July 9, 2009

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Duane Arnold Energy Center
Docket 50-331
License No. DPR-49

Response to Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Duane Arnold Energy Center

References:

1. Letter, Richard L. Anderson (FPL Energy Duane Arnold, LLC) to Document Control Desk (USNRC), "Duane Arnold Energy Center Application for Renewed Operating License (TSCR-109)" dated September 30, 2008, NG-08-0713
2. Letter, Richard L. Anderson (FPL Energy Duane Arnold, LLC) to Document Control Desk (USNRC), "License Renewal Application, Supplement 1: Changes Resulting from Issues Raised in the Review Status of the License Renewal Application for the Duane Arnold Energy Center" dated January 23, 2009, NG-09-0059.
3. Letter, Charles Eccleston (USNRC) to Richard L. Anderson (FPL Energy Duane Arnold, LLC), "Request for Additional Information, Including a Revision to RAI 3.H, Regarding Severe Accident Mitigation Alternatives for the Duane Arnold Energy Center (TAC NO. MD9770)" dated June 25, 2009.

By Reference 1, FPL Energy Duane Arnold, LLC submitted an application for a renewed Operating License, including an Environmental Report. Reference 2 provided Supplement 1 to the application. By Reference 3, the U.S. Nuclear Regulatory Commission (NRC) Staff requested additional information regarding the Severe Accident Mitigation Alternative analysis provided in the Environmental Report.

The enclosure to this letter contains the NextEra Energy Duane Arnold, LLC, (f/k/a FPL Energy Duane Arnold, LLC) responses to the Staff's requests for additional information.

A001
NRR

This letter contains the following new commitment:

> Any conforming changes, resulting from our responses, will be transmitted in the annual update of our License Renewal Application.

If you have any questions or require additional information, please contact Mr. Kenneth Putnam at (319) 851-7238.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 9, 2009.

(FOR)

Richard L. Anderson
Vice President, Duane Arnold Energy Center
NextEra Energy Duane Arnold, LLC

Enclosure: DAEC Response to NRC SAMA – Related Request for Additional Information

Cc: Administrator, Region III, USNRC
Project Manager, DAEC, USNRC
Senior Resident Inspector, DAEC, USNRC
Project Manager, NRR – License Renewal
License Renewal Environmental Project Manager, USNRC
M. Rasmusson (State of Iowa)

SAMA RAI 1a

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   a. Anticipated transient without scram (ATWS) events are stated to contribute 29 percent of the CDF. This amounts to approximately 3E-06 per year and seems very high. Discuss why ATWS makes such a significant contribution to CDF.

DAEC Response to SAMA RAI 1a

Comparison to a similar plant indicates that the DAEC has a higher ratio of rated power to suppression pool volume. This attribute lessens the time available for control room operators to initiate boron injection and still be able to prevent excessive heatup of the primary containment using RHR in the suppression pool cooling mode.

SAMA RAI 1b

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   b. Provide a breakdown of the internal event CDF by initiating event down to those that contribute 1 percent or more to the total CDF (including internal floods). Provide the contribution from station blackout events if not separately provided in this listing.

DAEC Response to SAMA RAI 1b

The following initiating event contributions are derived from quantifying the Revision 5C internal events single top model at a truncation limit of 1.0E-11/yr.

Initiating Event	Percent of CDF
Loss of Offsite Power	37.0
Turbine Trip With Bypass	14.6
MSIV Closure	13.1
Inadvertent Open Relief Valve	11.1
Loss of Condenser Vacuum	5.5
Division 2 125 Volt DC Bus Failure	3.0
Manual Shutdown	2.6
Loss of River Water Supply	2.6
Small LOCA	2.5
Loss of Feedwater	2.3
Medium LOCA	1.8
Division 1 125 Volt DC Bus Failure	1.3

Internal floods contribute less than 1 percent and station blackout events contribute 34.1 percent of the internal events CDF.

SAMA RAI 1c

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   c. Table 3.1.1.1-1 lists dominant contributors to CDF based on a risk reduction worth (RRW) importance analysis of the CDF cutsets. A number of types of basic events appear to be missing from this list, such as initiating events and common cause failures. Describe the development of this listing and provide the complete importance analysis listing down to a RRW of 1.005.

DAEC Response to SAMA RAI 1c

Table 3.1.1.1-1 contains important components and important operator actions sorted by the RRW importance measure. The list was developed by running the Revision 5C single top model for internal events at a low truncation limit of 1.0E-13/yr. This creates a large cutset file containing approximately 360,000 cutsets. With the cutset file displayed in CAFTA, the menu option "view importances" was selected to calculate importance values for each basic event contained in the file. Basic events representing component failure or human action failure where RRW was calculated to be greater than 1.005 were selected for inclusion in the Table.

Common cause failure terms having a RRW of 1.005 or greater are:

Both Standby Diesel Generators	P-DG-1G2131Z	1.178
Both 125 Volt DC Batteries	P-BT-F1D1/2Z	1.167
HPCI and RCIC Pumps	H-TPCCHPRCIZ	1.039
SBLC Squib Valves	B-XVCC18A/BZ	1.011
Rx Vessel Safety Relief Valves	OCCFSRVTRNSZ	1.009

The complete importance analysis listing down to a RRW of 1.005 is provided below.

Table 1
Important Basic Events Sorted by RRW

Component	Description	Basic Event	Probability	RRW
	Loss of Offsite Power	%TE	0.0481	1.595
	Standby Diesel Generators (CCF)	P-DG-1G2131Z	0.00156	1.178
	Turbine Trip With Bypass	%TT	1.45	1.171
	125 Volt DC Batteries (CCF)	P-BT-F1D1/2Z	0.00002	1.167
	MSIV Closure	%TM-	0.45	1.149
	Inadvertent Open Relief Valve	%TI	0.05	1.121
	Operator Fails to Inject SBLC Early	B-OPSLCE---U	0.18	1.099
	Rx Vessel Safety Relief Valves	O-RVLOWPRESE	0.15	1.079
	Rx Vessel Safety Relief Valves	O-RVANYSRV-N	0.0675	1.075
1X003	161KV/4160VAC Startup Transformer	P-TR--1X003M	0.009	1.070
1G031	Div 1 Standby Diesel Generator	P-DG1G31---R	0.0138	1.065

Component	Description	Basic Event	Probability	RRW
1G021	Div 2 Standby Diesel Generator	P-DG1G21---R	0.0138	1.064
	Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)	FTPE-Q4--Q4-	0.33	1.059
	Loss of Condenser Vacuum	%TC	0.15	1.058
	Operator Fails to Vent Containment Per EOPs	V-OPTORVENTU	0.0023	1.053
	Operator Fails to Prevent Overfilling RPV	FTPE-L---L--	0.15	1.053
	Operator Fails to Recover Torus Cooling	L2OPNOREC--U	0.24	1.049
	Operator Fails to Lower RPV Level to TAF for ATWS Pwr Cntrl	FTPE-L1--L1-	0.034	1.042
	HPCI and RCIC Pumps (CCF)	H-TPCCHPRCIZ	0.003	1.039
1P226	RCIC Turbine/Pump	R-TP1P226--R	0.0216	1.037
E/P4914	Control Air Supply E/P Converter for CV4914	W-PRE/P4914E	0.0207	1.033
CB8490	Switchyard Control Breaker 'M'	P-CB8490---N	0.003	1.033
	Operator Fails to Inhibit ADS (ATWS with High Press Inj)	FTPE-X---X--	0.034	1.031
	Div. 2 - 125 Volt DC Bus Failure	%TDC2	0.001	1.031
RWS B	RWS Loop 'B' in Maintenance	W-MPMTRWSBDM	0.0075	1.031
	Operator Fails to Restore RPV Level Post ED (ATWS)	FTPE-L2--L2-	0.025	1.03
	Operator Fails to Recover Main Condenser (about 15 hrs)	C-OPNOREP--U	0.45	1.029
1G031	Div 1 Standby Diesel Generator	P-DG1G31---S	0.00632	1.029
	Manual Shutdown	%MSD	1.85	1.028
E/P4915	Control Air Supply E/P Converter for CV4915	W-PRE/P4915E	0.0207	1.028
1G021	Div 2 Standby Diesel Generator	P-DG1G21---S	0.00632	1.028
RWS A	RWS Loop 'A' in Maintenance	W-MPMTRWSACM	0.0075	1.027
	Loss of River Water Supply	%TR	0.00075	1.026
	Small LOCA	%S2	0.01	1.026
1P216	HPCI Turbine/Pump	H-TP1P216--R	0.0216	1.025
	Loss of Feedwater	%TF	0.05	1.024
	Operator Fails to Manually Initiate ADS (Non-Med LOCA)	O-OPMANDEP-U	0.00026	1.023
	Operator Fails to Prevent Overfilling RPV	FTPE-LA--LA-	0.46	1.023
	Medium LOCA	%S1	0.003	1.018
	Div 1 CS/LPCI LLP Interlock Logic	I-PIMTDV1LLM	0.006	1.018
	Operator Fails to Bypass HPCI/RCIC Low RPV Press Trip	FTPE-TR--TR-	0.123	1.018
	SBLC Loop 'A' in Maintenance	B-SLCATEST-M	0.0137	1.018
	SBLC Loop 'B' in Maintenance	B-SLCBTEST-M	0.0137	1.018
	Operator Fails to Follow EOPs for Cont. Ht. Removal	L-OPCHRTRNSY	0.000001	1.017

Component	Description	Basic Event	Probability	RRW
	Operator Fails to Vent Torus (Transients/LOCA)	V-OPVENTTRNY	0.5	1.017
	Operator Fails to Open an MSIV and/or Bypass Valve	C-OPCD03---U	0.3	1.017
	RCIC System in Maintenance	R-RCICINMNTM	0.0109	1.017
1D2	Div 2 - 125 Volt DC Battery in Maintenance	P-BTMT1D2--M	0.001	1.017
	Operator Fails to Inject SBLC Late (Within 14 Minutes)	B-OPSLCLAT3U	0.095	1.016
PS4529	RPV Low Pressure Permissive for LPCI/CS	I-PIPS4529-H	0.00495	1.016
PS4545	RPV Low Pressure Permissive for LPCI/CS	I-PIPS4545-H	0.00495	1.016
1D1	Div 1 - 125 Volt DC Battery in Maintenance	P-BTMT1D1--M	0.001	1.014
	Operator Fails to Bypass MSIV Isolation Interlocks (ATWS)	FTPE-Q3--Q3-	0.077	1.014
	Essential Switchgear Room Cooling Function	P-COOLNEED--	0.1	1.014
1A311	SBDG 1G031 to Bus 1A3 Circuit Breaker	P-CB1A311--N	0.003	1.013
	Div. 1 - 125 Volt DC Bus Failure	%TDC1	0.001	1.013
CB103	Operator Fails to Close Swing Charger Breaker CB103	P-OPCB103--Y	0.01	1.013
1A411	SBDG 1G021 to Bus 1A4 Circuit Breaker	P-CB1A411--N	0.003	1.013
	Operator Fails to Open CV4914	W-OPWS04---U	0.3	1.013
	Operator Fails to Initiate Condensate for Alt Inj	C-OPALTINJ-U	0.14	1.013
	Operator Fails to Open CV4915	W-OPWS02---U	0.3	1.012
1D2	Div 2 - 125 Volt DC Battery	P-BT1D2----J	0.0005	1.012
	Operator Fails to Inhibit ADS (ATWS with No High Press Inj)	FTPE-XA--XA-	0.46	1.012
	Div 2 CS/LPCI LLP Interlock Logic	I-PIMTDV2LLM	0.006	1.011
HPCI	HPCI System in Maintenance	H-HPCIMAINTM	0.0112	1.011
	Miscalibration of Low Press Permiss Instrumentation	I-OPLRESPERX	0.00008	1.011
1D1	Div 1 - 125 Volt DC Battery	P-BT1D1----J	0.0005	1.011
	Operator Fails to Shutoff HPCI or RCIC	H-OP14-----U	0.1	1.011
XS2618A/B	SBLC Squib Valves (CCF)	B-XVCC18A/BZ	0.005	1.011
1T218	SBLC Storage Tank	B-LSSLCTANKH	0.00495	1.011
1P226	RCIC Turbine/Pump	R-TP1P226--S	0.00627	1.010
	Feedwater Not Recoverable (Loss of FW event)	Q-FWNOTRECTF	0.67	1.010
PS4548	RPV Low Pressure Permissive for LPCI/CS	I-PIPS4548-H	0.00495	1.010
PS4530	RPV Low Pressure Permissive for LPCI/CS	I-PIPS4530-H	0.00495	1.010

Component	Description	Basic Event	Probability	RRW
	Operator Fails to Cntrl Rx Level Following Scram	Q-OPLEVEL-TT	0.11	1.009
	Large LOCA	%A	0.0003	1.009
	Operator Fails to Maximize Well Water to Circ Pit	Z-OPWELLWTRU	0.1	1.009
	HPCI Turbine Trips Due to False Signal	H-HPCITRIP--	0.008	1.009
	Rx Vessel Safety Relief Valves (CCF)	OCCFSRVTRNSZ	0.0001	1.009
	Operator Fails to Manually Depressurize RPV (ATWS)	FTPE-X1--X1-	0.068	1.008
	Operator Fails to Follow EOPs for Cont. Ht. Removal	L-OPCHRATWSY	0.034	1.008
	Operator Fails to Initiate Feedwater (Large LOCA/ATWS)	Q-OPFW99--LU	0.33	1.008
1G031	Div 1 Standby Diesel Generator in Maintenance	P-DGMT1G31-M	0.0019	1.008
1G021	Div 2 Standby Diesel Generator in Maintenance	P-DGMT1G21-M	0.0019	1.008
1P216	HPCI Turbine/Pump	H-TP1P216--S	0.00627	1.007
	Operator Fails to Recover Battery Charger	P-OPBCREC--Y	0.1	1.007
	Operator Fails to Manually Initiate ADS (Medium LOCA)	O-OPMNDPML-U	0.012	1.006
	Reactor High Level Trip System	H-LSLS4592DC	0.00495	1.006
	HPCI Fails to Operate at Low RPV Pressure	UH-2HPCIOP--	0.5	1.006
	Operator Fails to Repressurize RPV for HPCI	U-OP2NOREPRS	0.03	1.006
	Feedwater Not Recoverable (non-Loss of FW event)	Q-FWNOTRECT-	0.017	1.006
	Operator Fails to Open CV4910A	W-OPFFWS04--	0.1	1.005
	Operator Fails to Open CV4910B	W-OPFFWS03--	0.1	1.005
	Operator Fails to Close Breaker to Start GSW Pump	G-OPLOCSTRTU	0.05	1.005
	ESW Loop 'B' in Maintenance	E-ESWBMAINTM	0.0014	1.005
HS4914	RWS Loop 'B' Makeup Hand Switch	W-FIHS4914-C	0.0033	1.005
PDI2046	RHRSW Loop 'A' Hx Diff Press Indicator	W-FIPDI2046C	0.0392	1.005
PDI1947	RHRSW Loop 'B' Hx Diff Press Indicator	W-FIPDI1947C	0.0392	1.005

SAMA RAI 1d

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   d. The third most important contributor to CDF listed in Table 3.1.1.1-1 is PDI1947 with a RRW of 1.053. Table 5.1.2 indicates that this event is addressed by SAMA 165, however, Table 6-1 indicates that a plant modification not reflected in the PRA would reduce this event's RRW and therefore this SAMA is not applicable. Justify using a PRA for SAMA identification and evaluation that does not reflect the current plant design with regard to a failure that contributes over 5 percent of the CDF. Identify any other design changes that are not reflected in the PRA, and provide an assessment of the impact of the design changes on the importance analysis, the results of the SAMA identification process, and the results of the cost-benefit analysis.

DAEC Response to SAMA RAI 1d

Due to an error in the preparation of Table 3.1.1.1-1, the RRW for PDI1947 was erroneously stated to be 1.053. The actual value is 1.005, and as such, this instrument contributes only one-half of one percent of the total CDF calculated for the Revision 5C internal events model. As noted in Table 6-1 of the SAMA report however, the worth of PDI1947 and its counterpart PDI2046 are believed to be much lower based on a plant modification performed in 2001 which removed the automatic control of two RHRSW discharge valves in favor of manual control.

The Revision 5 PRA model incorporated plant modifications completed up to approximately 1999. Plant modifications completed prior to July 2008 are being reviewed for incorporation into the Revision 6 PRA model, which is currently under development. This listing of plant modification packages initiated since late 1997 has been reviewed for their potential impact on SAMA results. No completed modifications would have a non-conservative impact on SAMA results.

SAMA RAI 1e(i)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   e. With regard to Revisions 3 (also called 3A) and 3B of the DAEC PRA:

      i. The table on page F-15 indicates a CDF of 3.3E-05 per year and a date of March 1995 for Rev. 3A, and a CDF of 1.5E-05 per year and a date of August 1995 for Rev. 3B. Other dates are given for these revisions on page F-14. Confirm the CDF and the dates for these two PRA revisions.

DAEC Response to SAMA RAI 1e(i)

Revision 3A was completed in March 1995 with a CDF of 3.30E-05 per year. Revision 3B was completed in Jan 1996 with a CDF of 1.50E-05 per year.

SAMA RAI 1e(ii)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   e. With regard to Revisions 3 (also called 3A) and 3B of the DAEC PRA:

      ii. The identification of DAEC PRA model changes since the Individual Plant Examination (IPE) submittal combines the changes for Rev. 3A and Rev. 3B. Provide a separate listing of the major changes in Rev. 3A (that contribute to the net increase in CDF) and the major changes in Rev. 3B (that contribute to the net decrease in CDF).

DAEC Response to SAMA RAI 1e(ii)

The principal effects of Rev. 3A resulting in an increase in CDF were:

- Inclusion of control building flood event trees
- LOOP event tree enhancements
- Addition of sole dependence of DC power on 125 Volt DC batteries (chargers excluded) for LOOP and LOCA initiators
- Incorporation of revised control building HVAC assessment

Changes to the LOOP event tree model in Rev. 3A resulting in a decrease in CDF include:

- Revision to HPCI/RCIC battery life estimates
- Reclassification of the DAEC offsite power independence group
- Re-evaluation of LOOP initiating event frequency

The only change incorporated in Rev. 3B was to remove control building flood scenarios where water from ruptured fire water lines propagates from the control building HVAC room to the essential switchgear rooms. A modification to the fire water system eliminated these scenarios from consideration. This change reduced CDF.

SAMA RAI 1f(i)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

      i. Rev. 4 – Automatic depressurization system (ADS) Suppression added as a means for vapor suppression – Explain how ADS provides vapor suppression, which normally means condensing steam released to the drywell to limit containment pressure.

DAEC Response to SAMA RAI 1f(i)

Use of ADS for vapor suppression applies to non-LOCA accident sequences. The four ADS safety/relief valves are piped directly to the suppression pool. As such, steam coming directly from the reactor vessel is condensed in the torus water. When there is no breach of the reactor cooling system boundary, the vapor suppression system and the drywell spray system do not apply because no steam enters the drywell space that would need to be condensed.

SAMA RAI 1f(ii)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

      ii. Rev. 4 – Allowance for failure of decay heat removal upon success of high pressure coolant injection/reactor core isolation cooling for small LOCAs – Explain what is meant by allowance.

DAEC Response to SAMA RAI 1f(ii)

Allowance was a poor choice of words. A better summary statement would have been: The small LOCA event tree was revised in Revision 4 to include dependency of HPCI/RCIC on decay heat removal in small LOCA accident sequences.

Although HPCI and RCIC are capable of providing successful vessel injection early in the event, cooling of the containment is ultimately required to prevent core damage as a result of excessive containment heating.

SAMA RAI 1f(iii)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

      iii. Rev. 4 – Sequences for loss of offsite power (LOOP) events with stuck-open relief valve categorized as LOOP to inadvertent open release valve – Clarify this statement.

DAEC Response to SAMA RAI 1f(iii)

Prior to the Revision 4 update, LOOP sequences with subsequent failure to reclose safety/relief valves were transferred to the MSIV closure event tree. These sequences are now transferred to the stuck open relief valve (SORV) event tree or to the inadvertent open relief valve (IORV) event tree where the plant conditions are more accurately characterized.

SAMA RAI 1f(iv)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

      iv. Rev. 4 – Revision of event trees for human error probabilities or containment heat removal – Explain how event trees are used for human error probabilities (HEPs) and containment heat removal (CHR).

DAEC Response to SAMA RAI 1f(iv)

The statement should have read: "Revision of event trees for human error probabilities <u>for</u> containment heat removal."

Containment heat removal is a node on an event tree while HEPs are generally in the system fault tree.

SAMA RAI 1f(v)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

      v. Rev. 4 – Incorporated initiating event frequencies for transients and manual shutdown – Explain how transients and manual shutdown were previously represented.

DAEC Response to SAMA RAI 1f(v)

Transients and manual shutdowns were included in the previous models. These were updated, not introduced, in Rev 4. The statement should read, "Updated initiating event frequencies for transients and manual shutdown to reflect recent operating history."

SAMA RAI 1f(vi)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

      vi. Rev. 5 – Incorporated changes with smaller impacts as result of BWROG certification comments – Identify which of the Revision 4 and 5 changes were in response to the BWROG comments.

DAEC Response to SAMA RAI 1f(vi)

In Revision 5, a fault tree for instrument air was developed in response to the following Level B comment:

> Some support systems are "black-boxed" (i.e., Instrument air in the Vent; Reactor Building Closed Cooling Water (RBCCW) in Control Rod Drive (CRD)). Also, there are cases where support dependencies are modeled only if they are an initiator. Independent failure of support systems, post-initiator, could be reviewed.

Also in Revision 5, component failure probability data were updated in response to the following Level B comment.

> All independent failure probabilities used in Revision 3B of the PSA model are generic values taken from a variety of generic data sources. The ability to use the PSA model in many potential applications, particularly regulatory applications, is strongly influenced by the amount of plant-specific equipment performance reflected in the model. Exclusive use of generic data for independent component failures significantly limits the utility of the PSA model for applications.
>
> Incorporate plant-specific equipment performance data into the model, especially for major equipment such as EDGs and pumps.

No changes were made to the PRA model in Revision 4 as a result of BWROG certification comments.

SAMA RAI 1g

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   g. Table 3.1.1.1-1 gives a risk reduction worth (RRW) of 1.053 for PDI1947 and 1.005 for PDI2046. From the descriptions provided, these events appear to involve the same instrument but in different loops of the residual heat removal service water. Explain why the RRW values are so different.

DAEC Response to SAMA RAI 1g

Due to an error in the preparation of Table 3.1.1.1-1, the RRW for PDI1947 was erroneously stated to be 1.053. The actual value is 1.005, which is the same as the RRW for its counterpart instrument, PDI2046.

SAMA RAI 1h

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   h. None of the listed changes incorporated in the DAEC PRA explicitly include updating the component failure rates to reflect DAEC plant-specific data. Clarify if and when this was done.

DAEC Response to SAMA RAI 1h

In Revision 4, a Bayesian update of initiating event frequencies was performed. Also, maintenance unavailability terms for individual pumps in the RHR, RHR Service Water, and River Water Supply systems were developed based on Maintenance Rule data. In Revision 5, failure rate of key plant equipment was updated based on plant-specific data.

SAMA RAI 1i

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   i. Provide a description of the Level 1 and 2 PRA update process, the quality control of PRA model changes, and the independent review and approval of the PRA model update documentation. Include a discussion of the results of any independent reviews that have taken place of the Level 1 and/or the Level 2 models other than that by the BWROG.

DAEC Response to SAMA RAI 1i

DAEC Department Instruction PSAG-1, "Quality Assurance Control Guidelines" defines responsibilities, authorities, and requirements for developing, maintaining, updating, and applying configuration management of the DAEC PRA model and supporting documentation. The intent of this document is to ensure compliance with industry and DAEC-specific standards for quality assurance commensurate with the application of the PRA tool. Department Instruction PSAG-2, "Maintenance and Update of PRA" provides guidance for maintenance, revision, and configuration management of the PRA model and associated documentation, and of PRA software. Areas covered by this guideline are:

1. Monitoring and collection of new information
2. Criteria for initiating model maintenance or model updates
3. PRA maintenance activities
4. PRA update activities
5. Evaluation of results
6. Evaluation of past PRA applications
7. Documentation

A PRA change database is maintained where plant modifications or procedure changes with potential impact on the PRA model are logged. Also logged are model and documentation errors found in the course of using the PRA and potential enhancements to the PRA. Information added to the database is assessed as to whether performing near-term model

maintenance is appropriate or whether the information warrants performing a more involved model update.

PRA model changes and associated documentation are reviewed by qualified individuals within FPL's corporate PRA department, which includes DAEC PRA personnel. If appropriate, changes and associated documentation are also reviewed by site System Engineering, Training, or Operations personnel. Completed documents are approved by either site or corporate supervisory personnel responsible for PRA activities.

A self-assessment of the DAEC PRA program was performed in May of 2004. The primary focus of the assessment was to ensure the DAEC PRA program complies with applicable standards and to identify potential program enhancement opportunities. The assessment team included individuals from one neighboring PWR and one neighboring BWR. The team concluded that, in general, the DAEC had established, implemented, and maintained a PRA program consistent with applicable fleet standards (at that time the DAEC was part of Nuclear Management Company).

SAMA RAI 1j

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   j. Confirm that the BWROG review scope included internal flooding as well as the Level 2 model, and that PRA Rev. 3B was the version that was reviewed.

DAEC Response to SAMA RAI 1j

The scope of the BWROG PSA Peer Review conducted in March 1997 included internal flooding as well as the Level 2 model of PRA Rev. 3B.

SAMA RAI 2a

2. Provide the following information relative to the Level 2 PRA analysis:

   a. It is stated that no major changes have been made to the Level 2 PRA model since the IPE submittal. Since the IPE Level 2 model was based on the state of knowledge in the 1991-1992 time frames, discuss the impact of the current state of knowledge regarding BWR accident progression and containment failure mechanisms on the DAEC Level 2 model and the evaluation of SAMAs using this model. Include a discussion of how implementation of the severe accident management program (including emergency procedure and severe accident guidelines) and the B.5.b security enhancements would impact the results of the Level 2 analysis and the identification and evaluation of SAMAs.

DAEC Response to SAMA RAI 2a

The statement made in the SAMA report that no major changes have been made to the Level 2 PRA model since the IPE submittal is referring to the status of the containment event trees and supporting data. It is true that this model has not been substantially changed since the 1991-1992 time frame. With each update to the internal events model

however, new Level 1 accident sequences--for which severe accident management program enhancements have been considered--have been tied into the existing Level 2 event trees so that Level 2 quantified results appropriately reflect all the changes made to the Level 1 model.

The question implies that there has been a major change in the state of knowledge regarding accident progression and containment failure mechanisms between 1992 and today. Though some licensees have upgraded their containment performance analyses and associated documentation, these changes have been mainly due to the need to address peer certification findings and observations, and not to incorporate new information regarding accident phenomena. Based on the results of peer assessments performed in 1997 and 2007, the original Level 2 analysis performed for the DAEC is comprehensive and is acceptable for supporting risk-informed applications such as SAMA and can still be considered "state of the art".

The expectation is that the implemented Emergency Operating Procedures, Severe Accident Management Guidelines and Security enhancements would lower the release frequency and reduce the impact of an accident. Thus, they would reduce the worth of any SAMA. These are being incorporated into the Revision 6 PRA model.

SAMA RAI 2b

2. Provide the following information relative to the Level 2 PRA analysis:

   b. Table 3.4.4-1 gives general emergency declaration times which, when compared with the release times from scram of Table 3.4.3-2, indicate that for 3 of the 4 "late" release categories the release begins well before 6 hours after declaration of a general emergency and are therefore "early" releases using the definition of early from the IPE. It is also noted that a number of the release fractions in Table 3.4.3-2 (M/L, M/I, L/I, L/E, LL/I) do not meet the definitions for release magnitude of the IPE. (The IPE is referenced here because the ER does not define the criteria used to classify releases in terms of release timing and magnitude.) Discuss the source category definitions with respect to timing and magnitude of release, the assignment of containment event tree endpoints to release categories, the development of the release fractions, the selection and definition of representative sequences, material access authorization program code version utilized for source term analysis, and the impact of the above apparent source term category disparities on the SAMA results.

DAEC Response to SAMA RAI 2b

Table 3.4.4-1 and Table 3.4.3-2 are not directly comparable.

Release Timing: The early, intermediate, and late releases are defined in terms of the time interval from accident initiation to general emergency declaration; the time intervals are <6 hours, 6-24 hours, and ≥ 24 hours, respectively. The time to core damage for each sequence was readily available in the MAAP results. This parameter was conveniently (and conservatively) chosen to represent the emergency declaration time (from SCRAM) of each of the modeled sequences in the SAMA Level-3 analysis. The emergency declaration times in SAMA Table 3.4.4-1 correspond to the core damage times used in the SAMA Level-3 analysis rather than PRA Level-2 timing. Sensitivity analyses (see SAMA Table 8.4-1)

showed that the site specific dose risk was insensitive to the choice of emergency declaration time. If the emergency declaration time for each release category was taken as zero (coincident with SCRAM, the earliest reasonable declaration time) the total Duane Arnold dose risk would be 2% less than the base case dose risk; if this declaration time was coincident with the first nuclide release to the environment (the latest reasonable declaration time), the dose risk would be 1% greater than the base case dose risk. Note that the emergency declaration time does not affect the cost risk.

Magnitude of Release, CET Endpoints and Release Category: CET Endpoints were assigned to release bins during the Level-2 PRA analysis. Those bins were defined as High (H), Moderate (M), Low (L), and Low-Low (LL). In general, the sequences were assigned according to their release fraction of CsI, with the release of that chemical species generally decreasing as the bins go from H to LL. As noted in the RAI, the CET Endpoints are also assigned according to their release timing relative to emergency declaration. As discussed above (see Release Timing), the choice of release timing is not a significant risk differentiator.

Release Fractions: Release fractions to the environment were obtained from the MAAP .TAB output files. The time intervals from those files, which typically exceeded in number the MACCS2 limit of 4 release time intervals, were generally chosen to best represent the transient release characteristics of the most important dose contributing nuclides (Cs, Noble Gases, I); i.e., release segment end times corresponding to changes in the slope of the release fraction/time relationship. Time intervals were also selected to meet the MACCS2 input criterion of a maximum of 24-hours. When it was necessary to limit release segment time intervals, releases were conservatively assigned to earlier rather than later segments. In all cases, the total nuclide release was conserved. That is, the total nuclide releases to the environment in the MACCS2 simulation were those indicated in the MAAP simulations, thus, accounting for the full radionuclide release.

Representative Sequence Selection: The Level-2 analysis sorted the various sequences by both release bin and accident class. The choice for the Duane Arnold SAMA analysis was to classify potential releases to the environment and the resulting overall risk by the release bins. Representative sequences for each of the bins were chosen to result in a conservatively large risk from those bins. The Duane Arnold Level-2 analysis identified multiple sequences for each release class. Representative sequences were based on availability of sequence simulations (MAAP files) and a general choosing of more conservative (larger release, larger risk) sequences. In many cases, when the choice of a representative sequence wasn't obvious, multiple sequences were simulated with MACCS2 and the sequence resulting in the largest risk chosen.

MAAP Code Version: MAAP code version 3.0B, revision 7.03 was utilized for source term analysis.

Affect of Source Term Category Choices on SAMA Results: Because the source term categories and accompanying parameters were chosen to result in conservative (large) risks, the SAMA results are conservative.

SAMA RAI 3a

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   a. Section 3.1.2 lists external event CDF values for PRA revisions 3B through 5C. Clarify whether any changes were made to the external events models in these revisions, or whether these values only reflect the changes to the internal event models for these revisions. Describe the external event model changes, if any.

DAEC Response to SAMA RAI 3a

In 1997, a PRA model was created for the DAEC consisting of fire and seismic initiated events. Logic model elements and assumptions from the Revision 3B internal events PRA model were employed in the creation of this original external events model.

In 1999, the external events model was updated to incorporate logic model elements and assumptions from the Revision 4A update to the internal events model. The scope of the fire portion of the model was expanded at this time to include additional fire areas, but the methodology used for both the fire and seismic portions did not fundamentally change from that used in the original analysis.

For subsequent updates of the internal events model, new external event models were created by replacing older system fault trees with updated trees. Evaluation methods for fire and seismic initiated events were not revised. Therefore, the CDF values cited in Section 3.1.2 reflect only the changes to the internal event models for these revisions.

SAMA RAI 3b

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   b. Provide more information on the development of the current seismic PRA beyond that provided in Section 3.1.2.2.1. Include a discussion of: the nature of the seismically induced core damage sequences, the treatment of loss of offsite power and its recovery, the determination of the fragilities utilized in the model for equipment and structures, the human error probabilities employed, the major conservatisms and/or non-conservatisms in the model, and the results of any reviews of the model (peer, independent/consultant, or other). Include discussion of failure of the turbine lube oil tank and potential fire as discussed extensively in the staff SER on the DAEC IPEEE.

DAEC Response to SAMA RAI 3b

Event trees were developed and quantified for different discrete hazard intervals from 0.1 g to 1g or nearly ten times the DAEC safe shutdown earthquake (SSE) based on the NUREG-1488 seismic hazard rates. The seismic event trees credited only systems on the DAEC Safe Shutdown Equipment List (SSEL) and containment hard pipe vent. The SSEL equipment or systems of interest were:

- Reactivity Control

- Safety Relief Valves
- Main Steam Isolation Valves
- Core Spray
- Residual Heat Removal
- Containment Isolation
- Emergency Diesel Generators, support systems and electrical distribution
- Emergency Service Water
- RHR Service Water
- Essential Room Cooling
- River Water Supply

The seismic event trees consider the following issues:

- Wide-Spread SSEL failure
- Turbine Lube Oil Tank collapse
- Loss of Offsite Power (LOOP)
- Reactor Scram
- RPV depressurization
- Low pressure injection
- Containment heat removal

Wide-spread SSEL failure event tree node considers the possibility of a seismic-induced common cause failure of SSEL equipment by considering component fragility dependence and plant High Confidence Low Probability of Failure (HCLPF). Component fragility dependence was assumed to be an exponential function while plant HCLPF was determined based on the approach suggested by NUREG/CR-4334. The Turbine Lube Oil Tank collapse event tree node was explicitly evaluated due to the low HPCLPF value of the turbine lube oil tank supports (0.05 pga). Similarly, Loss of Offsite Power was explicitly evaluated due to the HCLPF of the offsite power insulators (0.1pga). The fragility of the offsite power was considered comparatively high and recovery of the seismic-induced LOOP was not credited, due to the construction of the ceramic insulators in the switchyard.

To begin estimating component fragilities, the DAEC Integrated Plant Examination External Events (IPEEE) margins analysis was reviewed to identify any DAEC unique seismic capacity issues. Though the total core damage frequency for the Turbine Lube Oil Tank failure was below the 1E-6/yr IPEEE screening threshold, its unreliability was a significant contributor to the DAEC seismic risk profile during the IPEEE walkdowns. The Turbine Lube Oil Storage tank HCLPF of 0.05 pga was established by the walkdown information that indicated the support structure would likely buckle at 0.12g (DAEC SSE). EPRI NP-6041 was used to assign a value of 0.5 pga for the DAEC Mark 1 containment. HCLPF values for other SSEL equipment were based upon the NUREG/CR-4334 expert opinion values.

The seismic model did not incorporate any new specific human error probabilities or change any that existed in the internal events model.

The following aspects of the model introduced conservatism:

- The seismic event trees credit only systems on the DAEC Safe Shutdown Equipment List except for Hard Pipe Containment Vent which was installed to Class 1 seismic standards.

- No recovery is credited for offsite power or for equipment in the model.
- The seismic hazard frequency for each interval is the frequency of the lowest seismic activity, whereas the damage is evaluated with the highest seismic activity in an interval.

The following aspects of the model may have introduced non-conservatism:

- Seismic induced Anticipated Transients Without Scram core damage sequences are unanalyzed in the event trees as they are low frequency sequences.
- Dependencies among seismic induced component failures are assumed to follow an exponential curve.

No specific peer reviews have been completed for the DAEC seismic model.

The Turbine Lube Oil Tank collapse is modeled where following the failure of the lube oil tank and subsequent ignition, the sequence modeling conservatively assumes an uncontrolled fire. The damage from such a fire includes failure of adjacent SSEL equipment. At the low seismic activity level interval of 0.01 to 0.05 g, offsite power is credited due to the low fragility of offsite power at this seismic activity level. Ignition is assigned a failure probability of 0.1 after tank support buckling.

SAMA RAI 3c

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   c. The NRC staff safety evaluation report (SER) on the individual plant examination of external events (IPEEE) (p. 13) discussed rerouting of certain cables so that they would not pass through the cable spreading room, and indicated that this was nearing completion at the time of the IPEEE submittal. Confirm that this has been completed.

DAEC Response to SAMA RAI 3c

The rerouting of cables discussed in the IPEEE submittal and NRC Staff SER has been completed.

SAMA RAI 3d

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   d. Provide more information on the development of the current fire PRA beyond that provided in Section 3.1.2.1.1. Include a discussion of: the source and validity of fire ignition frequencies relative to the concerns about these values raised in the technical evaluation report (TER) for the DAEC IPEEE, the fire growth and suppression analysis including codes employed and major assumptions, assumptions regarding fire barrier effectiveness, conservatisms and non-conservatisms in the model, and the results of any reviews of the model (peer, independent/consultant, or other).

DAEC Response to SAMA RAI 3d

Modeling the external events fire sequences consists of three main steps:

- Determining the fire ignition frequency for each fire compartment;
- Performing fire growth and suppression analysis; and
- Determining the fire-induced CDF

The individual fire compartment fire ignition frequencies used are taken from the DAEC IPEEE Fire-Induced Vulnerability Evaluation (FIVE) (PLC 1992) analysis. As noted in the TER for the DAEC IPEEE, the existence of cables not meeting IPEEE 383 (Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations) was ignored in the original fire ignition frequency calculations. The quantity of non-IEEE 383 qualified cabling in the plant was determined to be limited and was judged to have an insignificant impact on the overall results of the fire evaluation. The IPEEE reviewers noted that the assumption that non-IEEE 383 cabling is evenly distributed throughout the plant may be optimistic given that the amount of such cabling could be large in some areas relative to others. In the current fire model, the contribution of non-IEEE 383 cabling to compartment fire ignition frequencies is still assumed to be inconsequential.

In the TER for the DAEC IPEEE, it was also noted that the fire frequency for the cable spreading room appeared to be optimistic compared to cable spreading room fire frequencies cited in NUREG/CR-4840 and the FIVE Plant Screen Guide. The cable spreading room was screened from further quantitative evaluation in the IPEEE based on the absence of fixed ignition sources in the room. In the current fire model, the cable spreading room is still screened from detailed quantitative evaluation based on lack of fixed ignition sources and on minimal opportunity for hot work resulting in fire of a magnitude necessitating plant shutdown.

The fire growth and suppression analysis makes use of data from the EPRI Fire Events Database to quantify nodal probabilities of a Fire Growth and Damage event tree for each fire compartment being assessed. The purpose of the Fire Growth and Damage event trees is to:

- Remove conservatisms inherent in the FIVE fire compartment ignition frequencies; and
- Characterize the fire damage states on a fire compartment basis for analysis in the fire induced core damage event trees.

The Fire Growth and Damage event trees address the following issues:

- Fire ignition type
- Self-termination and instant manual suppression
- Automatic and manually initiated suppression systems
- Fire brigade response
- Suppression-induced equipment damage
- Fire barriers
- Fire-induced trip/shutdown

The end states of the Fire Growth and Damage event trees are fire damage states. These are defined as follows:

- **Category A**: Fire-induced trip but no damage to equipment modeled in the PRA. No transfer to fire-induced core damage event trees.

- **Category B**: Fire-induced trip and damage to the equipment (component, train, or system, whichever is appropriate) in the fire compartment with the highest RAW importance value. Information is transferred to fire-induced core damage event trees.

- **Category C**: Fire-induced trip and damage to multiple pieces of equipment in the compartment. Equipment damage is based on deterministic fire modeling in the IPEEE fire analysis. Information is transferred to fire-induced core damage event trees.

- **Category D**: Multi-compartment fire. No transfer to fire-induced core damage event trees due to low frequencies.

The core damage frequency associated with each evaluated fire compartment is determined by constructing and quantifying fire induced core damage event trees. An event tree is developed for each unique fire damage state (Category B or Category C) for each fire compartment. The supporting system fault trees for the fire event trees are based on current internal event system fault trees. Credit is not given for recovery of equipment lost due to fire, including offsite power sources.

The following aspects of the model introduced conservatism:

- It is assumed that a reactor trip would be generated (either automatically or manually) for all fires inside the security fence. This assumption is consistent with AOP 913, FIRE, which requires manual shutdown of the plant for fires inside the security fence that cannot be extinguished within 10 minutes.
- Unprotected cables entering and exiting the metal-enclosed component are considered to be susceptible to failure for even low intensity fires.
- Internal cabinet fires are assumed to disable the entire MCC or cabinet.
- The DAEC IPEEE FIVE fire analyses do not credit fire suppression systems or fire brigades. It is assumed that these mitigation functions fail. This enhances the bounding nature of the analysis.
- ATWS mitigation features (e.g., Standby Liquid Control (SLC), manual rod insertion, level/power control, etc.) are not credited in the analysis. It is conservatively assumed that mechanical failures to scram are equivalent to core damage.
- Thermo-Lag or other fire wrap material is not credited in the analysis. Cables protected with fire wrap are modeled as unwrapped.
- Systems for which cabling has not been tracked and located are assumed to be disabled for all fires in the plant.

The following aspects of the model may have introduced non-conservatism:
- Motor control centers (MCCs) and other metal-enclosed components are not considered to be susceptible to failure due to a low-intensity external exposure fire

- It is assumed that offsite power is initially available. Offsite power is not failed as a precondition to the analysis. This is consistent with the FIVE methodology.
- Primary containment is not analyzed due to the nitrogen atmosphere inside the drywell during normal operation.
- Fire effects on reactivity control functions are not modeled. It is assumed that the electrical portion of the reactor scram system fails safe.
- Fire rated barriers will contain fires up to the listed rating.
- All cables credited in the PRA models are equivalent to IEEE 383 rated cable. This has been confirmed by review of DAEC specific cable test specifications.

Fire barriers are considered in the Fire Compartment Interaction Analysis (FCIA), which is the final step in Phase I of the FIVE methodology. Fire areas not screened out in previous steps are reviewed on a compartment basis to establish the adequacy of compartment boundaries. Two of the criteria used to assess adequacy of any particular boundary are:

- Boundaries that consist of a 2-hour or 3-hour rated fire barrier
- Boundaries that consist of a 1-hour rated fire barrier with a combustible loading in the exposing compartment less than 80,000 Btu per sq. ft.

If all boundaries of a compartment screen out and the compartment contains no safe shutdown equipment, or, following a fire, there is no demand for safe shutdown functions, then the compartment can be screened from further analysis. Adjacent fire compartments with unscreened boundaries are combined into a single compartment.

The DAEC External Events PRA has not been subject to either a comprehensive self-assessment or to a vendor or BWROG review.

SAMA RAI 3e

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   e. Provide the CDF and description of the dominant fire and seismic core damage sequences as indicated by the current external events PRA.

DAEC Response to SAMA RAI 3e

The frequency and description of the top 10 accident sequences from the Rev. 5B/5C external event model are provided below. These represent approximately 56% of the total CDF from fire and seismic initiated events:

1. F29-26 (7.44E-7/yr): This fire-induced core damage sequence is initiated by a fire in the Lower (non-essential) Switchgear Room that results in a plant trip. Multiple equipment in the room is also disabled (fire damage category C), rendering the main condenser and the feedwater / condensate systems unavailable to provide inventory control and decay heat removal. The fire-induced equipment damage, in combination with random failures, results in the failure of HPCI and RCIC, and failure to depressurize the reactor to allow low

pressure coolant injection. Core damage occurs with the RPV at high pressure (Accident Class IA).

2. F14-15 (4.38E-7/yr): This fire-induced core damage sequence is initiated by a fire in the Div. I Essential Switchgear Room that results in a plant trip and disables the 1A3 bus power (fire damage category B). The fire-induced equipment damage, in combination with random failures, results in failure of the main condenser function; but the motor-driven feedwater pumps are used to maintain coolant inventory in the RPV. However, the fire-induced equipment damage, in combination with random failures, also results in failure of RHR decay heat removal and primary containment venting. Core damage occurs due to loss of coolant injection induced by high primary containment pressure caused by the loss of decay heat removal (Accident Class IIT).

3. G9-12 (1.46E-7/yr): This seismic-induced core damage sequence is initiated by a seismic event with a magnitude greater than or equal to 1.0g. This extreme magnitude earthquake results in wide-spread failure of safe shutdown equipment. Core damage occurs due to loss of coolant injection with the primary containment potentially damaged (Class G).

4. F33-18 (1.28E-7/yr): This fire-induced core damage sequence is initiated by a fire in the Div. I Essential Switchgear Room that results in a plant trip and disables the 1A3 bus power, 1X4 and the containment vent function (fire damage category C). The fire-induced equipment damage in combination with random failures results in failure of the main condenser function and the feedwater/condensate function. HPCI or RCIC is used to maintain coolant inventory in the RPV. However, the fire-induced equipment damage in combination with random failures also result in failure of RHR decay heat removal (the primary containment venting function is already disabled by the fire). Core damage occurs due to loss of coolant injection induced by high primary containment pressure caused by the loss of decay heat removal (Accident Class IIT).

5. F32-18 (1.16E-7/yr): This fire-induced core damage sequence is the same as F33-18 above, except that the fire initiates in the Div. II Essential Switchgear Room (Accident Class IIT).

6. F32-15 (1.06E-7/yr): This fire-induced core damage sequence is initiated by a fire in the Div. II Essential Switchgear Room that results in a plant trip and disables the 1A3 bus power, 1X4, and the containment vent function (fire damage category C). The fire-induced equipment damage in combination with random failures results in failure of the main condenser function; but the motor-driven feedwater pumps are used to maintain coolant inventory in the RPV. However, the fire-induced equipment damage in combination with random failures also results in failure of RHR decay heat removal and primary containment venting. Core damage occurs due to loss of coolant injection induced by high primary containment pressure caused by the loss of decay heat removal (Accident Class IIT).

7. F33-15 (1.05E-7/yr): This fire-induced core damage sequence is the same as F32-15 above, except that the fire initiates in the Div. I Essential Switchgear Room (Accident Class IIT).

8. F40-02 (1.02E-7/yr): This fire-induced core damage sequence encompasses all potential multi-compartment fire events. Specific equipment failure scenarios are not explicitly modeled. Core damage is assumed to occur with the RPV at high pressure (Accident Class IA).

9. F34-04 (9.98E-8/yr): This fire-induced core damage sequence is initiated by a fire in the main Control Room that damages multiple functions (damage category C). Specific equipment failure scenarios are not explicitly modeled. Core damage is assumed to occur with the RPV at high pressure (Accident Class IA).

10. F34-02 (9.50E-8/yr): This fire-induced core damage sequence is initiated by a fire in the main Control Room that damages a single function, damage category B. A conditional core damage probability of 1E-5 is assumed for such a fire (i.e., specific equipment failure scenarios are not explicitly modeled). Core damage is assumed to occur due to loss of coolant injection induced by high primary containment pressure caused by the loss of decay heat removal (Accident Class IIT).

SAMA RAI 3f

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   f. If possible, provide the results of the CDF importance analysis for the combined internal and external events. If this is not possible, provide the results for the external events model.

DAEC Response to SAMA RAI 3f

DAEC does not have a combined model. The following table contains the seismic initiated contribution to CDF for each of the earthquake magnitudes evaluated in the Revision 5B/5C external events model.

Earthquake Magnitude	CDF	Percent of Total
(0.01 - <0.05g)	0.0	0.0
(0.05 - <0.12g)	2.00E-08	2.9
(0.12 - <0.20g)	4.04E-08	5.8
(0.20 - <0.30g)	3.08E-08	4.4
(0.30 - <0.50g)	4.75E-08	6.8
(0.50 - <0.70g)	7.68E-08	11.0
(0.70 - <0.90g)	2.23E-07	31.9
(0.90 - <1.0g)	1.00E-07	14.3
(>1.0g)	1.60E-07	22.9
Total	6.99E-07	100.0

The following table contains the fire initiated contribution to CDF for each of the fire compartments evaluated in the Revision 5B/5C external events model.

Fire Compartment	Description	CDF	Percent of Total
10F	Essential Switchgear Room, Division I	8.49E-07	28.9%
7B	Lower Non-essential Switchgear Room	7.76E-07	26.5%
10E	Essential Switchgear Room, Division II	3.37E-07	11.5%
12A	Control Room Complex	1.95E-07	6.6%
3AB	Reactor Building, Third Floor	1.23E-07	4.2%
10B	Battery Room, Division II	1.22E-07	4.2%
2A/2B/2C	Reactor Building, Second Floor	1.16E-07	4.0%
7AP	Turbine Building Pump Areas	6.55E-08	2.2%
8F	SBDG Room, Division II	5.52E-08	1.9%
8H	SBDG Room, Division I	5.52E-08	1.9%
3D	MG Set Room	5.45E-08	1.9%
10D	Battery Room, Division I	3.00E-08	1.0%
17A	Intake Structure, Pump Area, Division I	1.75E-08	0.6%
16B	Pump House, RHRSW/ESW Pump Area, Div I	1.53E-08	0.5%
16A	Pump House, RHRSW/ESW Pump Area, Div II	1.49E-08	0.5%
17B	Intake Structure, Pump Area, Division II	1.40E-08	0.5%
17C	Intake Structure, Screen Area, Division I	1.40E-08	0.5%
17D	Intake Structure, Screen Area, Division II	1.39E-08	0.5%
7E	Condensate Pump Area	1.15E-08	0.4%
1F	RCIC Room	1.10E-08	0.4%
1D	Southeast Corner Room	7.00E-09	0.2%
16F	Pump House, Safety Related Piping Area	6.86E-09	0.2%
12B	Control Building HVAC Room	6.06E-09	0.2%
7C	Turbine Lube Oil Tank Area	5.88E-09	0.2%
1E	HPCI Room	5.11E-09	0.2%
4A	Reactor Building, HVAC Hx and Chiller Area	4.19E-09	0.1%
1B	Northwest Corner Room	3.30E-09	0.1%
2G	Main Steam Valve Chamber	1.59E-09	0.1%
2D	RHR Valve Room	1.33E-09	0.0%
1C	Northeast Corner Room	1.06E-09	0.0%
	Total	2.93E-06	100.0%

The following table contains Rev 5B/5C's important components for fire and seismic initiated events sorted by RRW.

Component	Description	Basic Event	RRW
1G021	Div 2 Standby Diesel Generator	P-DG1G21---S	1.036
CB8490	Switchyard Control Breaker 'M'	P-CB8490---N	1.032
E/P4914	Control Air Supply E/P Converter for CV4914	W-PRE/P4914E	1.021
1A411	SBDG 1G021 to Bus 1A4 Circuit Breaker	P-CB1A411--N	1.017
CV4300	Torus Vent Line Inboard Isolation Valve	V-AVCV4300-P	1.015
PS4529	RPV Low Pressure Permissive for LPCI/CS	I-PIPS4529-H	1.012
PS4545	RPV Low Pressure Permissive for LPCI/CS	I-PIPS4545-H	1.012
MO1940	RHR Loop 'B' Heat Exchanger Bypass Valve	L-MVMO1940-N	1.012
E/P4915	Control Air Supply E/P Converter for CV4915	W-PRE/P4915E	1.011
MO1934	RHR Loop 'B' Torus Cooling Inboard Isolation Valve	L-MVMO1934-P	1.010
MO1932	RHR Loop 'B' Torus Spray/Cooling Outboard Isolation Valve	L-MVMO1932-P	1.010
1X041	Supply Transformer to 480 Volt AC Load Center 1B04	P-TR1X041--C	1.007
1S089B	ESW Pump 'B' Discharge Strainer	E-GF1S089B-B	1.007
1A4	4160 VAC Essential Switchgear	P-AB1A4----A	1.006
1P216	HPCI Turbine/Pump	H-TP1P216--R	1.006
1A3	4160 VAC Essential Switchgear	P-AB1A3----A	1.006
1G031	Div 1 Standby Diesel Generator	P-DG1G31---S	1.005

The following table contains Rev 5B/5C's important HEPs for fire and seismic initiated events sorted by RRW.

SUS No	Description	Basic Event	RRW
49.00	Operator Fails to Recover Torus Cooling	L2OPNOREC--U	1.435
8.00	Operator Fails to Maximize Well Water to Circ Pit	Z-OPWELLWTRU	1.057
45.01	Operator Fails to Cntrl Rx Level Following Scram	Q-OPLEVEL-TT	1.033
10.01	Operator Fails to Open CV4914	W-OPWS04---U	1.024
83.01	Operator Fails to Manually Initiate ADS	O-OPMANDEP-U	1.018
73.01	Operator Fails to Vent Containment Per EOPs	V-OPTORVENTU	1.017
10.01	Operator Fails to Open CV4915	W-OPWS02---U	1.013
10.01	Operator Fails to Open CV4910A	W-OPFFWS04--	1.012
10.01	Operator Fails to Open CV4910B	W-OPFFWS03--	1.012
43.00	Operator Fails to Control Pressure with Bypass Valves	C-OPPRESCTLU	1.011
11.01	Operator Fails to Close Breaker to Start GSW Pump	G-OPLOCSTRTU	1.010
44.00	Operator Fails to Initiate Condensate for Alt Inj	C-OPALTINJ-U	1.009
16.00	Operator Fails to Open MO1947 Locally	W-OPMO1947-U	1.005

The following table contains Rev 5B/5C's important maintenance terms for fire and seismic initiated events sorted by RRW.

SUS No	Description	Basic Event	RRW
86.00	34.5KV/4160VAC Standby Transformer	P-TR--1X004M	1.1056
1.00	345/161KV Auto Transformer	P-TRT1-----M	1.0975
10.01	RWS Loop 'B'	W-MPMTRWSBDM	1.0927
3.00	161KV/4160VAC Startup Transformer	P-TR--1X003M	1.0581
16.00	RHRSW Loop 'B'	W-RIMTBD---M	1.0401
49.00	Suppression Pool Cooling Loop 'B'	L-SPCBMAINTM	1.0338
10.01	RWS Loop 'A'	W-MPMTRWSACM	1.0312
42.00	Circ Water System	Z-CIRCWATERM	1.0167
49.00	Div 1 CS/LPCI LLP Interlock Logic	I-PIMTDV1LLM	1.0142
16.00	RHRSW Loop 'A'	W-RIMTAC---M	1.0135
54.00	ESW Loop 'B'	E-ESWBMAINTM	1.0129
49.00	Suppression Pool Cooling Loop 'A'	L-SPCAMAINTM	1.0125
2.00	125 Volt DC Battery Swing Charger	P-BCMT1D120M	1.0124
49.00	RHR Loop 'B'	L-RHRBDMAINM	1.0110
24.01	Div 2 Standby Diesel Generator	P-DGMT1G21-M	1.0106
50.00	RCIC System	R-RCICINMNTM	1.0071
49.00	Div 2 CS/LPCI LLP Interlock Logic	I-PIMTDV2LLM	1.0054
2.00	Div 1 - 125 Volt DC Battery Charger	P-BCMT1D22-M	1.0051

The following table contains Rev 5B/5C's important common cause factors for fire and seismic initiated events sorted by RRW.

SUS No	Description	Basic Event	RRW
24.01	Standby Diesel Generators	P-DG-1G2131Z	1.023
52.00	HPCI and RCIC Pumps	H-TPCCHPRCIZ	1.009
84.04	Rx Vessel Safety Relief Valves	OCCFSRVTRNSZ	1.007
16.00	RHRSW Heat Exchanger Outlet Valves	W-MVZM4647OZ	1.006

SAMA RAI 3g

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   g. The ER does not discuss how external events were considered in evaluating SAMA benefits. From the results provided in Section 4 (and from an October 10, 2008 e-mail from FPL), it is apparent that a multiplier of 1.57 was applied to the estimated benefits for internal events in order to account for additional benefits in external events. Confirm the use of a multiplier and provide a discussion on development of the multiplier. Justify why an external events multiplier was used instead of propagating the impact of SAMA related changes through both the internal and external events models (since DAEC is stated to have an external events PRA).

DAEC Response to SAMA RAI 3g

The January 2009 Supplement to the License renewal application explains that a multiplier of 1.57 was used. It was derived in the following manner:

Internal Events: 1.09E-5 (from page 15) rounded up to	1.1 E-05;
External Events (fire and seismic): 3.74E-06 (page 16) rounded up to	4E-06;
External Events (high winds and tornados): 1.4E-07 (page 20) rounded up to	2E-07;
External Events (flooding): Screening value of	1.0E-06.
External Events (transportation): Screening value of	1.0E-06
Total External Events =	6.2E-06
Grand Total =	1.72 E-05

Grand Total to Internal Events Ratio 1.72E-05 / 1.1E-05 = 1.564 rounded up to 1.57

The multiplier was used because a Level 2 model for external events was not available and the DAEC external model does not account for all external events. In particular, wind and flood are not modeled.

SAMA RAI 3h

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

   h. The NRC has developed an estimate of the DAEC seismic CDF (based on the NUREG-1488 seismic hazard curve) that is significantly higher than the value reported in the seismic IPEEE. It suggests that the DAEC external event multiplier used in the SAMA analysis may be too low. If the larger seismic CDF value is used, the external events multiplier would be approximately 2.3 versus the value of 1.57 used in the SAMA assessment. Provide an assessment of the impact on SAMA results (baseline and baseline with uncertainty) if an external events multiplier of 2.3 is used. This assessment can be limited to internal event SAMAs that could have significant benefits in external events.

DAEC Response to SAMA RAI 3h

Though we believe it is appropriate to use current site specific information when available, using the generic data and thus an external events multiplier of 2.3 rather than 1.57 will result in the following SAMAs having upper bound benefits greater than the initial cost estimate initially determined by the Expert Panel: 52, 55, and 163. None of these SAMAs have a base benefit greater than the initial estimate implementation cost. As noted in response to RAI 6f, SAMAs 52 and 55 have been estimated in previous license renewal applications to have higher costs than the initial DAEC estimate and higher than the upper bound with the suggested increased multiplier.

For SAMA 163, the suggested higher multiplier would indicate the improvement was potentially cost beneficial, however, the benefit calculation is very conservative in that it assumes the improvement would eliminate all failures of RWS which substantially over estimates the benefit.

As a result, increasing the external events multiplier to 2.3 will not alter the overall conclusions for any SAMA candidates.

SAMA RAI 4a

4. Provide the following information relative to the Level 3 PRA analysis:

   a. Provide additional information on how the population growth rates and the transient population data were developed, including: the source of the transient population estimate and how the growth rate estimates were applied.

DAEC Response to SAMA RAI 4a

The source of the transient population estimate was Evacuation Time Estimate for the Duane Arnold Energy Center Emergency Planning Zone, TOM COD Data Systems, June 19, 2003 (Figure 1.1 and Table 3.3). County growth projections were obtained from 2006 State Profile: Iowa, State Library of Iowa, State Data Center Program, Woods and Poole Economics, Inc, June 2006 (found at www.iowadatacenter.org). Annual population growth rates for each county within 50-miles of the site were applied to year 2000 populations for each population wedge (bounded by two distances from the site and in a specific direction, e.g., 10-20 miles in the NNW direction) and year 2040 populations calculated. The growth rate for each wedge was determined from the fraction of each county's area within that wedge and the county's growth rate. The growth rate was applied to the sum of residential and transient populations.

SAMA RAI 4b

4. Provide the following information relative to the Level 3 PRA analysis:

   b. Confirm that all three recently discovered problems in SECPOP2000 have been accounted for in preparing the MACCS2 input for DAEC, i.e., a formatting problem in input block text files, an error in formatting the economic database used by SECPOP2000, and gaps in the economic database file. (The ER description appears to address only two of these items.)

DAEC Response to SAMA RAI 4b

At the time the analysis was performed, only two of the SECPOP2000 problems (the formatting error and the missing "notes" parameter error) were generally known. The third problem (missing "county number" error) affects only counties with county numbers >955 in the SECPOP2000 data base. Iowa is among the states which are unaffected by the missing county number error. This was confirmed by rerunning SECPOP2000 (with all 3 errors corrected) for the Duane Arnold location; no change in the MACCS2 site file was seen from that used in the Level-3 SAMA analysis.

SAMA RAI 4c

4. Provide the following information relative to the Level 3 PRA analysis:

   c. The DAEC core inventory provided in Table 3.4.3-1 is stated to be end-of-cycle values for DAEC. Confirm that this core inventory reflects the expected fuel management/burnup during the license renewal period.

DAEC Response to SAMA RAI 4c

The inventory selected reflects the expected fuel management / burnup during the license renewal period.

SAMA RAI 4d

4. Provide the following information relative to the Level 3 PRA analysis:

   d. It is stated that releases were modeled as being from the off-gas stack or the top of the reactor building depending on the accident sequence release location. Indicate the type of sequences associated with releases from each location, and relate this to the relevant source term category.

DAEC Response to SAMA RAI 4d

The Level-2 analysis indicates either containment or vent releases. Containment releases would be from the blowout vents, located ~100 feet above grade; the top of containment (140 feet above grade) was used for conservatism. Other vent releases (e.g., wetwell vent) are taken from the stack, 100 meters or 328 feet above grade. Two modeled sequences, 3A02 (M/I source term category) and 1D03 (M/E source term category) are released from the stack via the wetwell vent; the remainder of the Level-3 analyzed sequences are released from the containment.

A sensitivity analysis was performed taking all of the source term categories as being released from either the top of containment or the stack. If all of the releases were from the top of the containment then the total dose risk would decrease <1% and the total cost risk would decrease <3% from the presented base case Level-3 analysis. If all of the releases were from the stack, the total dose risk would increase <0.5% and the total cost-risk would increase <1.5% from the presented base case Level-3 analysis. The choice of release heights are not an important differentiator between source term category risks.

SAMA RAI 4e

4. Provide the following information relative to the Level 3 PRA analysis:

   e. Crop production parameters (e.g., fraction of farmland devoted to grains, vegetables, etc.) are stated to have come from the 1997 National Census of Agriculture. Discuss why information on regional crops was not based on the more up-to-date 2002 Census of Agriculture, and any important differences between these two sources.

DAEC Response to SAMA RAI 4e

SECPOP2000 was used to create a base MACCS2 site file; the year 2000 population distribution in that file was replaced with projected 2040 populations to create the file used in the Level-3 analysis. SECPOP2000 is an NRC sponsored code which was created for the explicit purpose of creating MACCS2 site files. The most recent agriculture census in SECPOP2000's data base, that of 1997, was used.

When using parameters based on the 2002 National Census of Agriculture in place of those from the 1997 census, there was no change in the total dose risk and an increase of <1% in the total cost risk. The choice of Agriculture Census does not significantly impact the Level-3 results.

SAMA RAI 4f

4. Provide the following information relative to the Level 3 PRA analysis:

   f. Clarify the source/location of the precipitation data used in the MACCS2 input.

DAEC Response to SAMA RAI 4f

Onsite precipitation data from 2002 to 2006 was used in the MACCS2 input. The input data incorporated nearby airport precipitation data on those occasions when onsite data was not available.

SAMA RAI 5a

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   a. No SAMA items were added to the plant-specific list of SAMAs as a result of the review of important human actions, on the basis that DAEC plant procedures and training meet industry standards. The CDF contribution from failure of important operator actions could possibly be reduced by providing additional alarms or automating certain actions. For each of the important operator actions on page F-24, identify potential means of improving operator response, and provide an assessment of the costs and benefits of these improvements.

DAEC Response to SAMA RAI 5a

Risk significant operator actions have been prioritized in the DAEC operator training program and as a result have historically been closely scrutinized for improvement opportunities. Examples of improvements that have been completed include:

- Creating Quick Response Cards that simplify procedures for key operator actions under emergency conditions.
- Installation of key lock switches for overrides of appropriate design features when needed for emergency response.

- Creation of a computer mimic of key plant parameters to aid in recognizing the approach to thresholds where significant operator actions are needed.

Appropriate indications and alarms are already in place for operators to recognize risk significant actions. As a result the only remaining known opportunities to significantly improve the reliability of these risk significant operator actions would be hardware modifications that automate certain actions. This type of modification would typically cost substantially more than the greatest potential benefit and in many cases would create the potential for negative consequences. For example, automation of SLC initiation would require installation of a complex set of instrumentation logic that could create the potential for an unplanned spurious initiation. Automating the initiation of torus cooling would require installation of complex logic that would override portions of emergency core cooling and create the potential for spurious operation. Automating the bypass of MSIV isolation during ATWS and recovery of the main condenser would require complex logic whose spurious operation could override the safety function for primary containment isolation.

SAMA RAI 5b

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   b. The NRC SER for the DAEC IPE identifies nine potential improvements and evaluations. Seven of these are included in the Phase I list of SAMAs. Describe the resolution of the other two items, i.e., prioritize injection systems for use in degraded core conditions and evaluate the benefits of resetting the ADS timer instead of immediately locking out the automatic initiation of ADS. If not already implemented, discuss why these two items were not included in the Phase I SAMA list.

DAEC Response to SAMA RAI 5b

With respect to prioritizing injection systems, the DAEC has implemented the Severe Accident Guidelines based on the BWROG's strategies for degraded core conditions. These strategies prioritize injection, taking into consideration: source of water, location to inject and timing of the injection.

The potential benefit of not locking out ADS was reviewed as part of EOP/SAG activities. As discussed in the EOP 1 Bases document, permitting automatic ADS initiation may be undesirable depending on specific plant conditions. ADS actuation can impose a severe thermal transient on the RPV. It may complicate efforts to control RPV water level and may directly lead to loss of adequate core cooling if only steam driven systems are available for core cooling.

SAMA RAI 5c

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   c. In Table 5.1-2 these are several basic events (e.g., CB8490, 1G031, 1A311) that are addressed only by generic SAMAs. Explain why there is nothing unique about these failures or the DAEC design that might be better addressed by a DAEC-specific SAMA.

DAEC Response to SAMA RAI 5c

The design and operation of the DAEC switchyard, diesel generators, and AC power distribution system is typical of most power plants. There are no unique features about these failures or the design and operation of the equipment that would warrant a more plant specific SAMA.

SAMA RAI 5d(i and ii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   d. Although Table 5.5-1 includes SAMAs for external events based on generic insights and improvements identified in the IPEEE, all of which have been implemented, the current plant specific fire and seismic risk results do not appear to have been systematically reviewed for the purpose of identifying potential SAMAs specific to external events.

      i. For each of the major fire risk contributors at DAEC, provide an evaluation demonstrating that there are no viable SAMA candidates that would further reduce the fire risk.

      ii. For each of the major seismic risk contributors at DAEC, provide an evaluation demonstrating that there are no viable SAMA candidates that would further reduce the seismic risk.

DAEC Response to SAMA RAI 5d(i and ii)

Most equipment and operator actions necessary to mitigate fire or seismic initiating events are the same as those that are necessary to mitigate internal initiating events. Therefore, SAMAs identified in the ER are also expected to reduce the risk of events initiated by fire and seismic initiating events.

Important components and operator actions were reviewed for fire and seismically initiated events. Four components have a RRW greater than 1.005 in the external events model that have a RRW less than 1.005 in the internal events model. These are:

- CV4300 Torus Vent Line Inboard Isolation Valve
- MO1940 RHR Loop 'B' Heat Exchanger Bypass Valve
- MO1932 RHR Loop 'B' Torus Cooling Inboard Isolation Valve
- MO1934 RHR Loop 'B' Torus Cooling Outboard Isolation Valve

Each of these components support the containment heat removal function. Existing SAMAs 75 and 85 are related to enhancing containment heat removal capability.

75 Install an independent method of suppression pool cooling
85 Install an unfiltered, hardened containment vent

SAMA 85 was screened in Phase I because such a modification has already been implemented. This is the hardened pipe vent modification, of which CV4300 is part. SAMA 75 was screened in Phase II based on its cost exceeding its benefit. There are no SAMAs associated with these components that are unique to external events.

Only two operator actions have a RRW greater than 1.005 in the external events model that have a RRW less than 1.005 in the internal events model.

- Operator Fails to control pressure with bypass valves
- Operator Fails to open MO1947 locally

As stated in Section 5.1 of the ER, current plant procedures and training meet current industry standards. There are no additional specific procedure improvements that could be identified that would affect the result of the Human Error Probability (HEP) calculations. Therefore, no SAMA items were added to the plant specific list of SAMAs as a result of human actions on the list of basic events with RRW greater than 1.005. This reasoning is applicable to the two additional important operator actions identified for external events, and it is therefore not considered to be a potential SAMA candidate.

In addition to the analysis described above, the Turbine Lube Oil Tank was specifically reviewed to determine if a SAMA was warranted. Failure of the turbine lube oil tank contributes 1E-7 per year to the CDF, or less than 1% of the total CDF. Given that the DAEC MAB is $2,300,000, a SAMA contributing 1% would have to cost less than $23,000 to be viable. And given the Expert Panel's determination that the minimum cost for a hardware change is $100,000, modification of the Turbine Lube Oil Tank support is not warranted.

SAMA RAI 5e

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   e. The source for SAMA 156 (Provide an alternate source of water for the RHRSW/ESW pit) is stated to be "Expert Panel". This source is not discussed in the ER. Describe the "Expert Panel", the source of this SAMA, and if any other SAMAs were identified and discarded by this panel.

DAEC Response to SAMA RAI 5e

The expert panel consisted of sixteen individuals, each with over twenty years experience in a variety of fields related to nuclear power. Expertise included, but was not limited to: Operations, Project Management, Mechanical Engineering, Civil Engineering, Electrical Engineering, Design Engineering, Health Physics, and Probabilistic Risk Assessment. This

panel was convened to review the Generic and Site Specific SAMAs. During that process the panel recommended the addition of SAMA 156. No other SAMAs were identified by this panel.

SAMA RAI 5f(i)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      i. SAMA 57 – The disposition column indicates that the screen wash system is a reliable system and that firewater and well water are available as a backup for maintaining level in safety-related pump pit. Nevertheless failures in the river water system are high on the list of important events. Justify why enhancements to the system do not warrant further consideration, given the system importance.

DAEC Response to SAMA RAI 5f(i)

Industry operational experience indicates the type of plants that experience intake structure problems are ones that use once through condenser cooling with a high volume flowrate. These plants are susceptible to problems because of certain environmental conditions that may occur each year. These conditions cause some type of debris accumulation and loss of suction for the circulating water pumps. DAEC is less susceptible to this type of problem because the condenser cooling system is closed cycle. Therefore only a low volume of water (6,000 to 12,000 gpm vs. 500,000 to 1,000,000 gpm mentioned in industry operational experience) is removed from the Cedar River and debris accumulation under these conditions is much less likely.

SAMA RAI 5f(ii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      ii. SAMA 126 – The SAMAs that are cited in the disposition column are not related to flood propagation prevention, which is the focus of this SAMA. Confirm whether the internal flooding analysis indicates that any flood barriers are important and whether upgrading these barriers could be cost-beneficial.

DAEC Response to SAMA RAI 5f(ii)

DAEC internal flooding contribution is 0.3% of the internal events CDF. An additional review did not identify any flooding barriers that would be cost beneficial.

SAMA RAI 5f(iii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      iii. SAMA 134 – The SAMAs that are cited in the disposition column are not related to upgrading fire barriers, which is the focus of this SAMA. Confirm whether the fire analysis indicates that any fire barriers are important and whether upgrading these barriers could be cost-beneficial.

DAEC Response to SAMA RAI 5f(iii)

Per Section 6.2 of the DAEC Internal Fires Hazard Evaluation report, fire dampers, fire doors, and penetration seal assemblies credited in the internal fire evaluation were determined to be included in the DAEC surveillance program. The fire analysis for DAEC did not identify any vulnerabilities with regard to fire barriers, and therefore no barriers were considered to be in need of improvement.

SAMA RAI 5f(iv)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      iv. SAMA 135 – The SAMAs that are cited in the disposition column are not related to reducing fire-induced spurious actuations, which is the focus of this SAMA. Confirm whether the fire analysis indicates that spurious actuations are important.

DAEC Response to SAMA RAI 5f(iv)

Per Section 6.5 of the DAEC Internal Fires Hazard Evaluation report, no additional issues with regard to separation of redundant trains of safe shutdown equipment were identified that were not already part of ongoing fire protection engineering work. Also, contribution to core damage frequency of control room panel fires involving short circuits affecting operation of motor operated valves was estimated to be very low. Therefore, the fire analysis did not indicate that spurious actuations are important.

SAMA RAI 5f(v)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      v. SAMAs 1 and 3 – The disposition column indicates that these SAMAs were implemented through severe accident management guidelines (SAMG). Explain how the SAMG meets the intent of this SAMA (i.e., provide additional DC battery capacity, and add additional battery charger).

DAEC Response to SAMA RAI 5f(v)

Procedure SAMP 704 "Powering 125 VDC Battery Chargers From Portable Generator " provides a way to power the 125 Volt DC system battery chargers from a portable generator in situations that are beyond the plant's design bases. This meets the intent of the SAMA by providing an additional source of DC power.

SAMA RAI 5f(vi)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      vi. SAMA 9 – Describe the alternate mitigation strategy cited and how it meets the intent of this SAMA (i.e., reduce DC dependence between high-pressure injection system and ADS).

DAEC Response to SAMA RAI 5f(vi)

Procedure SAMP 707 "Emergency SRV Operation using portable DC Power" details guidance for depressurization of the reactor pressure vessel when high pressure injection sources are not available and normal DC power is not available. This meets the intent of the SAMA by providing an alternate supply of DC power.

SAMA RAI 5f(vii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      vii. SAMA 34 – Explain how the procedures that are in place meet the intent of this SAMA (i.e., improve reliability of ADS components).

DAEC Response to SAMA RAI 5f(vii)

A review of the corrective action system for the last five years has revealed no instances of failures affecting ADS component operability. A design feature which helps ensure reliability of ADS logic is power availability from both sources of essential 125 VDC.

Surveillance tests are performed on ADS components as required by the DAEC Technical Specifications. These tests include instrument calibrations and functional tests of ADS components.

This meets the intent of the SAMA by confirming the reliability of ADS components.

SAMA RAI 5f(viii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      viii. SAMA 38 – Explain how the procedures that are in place meet the intent of this SAMA (i.e., improve low pressure injection capability).

DAEC Response to SAMA RAI 5f(viii)

Alternate Injection Procedures 401, 402, 403, 404 and 405 provide diverse ways of injection when normal injection systems are inadequate or unavailable for the purposes of restoring RPV level, flooding the RPV, spraying the primary containment atmosphere, providing a makeup source to the Spent Fuel Pool or flooding the Primary Containment. The alternate sources are RHRSW, ESW, Well Water / GSW, Firewater and Condensate Service water respectively.

SAMA RAI 5f(ix)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      ix. SAMA 48 – The disposition column indicates that this SAMA (remove low pressure coolant injection loop select logic) is being addressed by a current licensing action. Cite the specific licensing action and indicate its status.

DAEC Response to SAMA RAI 5f(ix)

The specific licensing action was GEH BWROG Licensing Topical Report NEDO-33148, "Separation of Loss of Offsite Power from Large Break LOCA [Loss of Coolant Accident]". This action was withdrawn by the BWROG in 2008 because it was not cost effective.

SAMA RAI 5f(x)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      x. SAMA 59 and 60 – Describe the alternate mitigation strategies cited and how they meet the intent of these SAMAs (i.e, creating ability for emergency connection of existing or new sources to feedwater and condensate system, or installing an independent diesel for condensate storage tank makeup pumps).

DAEC Response to SAMA RAI 5f(x)

Procedure SAMP 709 "Emergency Hotwell Makeup With The Portable Diesel Fire Pump" provides guidance for an alternate makeup source to condensate and feedwater with a diesel driven pump. Procedure SAMP 710 "Emergency CST Makeup With The Portable Diesel Fire Pump" provides a large makeup source to the Condensate Storage Tanks (CSTs) to supply ECCS long term with the Portable Diesel Fire Pump (PDFP). These two procedures meet the intent of SAMAs 59 and 60 respectively

SAMA RAI 5f(xi)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      xi. SAMA 118 – Explain how the procedures that are in place meet the intent of this SAMA (i.e., add an independent boron injection system), considering that SAMA 119 addresses the use of alternative systems for injection.

DAEC Response to SAMA RAI 5f(xi)

SAMA 118 was improperly listed as being addressed by a procedure. It was eliminated due to excessive cost.

An independent system would need to penetrate primary containment and connect to the reactor coolant system. Isolation requirements would need to be safety related and automatic. If an existing penetration could be used, then appropriate overrides on the existing isolations to allow injection would be needed. The system would have to be piped

from a location with adequate room to install the hardware. Automatic and easy control from the control room would be necessary to be useful in mitigating an ATWS. The Expert Panel determined the cost of an independent system would exceed $2,500,000, which is above the MAB.

SAMA RAI 5f(xii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      xii. SAMA 136 – Describe the alternate mitigation strategy cited and how it meets the intent of this SAMA (i.e., to implement alternate shutdown methods if the control room becomes uninhabitable).

DAEC Response to SAMA RAI 5f(xii)

AOP 915 "Shutdown Outside the Control Room" provides guidance on how to shutdown the reactor when the main control room is uninhabitable using equipment outside the control room as an alternate to equipment in the control room.

SAMA RAI 5f(xiii)

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

   f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

      xiii. SAMA 158 and 159 – These SAMAs specifically address issues associated with maintenance and fires in the switchgear rooms and the river water system. Confirm whether the maintenance and risk management program cited in the disposition specifically covers these systems.

DAEC Response to SAMA RAI 5f(xiii)

WPG-2 "On-line Risk Management Guidelines" applies to all work activities that may affect calculated operational risk factors (CDF/LERF). OMG-7 "Outage Risk Management Guidelines" describes means used for risk assessment and management of DAEC outages. Switchgear and River Water Supply systems are explicitly addressed.

SAMA RAI 6a

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

a. In Table 7.1.3-1 the benefit for SAMA 41 (Provide capability for alternate injection via the reactor water cleanup) was indicated to be determined by considering it to be viable only for steam breaks. Confirm whether this SAMA would also be beneficial for either short term or long term transients.

DAEC Response to SAMA RAI 6a

The table is in error. The Expert Panel misunderstood this SAMA as being for decay heat removal, not injection. Since RWCU is not capable of being an alternate injection point, it would not be beneficial for either short term or long term transients.

SAMA RAI 6b

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   b. In Table 7.1.3-1 the benefit for SAMA 55 (Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers) was indicated to be determined by assuming that the RHR Service Water system did not fail. Confirm that this included not failing due to loss of electric power.

DAEC Response to SAMA RAI 6b

We have confirmed that for SAMA 55, the RHR Service water pumps did not fail due to loss of electric power.

SAMA RAI 6c

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   c. Table 7.1.3-1 indicates for SAMA 117 that elimination of all standby liquid control (SLC) injection failures reduces CDF by 6.6 percent, while Table 5.1-1 indicates that failure of the operator to inject SLC early contributes almost 10 percent of CDF. Explain the reason for this difference.

DAEC Response to SAMA RAI 6c

SAMA case 117 eliminated all mechanical failures of SLC injection. However, human error of not initiating SLC remains in the model for Case 117 .

SAMA RAI 6d

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   d. For SAMA 164 (Improve the reliability of the RWS control system) Table 7.1.3-1 identifies the SAMA case as RWS02 versus BASE02. Presumably the benefit of this SAMA was determined after another SAMA (SAMA 158?) was assumed to have been implemented. Clarify why a revised base case was needed for this SAMA. Describe the

assumptions in this evaluation, including what this SAMA involves, and provide the detailed assumptions and results for the revised base case.

DAEC Response to SAMA RAI 6d

A special version of the PRA base case was prepared so that the maximum benefit of improving controls for RWS stilling basin inlet valves CV4914 and CV4915 could be assessed more accurately. These valves have redundant control signals which tell them to open under emergency conditions. The backup controls, however, were not considered in the normal base model; they were included in the revised base model to avoid over predicting the benefit of potential modifications to the control system. These backup controls were assumed to have the same success rate as the primary controls.

CDF for this special base case is 1.043E-05/yr compared to 1.097E-05/yr for the normal base case. Release frequency for the special base case is 9.01E-06/yr compared to 9.52E-06 for the normal base case.

SAMA RAI 6e

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   e. Provide an expanded discussion of the use of the lower bound cost estimates of $30K and $100K for procedures and hardware changes, respectively, and what the expert panel cost estimates include, such as, inflation, contingencies, replacement power.

DAEC Response to SAMA RAI 6e

The lower bound cost estimate for procedure changes of $30,000 represents the Expert Panel's judgment of the minimum current cost of procedural changes that impact Licensed Operator qualifications and require formal training. No allowance is given for inflation, contingencies, or replacement power.

The lower bound cost estimate for hardware changes of $100,000 represents the Expert Panel's judgment of the minimum current cost of small modifications to the design of the facility affecting risk significant equipment based on a review of recent actual capital spending for the facility. No allowance is given for inflation, contingencies, or replacement power.

These lower bound cost estimates are comparable with industry experience as shown in recent License Renewal applications for Pilgrim, Vermont Yankee and Cooper.

SAMA RAI 6f

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   f. Provide more detail on the SAMA design and the basis for the stated cost for the following SAMAs: 12, 35, 41, 52, 55, 56, 75, 78, 139 and 163.

DAEC Response to SAMA RAI 6f

SAMA 12 Improve 4.16 KV bus cross tie capability

This improvement is assumed to require installation of multiple safety related circuit breakers and controls that would be necessary to preserve divisional separation under normal conditions while allowing a cross tie under emergency conditions while isolating the appropriate portion of the failed division. The existing hardware configuration was judged to not readily permit a reliable temporary cross tie. In order to make a temporary connection between the buses without a breaker on each bus would require removing power from the energized bus. If the energized bus was supplying some safety related loads supporting mitigation of the event, it would not be in the interest of safety to de-energize the only AC powered bus. Therefore, permanent equipment is needed. The basis for the stated cost is the Expert Panel's judgment which assumed the purchase of six safety related breakers at $900,000 dollars total plus design and installation costs of greater than $750,000. Additional costs for ongoing operations and maintenance would be required but were not quantified.

SAMA 35 Add signal to open safety relief valves automatically in an MSIV closure transient

This improvement was assumed to include design and installation of logic modifications and new supporting transient analysis of reactor response to an MSIV closure transient. The logic change would require inputs from all main steam isolation valves and interface with selected SRV control logic without adversely affecting existing logic for other safety related functions. The revised transient analysis would require external contract support. This change would likely require a license amendment, however, no cost estimate for this was included. Based on the judgment of the Expert Panel this combination of hardware changes and analysis would exceed $1 million. Estimates for similar modifications in the Cooper, Pilgrim, and Vermont Yankee license renewal applications were $1.5 million.

SAMA 41 Provide capability for alternate injection via Reactor Water Cleanup (RWCU)

This improvement was assumed to include installation of additional piping, valves and controls to allow connection of the RWCU system to an external source of water rather than the current normal configuration that re-circulates reactor water. Changes to emergency operating procedures and operator training would be required. Based on the location of existing components, the Expert Panel judged that this was a relatively complex modification that would cost on the order of $1.3 million. More detailed estimates were not prepared as the upper bound benefit expected was no greater than $861,000.

SAMA 52 Replace ECCS pump motors with air cooled motors

The cost of this improvement was assumed to be the cost of two large safety related air cooled motors, engineering design support and installation for a total of at least $1,500,000. No allowance in the cost estimate was given to account for the possibility that complex support or fit changes were needed. More detailed estimates were not prepared as the upper bound benefit expected was no greater than $1,426,000. A similar SAMA was previously estimated at $8.8 million in the Browns Ferry License Renewal application.

SAMA 55 Implement a modification to allow manual alignment of fire water system to RHR heat exchangers

This improvement was assumed to require installation of safety related valves and piping to interface with non-safety related fire protection system piping. No simple temporary connection or procedural option was judged to be practical. The combination of piping, valves, engineering and installation was judged by the Expert Panel to exceed $500,000. Since the upper bound benefit was less than $391,000 no more detailed estimate was warranted. A similar enhancement was estimated at $1.95 million in the Pilgrim License Renewal application.

SAMA 56 Add a service water pump

The cost of this improvement was judged to be in excess of $1 Million by the Expert Panel assuming it would require purchase and installation of a non-safety related pump with safety related piping and valve interface. Since the upper bound benefit was less than $391,000, no more detailed estimate was performed. A similar enhancement was estimated at $5.9 million in the Fitzpatrick License Renewal application.

SAMA 75 Install an independent method of suppression pool cooling

The cost of this improvement was judged to be greater than $1 Million by the Expert Panel on the assumption that it would require a large bore safety related interface with the primary containment as well as piping, pumps and heat transfer equipment. Since the upper bound benefit was less than $418,000, no more detailed estimate was performed. A similar improvement was previously estimated at $5.8 million in the Fitzpatrick License Renewal application.

SAMA 78 Enable flooding of the drywell head seal

This improvement would require piping and valve operator changes to allow manual flooding of the head seal and associated procedure and operator training. The Expert Panel judged that this combination would exceed $100,000. Since the upper bound benefit was $65,000, no more detailed estimate was prepared. A similar improvement was previously estimated at $1 Million in the Pilgrim and Vermont Yankee License Renewal applications.

SAMA 139 Install digital large break LOCA protection system

This improvement was assumed to install a combination of sensors, computer software and logic that would evaluate a variety of plant parameters and initiate a plant shutdown automatically in a manner that is more anticipatory than existing instrument logic. Such a system would require substantial engineering prior to installation as well as significant on-going maintenance costs. By way of comparison, a digital control system for the turbine generator that is already fairly well understood has a refined cost estimate of $13 million dollars at DAEC. The judgment of the Expert Panel is that this proposed improvement would be greater than $13 million which substantially exceeds the upper bound benefit of $1,426,000 and no more refined estimate is warranted.

SAMA 163 Improve the reliability of the RWS system control valves CV4914 and CV4915

This improvement was assumed to be the installation of an independent flow path and control valve on each loop of RWS. This combination of safety related piping, valves, engineering and on going maintenance was judged by the Expert Panel to exceed $1 million. Since the upper bound benefit was $800,000 no more refined estimate was warranted. The existing control valves are safety related and maintained under the preventive maintenance program and no significant improvement in reliability was judged likely through additional maintenance of the existing equipment.

SAMA RAI 6g

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   g. Provide dollar estimates instead of ">MAB" for the following SAMAs, since their benefit using a higher external event multiplier with uncertainties could exceed the maximum attainable benefit (MAB) reported in the ER: 10, 15, 17, 27, 28, 49, 120, 123, and 139.

DAEC Response to SAMA RAI 6g

SAMA 10 Provide an additional diesel generator

This improvement was assumed to be the design and installation of an additional safety related diesel generator capable of being connected to either safety related bus. The Expert Panel judgment is that the cost of this modification and on-going operations and maintenance cost would range from $10 million to $20 million. This judgment is consistent with the range listed in previous estimates in License Renewal Applications for Cooper and Nine Mile Point. Since the range of costs substantially exceeds the upper bound benefit of $2,386,000, no more refined estimate is warranted.

SAMA 15 Install a gas turbine generator

This improvement was assumed to be the design and installation of commercial grade gas turbine generator sized similar to existing diesel generators with a safety related interface that allows connection to either safety related bus. The Expert Panel's judgment is that the capital cost of an installed gas turbine generator of this size is approximately $3 million and the design and installation of the safety related interface and on-going operations and maintenance costs would be in excess of $2 million (total >$5 million). Since the cost of this improvement was judged to substantially exceed the upper bound benefit of $2,386,000, no more refined estimate was warranted.

SAMA 17 Install a steam driven turbine generator that uses reactor steam and exhausts to the suppression pool

The Expert Panel judged that the cost of this would be similar to SAMA 15 (>$5 million) for the turbine generator with the additional cost of safety related piping, primary containment isolation, and new containment analysis that would likely increase the cost to greater than $20 million. Since this is far in excess of the upper bound benefit of $2,386,000, no more refined estimate is warranted.

SAMA 27 Install an independent active or passive high pressure injection system

This improvement was previously estimated at greater than $2 million dollars in the Pilgrim License Renewal application. The Expert Panel judgment is that this estimate is likely low for DAEC. A somewhat similar modification to replace two existing non-safety related feedwater pumps with minimal change in flow path at DAEC has a detailed cost estimate of $20 million. The Expert Panel judgment is that to install a single independent injection system with a largely independent flow path would also likely be on the order of $20 million. This substantially exceeds the upper bound benefit of $1,426,000, and no more refined estimate is warranted.

SAMA 28 Provide an additional high pressure injection pump with independent diesel

This modification was assumed to be the equivalent of adding one new feedwater pump powered by a diesel rather than an electric motor with a suitable injection path and suction source that does not require additional primary containment connections. If the cost of this was one half the cost of replacing feed pumps discussed in SAMA 27 above, the cost would be $10 million and would substantially exceed the upper bound benefit of $2,035,000. The Expert Panel judgment is that no more refined cost estimate is warranted.

SAMA 49 Replace two of the four electric safety injection pumps with diesel powered pumps

Changes to how safety related pumps are powered would require substantial changes to the foot print of the system and re-analysis of safety related piping in addition to the procurement and installation of the diesel power device. The Expert Panel judged that the complexity of this modification would result in a cost similar in nature to the replacement of feedwater pumps mentioned in the discussion of SAMA 27 above ($20 million). As this value substantially exceeds the upper bound benefit of $1,426,000. No more refined estimate is warranted.

SAMA 120 Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS

This improvement would require complex modeling of safety related features for pressure spikes during an ATWS and significant design effort to ensure that any added relief valves did not adversely affect safety related features. The Expert Panel judged that the cost of this would approach $5 million. Given the upper bound benefit was $1,474,000, no more refined estimate is warranted.

SAMA 123 Install an ATWS sized filtered containment vent to remove decay heat

Based on the $3 million spent on the hard pipe vent modification at DAEC, the Expert Panel estimated that a larger vent with filtering capability would easily be in excess of this value. This type of modification was previously estimated to range from $1.5 million to $3 million dollars in License Renewal applications at Cooper, Pilgrim, Vermont Yankee and Fitzpatrick. Given that the upper bound benefit was $1,474,000, no more refined estimate is warranted.

SAMA 139 Install a digital large break LOCA protection system

This improvement was assumed to install a combination of sensors, computer software and logic that would evaluate a variety of plant parameters and initiate a plant shutdown automatically in a manner that is more anticipatory than existing instrument logic. Such a system would require substantial engineering prior to installation as well as significant on-going maintenance costs. By way of comparison, a digital control system for the turbine generator that is already fairly well understood has a refined cost estimate of $13 million dollars at DAEC. The judgment of the expert panel is that this proposed improvement would be greater than $13 million which substantially exceeds the upper bound benefit of $1,426,000, and no more refined estimate is warranted.

SAMA RAI 6h

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   h. On Page F-9 it is stated that a member of Design Engineering reviewed the cost estimates to assure adequate accuracy. Specify which cost estimates were reviewed in this manner.

DAEC Response to SAMA RAI 6h

Only the cost estimates for SAMAs 12, 78, 156 and 166 were reviewed by Design Engineering. As with the original estimate, the Expert Panel did not perform a detailed assessment and instead determined a reasonable low-end value. Also, note that this was an iterative process. SAMAs 12 and 78 were re-assessed after they were brought into consideration following the Upper Bound determination.

SAMA RAI 6i

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

   i. Provide the percent change in offsite economic cost risk (OECR) for each SAMA so that the benefits presented can be confirmed.

DAEC Response to SAMA RAI 6i

Assuming the percent change in offsite economic cost risk is the ratio of the SAMA's property damage benefit and the property damage sans SAMA, then the OECR for each SAMA in Table 8.2-1 is:

DAEC SAMA Number	SAMA Case	OECR
10	NOSBO	44%
12	NOSBO2A	19%
15	NOSBO	44%
17	NOSBO	44%

DAEC SAMA Number	SAMA Case	OECR
27	LOCA03	25%
28	LOCA01	36%
35	SRV01	7%
39	CONT01	7%
41	LOCA04	15%
49	LOCA03	25%
52	LOCA03	25%
55	SW01	7%
56	SW01	7%
75	CONT01	7%
78	CONT02B	1%
107	ISLOCA	0.5%
117	ATWS02	6%
120	NOATWS	26%
123	NOATWS	26%
139	LOCA03	25%
156	RWS01	14%
163	RWS01	14%
164	RWS02(b2)	0.5%
166	LOCA05	13%

SAMA RAI 7a

7. Provide the following information with regard to the sensitivity and uncertainty analyses:

   a. On page F-91 it is stated that "Unless otherwise noted, it is assumed in these sensitivity analyses that sufficient margin exists in the maximum benefit estimation that the Phase I screening would not have to be repeated in the sensitivity analysis." This assumption does not appear to be appropriate. Specifically, if the benefits were increased by a factor of 2.5 (to account for uncertainties) the maximum benefit would be increased to $5.65 million and several of the 13 Phase I SAMAs that were screened out based on excessive costs might have screened in (e.g., SAMAs 80 and 104). Provide an assessment of the impact of uncertainties on the Phase I screening.

DAEC Response to SAMA RAI 7a

The maximum attainable benefit is predicated on the elimination of all risk. For the 2.5 multiplier to have any effect on the Phase I screening, the SAMA would have to eliminate at least 40% of the risk. Given that the entire worth of Loss of Offsite power is 37% of the CDF and that the RRW of the dominant contributors to risk reduction are less than 1.1, it is improbable that implementation of a single SAMA would reduce the CDF by 40%. In addition, the SAMAs eliminated in Phase 1 due to excess cost consisted of complex design changes any one of which would easily exceed $5.6 million. Thus, using a multiplier of 2.5 would have no impact on the Phase 1 screening results.

SAMA 80 would require the construction of a seismically qualified large volume elevated, or pressurized, water supply. The cost of such a tank would easily exceed $5.6 million dollars. In addition, such a system could have a negative impact on both the internal flooding analysis and the impact of drywell spray on LERF. Quad Cities concluded that such a system would exceed $5.8 million.

SAMA 104 would require the construction of a barrier that would provide enhanced protection of the containment walls. Due to the paucity of space at Duane Arnold, construction of such a barrier may require the relocation of other safety related equipment. The expert panel agrees with the minimum cost estimated by Quad Cities of $12 million.

SAMA RAI 7b

7. Provide the following information with regard to the sensitivity and uncertainty analyses:

   b. In Section 8.2, Uncertainty, SAMAs 12 and 78 are stated to be cost beneficial. This does not appear to be the case in Table 8.2-1. Clarify this discrepancy.

DAEC Response to SAMA RAI 7b

The January 2009 Supplement to the License Renewal Application corrected this discrepancy. After the first iteration SAMAs 12 and 78 were considered viable because their upper bound benefits exceeded the low end cost of implementation. The cases used to determine the reduction in CDF were modified to more accurately depict the risk savings. After this second run, the upper bound benefits were below the low end implementation costs. The data provided in Tables 7.1.3-1 and 8.2-2 is from the second iteration.

SAMA RAI 8a

8. For certain SAMAs considered in the Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

   a. Use a portable diesel driven pump for low pressure injection through existing systems.

DAEC Response to SAMA RAI 8a

This alternative has been implemented at DAEC.

SAMA RAI 8b

8. For certain SAMAs considered in the Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

   b. Use a portable diesel driven pump to provide makeup to the RHRSW/ESW pit.

DAEC Response to SAMA RAI 8b

Use of alternate water sources for makeup to the RHRSW/ESW pit is provided for in existing procedures for loss of the normal river water supply. The preferred source of water is installed fire pumps, well water, and GSW, however use of a portable pump for fire water supply is also allowed.

SAMA RAI 8c

8. For certain SAMAs considered in the Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

   c. Use a portable DC power supply to maintain DC power availability for SBO sequences.

DAEC Response to SAMA RAI 8c

A procedure has been established at DAEC to utilize a portable generator to power battery chargers to 125 VDC busses.

SAMA RAI 8d

8. For certain SAMAs considered in the Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

   d. Improve the reliability of cross-ties between the RHR system and the RHR service water (RHRSW), the fire systems or other systems that could be used for alternate low pressure injection.

DAEC Response to SAMA RAI 8d

Alternative injection procedures are in place at DAEC to allow use of RHRSW cross-tied to RHR. The RHRSW cross-tie valve is within the DAEC maintenance program. Operators routinely train on alternate injection procedures. Additional alternate injection procedures are in place using ESW, Well Water or GSW, Fire Water, Condensate Service Water, and SLC as water sources. No additional improvements in reliability have been identified.

SAMA RAI 8e

8. For certain SAMAs considered in the Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

   e. Create a procedure to maximize CRD flow to provide early and/or late injection.

DAEC Response to SAMA RAI 8e

This alternative has been implemented at DAEC.