DGFTS_1_DG3C]	Common Cause: UNIT 3 DIESELS FAIL TO START, 2/4	3.02E+00
455	[PMSFR2___02300B1 PMSFR2___02300D1]	Common Cause: Group PMR, 2/4	2.89E+00
456	[PMSFS2___02300B1 PMSFS2___02300D1]	Common Cause: Group PMS, 2/4	2.89E+00
457	[PMSFR2___02300B2 PMSFR2___02300D2]	Common Cause: Group PMR, 2/4	2.85E+00
458	[PMSFS2___02300B2 PMSFS2___02300D2]	Common Cause: Group PMS, 2/4	2.84E+00
459	DCA_FLD	LINE BREAK IN DRYWELL CONTROL AIR	2.82E+00
460	PCA_FLD	LINE BREAK IN PLANT CONTROL AIR	2.82E+00
461	RAD_MONITOR	SPURIOUS OPERATION OF RADIATION MONITOR RESULTING IN MSIV CLOSUR	2.82E+00
462	BUSFR3SHTDBRD3EA	SHUTDOWN BD 3EA FAILS BUS FAULT	2.81E+00
463	[PMSFS1PMP074001A PMSFS1PMP074001D]	Common Cause: Group PSTART, 2/4	2.81E+00
464	[FN2FS1ROOM74001A FN2FS1ROOM74001D]	Common Cause: FAN COOLERS FAIL TO START, 2/4	2.80E+00
465	BUSFR1CAB3PNL9_9	I&C BUS B PANEL 9-9 CAB 3 UNIT 1 FAILURE.	2.78E+00
466	[FN2FS1ROOM74001A]	Common Cause: FAN COOLERS FAIL TO START, 1/4	2.77E+00
467	[PMSFR2___02300B1 PMSFR2___02300D2]	Common Cause: Group PMR, 2/4	2.77E+00
468	[PMSFS2___02300B1 PMSFS2___02300D2]	Common Cause: Group PMS, 2/4	2.76E+00
469	[RL1FD1RLY10AK58A RL1FD1RLY10AK58B]	Common Cause: Group RLY, 2/2	2.76E+00
470	MOVXC1FCV0740057	VALVE FCV-74-57 TRANSFERS CLOSED	2.76E+00
471	MOVXC1FCV0740059	VALVE FCV-74-59 TRANSFERS CLOSED	2.76E+00
472	[PMSFS1PMP074001A]	Common Cause: Group PSTART, 1/4	2.74E+00
473	[PMSFR2___02300B2 PMSFR2___02300D1]	Common Cause: Group PMR, 2/4	2.72E+00
474	CKVFO1CKV074560A	CHECK VALVE 74-560A FAILS TO OPEN ON DEMAND	2.72E+00
475	CKVFO1CKV074559A	CHECK VALVE 74-559A FAILS TO OPEN ON DEMAND	2.72E+00
476	[PMSFS2___02300B2 PMSFS2___02300D1]	Common Cause: Group PMS, 2/4	2.72E+00
477	FSWFR1M_B057__XA	CHARGER OUTPUT FUSE SWITCH-X FAILS OPEN.	2.71E+00
478	CB1FO1M_B05716C1	CHARGER INPUT BRK 16C1 FAILS OPEN.	2.71E+00
479	CHGFR1M_B057_SBA	CHARGER SB-A FAILS DURING OPERATION	2.71E+00
480	[PMSFR2___02300B1]	Common Cause: Group PMR, 1/4	2.71E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
481	[PMSFS2___02300B1]	Common Cause: Group PMS, 1/4	2.71E+00
482	COVFO2___0230522	CHECK VALVE 0-23-522 FAILS TO OPEN ON DEMAND	2.71E+00
483	HOVXC2___0230523	MANUAL VALVE 0-23-523 TRANSFERS CLOSED	2.71E+00
484	HOVXC2___0230524	MANUAL VALVE 0-23-524 TRANSFERS CLOSED	2.71E+00
485	COVXC2___0230522	CHECK VALVE 0-23-522 TRANSFERS CLOSED	2.71E+00
486	CB1XO2480SD2A_3A	FEEDER BRK 3A TRANSFERS OPEN DURING OPERATION.	2.70E+00
487	CB1XO2RMOV_2A_3D	BUS FEEDER BRK 3D TRANSFERS OPEN DURING OPERATION.	2.70E+00
488	BUSFR2480VRMOV2A	480V RMOV BD 2A BUS FAILS	2.70E+00
489	[PMSFR1PMP074001A]	Common Cause: Group PRUN, 1/4	2.70E+00
490	[DGFTS_1_DGB DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 2/4	2.70E+00
491	[DGFTS_1_DG3A DGFTS_1_DG3D]	Common Cause: UNIT 3 DIESELS FAIL TO START, 2/4	2.70E+00
492	[FN2FR1ROOM74001A]	Common Cause: FAN COOLERS FAIL TO RUN, 1/4	2.69E+00
493	MOVXC1FCV0740001	FCV-74-1 TRANSFERS CLOSED	2.68E+00
494	[DGFTS_1_DG3A]	Common Cause: UNIT 3 DIESELS FAIL TO START, 1/4	2.67E+00
495	HOVXC1HCV0740010	HCV-74-10 TRANSFERS CLOSED	2.65E+00
496	HOVXC1ISV0670567	VALVE 67-567 TRANSFERS CLOSED	2.65E+00
497	HOVXC1ISV0670571	VALVE 67-571 TRANSFERS CLOSED	2.65E+00
498	HOVXC1HCV0740086	HCV-74-86 TRANSFERS CLOSED	2.65E+00
499	HOVXC1ISV0670570	VALVE 67-570 TRANSFERS CLOSED	2.65E+00
500	HOVXC1ISV0670574	VALVE 67-574 TRANSFERS CLOSED	2.65E+00
501	HOVXC1HCV0670572	VALVE 67-572 TRANSFERS CLOSED	2.65E+00
502	[FCOFO_1_FCO_230C FCOFO_1_FCO_231C]	Common Cause: DAMPERS FAIL TO OPEN, 2/2	2.64E+00
503	[FN2FTS_DG3A_FANA FN2FTS_DG3A_FANB]	Common Cause: FAN FAILS TO START OR RUN, 2/2	2.64E+00
504	HXRRP1HEX074901A	HEAT EXCHANGER 1A RUPTURES	2.64E+00
505	HXRRP1SEAL74001A	SEAL HEAT EXCHANGER 1A RUPTURES	2.64E+00
506	HXRRP1HXR074001A	PUMP ROOM COOLER 1A (HEAT EXCHANGER DATA) RUPTURES	2.64E+00
507	BUSFR1CAB2PNL9_9	I&C BUS A PANEL 9-9 AB 2 UNIT 1 FAILURE.	2.64E+00
508	FRDXC_DG3A_1035	FIRE DAMPERS 1035, 1031 TRANSFER CLOSED	2.63E+00
509	CHARG_DG3ACHG3A2	CHARGER "3A", IN/OUT FUSES FAIL CHRGR INPUT, OUTPUT BRK TRANS.	2.63E+00
510	BUSFD_DG3ABUS3A	125V DC BUS OR BATTERY FAILS OR FUSED SWITCH TO DG CONT TRANSFER	2.63E+00
511	HOVXC_DG3A_862	MANUAL VALVES 862,699 TRANS. CLOSED OR EXPANSION JOINT LEAK.	2.63E+00
512	CB1XO_DG3A_1838	DG 3A BREAKER 1838 TRANS. OPEN OR BREAKER 1334 TRANS. CLOSED OR	2.62E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
513	[CB1FO0BKR0571614 CB1FO0BKR0571718]	Common Cause: BREAKERS FAIL TO OPEN, 2/4	2.61E+00
514	[CB1FO0BKR0571614 CB1FO0BKR0571718 CB1FO0BKR0571724]	Common Cause: BREAKERS FAIL TO OPEN, 3/4	2.61E+00
515	[PMSFR2___02300B2]	Common Cause: Group PMR, 1/4	2.60E+00
516	[PMSFS2___02300B2]	Common Cause: Group PMS, 1/4	2.60E+00
517	HOVXC2___0230527	MANUAL VALVE 0-23-527 TRANSFERS CLOSED	2.60E+00
518	COVFO2___0230526	CHECK VALVE 0-23-526 FAILS TO OPEN ON DEMAND	2.60E+00
519	COVXC2___0230526	CHECK VALVE 0-23-526 TRANSFERS CLOSED	2.59E+00
520	[PMSFR1PMP074001A PMSFR1PMP074001D]	Common Cause: Group PRUN, 2/4	2.58E+00
521	[FN2FR1ROOM74001A FN2FR1ROOM74001D]	Common Cause: FAN COOLERS FAIL TO RUN, 2/4	2.58E+00
522	[CB1FO0BKR0571614]	Common Cause: BREAKERS FAIL TO OPEN, 1/4	2.56E+00
523	[CB1FO0BKR0571614 CB1FO0BKR0571724]	Common Cause: BREAKERS FAIL TO OPEN, 2/4	2.56E+00
524	[MOVFC1FCV0740053 MOVFC1FCV0740067]	Common Cause: SPC VALVES FAIL TO CLOSE, 2/2	2.55E+00
525	CB1XC0BKR0571614	BRK 1614 TRANSFERS CLOSED	2.54E+00
526	CKVXC1CKV074560A	CHECK VALVE 74-560A TRANSFERS CLOSED	2.53E+00
527	CKVXC1CKV074559A	CHECK VALVE 74-559A TRANSFERS CLOSED	2.53E+00
528	[DGFTS_1_DGA]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 1/4	2.49E+00
529	[PMSFR2___02300A1 PMSFR2___02300C1 PMSFR2___02300C2]	Common Cause: Group PMR, 3/4	2.47E+00
530	[PMSFS2___02300A1 PMSFS2___02300C1 PMSFS2___02300C2]	Common Cause: Group PMS, 3/4	2.47E+00
531	[PMSFR2___02300A1 PMSFR2___02300C1]	Common Cause: Group PMR, 2/4	2.46E+00
532	[PMSFS2___02300A1 PMSFS2___02300C1]	Common Cause: Group PMS, 2/4	2.46E+00
533	[PMSFR2___02300A1 PMSFR2___02300C2]	Common Cause: Group PMR, 2/4	2.41E+00
534	[PMSFS2___02300A1 PMSFS2___02300C2]	Common Cause: Group PMS, 2/4	2.41E+00
535	[PMSFR2___02300A1]	Common Cause: Group PMR, 1/4	2.40E+00
536	[PMSFS2___02300A1]	Common Cause: Group PMS, 1/4	2.40E+00
537	COVFO2___0230502	CHECK VALVE 0-23-502 FAILS TO OPEN ON DEMAND	2.40E+00
538	HOVXC2___0230503	MANUAL VALVE 0-23-503 TRANSFERS CLOSED	2.40E+00
539	HOVXC2___0230504	MANUAL VALVE 0-23-504 TRANSFERS CLOSED	2.40E+00
540	COVXC2___0230502	CHECK VALVE 0-23-502 TRANSFERS CLOSED	2.40E+00
541	[FCOFO_1_FCO_64C FCOFO_1_FCO_65C]	Common Cause: DAMPERS FAIL TO OPEN, 2/2	2.34E+00
542	[PMSFR2___02300A2 PMSFR2___02300C1 PMSFR2___02300C2]	Common Cause: Group PMR, 3/4	2.33E+00
543	[PMSFS2___02300A2 PMSFS2___02300C1 PMSFS2___02300C2]	Common Cause: Group PMS, 3/4	2.33E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
544	[FN2FTS_DGA_FANA FN2FTS_DGA_FANB]	Common Cause: FAN FAILS TO START OR RUN, 2/2	2.33E+00
545	[PMSFR2___02300A2 PMSFR2___02300C2]	Common Cause: Group PMR, 2/4	2.32E+00
546	[PMSFS2___02300A2 PMSFS2___02300C2]	Common Cause: Group PMS, 2/4	2.32E+00
547	CHARG_DGA_CHGA2	CHARGER "A", IN/OUT FUSES FAIL.CHRGR INPUT OUTPUT BRK TRANS.	2.28E+00
548	HOVXC_DGA_532	MANUAL VALVES 532, 861 TRANS. CLOSED OR EXPANSION JOINT LEAK.	2.27E+00
549	BUSFD_DGA_BUSA	125V DC BD. BUS OR BATTERY FAILS OR FUSED SWITCH TO DG CONT TRAN	2.27E+00
550	CB1XO_DGA_1818	DG A BREAKER 1818 TRANS. OPEN OR BREAKER 1614 TRANS. CLOSED OR	2.26E+00
551	FRDXC_DGA_1023	FIRE DAMPERS 1023, 1019 TRANSFER CLOSED	2.26E+00
552	[MOVFO1FCV0230040 MOVFO1FCV0230046]	Common Cause: RHR HX MOVS FAIL TO OPEN ON DEMAND, 2/4	2.24E+00
553	XR2FR1_A_1A_TS1A	TRANSFORMER TS1A FAILS DURING OPERATION	2.23E+00
554	BUSFR1_480VBRD1A	480V SHUTDOWN BUS 1A FAILS	2.23E+00
555	CB1XO04KV_BD_A_5	INPUT BREAKER 5 TRANSFERS OPEN	2.23E+00
556	CB1XO1480BD1A_1C	OUTPUT BREAKER 1C TRANSFERS OPEN	2.23E+00
557	HER_HRSPC1	OPERATOR LOCAL RECOVERY OF SP COOLING FAILURE	2.23E+00
558	[RL1FD1RL68118A3A RL1FD1RL68118A3B RL1FD1RL68118B3A RL1FD1RL68118B3B]	Common Cause: Group RELAY1, 4/4	2.23E+00
559	[RL1FD1RL68118A3B RL1FD1RL68118B3A RL1FD1RL68118B3B]	Common Cause: Group RELAY1, 3/4	2.23E+00
560	[RL1FD1RL68118A3A RL1FD1RL68118B3A RL1FD1RL68118B3B]	Common Cause: Group RELAY1, 3/4	2.23E+00
561	[RL1FD1RL68118A3A RL1FD1RL68118B3A]	Common Cause: Group RELAY1, 2/4	2.23E+00
562	[RL1FD1RL68118A3A RL1FD1RL68118A3B RL1FD1RL68118B3B]	Common Cause: Group RELAY1, 3/4	2.23E+00
563	[RL1FD1RL68118A3A RL1FD1RL68118A3B RL1FD1RL68118B3A]	Common Cause: Group RELAY1, 3/4	2.23E+00
564	[RL1FD1RL68118A3B RL1FD1RL68118B3B]	Common Cause: Group RELAY1, 2/4	2.23E+00
565	[CB1FO1BKR0681440 CB1FO1BKR0681450 CB1FO1BKR0681540 CB1FO1BKR0681550]	Common Cause: RPT BREAKERS FAIL TO OPEN, 4/4	2.23E+00
566	[CB1FO1BKR0681450 CB1FO1BKR0681540 CB1FO1BKR0681550]	Common Cause: RPT BREAKERS FAIL TO OPEN, 3/4	2.23E+00
567	[CB1FO1BKR0681440 CB1FO1BKR0681540 CB1FO1BKR0681550]	Common Cause: RPT BREAKERS FAIL TO OPEN, 3/4	2.23E+00
568	[CB1FO1BKR0681440 CB1FO1BKR0681450 CB1FO1BKR0681550]	Common Cause: RPT BREAKERS FAIL TO OPEN, 3/4	2.23E+00
569	[CB1FO1BKR0681440 CB1FO1BKR0681450 CB1FO1BKR0681540]	Common Cause: RPT BREAKERS FAIL TO OPEN, 3/4	2.23E+00
570	[CB1FO1BKR0681540 CB1FO1BKR0681550]	Common Cause: RPT BREAKERS FAIL TO OPEN, 2/4	2.23E+00
571	[CB1FO1BKR0681440 CB1FO1BKR0681450]	Common Cause: RPT BREAKERS FAIL TO OPEN, 2/4	2.23E+00
572	[DGFTS_1_DGC DGFTS_1_DGD]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 2/4	2.19E+00
573	[PMSFR2___02300A2 PMSFR2___02300C1]	Common Cause: Group PMR, 2/4	2.13E+00
574	[PMSFS2___02300A2 PMSFS2___02300C1]	Common Cause: Group PMS, 2/4	2.13E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
575	[PMSFR2___02300A2]	Common Cause: Group PMR, 1/4	2.13E+00
576	[PMSFS2___02300A2]	Common Cause: Group PMS, 1/4	2.13E+00
577	COVFO2___0230506	CHECK VALVE 0-23-506 FAILS TO OPEN ON DEMAND	2.13E+00
578	HOVXC2___0230507	MANUAL VALVE 0-23-507 TRANSFERS CLOSED	2.13E+00
579	COVXC2___0230506	CHECK VALVE 0-23-506 TRANSFERS CLOSED	2.13E+00
580	[CB1FO3BKR0571334 CB1FO3BKR0571338 CB1FO3BKR0571342]	Common Cause: BREAKERS FAIL TO OPEN, 3/4	2.13E+00
581	[CB1FO3BKR0571334 CB1FO3BKR0571338]	Common Cause: BREAKERS FAIL TO OPEN, 2/4	2.13E+00
582	[CB1FO3BKR0571334]	Common Cause: BREAKERS FAIL TO OPEN, 1/4	2.13E+00
583	[CB1FO3BKR0571334 CB1FO3BKR0571342]	Common Cause: BREAKERS FAIL TO OPEN, 2/4	2.13E+00
584	[MOVFO1FCV0710034]	Common Cause: Group MOVFO, 1/4	2.12E+00
585	BE_HPTAF1	OPERATORS LOWER LEVEL TO TAF AND TERMINATE MOST INJECTION UNISOL	2.05E+00
586	HOVXC1HCV0630012	MANUAL VALVE 63-12 TRANSFERS CLOSED	2.05E+00
587	COVFO1___0630525	CHECK VALVE 63-525 FAILS TO OPEN	2.05E+00
588	COVFO1___0630526	CHECK VALVE 63-526 FAILS TO OPEN	2.05E+00
589	HOVXC1___0630524	MANUAL VALVE 63-524 TRANSFERS CLOSED	2.05E+00
590	COVPL1___0630525	CHECK VALVE 63-525 TRANSFERS CLOSED / PLUGS	2.05E+00
591	COVPL1___0630526	CHECK VALVE 63-526 TRANSFERS CLOSED / PLUGS	2.05E+00
592	[MOVFC1FCV0690001 MOVFC1FCV0690002 MOVFC1FCV0690012]	Common Cause: RWCU ISOLATION VALVES FAIL TO CLOSE, 3/3	2.05E+00
593	HOVXO1___0630013	MANUAL VALVE 63-13 TO DRAIN TANK TRANSFERS OPEN	2.05E+00
594	[PMSFS1___063001A PMSFS1___063001B]	Common Cause: Group A, 2/2	2.05E+00
595	TK2RP1___0630001	STANDBY LIQUID CONTROL STORAGE TANK RUPTURES	2.05E+00
596	[PMSFR1___063001A PMSFR1___063001B]	Common Cause: Group B, 2/2	2.05E+00
597	[EOVFD1___063008A EOVFD1___063008B]	Common Cause: SQUIB VALES FAIL ON DEMAND, 2/2	2.05E+00
598	HOVXC1___0630500	MANUAL VALVE 63-500 TRANSFERS CLOSED	2.05E+00
599	FSWFR2M_B057__XB	CHARGER OUTPUT FUSE SWITCH-X FAILS OPEN.	2.03E+00
600	CHGFR2M_B057_SBB	CHARGER SB-B FAILS DURING OPERATION	2.03E+00
601	CB1FO2M_B057_5A2	CHARGER INPUT BRK 5A2 FAILS OPEN.	2.03E+00
602	HOVXC1___0840703	MANUAL VALVE 703 TRANSFERS CLOSED	2.03E+00
603	HOVXC1___0840707	MANUAL VALVE 707 TRANSFERS CLOSED	2.03E+00
604	CKVXC1___0840709	CHECK VALVE 709 TRANSFERS CLOSED	2.03E+00
605	PCVFD1PCV0840706	PCV 84-706 FAILS ON DEMAND	2.03E+00
606	TK1RP0TK08400A	NITROGEN TK A RUPTURE	2.03E+00

Table SPSB-A.20-2 BFN Unit 1 Significant Basic Events By Risk Achievement Worth			
Rank	**Basic Event**	**Description**	**Risk Achievement Worth**
607	[DGFTS_1_DGB]	Common Cause: UNIT 1/2 DIESELS FAIL TO START, 1/4	2.00E+00

Note 1: Basic events names in brackets indicate a common cause failure event.

NRC Request 1[b]

For all three units, answer the following questions for low power/shutdown operations, as they relate to the extended power uprate (EPU). These questions, taken from the Standard Review Plan, Chapter 19, Table III-1, provide an acceptable way to assess risks from low power/shutdown operations. The responses previously provided to RAIs SPSB-A.18 (Reference 1), and SPSB-A.17 (Reference 2), did not answer the staff's question.

a. Does the proposed EPU introduce new initiating events or change the frequencies of existing events? Explain why or why not.

b. Does the proposed EPU affect the scheduling of outage activities? Explain why or why not.

c. Does the proposed EPU affect the ability of the operator to respond to shutdown events? Explain why or why not.

d. Does the proposed EPU affect the reliability or availability of equipment used for shutdown conditions? Explain why or why not.

e. Does the proposed EPU affect the availability of equipment or instrumentation used for contingency plans? Explain why or why not.

References

1. Letter from Brian O'Grady, TVA, to NRC, "Browns Ferry Nuclear Plant (BFN) – Unit 1 – Response to NRC Round 2 Requests for Additional Information Related to Technical Specifications (TS) Change No. TS-431 – Request for Extended Power Uprate Operation (TAC No. MC3812)," December 19, 2005, TVA-BFN-TS-431 (ML053560194)

2. Letter from Brian O'Grady, TVA, to NRC, "Browns Ferry Nuclear Plant (BFN) – Units 2 and 3 – Response to NRC Round 2 Request for Additional Information Related to Technical Specifications (TS) Change No. TS-418 – Request for Extended Power Uprate Operation (TAC Nos. MC3743 and MC3744)," December 19, 2005, TVA-BFN-TS-418 (ML053560186)

TVA Response to NRC Request 1[b]

TVA's revised responses to RAI SPSB-A.18 (Unit 1) and RAI SPSB-A.17 (Units 2 and 3) in the EPU submittals dated March 7, 2006, address these questions.

NRC Request 2

For all three units, provide the following information regarding the probabilistic risk analysis (PRA) success criteria for the safety/relief valves (SRVs):

a. How many SRVs are required to open to mitigate an anticipated transient without scram (ATWS) event at EPU conditions? For Units 2 and 3, what was the pre-EPU number of SRVs required?

b. How many SRVs are assumed to open on a transient event with pressure challenge under EPU conditions? For Units 2 and 3, what was this assumption pre-EPU?

c. How many SRVs are assumed to need to close following a transient event with pressure challenge under EPU conditions? For Units 2 and 3, what was this number pre-EPU?

d. What is the technical basis (e.g., Modular Accident Analysis Package calculations) for the success criteria given in answer to questions 2.a, 2.b and 2.c above?

e. Does the model consider failures of different numbers of SRVs to close as different sequences (i.e., do they transfer to different loss-of-coolant accident event trees)? Describe in detail.

f. How is common cause failure of multiple SRVs to open handled in the PRA models?

g. How is common cause failure of multiple SRVs to close after opening handled in the PRA models?

TVA Response to NRC Request 2

a. Main Steam Relief Valve (MSRV) success criteria (pressure relief mode) for ATWS sequences

The number of MSRVs required to open to mitigate an ATWS sequence initiated by main steam isolation valve (MSIV) closure is the same in the pre-EPU PRA models as in the EPU PRA models. The number of valves required to open in the BFN PRA model is nine. EPU MAAP calculations demonstrate that eleven MSRVs are required to open under EPU conditions. As discussed below, this difference in the PRA model versus the MAAP results regarding the number of required MSRVs to open is documented in problem evaluation report PER 96035.

b. MSRV Success Criteria (Pressure Relief mode) for transient sequences with pressure challenge

The number of MSRVs required to open in response to a transient event with a pressure challenge is the same in the pre-EPU PRA models as in the EPU PRA models. The number of valves required to open in the BFN PRA model is three.

c. Number of MSRVs required to reclose

The number of MSRVs required to close on a transient event with a pressure challenge is the same in the pre-EPU PRA models as in the EPU PRA models. The number of MSRVs required to close for this event is eight.

For ATWS sequences (both pre-EPU and EPU), the number of MSRVs required to close is thirteen.

d. Technical Bases for MSRV success criteria

Pre-EPU MSRV success criteria bases

The technical bases for the pre-EPU (i.e., Units 2 and 3 at current licensed thermal power) success criteria are derived from a combination of generic data, simplified analyses, and plant specific MAAP evaluations.

During ATWS scenarios, success requires nine of the thirteen MSRVs to open. This success criterion is based on the assumed reactor power level after MSIV closure and the automatic trip of the reactor coolant recirculation pumps. As reported on page 24 of NUREG/CR-3470, "ATWS At Browns Ferry Unit One – Accident Sequence Analysis," July 1984, tripping the reactor coolant recirculation pumps reduced reactor power from the initial 100% level to 28% of rated power after 50 seconds. Additionally, on page 5 of NUREG/CR-3596, "Severe Accident Sequence Analysis (SASA) Program Sequence Event Tree: Boiling Water Reactor Anticipated

Transient Without Scram," April 1984, it is estimated that reactor power will be immediately reduced by approximately 50% to 70% after pump trip, thus placing the reactor power level between 30% to 50% of rated thermal power. Using this latter estimate as an upper bound, it was conservatively assumed that the reactor power level would be 50% to 55%. Section 4.4.5 of the UFSAR states that the thirteen MSRVs are capable of relieving 84.1% of (based on Unit 1 pre-uprate) rated steam flow. Therefore, each MSRV is conservatively assumed to be capable of relieving 6% of rated steam flow. Consequently, nine valves would be required to open to relieve 54% of the rated steam flow. Opening nine MSRVs would mean that all three groups of MSRVs are affected; thus, it is assumed that all thirteen MSRVs open. Therefore, it is conservatively assumed that all thirteen MSRVs (since all three groups are affected) are required to close.

During non-ATWS scenarios involving a pressure challenge, success requires three of thirteen MSRVs to open. This number is based on the success criteria from NUREG/CR-4550, Vol. 4, Rev. 1, "Analysis of Core Damage Frequency: Peach Bottom, Unit 2 Internal Events," August, 1989. In addition, plant-specific MAAP analyses have been performed that confirm three MSRVs are required to remain below the ASME limit (1375 psig). The results of the plant-specific MAAP analyses are summarized in the table below.

Number of MSRVs Opening	Peak Pressure (psia)	Time of Peak Pressure (sec)
1	1445.4	14.4
2	1390.7	14.1
3	1343.4	12.5

It was assumed that the first two groups of MSRVs (involving eight MSRVs) would lift and, hence, eight MSRVs are required to close. (There are three groups of MSRV setpoints as noted in Tables 4.4-1 and 4.4-1A of the BFN UFSAR.)

EPU MSRV success criteria

The results of the recently performed MAAP analyses indicate that eleven MSRVs are necessary to maintain pressure below 1500 psig. Ten functioning valves resulted in a pressure curve that briefly (less than ten seconds) exceeds 1500 psig. Peak pressure with ten functioning valves is approximately 1535 psig. For the cases analyzed (ten, eleven, and twelve

functioning valves), each additional failed valve results in approximately a 50 psi increase in peak pressure.

The BFN PRA model MSRV success criterion for ATWS scenarios remains nine out of thirteen for EPU conditions. Because the MAAP analyses indicate eleven MSRVs are necessary to maintain pressure, TVA initiated a problem evaluation report (PER 96035) to document this issue in the BFN Corrective Action Program. Corrective actions will include a model revision for ATWS scenarios and use of eleven MSRVs as a success criterion.

The discussion presented above considers positive reactivity insertion early in the transient sequence. To account for the effects of a small amount of positive reactivity due to the increase in pressure, the above discussed series of MAAP runs were made to determine how many MSRVs are necessary to maintain peak pressure below 1500 psig. Since MAAP does not have neutronic modeling capability, it was necessary to manually adjust the initial power level in the MAAP analyses to reflect the reactivity insertion due to vessel pressurization.

To demonstrate the sensitivity of the PRA results to MSRV success criteria, a number of sensitivity cases were considered. The sensitivity of calculated core damage frequency (CDF) and large early release frequency (LERF) to MSRV success criteria is shown in the table below for Unit 1. Because of model similarities, analogous results would be expected for Units 2 and 3.

Case	MSRV Success Criterion	MSRV failure likelihood	Sum of sequence frequencies with failed MSRV (RVO1) (CDF)	Sum of sequence frequencies with failed MSRV (RVO1) (LERF)	Total CDF percent increase	Total LERF percent increase
Base Case	9 of 13 open for success	7.325E-6	7.715E-12	7.715E-12	1.7666E-6 N/A	4.3970E-7 N/A
Case 1	11 of 13 open for success	4.903E-5	9.434E-11	9.012E-11	1.7667E-6 0.006%	4.3977E-7 0.016%
Case 2	10 of 13 open for success	3.604E-5	6.756E-11	6.446E-11	1.7666E-6 0.0%	4.3975E-7 0.001%

The BFN PRA model MSRV success criterion for ATWS scenarios remains nine out of thirteen for MSRV opening. Note that if the criterion were to be eleven of thirteen for success, then the increase in CDF is less than 0.01% and the increase in LERF is less than 0.02%.

For non-ATWS event sequences, a large margin exists to vessel integrity challenges. Therefore, no new risk calculations were performed for EPU conditions. With three MSRVs opening in response to a non-ATWS pressure challenge, peak pressure remains well below levels that would challenge vessel integrity.

e. Modeling of different number of MSRVs failing to reclose

In the model for each of the three units, the top event that models MSRVs closing is a multi-state top event that models zero MSRVs stuck open, one MSRV stuck open, and two (or more) MSRVs stuck open.

A recent MAAP analysis performed for EPU conditions indicated that a single stuck open MSRV would depressurize the vessel for low pressure injection before core damage occurred, even with no high pressure injection. This approach is reflected in the Unit 1 PRA documentation and could be applied to Units 2 and 3 in a future revision. A safe and stable condition for such an event is low pressure injection with suppression pool cooling by one Residual Heat Removal (RHR) system pump and heat exchanger. High Pressure Coolant Injection (HPCI) system or Reactor Core Isolation Cooling (RCIC) system with RHR suppression pool cooling is also a safe and stable condition if the MSRVs close after depressurization has occurred. For two MSRVs stuck open, Core Spray (CS) system or Low Pressure Coolant Injection (LPCI) with one pump and suppression pool cooling with one RHR pump is a safe and stable condition.

The existing models for Units 2 and 3 were developed prior to performing the above analysis that indicated one MSRV valve could effectively depressurize the vessel prior to core damage. In the current Unit 2 and Unit 3 models, additional actions (e.g., operation of HPCI) are assumed to be required to depressurize the vessel to permit effective low pressure injection for the case of one stuck open MSRV.

Scenarios representing zero, one, or two (or more) stuck open MSRVs are represented explicitly in the event trees that reflect the response of the plant and operators to transient initiators. The event tree model does not transfer sequences with stuck open MSRVs to other event trees. Instead, the

logic necessary to represent the stuck open MSRV sequences is fully contained within the transient model event trees.

f. Common cause failure of MSRVs

The success criterion for transients involving a pressure challenge is that three of thirteen valves open. The independent failure modes are insignificant compared to the common cause modes. Current common cause failure parameters are limited to a group of six from both software and practical considerations. Thus, the best available approximation is to model failure as six valves failing to open.

For ATWS conditions, the success criterion is that nine of thirteen valves open. This is modeled as the common cause failure of five valves to open.

g. Common cause failure of MSRVs to reclose

Common cause failures of multiple MSRVs to close after opening is not modeled in the BFN PRAs. In the development of the models for all three units, it was assumed that the likelihood of a significant number of stuck open MSRVs is not a credible event.

NRC Request 3

During the PRA audit conducted the week of January 23, 2006, the audit team noted disagreement among the PRA model, the model documentation, and the explanations by the TVA PRA personnel regarding credit for control rod drive (CRD) injection in the post-EPU models. The staff also notes conflicting information in the RAI responses: The response to RAI SPSB-A.6.c (References 1 and 2) has a table that indicates "each unit models CRD injection." For Unit 1, RAI SPSB-A.21 says there is no credit for CRD. For Units 2 and 3, RAI SPSB-A.20 states that CRD is no longer viable; but SPSB-A.23 states that CRD is credited for some sequences.

For all three units, post-EPU: Provide details on whether CRD credited as an injection source. Describe the sequences for which CRD is credited. What is the basis for allowing credit? Provide the success criteria and timing for sequences where CRD is credited.

TVA Response to NRC Request 3

The RAI responses are correct, but clarification is provided below.

0 to 6 hours (Short-Term Response)

The pre-EPU models credited enhanced CRD flow as a success path in providing high pressure injection. Enhanced flow involves two CRD pumps and manual manipulation of valves. It is called for in block RC/L-4 of Emergency Operating Instruction (EOI) flowchart EOI-1 (RPV CONTROL) and described in EOI Appendix-5B (INJECTION SYSTEM LINEUP CRD). EPU eliminated enhanced CRD as a viable source of high pressure injection immediately after a scram. Due to the increased decay heat associated with EPU, the CRD system flow rate is not sufficient to maintain reactor vessel water level.

6 to 24 hours (Long-Term Response)

All of the BFN models partition HPCI and RCIC injection into an initial phase of 6 hours and a long-term phase from 6 to 24 hours. Enhanced CRD is viable after 6 hours because the decay heat at that time is reduced. The use of CRD is credited after 6 hours for level control in the Unit 2 and 3 models; however, it is not credited for level control in the Unit 1 model because this feature provides limited benefit on core damage frequency at this stage in the event sequence.

LERF Considerations

During the development of the Unit 1 model, a MAAP analysis indicated that CRD injection would be effective in some circumstances in preventing vessel melt through. A CRD top event for this purpose was placed in the Unit 1 model, but ultimately was not credited because the CRD injection rate provides limited impact on early core melt sequences.

In the Unit 2 and 3 models, a single CRD pump is assumed inadequate to cool the debris in the bottom head; enhanced CRD flow (e.g., starting a second CRD pump) is required. Therefore, CRD is not considered a viable system for averting early core damage scenarios; however, for Units 2 and 3 CRD is credited in providing water to the damaged fuel during late core damage sequences.

NRC Request 4

During the PRA audit, the audit team was told that core damage frequency (CDF) is quantified by first solving all the way through large early release frequency (LERF) and then "backing out" the CDF number. The team was also told that this practice results in some understating of the CDF number (i.e., a higher

CDF would be calculated if the PRA model was solved for CDF directly). For all three units, provide a sensitivity that shows how much CDF is "lost" due to the practice of quantifying all the way through LERF and then determining the resulting CDF. What types of CDF sequences are truncated because of this practice (i.e., is the "missing" CDF spread evenly across the plant risk profile, or are there sequence types that are preferentially truncated)? Discuss the impact of this practice on the risk results provided for EPU.

TVA Response to NRC Request 4

The practice noted in the NRC request is an inherent characteristic of the RISKMAN® computer code. The computer code calculates LERF, non-LERF, and CDF. The CDF is simply the sum of the LERF and non-LERF frequencies. The Level 2/LERF event trees (also known as Containment Event Trees or CETs) are linked to the Level 1 trees. If only Level 1 is quantified (i.e., the sequences do not pass through the CETs) and the truncation frequency is the same in the Level 2 calculation of record, then the truncation effect will be different for the two cases. A similar difference would be expected in a linked fault tree CDF model when it is modified to determine LERF. (The phenomenon is due to the slightly more complex model. The additional logic will result in a slight difference due to truncation).

The Unit 1 model was requantified in the "Level 1" mode where the calculation stops after determining core damage frequency. The resulting mean value of the CDF determined is 1.7781E-6 per year. The mean value for CDF that is determined in the Level 2 calculation (the one that corresponds to the reported LERF value) is 1.7666E-6 per year. The difference is 1.15E-8 or approximately 0.6%.

The sequential nature of the RISKMAN® computer code facilitates the ability to calculate either the Level 1 or Level 2 results with the same model. RISKMAN® does not calculate minimal sequences, but instead builds a database of unique possible combinations of success and failure. The sequences most likely to be retained in the Level 1 calculation and to then be truncated during the CET portion of the quantification are of very small frequency. In addition, they most likely are not new, unique failure combinations, but rather similar to sequences with higher frequency, but with fewer failures. It is unlikely that new, unique sequences are lost in the process of going from Level 1 to Level 2. The issue is not one of new or unique sequences of significance, but rather one of frequency.

The difference due to truncation is expected and is not significant. For consistency, the value 1.7666E-6 is reported as the mean CDF since it directly corresponds to the reported LERF value. Analogous results would apply for Units 2 and 3.

NRC Request 5

For all three units, provide an analysis of the sensitivity of core damage risk to an assumed increase in the initiating event frequency for turbine trip and for loss of feedwater to aid in understanding the uncertainties of these frequencies given modifications to the turbine electro-hydraulic control software and to the feedwater pumps and controllers. The staff would suggest doubling the existing frequencies for these sensitivity analyses, unless justification is provided for a different approach.

TVA Response to NRC Request 5

There are four initiating events for Unit 1 versus two initiating events each for Units 2 and 3 as discussed below. The difference is due to Unit 1 using the ASME standard as guidance, which calls for additional partitioning of selected initiating events.

Unit 1 Sensitivity

There are four initiators associated with turbine trip and loss of feedwater modeled in Unit 1, as follows:

Name	Initiating Event	Initiator Frequency (per year)	Initiator Contribution to CDF (per year)
TT	Turbine Trip	5.50E-1	1.90E-7
PLFW	Partial LOFW	2.47E-1	8.55E-8
TTA	Turbine Trip ATWS	5.50E-1	5.58E-8
TLFW	Total LOFW	2.58E-2	4.55E-8

The base model is U1050517, and it is copied to a sensitivity model U105517S where the initiator frequency for the above initiating events are doubled. The base case and the sensitivity results are as follows:

End State Group	Base Case Frequency (per year)	Sensitivity Case Frequency (per year)
NOLERF	1.33E-6	1.62E-6
LERF	4.40E-7	5.40E-7
CDF	1.77E-6	2.16E-6

Unit 2 Sensitivity

There are two initiators associated with turbine trip and loss of feedwater modeled in Unit 2, as follows:

Name	Initiating Event	Initiator Frequency (per year)	Initiator Contribution to CDF (per year)
TRAN	Turbine Trip	1.43E+0	4.42E-7
LOFW	Loss of FW	4.81E-2	4.81E-8

The base model is U2050530, and it is copied to a sensitivity model U205530S where the initiator frequency for the above initiating events are doubled. The base case and the sensitivity results are as follows:

End State Group	Base Case Frequency (per year)	Sensitivity Case Frequency (per year)
NLERF	1.20E-6	1.56E-6
LERF	3.51E-7	5.15E-7
CDF	1.55E-6	2.08E-6

Unit 3 Sensitivity

There are two initiators associated with turbine trip and loss of feedwater modeled in Unit 3, as follows:

Name	Initiating Event	Initiator Frequency (per year)	Initiator Contribution to CDF (per year)
TRAN	Turbine Trip	1.43E+0	4.74E-7
LOFW	Loss of FW	4.81E-2	4.97E-8

The base model is U3050531, and it is copied to a sensitivity model U305531S where the initiator frequency for the above initiating events are doubled. The base case and the sensitivity results are as follows:

End State Group	Base Case Frequency (per year)	Sensitivity Case Frequency (per year)
NLERF	2.38E-6	2.77E-6
LERF	3.84E-7	5.58E-7
CDF	2.76E-6	3.33E-6

The values in the above table are projected increases (for sensitivity purposes only) in CDF and LERF if the frequencies of the subject initiators are doubled. For all three units, doubling the initiating event frequency does have a measurable, but not significant, impact considering that the initiating event frequency was doubled.

NRC Request 6

For all three units, for important operator actions (i.e., Fussell-Vesely > .005 or Risk Achievement Worth > 2) that are time critical, justify that these actions can be completed within the time frame from receipt of the cue for the action to the point at which an irreversible plant state leading to core damage is reached under EPU conditions. (For this question, assume "time critical" means the action must be completed within 3 hours of the start of an initiating event or within 1 hour of receipt of the cue.) Provide the basis for the conclusion that the time available is sufficient to complete the action (e.g., information from simulator observations, job performance measures, walk-through, talk-through, etc.).

TVA Response to NRC Request 6

The adequacy of time to complete actions is a measure of the time to act compared to the time available. Reference 2 provides the methodology and basis for determining times to complete actions. This includes attributes such as time to recognize, diagnose, and accomplish the action. BFN MAAP evaluations are used to define the times available within which the operator must perform the action to avert a change to a failed state (e.g., maintain reactor vessel water level or initiate a safety function).

All three TVA PRAs for BFN take into account the time available and required to recognize and complete human actions as illustrated in Figure Q6-1. The objective is to correctly complete the action before the available time runs out.

The critical points in time can be generally described by the following events:

- The occurrence of the disturbance requires action. Initially, this is the start of a transient that causes a plant trip, but it could also be the entering of an intermediate state after shutdown (or ATWS).

- The point in time at which the plant transitions to a more degraded state that eliminates the option to accomplish the action. The designation used in the EPRI Calculator for total time between this and the initial disturbance is T_{SW}.

- The time between the beginning of the disturbance and the point at which a cue that something is wrong is presented to the operators is T_{delay}.

- The total time for the operators to complete their cognitive diagnosis of the problem and make the correct decision to accomplish the required manipulations is T_C.

- The time required to execute all the manipulations needed to align and initiate the equipment needed to accomplish the function is T_M.

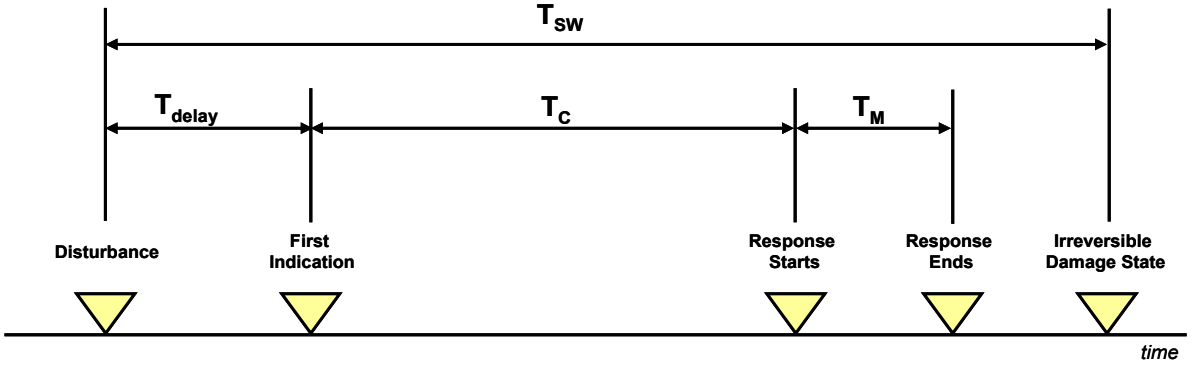

Figure Q6-1: Timeline for Cue-Response to a Plant Disturbance

The discussion of individual human error probabilities (HEPs) provided below consists of collecting documentation from, or providing references to existing reports. The Unit 1 HEPs are discussed separately from the HEPs for Units 2 and 3.

Unit 1

Table SPSB-A.7-1, provided in the response to RAI 1[a], presents the risk significant HEPs with respect to CDF for Unit 1 and is based on Model of Record (MOR) U1050517.

The Unit 1 PRA utilizes EPRI methodology, taking advantage of the formalization of approach and documentation provided within the EPRI human reliability analysis (HRA) calculator. The detailed report on each human failure event (HFE) generates a

figure similar to Figure Q6-1 and provides a structured format for documenting the sources of the judgments regarding the timeline for recognizing, diagnosing, and executing the action. These timelines are contained in the detailed descriptions of important HFE requested in Question SPSB-A.7 of the NRC Round 2 Requests for Additional Information (ML052430341). TVA transmitted its response to NRC Round 2 RAIs in Reference 4. The detailed HFE reports were provided in Appendix B of the letter.

Units 2 and 3

The BFN Unit 2 and Unit 3 PRAs document time related considerations using two different methodologies:

- *Failure Likelihood Index Methodology (FLIM)*. This methodology is equivalent to the Success Likelihood Index Methodology (Embrey et al., NUREG/CR-3518, 1984), but focuses on those aspects of the action that make it more difficult for the operators to complete the action. Time limitations are explicitly evaluated as a performance shaping factor contributing to a higher HEP.

- *An Approach to the Analysis of Operator Actions in Probabilistic Risk Assessment*, EPRI TR-100259, Parry, G. et al, 1992.

Tables SPSB-A.7-1 presented in response to RAI 1[a] above presents the important HEPs with respect to CDF for Units 2 and 3 based on models of record (MORs) U2050530 and U3050531, respectively.

The following paragraphs summarize the documentation for each of the important U2/U3 HEPs with respect to time constraints. Additional supporting documentation is contained within the BFN Unit 2 IPE (i.e., Appendix B of Reference 2).

HEP:	**OHC1**
Description:	Operator fails to take early action to control HPCI/RCIC injection
Source:	Reference 1
	From Table A-4:
	Continuous requirement - react within 5 minutes of high level alarm to prevent automatic HPCI trip at +55”. The time constraints for controlling level and pressure are based on potential mismatch of flow. The results of the hand calculation are included in Reference 1.

HEP:	**OHC2**
Description:	Operator fails control of HPCI for level control
Source:	Reference 1 From Table A-4: Continuous requirement; react within 5 minutes of high level alarm to prevent automatic HPCI trip at +55″. The time constraints for controlling level and pressure are based on potential mismatch of flow. The results of the hand calculation are included in Reference 1.
HEP:	**OHC3**
Description:	Operator fails to take early action to control RCIC injection
Source:	Reference 1 From Table A-4: Continuous requirement; react within 8 minutes of high level alarm to prevent automatic RCIC trip at +55″. The time constraints for controlling level and pressure are based on potential mismatch of flow. The results of the hand calculation are included in Reference 1.
HEP:	**OHL2**
Description:	Operator fails long term control of HPCI and/or RCIC given OHC=F
Source:	Reference 1 From Table A-4: Continuous requirement; react to alarm within 15 minutes of indication to prevent automatic trip at +55″. The 15 minute time frame is based on operator interviews.

HEP:	**OPERR_OLP1**
Description:	Operator fails to manually control LPCI/CS
Source:	Reference 1 From Table A-4: The action is not time sensitive. Initiate after cooldown. Over 2 hours to core uncovery from normal RPV level with no injection. Cooldown is assumed to take 4 hours. Two hours is based on decay heat at four hours and the amount of water required to boil off.
HEP:	**OPERR_OLP2**
Description:	Operator fails to open hardened wetwell vent - AC power avail - OP action to init SPC failed.
Source:	Reference 1 From Table A-4: Initiate after cooldown. Over 2 hours to core uncovery from normal RPV level with no injection. The results of the hand calculation are included in Reference 1.
HEP:	**OPERR_OSP1**
Description:	Operator fails to align for suppression pool cooling
Source:	Reference 1 From Table A-4: Not time sensitive because it is about 90 minutes before SP temperature exceeds 140°F. Temperature rise from alarm temperature of 95°F to RCIC upper design limit of 140°F. The results of the hand calculation are included in Reference 1.
HEP:	**OPERR_OSP3**
Description:	Operator fails to align suppression pool cooling, one RHR loop available, non-ATWS
Source:	Reference 1 From Table A-4: Not time sensitive because it is much more than one hour before SP temperature exceeds 140°F. See OSP1.

HEP:	**OSW1**
Description:	Operator fails to transfer mode switch to refuel/shutdown
Source:	Reference 1 From Table A-4: Not time significant.
HEP:	**OU11**
Description:	Operator fails to align U1 RHR loop II thru X-tie to U2 RHR loop
Source:	Reference 1 From Table A-5: 30 minutes to avoid core uncovery if injection into RPV lost during the initial phase of the flood. The results of the hand calculation are included in Reference 1.
HEP:	**OU12**
Description:	Operator fails to align RHRSW to Unit 2 RHR loop I
Source:	Reference 1 From Table A-5: 30 minutes if injection into RPV lost during initial phase of flood. Same analysis as OU12.
HEP:	**OF1**
Description:	Operator fails control of vessel level with feedwater, auto-control = S, one feedpump
Source:	Reference 1 Reference 1 (page 4-7) states that OF1 should be set equal to OF2, which was done in the PSA model From Table A-4 for OF2: Continuous requirement during cooldown. Respond to alarm within 5 minutes to avoid automatic trip. The response time is based on a flow anomaly four times the flow required to remove decay heat.

HEP:	**OLA1**
Description:	Operator fails to maintain vessel level at top of active fuel with RHR/CS
Source:	Reference 1 From Table A-4: Continuous requirement for close control until sub-criticality and refill From Table B.2.7: Time Window: less than or equal to 4 minutes (NUREG/CR-3470) The human error is a failure to turn on LPCI (or control level too low) and failure to inhibit LPCI during either depressurization or blowdown. The failure event corresponds to missing a step in the procedure since decision to depressurize already taken. The cue for controlling level based on completing previous steps. It is a high-stress situation.
HEP:	**OSV1**
Description:	Operator fails to defeat MSIV closure interlocks during ATWS
Source:	Reference 1: From Table A-4: Accomplish in first 10 minutes of transient, after reaching boron injection initiation time (BIIT); circa 7 minutes before SP reaches 110°F, forcing lowering of level. From Table B.2.13: Time Window: MSIV interlock bypass is called out in 2-C5-4 after reaching BIIT. OSV1 is failure to bypass MSIV closure logic given ATWS (unisolated RPV). It is an action taken concurrently with actions to initiate and control SLC injection, actions to insert control rods, and actions control FW. The given HEP is a screening value.

HEP:	**HER_HPRVD1**
Description:	Operator fails to depressurize given HPCI/RCIC hardware failed (OHPR=S)
Source:	Refer to the portion of this response corresponding to Unit 1.
HEP:	**ORVD2**
Description:	Operator fails to depressurize given HPCI/RCIC hardware failed and (OHPR=F)
Source:	Refer to the portion of this response corresponding to Unit 1.
HEP:	**OAD1**
Description:	Operator fails to inhibit ADS, ATWS, unisolated vessel
Source:	Reference 3 From Table SPSB-A.7-3: Time Constraints: Approx 8.5 minutes to -122" 4 minutes provided by timer. (For EPU the time indicated was reduced by a factor of 105/120 to reflect the increase in power.) The results of the hand calculation are included in Reference 1.
HEP:	**OSL1**
Description:	Operator fails to start SLC, unisolated vessel
Source:	Reference 3 From Table SPSB-A.7-3: Time Constraint: Slightly less than 3 to 5 minutes available to avoid level/ power control requirement. (For EPU the time indicated was reduced by a factor of 105/120 to reflect the increase in power.)

HEP:	**OSL2**
Description:	Operator fails to start SLC, isolated vessel
Source:	Reference 3
	From Table SPSB-A.7-3:
	Time Constraints:
	At 50% power SP reaches 110°F in about 2 minutes. However, ATWS runs indicate that power may be lower, at about 30%. (For EPU the time indicated was reduced by a factor of 105/120 to reflect the increase in power.)

References:

1. BFN PSA Human Reliability Analysis Notebook, Rev. 1, ABSG Consulting, Inc., April 2002
2. TVA Nuclear, Browns Ferry Nuclear Plant Unit 2 PSA, Volume 3, Revision 1, 1994
3. TVA letter to NRC for EPU, Units 2 and 3, dated December 19, 2005 (ML053560186)
4. TVA letter to NRC for EPU, Unit 1, dated December 19, 2005 (ML053560194)

NRC Request 7

During the PRA audit, the audit team noted that the Unit 1 event tree for ATWS has both an "OAL" and an "OTAF" top event, representing lowering level and maintaining level at the top of active fuel, respectively. However, there is no calculation in the Human Reliability Analysis (HRA) notebook for the OAL event, but there is a calculation for OTAF. The definition of OTAF appears to include both lowering level and controlling level at the top of active fuel. The PRA staff indicated that the intent is to only have one event, representing OTAF, in the event tree model. However, in the response to RAI SPSB-A.20 (Reference 1), the event HOAL2 (representing OAL) is one of the events with the highest Fussell-Vesely importance measure, indicating that it exists in the PRA model and has an associated human error probability.

Describe how events OAL and OTAF are modeled in the Unit 1 ATWS event tree. Provide the HRA for these events. Explain how dependency between these events is addressed.

Reference 1: Letter from Brian O'Grady, TVA, to NRC, "Browns Ferry Nuclear Plant (BFN) – Unit 1 – Response to NRC Round 2 Requests for Additional Information Related to Technical Specifications (TS) Change No. TS-431 – Request for Extended Power Uprate Operation (TAC No. MC3812)," December 19, 2005, TVA-BFN-TS-431 (ML053560194)

TVA Response to NRC Request 7

During the PRA audit it was noted that the OAL event does not belong in the event tree for Unit 1. It was originally in the trees as a placeholder for top event OTAF. When top event OTAF was placed in the event tree top event, OAL should have been deleted, but was not. The definition of OTAF includes both lowering level and controlling level at the top of active fuel. TVA initiated a problem evaluation report (PER 96035) to document this issue in BFN's Corrective Action Program. The impact of retaining this top event is an over-estimate of the CDF and LERF values from the ATWS core damage sequences.

NRC Request 8

For Units 2 and 3, provide an assessment of the increase in risk if only EPU is considered. For example, the effect of changing the high pressure coolant injection/reactor core isolation cooling common cause treatment was to lower risk, thereby offsetting part of the increase in risk that resulted from actual plant physical changes or reduced operator action timing. The staff notes that changing the common cause treatment does not represent a real change in risk. Changes in methodology, model enhancements, or correction of errors should be represented in both the base case model and the post-EPU model (or in neither) in order to obtain a representation of change in risk that is not masked by these nonphysical factors. Both the change in CDF and the change in LERF should be provided for both units.

TVA Response to NRC Request 8

The following table provides a summary risk comparison between the baseline pre-EPU (i.e., Units 2 and 3 at current licensed thermal power) and EPU. This information was previously included in Table 10-3 of the June 25, 2004, submittal (ML041840301) supporting EPU for Units 2 and 3. The pre-EPU model is a 2002 model and the EPU model is an assessment of CDF and LERF if only EPU is considered. The differences in CDF and LERF are due to EPU and not due to changes in methodology, model enhancements, or correction of errors. The revisions to reflect EPU included changes to HEPs and removing the credit for

enhanced CRD as a success path for high-pressure injection in the short term.

Summary Comparison of Baseline and Updated CDF and LERF

(all units yr^{-1}, mean value)

	Baseline (pre-EPU)	EPU
Browns Ferry Unit 2		
Total CDF	1.255E-6	2.624E-6
LERF	2.455E-7	3.927E-7
Browns Ferry Unit 3		
Total CDF	1.907E-6	3.361E-6
LERF	2.688E-7	4.532E-7

NRC Request 9

RAI SPSB-A.12 asked about the impact of increasing the ultimate heat sink temperature from 91 to 95 degrees on Units 2 and 3. However, the response (Reference 2) only addressed Unit 1. Please address this for Units 2 and 3 as originally requested. Identify the PRA basic events affected by this change.

Reference 2: Letter from Brian O'Grady, TVA, to NRC, "Browns Ferry Nuclear Plant (BFN) – Units 2 and 3 – Response to NRC Round 2 Request for Additional Information Related to Technical Specifications (TS) Change No. TS-418 – Request for Extended Power Uprate Operation (TAC Nos. MC3743 and MC3744)," December 19, 2005, TVA-BFN-TS-418 (ML053560186)

TVA Response to NRC Request 9

See TVA's response to RAI SPSB-A.12 dated March 7, 2006.