FENOC
FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

June 24, 2011
L-11-154

10 CFR 54

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

SUBJECT:
Davis-Besse Nuclear Power Station, Unit No. 1
Docket No. 50-346, License Number NPF-3
Reply to Request for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application (TAC No. ME4613) Environmental Report Severe Accident Mitigation Alternatives Analysis, and License Renewal Application Amendment No. 10

By letter dated August 27, 2010, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102450565), FirstEnergy Nuclear Operating Company (FENOC) submitted an application pursuant to Title 10 of the *Code of Federal Regulations*, Part 54 for renewal of Operating License NPF-3 for the Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS). By letter dated April 20, 2011 (ADAMS Accession No. ML110910566), the Nuclear Regulatory Commission (NRC) requested additional information to complete its review of the License Renewal Application (LRA).

The Attachment provides the FENOC reply to the NRC request for additional information. The NRC request is shown in bold text followed by the FENOC response. The Enclosure provides Amendment No. 10 to the DBNPS LRA. The due date for this reply was changed from June 20 to June 24, 2011, as mutually agreed to by Ms. Paula Cooper, NRC Environmental Project Manager, on June 17, 2011.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Clifford I. Custer, Fleet License Renewal Project Manager, at 724-682-7139.

A145
NRR

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 24, 2011.

Sincerely,

Kendall W. Byrd
Director, Site Performance Improvement

Attachment:
Reply to Request for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application, Environmental Report, Attachment E, Severe Accident Mitigation Alternatives Analysis

Enclosure:
Amendment No. 10 to the DBNPS License Renewal Application

cc: NRC DLR Project Manager
NRC DLR Environmental Project Manager
NRC Region III Administrator

cc: w/o Attachment or Enclosure
NRC DLR Director
NRR DORL Project Manager
NRC Resident Inspector
Utility Radiological Safety Board

Item 1

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

Question RAI 1.a

Environmental Report (ER) Section E.3.1.1.2 explains that the SAMA evaluation is based on an updated version of the Davis-Besse Revision 4 PRA model that takes advantage of a 2008 "gap self assessment." This model, referred to as the "SAMA Analysis Model" represents a "freeze date" of July 9, 2009 for plant configuration, August 1, 2006 for component failure data and initiating event data, April 30, 2007 for equipment availability, and January 1, 2006 for non-Maintenance Rule unavailability. Identify any changes to the plant (physical and procedural modifications) since July 9, 2009 that could have a significant impact on the results of the PRA and/or SAMA analyses. Provide an assessment of their impact on the PRA and on the results of the SAMA evaluation.

RESPONSE RAI 1.a

As discussed in the response to RAI 1.c, below, plant changes are tracked for subsequent PRA updates. While there have been some plant changes since the SAMA model, no changes have been identified that have a significant impact on the PRA results or SAMA evaluation. Based on FirstEnergy Nuclear Operating Company (FENOC) Nuclear Operating Business Practice NOBP-CC-6001, "PRA Model Management," plant changes are evaluated to determine if they would cause a change of greater than 10 percent core damage frequency (CDF), or greater than 20 percent large early release frequency (LERF); there have been no changes that meet this criteria since the SAMA model.

Question RAI 1.b

ER Section E.3.1.1.2 describes the PRA model history from 1993, when the IPE was issued, to July 2009 when the SAMA Analysis Model became effective. This section specifically discusses the model updates to Revision 2, 3, 4, and the SAMA Analysis Model. This section does not discuss the model revision from the IPE to the Revision 0, when the largest decrease in internal events CDF occurred (i.e., a decrease from 6.6E-05/yr to 1.4E-05/yr), or the update to Revision 1. Also, the reason for the drop in internal events CDF between the Revision 3 and 4 PRA models of approximately a factor of three is not apparent from the model update discussion. Provide a discussion of the PRA model changes that most impacted the change in total internal events CDF for the Revision 0, 1, and 4 PRA models. Also provide the effective dates of the Revision 0, 1, and 2 PRA models.

RESPONSE RAI 1.b

The second underlined section in Environmental Report (ER) Section E.3.1.1.2 is titled "Davis-Besse PRA, Revision 0 – CDF = 1.4E-05/yr to Revision 2 CDF = 1.7E-05/yr and LERF = 7.3E-08/yr"; this section discusses changes made in the PRA Revision 0, PRA Revision 1 and PRA Revision 2 models, collectively. The largest decrease in risk, from the Individual Plant Examination (IPE) CDF of 6.5E-05/yr, to the PRA Revision 0 CDF of 1.4E-05/yr, is primarily due to a reduction in transient frequencies for the reactor/turbine trip (T_1) and the loss of main feedwater (T_2) transients. The slight increase in risk from the PRA Revision 0 CDF of 1.4E-05/yr, to the PRA Revision 1 CDF of 1.6E-05/yr is primarily associated with a data update.

Subsequent PRA revisions are also discussed in ER Section E.3.1.1.2. The decrease in risk from the PRA Revision 3 CDF of 1.3E-05/yr, to the PRA Revision 4 CDF of 4.7E-06/yr is primarily associated with increasing the time operators have to trip the reactor coolant pumps (RCPs) following a loss of seal cooling (supplied by the Component Cooling Water (CCW) System), and a data update.

The IPE was completed in February 1993; the PRA Quantification Notebook was signed off in March 1999 for PRA Revision 0, August 1999 for PRA Revision 1, October 1999 for PRA Revision 2, and September 2007 for PRA Revision 4. These are the effective dates for each PRA revision.

Question RAI 1.c

Provide a brief description of the quality control process used for controlling changes to the PRA, including the process of monitoring potential plant changes, tracking items that may lead to model changes, making model changes (including frequency for model updates), documenting changes, software quality control, independent reviews, and qualification of PRA staff.

RESPONSE RAI 1.c

PRA quality control is covered under: 1) FENOC Nuclear Operating Program Manual NOPM-CC-6000, "Probabilistic Risk Assessment Program;" and 2) FENOC Nuclear Operating Business Practice NOBP-CC-6001, "Probabilistic Risk Assessment Model Management." Both procedures identify requirements for maintaining and updating the PRA models and applications and both were developed in accordance with Regulatory Guide 1.200, An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, to assure the PRA is technically acceptable and supports risk-informed applications in accordance with NRC regulatory guidelines. Specific elements of NOPM-CC-6000 include:

- Requirement 4.2.1, that the PRA be maintained and updated to represent the as-designed, as-built, as-operated plant.

- Requirement 4.2.4, that the PRA be conducted by qualified personnel with industry recognized levels of capabilities and skills in PRA, commensurate with EPRI TR-1011981, "Development of PRA Qualification and Curriculum," dated September 2005. In addition, Section 5 of NOPM-CC-6000 addresses Qualifications and Training. This section requires that PRA team members meet the PRA Analyst qualification requirements of Job Performance Requirement (JPR) 2.4; this JPR addresses the requirements for a Davis-Besse Analyst, requring completion of the EPRI PRA Fundamentals course (or equivalent), required reading, as well as mentor discussions and proficiency demonstrations. One pre-requisite for JPR 2.4 is completion of the Davis-Besse Engineering Support Personnel orientation training, and the Davis-Besse systems training.

- Section 6.2 on Self-Assessments; they are to be performed on as as-needed basis, and at an interval not to exceed 3 years. The results of Self-Assessments and issues identified are evaluated and changes incorporated into the PRA Program as appropriate as required by the FENOC Self-Assessment/Benchmarking procedure.

- Section 7.3 on PRA Software and Computer Control. All PRA software and computers shall be under configuration control as specified in the PRA Software and Computer Control Plan in accordance with NOP-SS-1001, FENOC Administrative Program for Computer Related Activities; this provides requirements for verification of all approved versions of PRA specific software and computers.

- Section 8.4 on PRA Software QA Requirements. All PRA software shall comply with NOP-SS-1001, FENOC Administrative Program for Computer Related Activities.
- Section 9.1 on PRA Program Records that identifies specific PRA documentation that should be maintained.

Specific elements of NOBP-CC-6001 include:

- Section 5.1.1 on Tracking and Disposition of Plant Changes. Each site is required to have a system for identifying, tracking and dispositioning plant changes that may affect the PRA model; at Davis-Besse, this is done in accordance with NOP-CC-2004, "Design Interface (DIE) Reviews and Evaluations," in which proposed plant changes are routed to the PRA group to identify if the change will impact the PRA. The DIE forms are contained in the Configuration Management Interface System (CMIS). Similarly, NOP-SS-3001, "Procedure Review and Approval," requires a cross-disciplinary review of proposed procedure changes.
- Section 5.1.2 on Reference Model Updates. This section identifies those items that should be reviewed for possible PRA updates, including plant changes, data, and industry experience.
- Section 5.3 on PRA Revisions; PRA models are expected to be revised every other refueling cycle.
- Section 5.4 on Models and Documentation.

Question RAI 1.d

ER Section E.3.1.1.2 identifies a Babcock and Wilcox (B&W) owner's group peer review of the internal events Level 1 and LERF PRA models performed on November 8, 1999 and states that no Level A and 18 Level B supporting requirements findings were identified. The ER further explains that following the review a Revision 3 PRA was issued to "close gaps to the draft industry standards." It is not clear from this statement whether all Level B findings were resolved by the Revision 3 PRA model. Section E.3.3 of the ER also discusses a B&W owner's group peer review that was finished in March 2000 which states that there were no Level A findings, and presents 5 Level B findings, three of which are closed and two that are still open. It is not clear whether this is the same B&W

owner's group peer review comments described in Section 3.1.1.2, and if it is, why there are discrepancies in the two descriptions. The ER also states that in 2008 a "gap self assessment" was performed using a team of industry peers and internal staff that identified four Level A findings and 23 Level B findings associated with not meeting Capability Category 2 requirements of the 2005 ASME PRA standard. It is not clear from the description what the scope of this "gap self assessment" included. The ER does not identify any other peer reviews, technical reviews, or self assessments of the PRA. In light of these issues, provide the following:

i. **Clarify whether there were one or two B&W owner's group peer reviews performed in late 1999 and early 2000 and the differences (e.g., scope) between these reviews if there were two. Clarify whether any Level A or B findings remain unresolved from this peer review (or these peer reviews) and if so, provide an assessment of their impact on the SAMA evaluation.**

ii. **Clarify the scope of the 2008 "gap self assessment" including whether it covered Level 1 and 2 internal events, internal flooding, and the high winds hazard. Also, identify the open Level A and B findings from this self assessment and provide an assessment of their impact on the SAMA evaluation.**

iii. **Provide a summary of the scope of any other PRA model internal and external reviews, a discussion of each unresolved finding, and an assessment of the impact of all unresolved findings on the SAMA evaluation.**

RESPONSE RAI 1.d

1.d.i

There was one B&W peer review performed; it was performed in late 1999, and the report was issued in early 2000. There were no Level A findings, and of the 18 Level B level findings, 13 were closed prior to implementation of the Mitigating Systems Performance Index (MSPI) Basis Document; 4 were closed in the SAMA model; and the 1 remaining finding recommended additional sensitivity studies be performed.

As noted in ER Section E.3.3, FENOC plans to include sensitivity studies in Revision 5 of the PRA. The sensitivity studies recommended in EPRI Report 1016737, Treatment of Parameter and Model Uncertainty for Probabilistic Risk Assessments, address Human Error Probabilities (HEP) and Common Cause Factors (CCF). Since the basic event importance results for the Level 1 PRA and LERF (discussed in ER Sections E.5.4 and E.5.5, as well as E.3.1.1.1 and E.3.2.1) include Human Failure Events (HFEs), components, and initiating events, and these items were reviewed and considered in identifying SAMAs, no new or additional insights are expected that would have a significant impact on the SAMA evaluation.

1.d.ii

The scope of the 2008 gap self-assessment included the following PRA technical areas: initiating events; accident sequences evaluation; success criteria; systems analysis; human reliability analysis; data analysis; quantification; and, maintenance and update.

As discussed in ER Section E.3.1.1.2, the 2008 gap self-assessment was targeted at identifying 'gaps' to meet Capability Category II (of the PRA standard ASME RA-Sb-2005). Also, as discussed in ER E.3.1.1.2, the Davis-Besse SAMA model has all level A and B findings addressed.

1.d.iii

Other than those reviews described in paragraphs i and ii above, the PRA team is not aware of any other peer reviews of the PRA model.

Question RAI 1.e

ER Section E.3.1.1.1 states that the Davis-Besse Level 1 PRA internal events CDF is estimated to be 9.2E-6/yr, but further explains that if high winds and internal flooding is included that the CDF is estimated to be 9.8E-6/yr. Regarding the internal events CDF, provide the following:

i. **The ER provides a caveat about the "tornado high winds" analysis in Section E.3.1.2.3 saying that the model does not include tornado-generated missiles. Based on the top 100 cutsets presented in Table E.5-1, the contribution to the total CDF from tornadoes does not appear to be significant (i.e. Cutset #1 = 3.0E-8/yr, #30 = 2.8E-8/r, #69 =1.2E-8/yr, and #87 = 1.2E-8/yr). The NRC staff notes that the contribution to the internal events CDF from internal flooding is typically included in the internal events CDF whereas the contribution from high winds is generally not included. In light of this and given the high winds analysis is not complete, provide the internal events CDF including flooding but excluding high winds.**

ii. **ER Table E.3-1 presents dominant internal event sequences by initiating event and their percentage contribution to CDF that includes a contribution**

from internal flooding (i.e., F3AM and F7L). The calculated contribution percentages in Table E.3-1 appear to be based on a CDF of 9.2E-06/yr. This is consistent with the CDF reported in Section E.3.1.1.1 for the internal events CDF that does not include internal flooding and external wind, rather than the CDF of 9.2E-06/yr that does includes internal flooding and external winds. Clarify this apparent discrepancy. Also, clarify which model the Level 2 PRA was based on (i.e., with or without inclusion of internal flooding and external wind).

RESPONSE RAI 1.e

1.e.i

ER Section E.3.1.1.1, second paragraph is revised to read:

The Davis-Besse Level 1 PRA internal event CDF (including internal flooding) is 9.2E-6/yr, and, when also including high winds, the CDF is 9.8E-6/yr.

1.e.ii

As discussed above, the Davis-Besse Level 1 PRA internal event CDF, including internal flooding, is 9.2E-6/yr. The Davis-Besse Level 2 PRA is based on the Level 1 internal event PRA, including internal flooding and tornados/high winds, with a CDF of 9.8E-6/yr.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 1.f

In ER Table E.3-1, initiating event T2B-1 listed as "SP6A fails to throttle" and T2A-1 listed as "SP6B fails to throttle" appear to have mismatching nomenclature and descriptions. Also it is not clear which valves are being referred to or what their function is in the plant. Initiating event T2A-2 listed as "FICICS35B fails high" and T2B-2 listed as "FICICS35A fails high" also appear to have mismatching nomenclature and descriptions. It is also unclear for these initiating events which components are being referred to or what their function is in the plant. Clarify these apparent discrepancies and provide layman descriptions for these four initiators.

RESPONSE RAI 1.f

The nomenclature is based on plant numbering guidelines. Davis-Besse typically assigns train 1 valves "B" suffixes, and train 2 valves "A" suffixes. Valves SP6A and SP6B are the main feedwater flow control valves: FICICS35A and FICICS35B are the associated flow controllers for the valves. Events T2A-1 and T2A-2 represent main feedwater overfeeds on steam generator 1: T2A-1 is associated with valve SP6B and T2A-2 is associated with its flow controller FICICS35B. Events T2B-1 and T2B-2 represent main feedwater overfeeds on steam generator 2: T2B-1 is associated with valve SP6A and T2B-2 is associated with its flow controller FICICS35A.

Item 2

Provide the following information relative to the Level 2 analysis:

Question RAI 2.a

ER Section E.3.1.1.1 states that the Level 1 PRA quantification was performed using a "truncation cutoff" of 5E-13/yr, but no reference is made to the Level 2 truncation cutoff. Provide the Level 2 PRA truncation cutoff.

RESPONSE RAI 2.a

The Level 2 PRA was also performed at a truncation of 5E-13/yr. ER Section E.3.2.1 is revised to include this truncation value.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 2.b

ER section E.3.2.1 states that "The CET provides the framework for evaluating containment failure modes and conditions that would affect the magnitude of the release." The ER also explains that "The probabilities of the CET end states were quantified for each PDS." However, the Containment Event Tree (CET) is not presented in the ER nor is a description of its structure and composition provided. Provide the CET or a description of the CET used in the Level 2 analysis. Include in the response a discussion of how the CET top events were selected and how branch points probabilities were determined, including how phenomenological versus system failure mode branch point probabilities were determined.

RESPONSE RAI 2.b

The Containment Event Tree (CET) provides the framework for evaluating containment failure modes and conditions that would affect the magnitude of a release. The Davis-Besse CET was developed from a Babcock & Wilcox Owners Group (B&WOG) generic CET and refined to address phenomena that could have a significant impact on RCS integrity, containment response and eventual release from containment. Table 2.b-1, below, identifies the top events and branches in the CET.

Table 2.b-1: Containment Event Tree Events and Branches

CET Events	Branches
A: Arrest of Core Damage In-Vessel	Success – core cooling restored in time to prevent vessel failure or steam generator tube creep rupture Failure – cooling not restored
R: Submerged-Vessel Cooling of Core Debris	Success – reactor cavity flooding prevents vessel failure Failure – vessel breach
V: Ctmt Bypass	No Bypass Bypassed – ISLOCA or SGTR (i.e., direct radionuclide release)
B1: Ctmt Isolated	Containment Isolated Isolation failure
B2: Isolation Failure	Small – containment did not depressurize appreciably Large – containment depressurizes
E: Early Ctmt Failure Prevented	No Early Failure Early Failure – no potential for fission product scrubbing
C: Ex-Vessel Cooling	Debris Cooled – prevents core-concrete interaction Debris Uncooled – basemat or sidewall failure
D: Ctmt Sidewall	No Sidewall Failure Sidewall Failure
L: Late Ctmt Failure	No Late Failure Late Failure
F: Late Revaporization Release	No Revaporization Revaporization
S: Fission Product Scrubbing	Scrubbed Unscrubbed

Branch probabilities in the CET were determined based on a consideration of phenomena and elements of the associated core damage bin and plant damage state. Phenomena probabilities were estimated based on references (e.g., NUREG-1150), sensitivity studies, and judgment. House events were used to determine applicable CET branches based on the core damage bin and plant damage state.

Question RAI 2.c

ER Section 3.1.1.2 states that an explicit LERF model was added to the PRA. ER Section 3.2.1 states that 14 additional PDSs were added to better define the status of certain containment systems. Clarify how the Level 2 model used in the SAMA evaluation differs from the IPE analysis.

RESPONSE RAI 2.c

ER Section E.3.2.2 discusses the Level 2 PRA model changes since the IPE. One of the most significant changes is the level of detail reflected in the plant-damage states (PDS), and the manner in which their frequencies were calculated. Nearly 500 PDS were defined to accommodate the core-damage bins and the various combinations of system states that could affect subsequent Containment response. In the SAMA Level 2 PRA, 14 additional PDS were added to better define the status of Containment systems to support CET quantification. Since the IPE, a framework was also established to allow all of the PDS frequencies to be calculated in a manner that could be readily repeated for sensitivity studies and applications.

Another change involved developing a probability distribution for Containment failure as a function of internal pressure. The analysis investigated various mechanisms for Containment failure to identify those that might limit its capacity. The expected yield strength was calculated and a distribution was developed based on variability in the materials used, and uncertainties. A second distribution was developed to apply to scenarios in which pressurization would occur over a long period of time, such that the heating of the Containment might reduce the strength of the Containment shell.

Reviews were also made of new analytical studies completed since the IPE. One review identified a change in the treatment of the potential for a rupture of a steam generator tube to be induced due to the transport of hot gases to the steam generators during meltdown of the core (e.g., PDS TIN_18Y).

Other changes include enhancements in quantification capabilities, and changes in the Level 1 PRA, including: updates based on plant changes, procedure changes, and maintenance changes; system enhancements to support applications such as the Maintenance Rule; updates to the SGTR analysis based on emergency operating procedure (EOP) changes; updates in initiating event frequencies and component failure rates based on plant experience; and improvements in technical methods such as the Human Reliability Analysis.

The LERF quantification process has also been simplified; the process allows LERF cutsets to be generated without the lengthy quantification process required to a complete the Level 2 analysis.

Question RAI 2.d

Identify the version of MAAP used in the SAMA analysis.

RESPONSE RAI 2.d

MAAP 4.0.6 was used in the SAMA analysis.

Question RAI 2.e

Identify the release categories that compose the large early release frequency (LERF) from those presented in Table E.3-4 (Release Categories 1.1 through 9.2). Confirm that the identified release categories are those reviewed in Table E.5-3 (Basic Event LERF Importance).

RESPONSE RAI 2.e

ER Table E.3-4 identifies the Release Categories and descriptions; LERF was calculated using the following Release Categories: 1.2 and 1.4 (steam generator tube rupture (SGTR)), 2.1 and 2.2 (interfacing system loss of coolant accident (ISLOCA)), 3.2 and 3.4 (Large Isolation containment failure), 5.2 and 5.4 (Early containment failure), and 6.1 and 6.2 (Sidewall containment failure).

A re-review of LERF importance and ER Table E.5-3, "Basic Event LERF Importance" (pg E-136), based on these Release Categories, identified a few discrepancies: the omission of two events (UHAMUHPE and FMFWTRIP); and the inclusion of two extra events (ZHABWMUE and NORCVRT3, which are just below the risk reduction worth (RRW) cutoff). There are also some slight discrepancies in the rankings, Fussell-Vesely (F-V) importance measures, and RRW importance measures (e.g., in the ER, QHAMDFPE has a F-V of 5.96E-02 and a RRW of 1.063, but should have a F-V of 6.80E-02 and RRW of 1.073, and should be immediately preceding FLC0100F and not immediately following FLC0100F). In addition, FVV011AT should be defined as 'AVV fails to reseat after steam release' (and not fails to reseat after SGTR).

ER Table E.5-3 is revised to correct the identified discrepancies.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Item 3

Provide the following information with regard to the treatment and inclusion of external events in the SAMA analysis:

Question RAI 3.a

For each of the four dominant fire areas identified in ER Section E.3.1.2.1, provide the following:

i. **Explain what measures have already been taken to reduce risk. Include in the response specific consideration of improvements to detection systems, enhancements to suppression capabilities, changes that would improve cable separation and drain separation, and monitoring and controlling the quantity of combustible materials in critical process areas.**

ii. **Review to identify potential SAMA candidates to reduce fire risk. Provide a Phase I and II assessment, as applicable, of each SAMA candidate. If no SAMA candidates are identified, explain why the fire CDF cannot be further reduced in a cost effective manner through implementation of SAMAs specific to fire events.**

RESPONSE RAI 3.a

3.a.i

A large portion of fire risk is associated with control of combustibles, both transient and permanent; this is primarily accomplished through proper management of maintenance of fire detection and suppression systems, and configuration control of the fire design features, such as fire barriers. Following the issuance of the Individual Plant Examination for External Events (IPEEE), Davis-Besse began utilizing a software tool, the Fire Risk Management Program, that tracks inoperable or degraded fire protection features as well as manages transient combustible loads and travel paths. This software is maintained by the site Fire Marshall and controlled by operations procedures: DB-FP-0007, “Control of Transient Combustibles”, DB-FP-0018, “Control of Ignition Sources”, and DB-FP-0009,”Fire Protection Impairment and Fire Watch”.

The Fire Risk Management Program is a software tool designed to capture fire protection requirements along with expert knowledge to provide real time fire risk assessment and management. This tool allows users at all levels to understand fire risks and ensure the application of appropriate risk management techniques, and includes establishing fire watches, limiting hot work and prohibiting transient combustibles.

3.a.ii

The four dominant areas identified in ER Section E.3.1.2.1 are Q.01, S.01, X.01, and FF.01. The dominant contributors to risk in three of these areas are the motor-driven feedwater pump (MDFP), the Auxiliary Feedwater (AFW) System, and the pilot-operated relief valve (PORV). The fourth area, the Control Room, area FF.01, is further divided into “control room not evacuated” and “control room evacuated”. In both cases, the dominant contributor is a loss of feedwater, and AFW, MDFP, and the PORV are again the main contributors to risk. When the control room is evacuated, the ability to feed and bleed is greatly hindered, so the importance of the PORV is diminished for control room evacuation scenarios.

A review of SAMAs was performed with the intent of identifying modifications that could improve fire-related risk. As described above, the fire risk is generally driven by loss of all feedwater and inability to perform feed and bleed; the fire initiator feeds into the transient event tree and core damage sequences are governed by a loss of feedwater or inability to perform feed and bleed cooling. The following SAMAs apply and the alternatives and evaluations are bounded by the existing analysis; these SAMAs were evaluated as ‘Already Implemented’ in ER Table E.6-1:

- CC-16
- FW-02
- FW-08
- FW-09
- FW-10
- FW-11

No additional SAMAs were identified unique to fire risk.

Question RAI 3.b

ER Section E.3.1.2.1 presents the four fire areas identified in the IPEEE that had an estimated CDF above the screening criteria of 1E-06/yr. It also presents the summation of those fire area CDFs to be 2.5E-05/yr which is then used as the basis to develop an external events multiplier. The IPEEE SER (Enclosure 3, Section 2.1.7) explains that the total frequency of the fire area CDFs which had been screened out after detailed analysis (some of which had revised CDFs greater than 1E-06/yr) is 3.8E-06/yr, which results in a total fire CDF of 2.9E-05/yr. Identify the fire compartments that were screened after detailed analysis and the

corresponding CDFs and provide a review of these fire compartments for potential SAMAs.

RESPONSE RAI 3.b

The fire compartments that were screened are delineated in Table 4.2.3.2 of the IPEEE. There are fifteen compartments that start with A.07 and end with Y.02. One column in this table describes the fire effects. The effects are identical to those described in response to RAI 3.a.ii, above; they are associated with secondary side actions including a loss of feedwater and actions pertaining to the AFW System. The SAMAs associated with these actions have been evaluated in response to RAI 3.a.ii; no new SAMAs were identified unique to these compartments or fire risk.

Question RAI 3.c

ER Section E.3.1.2.4 presents the basis for an external events multiplier of 3 based on a "conservatively" estimated fire CDF of 2.5E-05/yr developed using the FIVE methodology and the assumption that a "realistic" fire CDF is a factor of 3 less than this FIVE-produced fire CDF. The NRC staff disagrees that a fire CDF produced using the FIVE screening methodology is necessarily conservative in light of more recent research and guidance on hot short probabilities (i.e., NUREG/CR-6850). The NRC staff particularly notes that the minimal or non-treatment of hot shorts in the IPEEE FIVE analysis may more than offset other conservatisms in the FIVE analysis. Based on this, and the previous RAI, the NRC staff believes the best estimate of the fire CDF for Davis-Besse is 2.9E-05/yr. In addition, the USGS issued updated seismic hazard curves for much of the U.S. in 2008. Using this data, the NRC staff estimated a "weakest link model" seismic CDF for Davis-Besse of 6.7E-06/yr (see NRC Information Notice 2010-18 regarding Generic Issue 199). Based on a fire CDF of 2.9E-05/yr, a seismic CDF of 6.7E-06/yr, and an internal events CDF of 9.8E-06/yr, the NRC staff estimates the external events multiplier to be 3.6. In light of this, provide a revised SAMA evaluation using an external events multiplier of 3.6 or alternatively provide justification for an evaluation of a different multiplier based on this updated USGS information.

RESPONSE RAI 3.c

Based on the information provided in the RAI, an updated external events multiplier was calculated for Davis-Besse. The updated external events multiplier includes risk contribution from fire, seismic, and other hazard groups. The risk contribution for the fire and seismic hazard groups was determined by a ratio between the hazard group

CDF and the internal events CDF as shown in the equations below. The risk contribution from the other hazard group was conservatively assumed to be equivalent to the internal events contribution. Therefore, the other hazard group multiplier is 1.0.

Fire Hazard Multiplier:

$$\frac{\text{Fire CDF}}{\text{Internal Events CDF}} = \frac{2.9\text{x}10^{-5}/\text{yr}}{1.0\text{x}10^{-5}/\text{yr}} = 2.90$$

Seismic Hazard Multiplier:

$$\frac{\text{Seismic CDF}}{\text{Internal Events CDF}} = \frac{6.7\text{x}10^{-6}/\text{yr}}{1.0\text{x}10^{-5}/\text{yr}} = 0.67$$

To determine the multiplier to account for fire, seismic, and other hazard groups, the three individual multipliers were summed, resulting in a multiplier of 4.6. The cost-benefit evaluation was updated using an external event multiplier of 4.6. The updated maximum benefit for Davis-Besse is $1,955,223. Based on the updated maximum benefit, one SAMA candidate, AC/DC-03 (add a portable diesel-driven battery charger to the direct current (DC) system) was determined to be cost-beneficial.

ER Section E.3.1.2.4, “External Event Severe Accident Risk,” is deleted based on the response to this RAI. ER Section E.4.5, “Total Cost of Severe Accident Risk,” is revised to explain the updated external events multiplier. ER Tables E.4-1, E.7-2, E.7-3, E.7-5, and E.8-1 are revised to reflect the revised cost-benefit results.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Item 4

Provide the following information concerning the Level 3 analysis:

Question RAI 4.a

Regarding ER Section E.3.4.7, clarify that the core inventory is based on the rated thermal power of 2,817 MWt and, if not, provide justification for the thermal power used.

RESPONSE RAI 4.a

The core inventory source term analysis used to generate Environmental Report Table E.3-17, "Davis-Besse Core Inventory (Full Core at EOC; 177FAs)," incorporates a two percent uncertainty in core power, or:

P=1.02 x 2772 megawatts thermal (Mwt) = 2827.44 Mwt

Question RAI 4.b

Table 2.6-1 identifies that the year 2000 population living within the 50-mile site boundary is 2,375,624. Table E.3-11 identifies that the escalated population to year 2040 is only 2,227,192. The year 2040 population was stated to be a 4.7% escalation per decade from year 2000. Clarify this discrepancy. Also, in ER Section E.3.4.2, the statement that actual population within the 50-mile radius decreases appears to be incorrect. This statement appears to apply only to the US population groups within a 20-mile radius. Clarify that this understanding is correct.

RESPONSE RAI 4.b

The discrepancy in the 2000 population within a 50-mile radius of Davis-Besse as reported in Table 2.6-1 (of the Environmental Report) and the escalated population in 2040 used as input to the Level 3 Probabilistic Risk Assessment (PRA) is because SECPOP2000 only includes population in the United States. SECPOP2000 calculates estimated population and economic data about any point (specified by longitude and latitude) that lies within the continental United States. The population data in SECPOP2000 are based on 2000 U.S. Census Bureau data. The year 2000 population in a 50-mile radius of Davis-Besse (used as the basis of the escalation) was taken from SECPOP2000. Since SECPOP2000 does not include Canadian population, the 2000 population used in Level 3 PRA underestimated the total population in a 50-mile radius around Davis-Besse. The population data in Table 2.6-1 included the Canadian population. The Level 3 PRA has been revised to include the Canadian population in sectors 30-40 miles/N, 30-40 miles/NNE, 30-40 miles/NE, 40-50 miles/N, 40-50 miles/NNE, and 40-50 miles/NE. The total escalated population for the year 2040 is 2,903,784. The Canadian population is based on the difference of the population reported in Table 2.6-1 and the SECPOP2000 data originally developed.

Section E.3.4.2 of Attachment E of the Environment Report is revised to explain the addition of Canadian population data. Sections E.4.1, E.4.2, E.4.5, and E.9 are revised to reflect the adjusted cost-benefit results. In Section E.10, Table E.3-11 is revised to reflect the Canadian population data. Tables E.3-21 through E.3-32 are revised to reflect the adjusted results of the base case and the sensitivity cases. Tables E.4-1, E.7-2, Table E.7-3, Table E.7-5, and Table E.8-1 are revised to reflect the adjusted cost-benefit results.

In Section E.3.4.2, the statement concerning the declining population related specifically to population estimated from Reference 19 of Attachment E of the Environmental Report; when the population data by year are summed over the counties surrounding Davis-Besse, it shows increasing population until about 2004, and then slightly decreasing population after that until 2008. The population data from Reference 19 are not explicitly provided in Attachment E of the Environmental Report since these data are publicly accessible through the US Census. This observation underscored the conservative assumption of using a constant population escalation factor for each decade through 2040.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 4.c

Three SECPOP2000 code errors have been publicized, specifically: 1) incorrect column formatting of the output file, 2) incorrect 1997 economic database file end character resulting in the selection of data from wrong counties, and 3) gaps in the 1997 economic database numbering scheme resulting in the selection of data from wrong counties. Address whether these errors were corrected in the Davis-Besse analysis. If they were not corrected, then provide a revised cost-benefit evaluation of each SAMA with the errors corrected.

RESPONSE RAI 4.c

First Energy Nuclear Operating Company (FENOC) is aware of the code errors reported for SECPOP2000. These code errors, as noted in the request for additional information

(RAI), are unrelated to the population data. For the Davis-Besse Level 3 PRA, only the population data were extracted from SECPOP2000. All other SITE file input parameters were independently developed. Accordingly, there is no need to correct these code errors, nor is there a need to provide a revised cost-benefit evaluation of each SAMA candidate.

Question RAI 4.d

ER Section E.3.4.6.2 does not identify the population base/year reference for the emergency planning zone (EPZ) evacuation speed. Describe how/whether the EPZ evacuation time was corrected for the year 2040 population (and address the population discrepancy noted in RAI 4.b).

RESPONSE RAI 4.d

Reference [4] (in Attachment E of the Environmental Report) does not identify a collection date for the data that were used to estimate the evacuation speed in Section E.3.4.6.2. The evacuation information provided in Reference [4] was assumed to be current as of the 2000 census. However, no correction factor was applied to account for the increased population in 2040 in the original analysis.

Assuming that an increase in population is proportional to a decrease in evacuation speed, the evacuation speed was adjusted from 0.58 meters/second to 0.52 meters/second. This adjustment represents a 9.6 percent decrease in the evacuation speed, which was used to offset a 9.6 percent [$(1.047)^2 = 1.096$] increase in population at the end of the two-decade license renewal period. This decrease in evacuation speed was evaluated as a new sensitivity case (Sensitivity Case E3). The results are provided in Table 4.d-1, below, and show very little change from the base case, indicating that the results are not sensitive to slow evacuation speeds. The base case results shown in Table 4.d-1 includes the updated population (as needed to respond to RAI 4.b); similarly, sensitivity case E3 includes the updated population, to permit an equitable comparison to the base case.

Table 4.d-1: Comparison of Base Case and Case E3

	Internal Events		
	Base	**E3**	**% diff.**
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.31E+00	0.4%
Economic Impact (50) ($/yr)	1.80E+03	1.80E+03	0.0%

Question RAI 4.e

In ER Section E.3.5.2.3, for Case A1, identify the heat release energy (e.g. thermal, 1 MW) assumed for both the base and sensitivity cases.

RESPONSE RAI 4.e

The energy of release for the base case and sensitivity Case A1 are provided for each release category in Table 4.e-1, below.

Table 4.e-1 Energy of Release: Base Case and Sensitivity Case A1

Release Category	PLHEAT/Energy of Release (watts)	
	Base Case	Sensitivity Case A1
1.1	6.94E+07	2.16E+09
1.2	6.94E+07	2.16E+09
1.3	6.94E+07	2.16E+09
1.4	6.94E+07	2.16E+09
2.1	6.92E+06	6.19E+08
2.2	9.44E+06	6.02E+08
3.1	2.22E+06	2.67E+07
3.2	2.63E+06	1.82E+07
3.3	2.22E+06	2.50E+07
3.4	2.63E+06	1.82E+07
4.1	9.28E+05	1.66E+07
4.2	2.31E+05	1.66E+07
4.3	7.41E+05	1.66E+07
4.4	2.21E+05	1.66E+07
5.1	3.25E+06	2.10E+07
5.2	1.07E+07	6.48E+07
5.3	3.07E+06	1.85E+07
5.4	9.10E+06	5.58E+07
6.1	6.44E+07	2.98E+08
6.2	9.70E+07	4.30E+08
6.3	6.19E+07	3.98E+08
6.4	9.17E+07	4.27E+08
7.1	2.80E+07	1.68E+08
7.2	2.78E+07	1.67E+08
7.3	2.89E+07	1.72E+08
7.4	2.84E+07	1.68E+08
7.5	2.24E+07	1.42E+08
7.6	2.56E+07	1.31E+08
7.7	1.96E+07	1.34E+08
7.8	2.53E+07	1.34E+08
8.1	1.15E+07	1.52E+08
8.2	9.07E+07	5.21E+08
9.1	2.65E+02	2.08E+03
9.2	3.29E+02	2.14E+03

Item 5

Provide the following with regard to the SAMA identification and screening process:

Question RAI 5.a

ER Section E.5.2 describes major contributors to plant CDF, suggested improvements from the IPE study, and specific SAMA candidates identified to address the major contributors and suggested improvements. In addition to the suggested improvements identified in the ER, the IPE (in Section 3, Other Potential Plant Improvements) identifies four potential plant improvements related to the "back-end analysis": 1) BWST level at switchover to sump recirculation, 2) operator actions for inadequate core cooling, 3) emergency plan evacuation criteria, and 4) monitoring of carbon monoxide levels in containment. Describe the status of the implementation of each of these suggested improvements and identify and assess SAMAs to address each unimplemented improvement.

RESPONSE RAI 5.a

In the IPE, Part 6, Section 3, Other Potential Plant Improvements, one insight discussed is borated water storage tank (BWST) refill options. The discussion notes that for some sequences involving steam generator tube ruptures, the BWST inventory could be depleted by injection before the Reactor Coolant System (RCS) was depressurized sufficiently to terminate flow through the broken tube. The discussion also notes that while means are available to provide water to refill the BWST, there is no explicit procedural guidance to taking that step. Since the issuance of the IPE, the EOP has been revised; in EOP Section 8, Steam Generator Tube Rupture, Section 8.54 directs the operators to lineup and transfer the contents of the Clean Waste Receiver Tank (CWRT) to the BWST (if BWST inventory is required). It also directs the operators to procedure DB-OP-06101, "Clean Liquid Radwaste System," which includes specific steps to lineup the CWRT to refill the BWST.

In the IPE, another insight discussed is Operator actions for inadequate core cooling. The discussion notes that different timing of operator inadequate core cooling actions, and particularly those related to RCS depressurization and restarting the RCPs, would have delayed the onset of serious core damage. The discussion also notes that there are concerns regarding the effect of RCP restarts on creep rupture of the SG tubes or RCS for high pressure accidents. Since the IPE, FENOC has prepared Severe Accident Management Guidelines (SAMGs). Davis-Besse SAMG candidate high level actions for all plant damage conditions include the injection of water into the RCS and/or Containment. The likelihood of pressurizer surge line creep rupture, hot leg creep rupture, and SGTR due to bumping or restarting of the RCPs is addressed for plant conditions which have the primary system pressurized.

In the IPE, another insight discussed is emergency plan evaluation criteria. The discussion notes that a re-examination of evaluation criteria should be accomplished to ensure consistency with the more realistic accident source terms available for severe accidents. On September 30, 2009, Davis-Besse implemented revised Emergency Action Levels (EALs) based on Nuclear Energy Institute (NEI) 99-01, "Methodology for Development of Emergency Action Levels", Revision 5. The NRC approved the revised EALs in a safety evaluation report (DBNPS, Unit 1, Safety Evaluation for Emergency Action Levels (ADAMS Accession number ML083450120)). NEI 99-01 Revision 5 EALs use two isotopic mixes to determine EALs associated with fuel melt and failure. The Davis-Besse station dose assessment program has the ability to perform dose assessment using either mix.

In the IPE, another insight discussed is monitoring of carbon monoxide levels in containment. The discussion notes that if core-concrete interactions occur in a severe accident, significant amounts of flammable carbon monoxide would be generated and consideration of carbon monoxide as well as hydrogen may be appropriate in emergency plan evacuation or severe accident management guidelines. The Davis-Besse SAMGs address hydrogen burn likelihood and resultant containment pressures for various hydrogen concentrations (hydrogen production is assumed to be 50 percent or 75 percent of clad oxidation). Containment pressure change due to core concrete interaction gas evolution is also estimated. The Davis-Besse SAMG Technical Basis Document (TBD) discusses Core Concrete Interactions (CCI), the release of carbon dioxide (CO_2), and the potential for combustible concentrations of carbon monoxide (CO) and hydrogen (H_2) in Containment.

Because the improvements discussed above have been implemented at Davis-Besse, there is no need to identify and assess additional SAMAs.

Question RAI 5.b

ER Section E.5.2 indicates that no plant-specific vulnerabilities that would affect the PRA CDF were identified in the IPEEE. NRC staff notes that the IPEEE safety evaluation report (Section 3.0, of the seismic attachment) states that "The aggregate of the material provided in the submittal and the licensees response to the RAIs is not quite sufficient to meet NUREG 1407" but that "The license did provide an incomplete list of HCLPF values for the plant, with the lowest HCLPF value being 0.26g" and so concluded that the submittal "did come close to meeting the objectives of a focused scope analysis." A FirstEnergy response to an NRC staff RAI on the IPEEE dated May 25, 2000 identifies a number of plant

components with high-confidence low probability of failure (HCLPF) values less than 0.3g:

- **Borated Water Storage Tank roof from sloshing (0.28g)**
- **Masonry Wall No. 2367 associated with 480 V Essential MCC (0.26g)**
- **Masonry Wall No. 3407 associated with Component cooling water room (0.27g)**
- **Masonry Wall No. 4786 associated with Essential Distribution Panel "D2N" (0.27g)**
- **Masonry Wall No. 6107 associated with Control Room Emergency Vent Fan Temperature Switch (0.29g)**

Discuss whether plant improvements to meet 0.3g for these components has been implemented at the plant and, if not, identify and evaluate SAMAs to improve the seismic capacities of each of these components.

RESPONSE RAI 5.b

SAMA SR-01 considers increasing the seismic ruggedness of plant components. As identified in ER Table E.6-1, the Seismic Qualification Utility Group (SQUG) previously identified the need for additional seismic restraints in the plant, and these restraints have been added.

No modifications have been made to the borated water storage tank roof that would increase the seismic capability of the tank roof.

Plant improvements and updated analyses have also been performed on the masonry wall plant components listed that may impact their HCLPF. During the masonry wall project in 2007, changes were made to Masonry wall 3407; the pipe support load was removed from the wall thereby eliminating a major load on the wall. Similarly, changes were made to Masonry wall 6107; the steel beam supporting the wall loads was reinforced. In addition, in the 2006-2007 time frame, the masonry wall analysis was updated for a majority of masonry walls, including Masonry walls 2367 and 4768. The analyses were updated to ensure they met allowable stresses and Design Basis requirements. Although improvements in seismic capacity of the masonry walls have been made, no specific analysis has been performed to determine whether the walls meet the HCLPF value of 0.3g.

In addition, several other SAMAs also meet the intent of improving the seismic capacity of plant components (e.g., AC/DC-01, CC-10, and CW-09).

Question RAI 5.c

None of the SAMA candidates identified in Table E.5-4 appear to be plant-specific SAMAs identified from plant-specific risk insights based on the current PRA model. Clarify how the importance lists were used to develop plant-specific SAMA candidates and justify the apparent absence of any plant-specific SAMA candidates. Also, the basic events identified in importance analysis Tables E.5-2 and E.5-3 are not linked to SAMA candidates. Sections E.5.4 and E.5.5 only discuss the SAMA candidates identified to address basic events with high risk reduction worth (RRW) values. Identify, for each basic event having a RRW benefit value (averted cost risk) greater than the minimum cost of a procedure change at Davis-Besse, the specific SAMA(s) that address each event and describe how the SAMA(s) address the basic event. Identify and evaluate SAMAs for basic events not addressed by an existing SAMA (e.g., flooding related basic events and initiators, including WHAF3ISE, SHAF2ISE, F3AM, and F7L). For any basic event for which no SAMA is identified, provide justification for not identifying a SAMA(s).

RESPONSE RAI 5.c

The final list of SAMA candidates was developed from a combination of generic data, industry SAMA analyses and Davis-Besse-specific insights. The following SAMA candidates were added to the generic list based on Davis-Besse PRA-identified insights:

- SAMA candidate AC/DC-25 (dedicated DC power for AFW) and AC/DC-26 (alternator/generator for turbine-driven auxiliary feedwater (TDAFW) pump) were designed to extend the life of the TDAFW pumps in a station blackout (SBO) event and improve the likelihood of successful restoration of alternating current (AC) power.

- SAMA candidate AC/DC-27 (increased size of SBO fuel oil tank) was also designed to help mitigate an SBO event.

- SAMA candidate CB-21 (pressure sensors between the two in-series Decay Heat Removal (DHR) System suction valves) was designed to help reduce the likelihood of ISLOCA events.

- SAMA candidate CC-19 (automatic switchover of high pressure injection (HPI) and low pressure injection (LPI) suction from the BWST to the containment sump) was designed to increase the reliability of the switchover during a loss of coolant accident (LOCA) event.

- SAMA candidate CC-20 (modify hardware and procedures to allow using make-up pumps for high pressure recirculation from the containment sump) was designed improve the reliability of high pressure recirculation following the loss of HPI.

- SAMA candidate CC-21 (reduce the BSWT level at which switchover to containment recirculation is initiated) was designed to extend the time available to accomplish BWST refill..

- SAMA candidate CP-19 (install a redundant containment fan system) was designed to increase containment heat removal ability. This SAMA candidate was added as a variation to CP-18 to provide a redundant containment cooling function, in the form of containment fan coolers.

- SAMA candidates CW-24 (adding a diversified CCW pump) and CW-25 (providing the capability to cool makeup pumps with fire water on loss of CCW) were designed to mitigate the total loss of CCW cooling.

- SAMA candidate FW-16 (surveillance of manual AFW suction valves) was designed to improve the reliability of alternate sources of AFW water supply.

- SAMA candidate HV-06 (procedure guidance for alternate means of switchgear cooling) was designed to prevent the loss of one train of service water in the event of loss of one HVAC fan for the service water pump room. This SAMA candidate was developed from Davis-Besse IPE insights.

Evaluating Basic Events with Potential Benefit Greater Than the Cost of a Procedure Change

The internal events and LERF basic events with an RRW value estimated to be equal to or greater than the cost of a procedure change were evaluated. These basic events were dispositioned by either identifying resulting SAMAs or presenting the reason for no new SAMA candidate. One new SAMA candidate (OT-9R) resulted from this evaluation.

An estimate of the cost-benefit versus RRW was developed for the internal events basic events calculated for the base PRA model. The minimum cost of a procedure change was assumed to be $10,000. In addition, the minimum cost of a hardware modification was estimated to be $100,000. The cost-benefit versus RRW assumed that cost-benefit was directly proportional to the reduction in core damage frequency (CDF). Cost is not perfectly correlated with CDF, due to the fact that different scenarios, even with the same CDF, will result in different distributions of release categories. It is judged, however, that this correlation provides a reasonable estimate of potential benefit along with what is judged to be a low cost for a procedure change, and provides strong confidence that cost-effective SAMA candidates will be captured.

For the total benefit for the hazard group (Bt), the cost-benefit versus RRW used the maximum derived benefit of $349,147.

The following formula is used for deriving the estimated benefit by hazard group based on RRW:

$$EB_{(BE)} = B_t\left(1 - \frac{1}{RRW}\right)$$

where,

$EB_{(BE)}$ = the estimated benefit based on a basic event

B_t = the total benefit for the hazard group (internal events, fire, or seismic)

RRW = the RRW for the basic event from the PSA, by hazard, assuming the basic event failure probability is reduced to zero.

The RRW for the Level 2 PRA basic events may be calculated based on LERF rather than CDF. Additional conservatism is added by treating Level 2 PRA basic event RRW values based on LERF as if they were based on CDF (i.e., the use of Bt significantly overstates their benefit), and the degree of conservatism could be large.

Based on these estimates, an RRW value of 1.03 was calculated to have a maximum cost benefit of $10,000 and an RRW of 1.40 was estimated to have a maximum cost benefit of $100,000. The maximum cost benefit is based on the RRW of the basic event being reduced to 1.0 (basic event modeled as perfect). For all basic events having an RRW value estimated to be at, or above, the value of a procedure change, a disposition was provided either identifying the SAMA candidate(s) addressing that basic event or a description as to why the basic event was not addressed in a SAMA candidate. No basic events had an RRW value equal to, or greater than the estimated cost of a hardware modification. Table 5.c-1, below, lists the basic events with the highest RRW for CDF.

Table 5.c-2, below, tabulates the basic events with the highest RRW for LERF. The estimated benefit for each basic event was derived by taking the RRW for LERF and applying the maximum total benefit used for the CDF basic events. This is very conservative, since the total maximum benefit does not apply only to LERF. For all basic events having an RRW value estimated to be at, or above, the value of a procedure change, a disposition was provided either identifying the SAMA candidate(s) addressing that basic event or a description as to why the basic event was not addressed in a SAMA candidate. No basic events had an RRW value equal to, or greater than the estimated cost of a hardware modification.

Basic events WHAF3ISE, SHAF2ISE, F3AM, and F7L did not have RRW values with potential benefit equal to, or greater than, the minimum cost of a procedure change. Basic event F7L, a large circulating water flood in the Turbine Building, did, however, result in an RRW value greater than the minimum cost of a procedure change for the 95 percent uncertainty CDF model. SAMA candidate FL-01 (improve inspection of rubber expansion joints on main condenser) was initially identified to address basic event F7L, and was designed to reduce the frequency of a large circulating water system flooding event due to failure of the circulating water system expansion joints. Based on the F7L RRW value from the 95 percent uncertainty CDF model and its original screening of "Very Low Benefit," SAMA candidate FL-01 was reevaluated and screened as "Already Implemented," as discussed in the response to RAI 6.k.

The ER is revised (numerous locations) to identify that there are now 168 SAMA candidates that were evaluated instead of the original 167. Also, ER Table E.5-4 is revised to include changes identified in Tables 5.c-1 and 5.c-2, below.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Table 5.c-1 – Basic Event Level 1 PRA Importance				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
UHAMUHPE	2.59E-01	1.349	Failure to initiate makeup/HPI cooling after loss of all feedwater	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
QHAMDFPE	2.45E-01	1.324	Failure to start MDFP after loss of feedwater	SAMA candidate FW-17R evaluates implementing an automatic start of the motor-driven feed pump (MDFP) on loss of main feedwater (MFW).
QHARCPCE	2.32E-01	1.302	Operators fail to trip RCPs after a total loss of seal cooling	SAMA candidate CW-26R evaluates implementing an automatic RCP trip on high bearing cooling temperature or loss of CCW flow to the RCP thermal barrier cooler and loss of seal injection flow.
T3	1.96E-01	1.243	LOOP (initiating event)	Numerous SAMA candidates that address LOOP were evaluated: AC/DC-01, additional battery capacity AC/DC-14, install gas turbine generator AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps AC/DC-27, increase SBO fuel oil tanks size
EHASBDGE	1.64E-01	1.196	Operators fail to align power from SBO diesel generator to supply MDFP	SAMA candidate AC/DC-28R evaluates the automatic start of the SBO diesel and loading to Bus D2 upon loss of power to Bus D2.

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
EHASBD1E	1.58E-01	1.187	Operators fail to start SBO diesel generator and align to bus D1	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
EHAD2DGE	1.53E-01	1.181	Operators fail to align power from EDG 1-1 or EDG 1-2 to supply MDFP given LOOP	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
T1	1.35E-01	1.156	Reactor/turbine trip (initiating event)	This is based on a somewhat conservative T1 value of 1.02/yr. Davis-Besse trip occurrence frequency is considered representative of industry values. SAMA candidates have been evaluated that address various Davis-Besse important scenarios following a reactor/turbine trip. CC-01, evaluates the installation of an independent active or passive HPI system. CW-26R, evaluates an automatic RCP trip on high motor bearing temperature or loss of CCW flow to the RCP thermal barrier cooler and loss of seal injection flow. FW-17R, evaluates an automatic start of the motor driven feedwater pump. HV-01, evaluates a redundant train for ventilation. HV-03, evaluates the staging of backup fans in the switchgear room.
QHAOVF2E	1.22E-01	1.139	Operators fail to take local manual control of TDAFW pump 1-2 speed.	SAMA candidate AC/DC-25 provides a dedicated DC system to TDAFW pumps and SAMA candidate AC/DC-26 provides an alternator/generator driven by TDAFW pumps. These SAMA candidates would eliminate the need for local manual control of the TDAFW pumps.
ZHARCPCE	1.10E-01	1.124	Operators fail to trip RCPs following loss of seal cooling	SAMA candidate CW-26R evaluates implementing an automatic RCP trip on high bearing cooling temperature or loss of CCW flow to the RCP thermal barrier cooler and loss of seal injection flow.

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
WHASPREE	1.07E-01	1.12	Failure to recover CCW using spare CCW train (prior to damage)	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
QMBAFP11	7.61E-02	1.082	AFW Train 1 in maintenance	This estimated benefit of this basic event is below the minimum estimated cost of a hardware modification. The following SAMA candidates address improvements to the reliability of AFW in loss of off-site power scenarios: AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps
XHOS-CCW1RUN2STBY	7.54E-02	1.082	CCW Pump 1 running, Pump 2 in standby	This is a plant configuration probability in the model. It does not contribute to risk.
EDG0012F	7.12E-02	1.077	EDG 1-2 fails to run	SAMA candidate AC/DC-14 evaluates adding a gas turbine generator as an additional source of on-site power.
ZOP007BR	7.09E-02	1.076	Failure to restore off-site power	Numerous SAMA candidates that address LOOP were evaluated: AC/DC-01, additional battery capacity AC/DC-14, install gas turbine generator AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps AC/DC-27, increase SBO fuel oil tanks size

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
TMPP43XF-CC_ALL	6.79E-02	1.073	All CCW pumps fail to run due to CCF (initiating event)	SAMA candidate CW-24 evaluates the standby CCW pump with a pump diverse from the other two CCW pumps.
XHOS-CCW2RUN1STBY	6.57E-02	1.07	CCW Pump 2 running, Pump 1 in standby	This is a plant configuration probability in the model. It does not contribute to risk.
R	6.37E-02	1.068	SGTR (initiating event)	Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.
EHAD1ACE	5.90E-02	1.063	Failure to lineup alternate source to D1	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
T2	5.86E-02	1.062	Plant trip due to loss of MFW (initiating event)	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
NORCVRT3	5.57E-02	1.059	Offsite power recovery not possible after a tornado.	Numerous SAMA candidates that address LOOP were evaluated: AC/DC-01, additional battery capacity AC/DC-14, install gas turbine generator AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps AC/DC-27, increase SBO fuel oil tanks size

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
AV	5.12E-02	1.054	Reactor vessel rupture	Reactor vessel rupture is a low probability event that that is assumed to result in guaranteed core damage. No applicable SAMA candidates were considered possible to prevent core damage.
QTP000XA-CC_1_2	5.13E-02	1.054	CCF of two components: QTP0001A & QTP0002A (TDAFW)	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
QTP0001A	4.90E-02	1.051	AFP/T-1 fails to start	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
QMBAFP12	4.67E-02	1.049	AFW Train 2 in maintenance	The estimated benefit for this basic event is below the cost of a hardware modification. The following SAMA candidates address improvements to the reliability of AFW in LOOP scenarios: AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps
ZOP006FR	4.58E-02	1.048	Failure to restore off-site power	Numerous SAMA candidates that address LOOP were evaluated: AC/DC-01, additional battery capacity AC/DC-14, install gas turbine generator AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps AC/DC-27, increase SBO fuel oil tanks size

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
S	4.35E-02	1.045	Small LOCA (initiating event)	SAMA candidate CC-01 evaluates the installation of an independent active or passive HPI system. SAMA candidate CC-19 evaluates the implementation of automatic switchover of HPI and LPI suction from the BWST to the to containment sump for LOCAs.
T13A-1-3-IEF	4.18E-02	1.044	Loss of CCW Train 1 initiating event Pump 1 running	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
MHARMVTE	4.17E-02	1.043	Operators fail to compensate for loss of room cooling for makeup pumps.	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
XHAMUCDE	4.10E-02	1.043	Operators fail to attempt cooldown via makeup/HPI cooling.	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
T13A-2-3-IEF	3.93E-02	1.041	Loss of CCW Train 2 initiating event Pump 2 running	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
EMBEDG12	3.85E-02	1.04	EDG Train 2 in maintenance	SAMA candidate AC/DC-14 evaluates adding a gas turbine generator as an additional source of on-site power.

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
CHASGDPE	3.63E-02	1.038	Operators fail to cooldown during a SGTR	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R. Also, Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.
FMFWTRIP	3.71E-02	1.038	MFW/ICS faults following trip	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
FMM00003	3.52E-02	1.037	Any MSSVs on SG1 fail to reseat	SAMA candidate CB-22R evaluates the use of a "gagging device" to close a stuck open MSSV.
EDG0012A	3.46E-02	1.036	EDG 1-2 fails to start	SAMA candidate AC/DC-14 evaluates adding a gas turbine generator as an additional source of on-site power.
AASGTR11	3.42E-02	1.035	SGTR occurs on OTSG 1-1 (split fraction)	Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.

Table 5.c-1 – Basic Event Level 1 PRA Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
LHAMSIVE	3.34E-02	1.035	Failure to close MSIV and isolate steam generator containing ruptured tube	Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.
QHAMDF3E	3.34E-02	1.035	Failure to start MDFP prior to depletion of BWST during makeup	SAMA candidate FW-17R evaluates implementing an automatic start of the motor-driven feed pump (MDFP) on loss of main feedwater (MFW). SAMA candidate CC-22R evaluates implementing an automatic refilling of the BWST.
QTP0002A	3.25E-02	1.034	AFP/T-2 fails to start	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
EDG0011F	3.13E-02	1.032	EDG 1-1 fails to run	SAMA candidate AC/DC-14 evaluates adding a gas turbine generator as an additional source of on-site power.
FCIRCTMP	3.00E-02	1.031	Circ water temperature not acceptable	This is a PRA model flag. It is not a candidate for a SAMA. No SAMA candidate considered.
RRW of 1.03 is estimated to have a cost of approximately $10,000. This is assumed to be the minimum cost of a procedure change.				

Table 5.c-2 – Basic Event LERF Importance				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
R	9.00E-01	10.048	SGTR (initiating event)	Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.
XHAMUCDE	6.10E-01	2.563	Operators fail to attempt cooldown via makeup/HPI cooling	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
CHASGDPE	5.40E-01	2.175	Operators fail to cooldown during a SGTR	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.
LHAMSIVE	4.97E-01	1.989	Failure to close MSIV and isolate steam generator containing ruptured tube	A SAMA candidate was developed that presents the highest worth PRA human actions to the Davis-Besse operator training. SAMA candidate OT-09R was added to the initial list of SAMA candidates, but subsequently found to be already implemented at Davis-Besse.

Table 5.c-2 – Basic Event LERF Importance (continued)

Event Name	F-V	RRW	Description	Disposition
AASGTR11	4.81E-01	1.926	SGTR occurs on OTSG 1-1 (split fraction)	Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.
AASGTR12	3.93E-01	1.646	SGTR occurs on OTSG 1-2 (split fraction)	Davis-Besse is scheduled to install new steam generators in 2013. This modification, with resulting reduction in SGTR frequency, is not reflected in the current PRA model. This plant improvement is assumed to result in a reduction risk importance of SGTR events.
RRW of 1.40 is estimated to have a cost of approximately $100,000. This is assumed to be the minimum cost of a hardware modification.				
FMM00003	7.90E-02	1.086	Any MSSVs on SG1 fail to reseat	SAMA candidate CB-22R evaluates the use of a "gagging device" to close a stuck open MSSV.
VD-IEF	7.54E-02	1.082	ISLOCA due to internal rupture of DHR suction valves	SAMA candidate CB-21 evaluates placing pressure measurements between the two DHR suction valves in the RCS hot leg allowing early detection of inboard isolation valve leakage.
FLCO101F	7.31E-02	1.079	Logic card fails during operation – MSIV 101 fails to close	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.

Table 5.c-2 – Basic Event LERF Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
LPPNISOZ	7.18E-02	1.077	ISLOCA occurs in non-isolable portion of DHR system	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
FMM00004	6.80E-02	1.073	Any MSSVs on SG2 fail to reseat	SAMA candidate CB-22R evaluates the use of a "gagging device" to close a stuck open MSSV.
FLC0100F	6.13E-02	1.065	Logic card fails during operation – MSIV 100 fails to close	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
QHAMDFPE	5.96E-02	1.063	Failure to start MDFP as backup to turbine-driven feedwater pumps for transient, Small LOCA or SGTR events	SAMA candidate FW-17R evaluates implementing an automatic start of the motor-driven feed pump (MDFP) on loss of main feedwater (MFW).
EC1ZXXXN-CC_1_2	5.19E-02	1.055	CCF of two components: EC1Z089N & EC1Z100N	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
LPSRC2BH	4.93E-02	1.052	Press switch PSH RC2B4 fails high – fails DHR	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
LPSZ416H	4.93E-02	1.052	Press switch PSH 7531A fails high - fails DHR	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.

Table 5.c-2 – Basic Event LERF Importance (continued)

Event Name	F-V	RRW	Description	Disposition
LMVF012R	4.53E-02	1.047	Internal rupture of DH 12 (annual frequency)	SAMA candidate CB-21 evaluates placing pressure measurements between the two DHR suction valves in the RCS hot leg allowing early detection of inboard isolation valve leakage.
LMBCWRT1	4.12E-02	1.043	CWR Train 1 unavailable due to maintenance	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
EDG0012F	3.47E-02	1.036	EDG 1-2 fails to run	SAMA candidate AC/DC-14 evaluates adding a gas turbine generator as an additional source of on-site power.
FCIRCTMP	3.00E-02	1.031	Circ water temperature not acceptable	This is a PRA model flag. It is not a candidate for a SAMA. No SAMA candidate considered.
FVV011BT	3.04E-02	1.031	AVV ICS11B fails to reseat after steam	The estimated benefit for this basic event is below the cost of a hardware modification. No SAMA candidate considered.
LMVF011R	3.01E-02	1.03	Internal rupture of DH 11 (annual frequency)	SAMA candidate CB-21 evaluates placing pressure measurements between the two DHR suction valves in the RCS hot leg allowing early detection of inboard isolation valve leakage.

Table 5.c-2 – Basic Event LERF Importance (continued)				
Event Name	**F-V**	**RRW**	**Description**	**Disposition**
ELOOPRT	2.93E-02	1.03	LOOP given reactor trip	Numerous SAMA candidates that address LOOP were evaluated: AC/DC-01, additional battery capacity AC/DC-14, install gas turbine generator AC/DC-25, provide dedicated DC system to TDAFW pumps AC/DC-26, provide alternator/generator driven by TDAFW pumps AC/DC-27, increase SBO fuel oil tanks size
RRW of 1.03 is estimated to have a cost of approximately $10,000. This value is assumed to be the minimum cost of a procedure change.				

Question RAI 5.d

ER Section E.5.3, E.5.4, and E.5.5 discuss significant contributors to core damage frequency (CDF) and large early release frequency (LERF). These sections and the associated tables show that there are a number of operator errors and non-recovery actions that occur in these listings, but report that no weaknesses in training or procedures were identified. Given: 1) the significant number of operator errors in these lists, 2) that human errors are among the most dominant failure modes presented in the importance Tables E.5-2 (i.e., the first 9 basic events listed by RRW are human error events) and E.5-3, and 3) that operator errors often have relatively high failure probabilities, provide the following:

i. **Explain the process used to make the determination that there were no opportunities to improve procedures and training.**

ii. **Discuss whether any of the risk significant operator action failures could be addressed by a SAMA to automate the function (i.e., automating tripping of the RCPs after a loss of seal cooling -see RAI 7.a).**

RESPONSE RAI 5.d

5.d.i

The Human Failure Events (HFEs) included in the dominant cutsets, and identified in the Level 1 and LERF importance tables (as discussed in ER Sections E.5.3, E.5.4 and E.5.5) were reviewed. In the Davis-Besse PRA, the EPRI software supporting the Computer-Aided Fault Tree Analysis (CAFTA) Software, the Human Reliability Analysis (HRA) Calculator, was utilized to quantify and document the HRA analysis. The documentation for each HFE includes a discussion of the action, associated cues, relevant procedures, training, assumptions, staffing, performance shaping factors, and timing. The review concluded that adequate procedures and training were in place; no specific weaknesses were identified in the review of the HFEs.

By their nature, and the way in which they support system fault trees and functional event trees, operator actions are recognized as a key source of model uncertainty and important contributors to core damage. Accordingly, operator actions are discussed in ER Sections E.5.3, E.5.4, and E.5.5. Over the last fifteen years, there has been a significant industry effort in improving procedure content, procedure use, human error reduction techniques, and training.

5.d.ii

In addition to the new SAMAs addressed in RAI 7, two additional SAMA candidates were evaluated to address automating risk significant operation actions: SAMA candidate AC/DC-28R (automatically start and load the SBODG on Bus D2 upon loss of power to the bus), and SAMA candidate OT-08R (automatically start and load the SBODG on Bus D2 upon loss of power to the bus in combination with automatically starting the MDFP). Table 5.d-1 and Table 5.d-2, below, provide the internal event and total benefit results for SAMA candidates AC/DC-28R and OT-08R, respectively. Table 5.d-3, below, provides the final results for the ten sensitivity cases for SAMA candidate AC/DC-28R and OT-08R. The implementation cost for SAMA candidate AC/DC-28R was estimated as $1,600,000. Therefore, this SAMA candidate is not cost-beneficial at Davis-Besse. The implementation cost for SAMA candidate OT-08R was estimated as $4,400,000. Therefore, this SAMA candidate is not cost-beneficial at Davis-Besse.

Table 5.d-1: Internal Events Benefit Results for SAMA Candidates AC/DC-28R and OT-08R

Case	**AC/DC-28R** (Auto SBODG)	**OT-08R** (Auto SBODG & MDFP)
Off-site Annual Dose (rem)	2.23E+00	2.10E+00
Off-site Annual Property Loss ($)	1.74E+03	1.63E+03
Comparison CDF	1.0E-05	1.0E-05
Comparison Dose (rem)	2.30E+00	2.30E+00
Comparison Cost ($)	1.80E+03	1.80E+03
Enhanced CDF	8.3E-06	5.7E-06
Reduction in CDF	**17.00%**	**43.00%**
Reduction in Off-site Dose	**3.04%**	**8.70%**
Immediate Dose Savings (On-site)	$138	$348
Long Term Dose Savings (On-site)	$600	$1,518
Total Accident Related Occupational Exposure **(AOE)**	$738	$1,866
Cleanup/Decontamination Savings (On-site)	$22,502	$56,916
Replacement Power Savings (On-site)	$22,766	$57,584
Averted Costs of On-site Property Damage **(AOSC)**	$45,267	$114,500
Total On-site Benefit	**$46,005**	**$116,366**
Averted Public Exposure **(APE)**	$1,718	$4,908
Averted Off-site Damage Savings **(AOC)**	$736	$2,086
Total Off-site Benefit	**$2,454**	**$6,994**
Total Benefit (On-site + Off-site)	**$48,459**	**$123,360**

Table 5.d-2: Total Benefit Result for SAMA Candidates AC/DC-28R and OT-08R

	AC/DC-28R (Auto_SBODG)	**OT-08R** (Auto_SBODG & MDFP)
Internal Events	$48,459	$123,360
Fires, Seismic, Other	$222,912	$567,455
Total Benefit	$271,371	$690,815

Table 5.d-3: Final Results of the Sensitivity Cases for SAMA Candidates AC/DC-28R and OT-08R

SAMA ID	Repair Case	Low Discount Rate Case	High Discount Rate Case	On-site Dose Case	On-site Clean-up Case
AC/DC-28R	$169,380	$409,899	$187,033	$275,551	$313,374
OT-08R	$432,838	$1,043,605	$476,456	$701,388	$797,058

SAMA ID	Replacement Power Case	Multiplier Case	Evacuation Speed	Off-site Economic Cost	95th CDF Case
AC/DC-28R	$356,944	$387,673	$302,292	$272,745	$393,488
OT-08R	$907,264	$986,879	$721,735	$692,189	$1,001,682

Question RAI 5.e

Table E.5-2 identifies events QMBAFP11 and QMBAFP12 representing unavailability of Auxiliary Feedwater (AFW) Trains 1 and 2, respectively, due to maintenance. Provide an evaluation of a SAMA to improve the availability of the AFW pumps by making improvements to maintenance practices or by making hardware modifications.

RESPONSE RAI 5.e

The events QMBAFP11 and QMBAFP12 represent unavailability of AFW trains 1 and 2. The AFW maintenance unavailability data in the PRA is based on the Maintenance Rule data. The SAMA PRA model includes the following: AFW train 1 in maintenance 285 hours and AFW train 2 in maintenance 311 hours, over 24,209 hours (3 years). These values equate to a maintenance unavailability of 1.18E-2/yr and 1.29E-2/yr for AFW trains 1 and 2, respectively. This data is consistent with the generic Industry unavailability data in NUREG/CR-6928 for a turbine-driven AFW pump of 5.44E-3/yr. Improvements to maintenance practices are proposed and evaluated as a normal course of business to maintain AFW train unavailability at its lowest achievable value. Safety-related hardware modifications are costly, and, based on the industry unavailability data, a SAMA to improve the availability of the AFW pumps is not expected to be cost-beneficial.

Question RAI 5.f

Table E.5-4 does not provide the source for identifying SAMAs CC-19, CW-24, and CW-25. ER Section E.5.2 implies that CW-24 and CW-25 were identified to address IPE risk insights. Clarify the basis for identifying these SAMA candidates.

RESPONSE RAI 5.f

The basis for identifying SAMA candidates CC-19, CP-19, CW-24 and CW-25 were inadvertently omitted from Table E.5-4. The following provides a discussion of the basis for each of these SAMA candidates.

CC-19: Davis-Besse currently has the automatic switchover of HPI and LPI suction from the BWST to the containment sump removed. SAMA candidate CC-19 examined re-installing the automatic switchover of HPI and LPI suction from the BWST to the containment sump. The first MLOCA cutset (cutset #12) included basic event ZHALPRME (operators fail to initiate low pressure recirculation) as a single-element cutset.

CP-19: This SAMA candidate evaluates the installation of a redundant containment fan system. SAMA candidate CP-18 was taken from the generic list of SAMA candidates, and evaluates the implementation of a redundant containment spray system. SAMA candidate CP-19 was added as a variation to CP-18 to provide a redundant containment cooling function, in the form of containment fan coolers.

CW-24: This SAMA candidate to add a diversified CCW pump was developed based on the high importance of CCW, as indicated in cutsets and RRW importance values.

CW-25: This SAMA candidate to provide the ability to cool makeup pumps using fire water in the event of loss of CCW was developed based on the high importance of CCW, as indicated in cutsets and RRW importance values.

ER Table E.5-4, "List of Initial SAMA Candidates," rows CC-19, CP-19, CW-24 and CW-25, are revised to include a reference source.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 5.g

Several SAMA candidates identified in Table E.6-1 are subsumed in another SAMA candidate (e.g., AC/DC-06, AC/DC-09, AC/DC-20). For each subsumed SAMA candidate, provide an assessment of its implementation cost relative to that of the SAMA into which it was subsumed. If the implementation cost of the subsumed SAMA is less, provide a revised basis for the Phase I screening and Phase II cost-benefit evaluation if it meets Criterion F.

RESPONSE RAI 5.g

SAMA candidate CB-08 was subsumed in SAMA candidate CB-07 in Table E.6-1. SAMA candidate CB-07 was screened as already been implemented at Davis-Besse. The nature of the operation action/training is similar in both SAMA candidates. Therefore, SAMA candidate CB-08 was re-screened as Criterion B (Already Implemented). Accordingly, there was no need to determine the cost of implementation and assess the cost-benefit of SAMA candidate CB-08. ER Table E.6-1 is revised to identify the re-screening of SAMA candidate CB-08.

The SAMA candidates subsumed in Phase I (AC/DC-06, AC/DC-09, AC/DC-20, and CC-08) have an equivalent or higher cost of implementation than the SAMA candidates evaluated in Phase II. Nonetheless, an analysis was performed to assess the cost-benefit of the subsumed SAMA candidates. The total benefit was derived from the SAMA candidates into which they were subsumed and compared to the cost of implementation. Table 5.g-1 provides the results of the cost-benefit evaluation. None of the subsumed SAMA candidates are cost-beneficial to implement at Davis-Besse.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Table 5.g-1: Final Results of the Cost-Benefit Evaluation for Subsumed SAMA Candidates

SAMA ID	Modification	Estimated Benefit	Cost Estimate	Conclusion
AC/DC-06	Provide additional DC power to the 120/240V vital AC system.	$94,363	$1,750,000	Not Cost Effective
AC/DC-09	Provide an additional diesel generator.	$94,363	$2,800,000	Not Cost Effective
AC/DC-20	Add a new backup source of diesel generator cooling.	$33,745	$700,000	Not Cost Effective
CC-08	Add the ability to automatically align ECCS to recirculation mode upon BWST depletion.	$15,155	$1,500,000	Not Cost Effective

Question RAI 5.h

A few SAMA candidates identified in Table E.6-1 are screened for Very Low Benefit based on low contribution to LERF (e.g., CB-02, CP-21, OT-07). The ER does not provide sufficient information to assess the contribution of LERF to population dose-risk and offsite economic cost-risk relative to the total contribution from all release categories. Considering that the benefit of a SAMA is potentially based on the contribution from multiple release categories, provide additional justification for screening these SAMAs on Very Low Benefit.

RESPONSE RAI 5.h

SAMA candidate CB-02 addresses the reliability of containment isolation, and was included in the generic SAMA list within the CB (containment bypass) category. Isolation failure leads to a LERF event. Therefore, this SAMA candidate has no impact on CDF. At Davis-Besse, isolation failure is not a significant contributor to LERF, based on LERF basic event RRW values. Improving containment isolation reliability will not have any significant improvement in other release categories; therefore this SAMA candidate was not considered further.

SAMA candidate CP-21 addresses installing a passive hydrogen control system. A hydrogen burn or detonation typically leads to an early large release. A hydrogen burn or detonation is not risk-significant for LERF at Davis-Besse; therefore this SAMA candidate was not considered further.

SAMA candidate OT-07 is designed to reduce the likelihood of a main steam line break upstream of the main steam isolation valves (MSIVs). This SAMA candidate should not have been eliminated based on LERF. Rather, main steam line breaks are not a significant contributor to either CDF or LERF since they are not found in the top 100 cutsets or the list of either Level 1 or Level 2 risk-significant basic events. The disposition of this SAMA in ER Table E.6-1, "Qualitative Screening of SAMA Candidates," is revised to include a reference to CDF.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 5.i

SAMA CB-18, "direct steam generator flooding after a steam generator tube rupture (SGTR), prior to core damage," was screened in Table E.6-1 because it could impact efforts to mitigate the SGTR. This SAMA was determined to be potentially cost-beneficial in previous SAMA analyses (e.g., Diablo Canyon, TMI-1). Provide a cost-benefit evaluation of this SAMA.

RESPONSE RAI 5.i

In the Davis-Besse PRA model, steam generator tube rupture sequences resulting in core damage are placed in one of the following core damage bins: RRY, RRN, RIY, or RIN. Core damage bins RRN and RIN represent sequences in which feedwater is unavailable to the steam generators. In these sequences, it would be impossible to flood the steam generators because no feedwater is available to do so. For core damage bins RRY and RIY, feedwater is available, and it was judged that scrubbing would occur in the steam generator. The auxiliary feedwater nozzles spray high into the tubes and would be expected to provide scrubbing even if the break location was not flooded. Therefore, flooding the steam generators as suggested in CB-18 provides no additional scrubbing benefit, and as such, a cost-benefit evaluation of those SAMAs is not warranted.

Item 6

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

Question RAI 6.a

ER Section E.7.2 states that an expert panel developed the implementation cost estimates for each of the SAMAs. Briefly, describe the level of detail used to develop the cost estimates (i.e., the general cost categories considered). Also, clarify whether the cost estimates accounted for inflation, contingency costs associated with unforeseen implementation obstacles, replacement power during extended outages required to implement the modifications, and maintenance and surveillance costs during plant operation.

RESPONSE RAI 6.a

The Expert Panel process was a collegial review process that relied upon the expertise and judgment of long-term site staff drawn from engineering, operations, procurement, and project management, and assisted by select support personnel (License Renewal, SAMA & probabilistic risk assessment (PRA)). The Panel reviewed each SAMA candidate and, based on their professional expertise and judgment, approximated the costs associated with implementation processes and equipment.

Main cost categories considered included:

- equipment, including the specific mechanical or electrical components identified in the SAMA (e.g., gas turbine-powered generator), and associated piping and piping components, and electrical cables, switchgear, connectors and conduit;
- fuel (natural gas or petroleum-based fuels), if appropriate;
- space requirements, and whether existing space was available or new spaces need to be constructed to house and protect the equipment or for storage of associated fuel and supporting equipment; and,
- extent of modifications, considering whether modifications were safety-related (higher costs) or nonsafety-related, the seismic requirements (higher costs), calculation requirements (higher costs), whether piping or electrical runs would be required between structures or through walls (higher costs), or whether the Control Room envelope was potentially impacted (higher costs).

Some implementation costs were assigned a standard value based upon plant experience or estimated man-hours required:

- minimal procedure changes will be between $10,000 and $50,000;
- procedure changes with Engineering support will be between $50,000 and $200,000;
- procedure changes with Engineering support and testing or training required will be between $200,000 and $300,000; and,
- minimal physical plant changes (modifications) start at $100,000.

Least cost "out-of-the-box" options were included wherever possible (e.g., securing retail store small generator(s)). Detailed design concepts were not developed by the Expert Panel, but every effort was made to identify and reasonably price all activities that need to be performed in support of each SAMA candidate (i.e., "conceptually estimated," as described by NEI 05-01, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document," (Nov. 2005), Section 7.2, "Cost of SAMA Implementation"). These support activities included costs associated with procurement, installation, long-term maintenance, surveillance, calibration, and initial and ongoing training. Inflation, contingency costs associated with unforeseen implementation obstacles, and replacement power costs during extended outages required to implement modifications were not specifically identified or included in the cost estimates.

Question RAI 6.b

SAMA CC-19, "provide automatic switch over of HPI and LPI suction from the BWST to containment sump for LOCAs," has an estimated implementation cost of $1.5M. Table E.6-1 states that Davis-Besse already has this capability but that the feature has been deactivated, and that the cost would be minor to reactivate this feature. The estimated cost of $1.5M seems very high based on this description. Furthermore, other SAMA analyses have estimated the cost of this SAMA to range from $265K (Robinson) to $1M (Catawba). Provide a more detailed description of this modification and justification for the estimated cost.

RESPONSE RAI 6.b

The SAMA Expert Panel made the following assumptions regarding SAMA candidate CC-19 to provide automatic switchover of HPI and LPI suction from the BWST to the containment sump:

- the hardware for automatic switchover is already in-place, but not connected, so reconnection and reactivation of the equipment is necessary;
- the associated valves were de-powered in support of Appendix R criteria;
- Appendix R analyses would need to be re-performed (approximately $500K);
- the change would require a safety-related modification due to the safety-significance of the affected equipment, and calculation support would be necessary (approximately $500K);
- procedure changes with Engineering support and initial testing or training required (approximately $300K); and,
- ongoing testing, surveillances, maintenance and training (approximately $200K).

Estimated cost to implement would be approximately $1.5M or greater.

Based on the review by the SAMA Expert Panel, the costs to implement the modification are not 'minor'; therefore, the ER is revised to delete the statements that the costs to reactivate the automatic switchover feature would be minor.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 6.c

SAMA AC/DC-25, "provide a dedicated DC power system (battery/battery charger) for the TDAFW control valve and NNI-X for steam generator level indication," has an estimated implementation cost of $2M. This cost seems quite high for a system dedicated to just the TDAFW control valves and in light of the estimated costs for AC/DC-01 and AC/DC-03. Provide a more detailed description of this modification and justification for the estimated cost. Also, consider whether a portable system can provide the same benefit at a lower cost.

RESPONSE RAI 6.c

The Expert Panel made the following assumptions regarding SAMA candidate AC/DC-25 to provide a dedicated DC power system (battery/battery charger) for the TDAFW control valve and NNI-X for steam generator level indication:

- the DC power system will consist of a dedicated set of batteries and a battery charger;
- the intent of this SAMA would be to extend TDAFW pump operating time in the event of an SBO event, or loss of DC power to a TDAFW pump. Therefore, the dedicated DC system must have a longer battery lifetime than the existing safety-related DC system, or be able to supply power following loss of the current safety-related DC system;
- automatic steam generator level control will be needed (pump control, valves, indications, and speed changer motor, which means more DC power is required) to make the probabilistic risk assessment (PRA) case that the TDAFW pumps and level control are reliable;
- safety-related space for the batteries will be required (approximately $400K);
- major safety-related modification with seismic evaluation and calculation support required (approximately $500K);
- procedure changes with Engineering support and testing or training required (approximately $300K);
- batteries and other components and equipment, cable and conduit, disconnects to transfer DC power, including installation (approximately $700K); and
- both batteries / trains affected (additional costs).

Estimated cost to implement would be approximately $2M or greater.

A portable system, such as a diesel-driven battery charger or generator was evaluated in AC/DC-03, and was determined to cost approximately $330K or greater, and is considered cost-beneficial. For SAMA candidate AC/DC-25, due to the additional loads described above, an assumed portable system for this SAMA may require a larger generator unit to carry the loads. A portable system was not considered for this SAMA, however, because of the wording of the SAMA (i.e., a dedicated DC power system (battery/battery charger)).

Question RAI 6.d

SAMA CW-24 , "replace the standby CCW pump with a pump diverse from the other two CCW pumps," has an estimated implementation cost of $7.5M. This cost seems quite high for a pump replacement. Provide a more detailed description of this modification and justification for the estimated cost.

RESPONSE RAI 6.d

The Expert Panel made the following assumptions regarding SAMA candidate CW-24 to replace the standby CCW pump with a pump diverse from the other two CCW pumps:

- merely changing the standby pump with a different style pump would not meet the intent of the SAMA;
- additional safety-related space is needed that is separate from the existing component cooling water pumps due to the lack of space in the CCW pump room and to eliminate the potential for a common failure (i.e., flood) of all CCW pumps (approximately $2M);
- a new design pump, piping, valves and fittings will be required; cable and conduit required; components and equipment, including installation (approximately $4M);
- major safety-related modification with seismic evaluation and calculation support required (approximately $1M);
- procedure changes with Engineering support and testing or training required (approximately $500K);

Estimated cost to implement would be approximately $7.5M or greater.

Question RAI 6.e

As reported in Table E.7-2, the population dose risk reduction is either 10.00% (for 3 SAMAs) or 0.00% (for all other SAMAs). Explain how population dose risk was calculated and justify the result for each SAMA individually.

RESPONSE RAI 6.e

The results presented in Table E.7-2 appeared to be binary (either 0.00 percent or 10.00 percent). These population dose risk reduction values are correct, however, due to rounding in the Excel spreadsheet, the distinction between values for each SAMA candidate was not evident.

The population dose risk for each SAMA candidate is determined as follows:

1. The population dose is determined by execution of MACCS2 for each release category.
2. A PRA run for each SAMA candidate generates a new "vector" of release category frequencies.
3. The population dose risk (for each SAMA candidate) equals the sum (over all release categories) of the population dose for release category i times the frequency for release category i.

The percent change is determined by comparison of the population dose risk for each SAMA candidate compared with the base case (comparison dose). As the input from MACCS2 has changed (see response to RAI 4.b, above), the results presented in Table E.7-2 are revised; see the Enclosure to this letter for the revision to Table E.7-2. Note that the number of significant digits for the population dose (Off-site Annual Dose) provided in Table E.7-2 has increased to permit a discernable distinction between the population dose risk values for each SAMA candidate.

Question RAI 6.f

The model approach for SAMA AC/DC-01, "provide additional DC battery capacity," assumes a seven hour battery life. Provide the battery life assumed in the base PRA model, the basis for assuming a seven hour battery life in the SAMA analysis, and justification for the estimated implementation cost of $1.75M.

RESPONSE RAI 6.f

Davis-Besse has 4 Essential Batteries (1P, 1N, 2P & 2N). The four 125V DC, 1500 ampere-hour, lead-calcium batteries are provided and arranged to form two independent 125/250V DC Motor Control Centers (MCC). The batteries are sized to supply the anticipated DC and Instrument AC supply for a period of one hour after the loss of the battery charger supply. As discussed in FENOC procedure DB-OP-02521, "Loss of AC Bus Power Sources," non-essential loads can be shed to prolong battery life during a station blackout. The PRA assumes a 1 hour battery life. And, as discussed in USAR Chapter 15.2.9, decay heat removal after coastdown of the reactor coolant pumps is provided by natural circulation due to the raised loop design of Davis-Besse; the turbine-driven auxiliary feedwater pumps provide feedwater to the steam generators by taking suction from the condensate storage tanks. Feedwater level control can be provided by DC power, or manually. FENOC procedure DB-OP-02600, "Operational Contingency Response Action Plan," Attachment 1, "Emergency Control of Auxiliary Feedwater," identifies AFW System manual control actions, and Attachment 2, "Providing RPS/NNI Emergency Power Source," identifies actions to line up a portable gasoline-powered AC generator (located in the Fire Brigade Equipment Room) to support manual operation of the AFW System following a loss of all AC and DC power.

A 6 - 8 hr battery was considered a reasonable extension for additional DC battery capacity based on the likelihood of recovering off-site power in this timeframe; SAMA AC/DC-01 considered 7 hrs.

The SAMA Expert Panel made the following assumptions regarding SAMA candidate AC/DC-01 to provide additional DC battery capacity:

- consider moving nonsafety-related loads to a new nonsafety-related battery;
- additional safety-related space for the batteries will be required; no space exists for additional batteries in the current battery room (approximately $500K);
- major modification required (approximately $200K);
- procedure changes with Engineering support and testing or training required (approximately $300K);
- batteries and other components and equipment, cable and conduit, including installation (approximately $600K); and,
- both batteries / trains affected – additional costs.

Estimated cost to implement would be approximately $1.75M or greater.

Question RAI 6.g

The model approach for SAMA AC/DC-14, "install a gas turbine generator," assumes failure of the station blackout (SBO) diesel generator is eliminated. This assumption does not provide credit for the gas turbine generator in the situation where all the emergency diesel generators (EDGs) are unavailable. Provide an assessment of the impact of this omission.

RESPONSE RAI 6.g

The Davis-Besse SBODG is manually started and loaded to supply power to Bus D2 in the event of an SBO. The SBODG is also available to power either shutdown Bus C1 or D1 at the onset of an SBO. In the Davis-Besse PRA, the SBODG is modeled as a backup to either EDG 1 or 2; it is considered in cases where both or either EDG 1 or 2 are unavailable . By eliminating failure of the SBODG (i.e., assuming it is perfectly reliable and available), this SAMA already accounts for crediting a gas turbine generator by ensuring one train of emergency power.

Question RAI 6.h

The model approach for SAMA CB-21, "install pressure measurements between the two DHR suction valves in the line from the RCS hot leg," assumes latent failures of the upstream valve are eliminated. It is unclear what is meant by "latent failures." Provide a more detailed description of the PRA model changes made to evaluate this SAMA.

RESPONSE RAI 6.h

The DHR ISLOCA model considers combinations of failures of the two motor-operated suction isolation valves in the DHR drop line. The valves are in series, so both must fail to result in an ISLOCA. Since both valves must fail, one valve could have failed at some point in the past without being detected as long as the other is not failed; this is what is meant by "latent failures." The failure of the other valve would then be the initiating event for the ISLOCA.

SAMA CB-21 proposed installing pressure indication in the piping between the two valves, which is not normally at RCS pressure. The pressure indication could detect if the inboard isolation valve (DH12) connected to the RCS had failed since startup, either by having failed to close while indicating closed, or by an internal rupture after startup. The analysis for SAMA CB-21 eliminated these failures of DH12, assuming that the failure would be detected and the unit shut down before the outboard isolation valve (DH11) fails. The PRA model also considers the case where DH12 fails, and the sudden increase in pressure on DH11 causes it to fail immediately. These failures were not removed from the cutsets because pressure indication would not serve to prevent the ISLOCA in that case.

Question RAI 6.i

i. **ER Section E.8.6 discusses six sensitivity cases. Relative to these sensitivity cases, provide the following:**

i. **Insufficient information is provided to understand the specific changes made to the baseline analysis assumptions for the first and fourth sensitivity cases. Provide a more detailed description of the analysis assumptions and methodology for these two cases.**

ii. **The description of the sixth sensitivity case states that off-site economic cost was increased by 25 percent. Table E.8-1 indicates that the total benefit for each of the SAMA candidates was increased by the same amount of $19,632, the offsite economic cost (AOC) value. Clarify how the**

increase of 25 percent in off-site economic cost correlates to the increase in total benefits of $19,632 for each SAMA.

RESPONSE RAI 6.i

6.i.i

The first sensitivity case in Section E.8.6 investigated the impact of assuming damaged plant equipment is repaired and refurbished following an accident scenario, as opposed to automatically decommissioning the facility following the event. For the purpose of this sensitivity case, the cost of repair and refurbishment over the lifetime of the plant is equivalent to 20 percent of the replacement power cost in accordance with NUREG/BR-0184. To calculate the benefit for the first sensitivity case, 20 percent of the replacement power cost from the baseline analysis for each SAMA candidate is used to estimate the repair and refurbishment costs.

The fourth sensitivity case in Section E.8.6 investigated the sensitivity of each analysis to the cost of replacement power. To determine the replacement power cost in 2009 dollars, the variable string power cost calculated in Section E.4.4.2 was modified for energy price inflation. The inflation rate was determined by assessing the electricity costs in 1993 and in 2009. The retail electricity cost for the state of Ohio in 1993 was 6.22 cents/kW-h and in 2009 was 8.96 cents/kW-h. The inflation rate was calculated using the method shown below:

$$z = \frac{2009\text{cost}}{1993\text{cost}} = \frac{8.96\text{cents/kW} - \text{h}}{6.22\text{cents/kW} - \text{h}} = 1.44$$

$$(1+x)^{(\Delta y)} = z$$

$$(1+x)^{(2009-1993)} = 1.44$$

$$x = 0.0231 \Rightarrow 2.31\%$$

$$y = \text{year}$$

$$x = \text{inflation rate}$$

The next step calculated the 2009 value for the string of replacement power costs based on the calculated inflation rate. The inflation of the string of replacement power costs (B) scaled for Davis-Besse was calculated using the equation shown below. The 2009 value for the string of the replacement power costs (B2009) was used to determine the present value of replacement power costs (PVRP) in 2009 dollars with a seven percent discount rate.

$$B_{2009} = B_{1993}(1+0.0231)^{(2009-1993)}$$

$$B_{2009} = (1.20E+08)(1+0.0231)^{(16)}$$

$$B_{2009} = \$1.73E+08$$

6.i.ii

The sixth sensitivity case investigated the sensitivity of the analysis to the off-site economic cost. For each SAMA candidate, a delta between the maximum benefit value and the specific SAMA candidate value is used to estimate the benefit for each SAMA candidate. This sensitivity case increased the maximum benefit off-site economic cost (AOC) value by 25 percent. When performing the delta calculation between the 25 percent increase to the maximum benefit AOC and AOC best-estimate value for each SAMA candidate, the total benefit increases by a constant value.

For example, for SAMA candidate AC/DC-01, the increased AOC value is $1,800 * 1.25 = $2,250. From this value, the AC/DC-01-specific off-site annual economic loss (property loss) value of $1,790 is subtracted, yielding a delta of $460. This value is compared to the base case delta calculation ($1,800 – $1,790 = $10). The total benefit increase when comparing the base case to the sensitivity case (for internal events) is $450 ($460 – $10 = $450); the total increase considering fire, seismic and other external events (multiplier of 4.6) is $450 + ($450 * 4.6) = $2,520. This value is then multiplied by the present worth factor of 12.27 to yield an increase of $30,920, as shown in Table E.8-1. Since the specific SAMA candidate off-site economic cost is included in both the base case calculation and the sensitivity case calculation, when subtracted, it yields a constant increase in the benefit for each SAMA candidate.

Since the cost-benefit analysis was revised with the results from the Level 3 PRA (see response to RAI 4.b), the constant value differs from the $19,632 stated in the RAI. The revised results are provided in the LRA mark-up of Table E.8-1 in the response to RAI 4.b.

Question RAI 6.j

ER Section 8.3 discusses a sensitivity case using a higher evacuation speed. Provide the evacuation speed used for this analysis. Also, Table E.3-31 shows that the population dose decreased compared to the base case yet Table E.8-1 shows the total net benefit increased by $1,963 for each SAMA. Explain this anomalous result and describe the methodology for developing the $1,963 used for each SAMA.

RESPONSE RAI 6.j

The evacuation speed used in the sensitivity case discussed in ER Section E.8.3 was 1.0 meter/second. The population dose used in the Section E.8.3 sensitivity case was the result of the Level 3 PRA sensitivity case E1.

As noted in the RAI, with a decrease in population dose, the net benefit for each SAMA candidate would be expected to decrease. The anomalous result (e.g., a net benefit increase) was due to the number of significant figures used in the Level 3 PRA and the cost-benefit evaluation. The population dose values differed in the third significant digit, which when rounded caused the unexpected results. As a result of the response to RAI 4.b, above, the population dose values have been revised for the Level 3 PRA sensitivity case E1. The ER revisions due to population dose were identified in the response to RAI 4.b.

With the revised results from RAI 4.b and consistent use of significant figures between the Level 3 PRA and cost-benefit analysis, the value $1963 is no longer germane to the sensitivity case in Section E.8.3.

As noted in the staff's RAI, a decrease in population dose was the result of sensitivity case E1 (where the evacuation speed was increased). Since NEI 05-01 suggested an evacuation speed sensitivity case to assess the impact on the results due to the uncertainty in the evacuation speed, it is logical to test (via a sensitivity case) the impact of a lower evacuation speed (which may cause a previously screened SAMA candidate to become cost-beneficial). Accordingly, the cost-benefit sensitivity case (Evacuation Speed from Table E.8-1) has been revised to use the results from Level 3 PRA sensitivity case E3, in which the evacuation speed is decreased by 9.6 percent, which causes a slight increase in population dose. ER Section E.3.5.2.4 is revised and new ER Table E.3-33 is added to incorporate sensitivity case E3.

The total benefit for each SAMA candidate has been increased by $1374, which is consistent with the increase in population dose. For the sensitivity case in Section E.8.3, the population doses values are taken from the Level 3 PRA sensitivity case E3 and replace the base case values in the determination of the averted public exposure (APE). Since there is a constant difference in the population dose values, for the Section E.8.3 sensitivity case, the total benefit for each SAMA is changed by the same dollar amount. (See Table E.8-1 for results of evacuation speed sensitivity case in response to RAI 4.b.)

See the Enclosure to this letter for the revision to the DBNPS LRA.

Question RAI 6.k

The ER provides no assessment of the uncertainty distribution for CDF. Relative to the uncertainty distribution, address the following:

- **Provide the uncertainty distribution (5th, mean, and 95th percentiles) for the Davis-Besse PRA model CDF and describe how the distribution was developed.**

- **Provide an assessment of whether an uncertainty analysis using the 95th percentile CDF and the external events multiplier of 3.6 developed in RAI 3.c is bounded by the Multiplier Case sensitivity analysis. If not bounded, provide an uncertainty analysis using the 95th percentile CDF. In this analysis, provide an assessment of each Phase 1 SAMA eliminated using Screening Criterion D and E to determine whether any Phase 1 SAMAs originally screened should have a Phase 2 cost-benefit evaluation performed. Provide a Phase 2 cost-benefit evaluation for any SAMA not screened.**

- **If the Multiplier Case is bounding, provide an assessment of each Phase 1 SAMA eliminated using Screening Criteria D and E to determine whether any Phase 1 SAMAs originally screened should have a Phase 2 cost-benefit evaluation performed. Provide a Phase 2 cost-benefit evaluation for any SAMA not screened.**

RESPONSE RAI 6.k

The following table provides the uncertainty distribution for the Davis-Besse SAMA PRA model CDF. The 5th, mean, and 95th percentile values are in **bold** font:

	5% Conf.	Mean	95% Conf.
Point Estimate		9.70E-06	
Mean	1.06E-05	**1.07E-05**	1.09E-05
5th percentile	7.18E-06	**7.20E-06**	7.22E-06
Median	9.51E-06	9.53E-06	9.55E-06
95th percentile	1.53E-05	**1.55E-05**	1.56E-05
StdDev		1.48E-05	
Skewness		5.75E+01	
Kurtosis		4.55E+03	

The SAMA analysis model database was modified to support performance of an uncertainty analysis using the UNCERT software package. Failure rate distributions were entered into the database and modifications were made to make the database compatible with the UNCERT software. The SAMA analysis level 1 model was re-quantified to provide a cutset file compatible with the UNCERT software, and the uncertainty analysis was performed using the revised cutset file and database.

An assessment of the impact of the 95th percentile CDF uncertainty for internal events was performed for Davis-Besse. The uncertainty factor was derived from a ratio of the 95th percentile CDF uncertainty (1.55E-05/yr) to the point estimate CDF (1.07E-05/yr) for internal events. The uncertainty factor used in this analysis was 1.45. The analysis also used an external events multiplier of 4.6 (see the response to RAI 3.c for additional information on the development of the external events multiplier). Table 6.k-1, below, provides the cost-benefit results for the 95th percentile CDF uncertainty factor case. Also, the Multiplier Case was updated using an external events multiplier of seven (7). Table 6.k-2, below, provides the Multiplier Case cost-benefit results. The results of the 95th percentile CDF uncertainty and Multiplier Case sensitivity analyses identified one SAMA candidate (AC/DC-03) to be cost effective.

Since the external event multiplier used in the base case and the sensitivity case have changed, the issue of bounding is no longer relevant. Nonetheless, the SAMA candidates designated as Criterion D (Very Low Benefit) were re-evaluated (see Table 6.k-3, below) based on the results of the 95th percentile CDF uncertainty. For SAMA candidates where the 95th percentile CDF uncertainty basic event data were available, these basic events' RRW data were used as a basis for the final determination. For some SAMA candidates, either basic event data were not available, or basic event data were not applicable to the determination; for those cases, the determination basis is also provided.

SAMA candidate FL-01 (improve inspection of rubber expansion joints on main condenser) was initially identified for cost-benefit analysis based on the 95th percentile CDF uncertainty results. However, upon further investigation, the disposition of SAMA candidate FL-01 is changed to Criterion B (Already Implemented). The basis for the revised disposition is that the circulating water joints are currently inspected during outages and periodically replaced. ER Table E.6-1 is revised to include this change.

Further, based on additional information, SAMA candidate OT-05 (increase training and operating experience feedback to improve operator response) is changed from Criterion D (Very Low Benefit) to Criterion B (Already Implemented). The basis for the revised disposition is that Davis-Besse provides PRA information, such as risk significant initiating events, high worth operator actions and high worth equipment, to operators and other departments. Attachment 2 of FENOC procedure NOPM-CC-6000, "Probabilistic Risk Assessment Program," identifies items supported by the PRA Program; one item is PRA training support in areas such as new licensed operator training and operator re-qualification training cycles. ER Table E.6-1 is revised to include this change.

SAMA candidates screened with Criterion E (Subsumed) were addressed in the response to RAI 5.g, above.

See the Enclosure to this letter for the revision to the DBNPS LRA.

Table 6.k-1: 95th Percentile Uncertainty Factor Cost-Benefit Results

SAMA ID	95th Percentile Uncertainty Factor Estimated Benefit	Estimated Cost	Conclusion
AC/DC-01	$136,827	$1,750,000	Not Cost Effective
AC/DC-03	$548,194	$330,000	Cost Effective
AC/DC-14	$284,503	$2,000,000	Not Cost Effective
AC/DC-19	$48,930	$700,000	Not Cost Effective
AC/DC-21	$68,912	$100,000	Not Cost Effective
AC/DC-25	$341,569	$2,000,000	Not Cost Effective
AC/DC-26	$341,569	$2,000,000	Not Cost Effective
AC/DC-27	$0	$550,000	Not Cost Effective
CB-21	$46,827	$550,000	Not Cost Effective
CC-01	$2,989	$6,500,000	Not Cost Effective
CC-04	$0	$5,500,000	Not Cost Effective
CC-05	$0	$6,500,000	Not Cost Effective
CC-19	$21,974	$1,500,000	Not Cost Effective
HV-01	$0	$50,000	Not Cost Effective
HV-03	$0	$400,000	Not Cost Effective
AC/DC-28R	$393,488	$1,600,000	Not Cost Effective
CB-22R	$141,643	$4,600,000	Not Cost Effective
CC-22R	$0	$2,200,000	Not Cost Effective
CW-26R	$512,381	$1,500,000	Not Cost Effective
FW-17R	$584,227	$2,800,000	Not Cost Effective
OT-08R	$1,001,682	$4,400,000	Not Cost Effective

Table 6.k-2: Multiplier Case Cost-Benefit Results

SAMA ID	Multiplier Case	Estimated Cost	Conclusion
AC/DC-01	$134,805	$1,750,000	Not Cost Effective
AC/DC-03	$540,092	$330,000	Cost Effective
AC/DC-14	$280,299	$2,000,000	Not Cost Effective
AC/DC-19	$48,207	$700,000	Not Cost Effective
AC/DC-21	$67,893	$100,000	Not Cost Effective
AC/DC-25	$336,521	$2,000,000	Not Cost Effective
AC/DC-26	$336,521	$2,000,000	Not Cost Effective
AC/DC-27	$0	$550,000	Not Cost Effective
CB-21	$46,135	$550,000	Not Cost Effective
CC-01	$2,945	$6,500,000	Not Cost Effective
CC-04	$0	$5,500,000	Not Cost Effective
CC-05	$0	$6,500,000	Not Cost Effective
CC-19	$21,649	$1,500,000	Not Cost Effective
HV-01	$0	$50,000	Not Cost Effective
HV-03	$0	$400,000	Not Cost Effective
AC/DC-28R	$387,673	$1,600,000	Not Cost Effective
CB-22R	$139,550	$4,600,000	Not Cost Effective
CC-22R	$0	$2,200,000	Not Cost Effective
CW-26R	$504,809	$1,500,000	Not Cost Effective
FW-17R	$575,593	$2,800,000	Not Cost Effective
OT-08R	$986,879	$4,400,000	Not Cost Effective

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit"			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
Enhancements Related to AC and DC Power			
AC/DC-08	Increase training on response to loss of 120V AC buses that cause inadvertent actuation signals.	Criterion D Very Low Benefit	Abnormal Procedure DB-OP-2532 addresses the loss of both AC and DC power to both the Non-Nuclear Instrumentation (NNI) and the ICS that are powered from uninterruptible AC instrumentation distribution panels YAU and YBU. It is judged that operator awareness to the required actions is well established. *This SAMA should remain Criterion D.*
AC/DC-16	Improve uninterruptible power supplies.	Criterion D Very Low Benefit	Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to uninterruptible power supplies has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
Enhancements Related to ATWS Events			
AT-01	Add an independent boron injection system.	Criterion D Very Low Benefit	Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to emergency boration has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
AT-02	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.	Criterion D Very Low Benefit	Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to ATWS pressure relief has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
AT-07	Install motor generator set trip breakers in control room.	Criterion D Very Low Benefit	Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to reactor trip has an RRW value above the minimum cost of a hardware modification Also, if the reactor power is not decreasing, procedures instruct the operators to first de-energize substations E2 and F2, and, if necessary, locally open reactor trip breakers in the Low Voltage Switchgear room. *This SAMA should remain Criterion D.*
Enhancements Related to Containment Bypass			
CB-02	Add redundant and diverse limit switches to each CIV.	Criterion D Very Low Benefit	Failure of containment isolation typically leads to a LERF if core damage has occurred. LERF results are dominated by containment bypass events such as SGTR and ISLOCA events. Containment isolation is not shown to be a significant contributor to LERF in the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CB-03	Increase leak testing of valves in ISLOCA paths.	Criterion D Very Low Benefit	HPI and LPI injection check valves are leak tested per Appendix J. DHR suction lines are not tested, but rather than a leakage test, it is judged that continuously monitoring these valves at power would be preferable to leakage test. A SAMA candidate to continuously monitor the DHR suction valves is provided in SAMA candidate CB-21. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CB-04	Install self-actuating CIVs.	Criterion D Very Low Benefit	Important CIVs receive a close signal from the safety actuation system. Many are air-operated and fail in the closed position. It is judged that self-actuating valves would not provide any significant increase in the reliability of isolation. Containment isolation is not shown to be a significant contributor to CDF or LERF in the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CB-06	Ensure ISLOCA releases are scrubbed. One method is to plug drains in potential break areas so that break point will be covered with water.	Criterion D Very Low Benefit	This SAMA candidate would have very little benefit. It is likely that the break would be well above floor drain level. Therefore, a significant height of water would be required before any scrubbing took place. At these levels, the water level would likely have undesirable effects, such as threatening mitigating equipment due to flooding. This conclusion remains valid for the 95% CDF uncertainty results. *This SAMA should remain Criterion D.*
CB-09	Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage.	Criterion D Very Low Benefit	Davis-Besse is scheduled to replace the steam generators in 2013, which would result in inspecting new steam generator tubes. Therefore, this SAMA candidate is considered very low benefit for Davis-Besse. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CB-18	Direct steam generator flooding after a SGTR, prior to core damage.	Criterion D Very Low Benefit	Flooding the SG prior to core damage could impact efforts to mitigate the SGTR. For example, flooding may present a risk to the operation of the TDAFW pumps by risking steam generator overfill. *Disposition of this SAMA candidate is addressed in the response to RAI 5.i.*
CB-19	Vent MSSVs in containment.	Criterion D Very Low Benefit	This SAMA candidate would result in plant decay heat being deposited into primary containment, resulting in a harsh environment. The possible advantages for SGTR will be offset by the negative impacts for other events where secondary steam is deposited into containment with intact steam generators. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CB-20	Install relief valves in the CCW system.	Criterion D Very Low Benefit	Based on the top 100 cutsets and component basic event importance, ISLOCA in the CCW is not significant risk contributor at Davis-Besse. An ISLOCA occurring in the CCW system is not a risk contributor in the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
Enhancements Related to Core Cooling Systems			
CC-11	Modify procedures to throttle LPI pumps earlier in medium or large break LOCAs to maintain BWST inventory.	Criterion D Very Low Benefit	Davis-Besse operators are prohibited from throttling LPI pumps earlier in medium or large break LOCAs to maintain BWST inventory. If BWST flow was throttled down to reduce flowrate, the additional time gained is approximately 20 minutes, which, from a PRA perspective, is of low benefit for a LOCA condition. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CC-13	Upgrade the chemical and volume control system to mitigate small break LOCAs.	Criterion D Very Low Benefit	The make-up system can be used to provide make-up to the RCS in the event of a small LOCA. Because of the separate HPI and make-up systems, the plant has essentially four separate systems capable of injecting from the BWST into the RCS at high pressure. This was identified as a unique safety feature in the IPE. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CC-21	Reduce the BWST level at which switchover to containment recirculation is initiated.	Criterion D Very Low Benefit	Reducing the level at which switchover occurs (nine feet) would not significantly extend the time to switchover, and would increase the probability of pump failure due to loss of suction head. Davis-Besse has installed more accurate BWST level instrumentation that allows reaching a lower level prior to switchover to recirculation. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
Enhancements Related to Containment Phenomena			
CP-03	Use the fire water system as a backup source for the containment spray system.	Criterion D Very Low Benefit	Davis-Besse has a very large dry containment. Containment over-pressurization is not a significant risk contributor. This conclusion remains valid for the 95% LERF uncertainty case. *This SAMA should remain Criterion D.*
CP-06	Enhance fire protection system hardware and procedures.	Criterion D Very Low Benefit	This SAMA candidate addresses the scrubbing of radioactive releases into certain areas by actuating the fire protection system. Although some scrubbing benefits might be realized, this SAMA candidate presents the risk of impacting required equipment by spray or flooding. This could only be performed with fire protection systems that could be remotely actuated. If the temperature in certain areas became high enough, some existing fire protection systems may automatically actuate. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CP-16	Delay containment spray actuation after a large break LOCA.	Criterion D Very Low Benefit	The delay time that could be realized if containment spray was delayed would be less than 10 minutes. This SAMA candidate is considered to be of very low benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CP-17	Install automatic containment spray pump header throttle valves.	Criterion D Very Low Benefit	The capability already exists at Davis-Besse to throttle containment spray after the switchover to the sump. The delay time that could be realized if containment spray was throttled would be less than 10 minutes. This SAMA candidate is considered to be of very low benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CP-19	Install a redundant containment fan system.	Criterion D Very Low Benefit	Based on component basic event importance, containment fan coolers are not significant risk contributors at Davis-Besse. This SAMA candidate is considered to be very low benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CP-20	Install or use an independent power supply to the hydrogen control system using either new batteries, a non-safety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel generator.	Criterion D Very Low Benefit	Davis-Besse has a very large dry containment. Hydrogen burn does not present a significant risk in terms of LERF. This SAMA candidate is considered to be very low benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CP-21	Install a passive hydrogen control system.	Criterion D Very Low Benefit	This SAMA would mitigate large early releases resulting from a hydrogen burn. LERF is dominated by containment bypass events such as SGTR and ISLOCA. Failure of containment is not a significant contributor to LERF. This SAMA candidate is considered to be very low benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
Enhancements Related to Cooling Water			
CW-01	Add redundant DC control power for service water pumps.	Criterion D Very Low Benefit	Failure of DC power would impact much more than service water and improving the reliability of DC power to only service water would have very limited value. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to service water performance has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
CW-04	Add a redundant service water pump.	Criterion D Very Low Benefit	Davis-Besse has three service water pumps. In addition, the normally running cooling tower makeup pump is the preferred supply of service water following loss of service water. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to service water performance has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CW-05	Enhance the screen wash system.	Criterion D Very Low Benefit	The Davis-Besse water supply from Lake Erie travels through a long canal before reaching the intake structure. There is a screen at the intake from Lake Erie. The long distance traveled through the canal results in a significant fraction of material passing through the initial screen settling out prior to reaching the intake structure. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to service water performance has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
CW-06	Cap downstream piping of normally closed CCW drain and vent valves.	Criterion D Very Low Benefit	Loss of CCW through drain and vent lines is not considered to be a significant contributor to loss of CCW. These lines are small, and any leakage would likely be low. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CW-08	Enhance loss of CCW procedure to underscore the desirability of cooling down the RCS prior to seal LOCA.	Criterion D Very Low Benefit	Seal LOCA is not a concern at Davis-Besse if the RCPs are tripped. On loss of CCW, the makeup pumps can continue operation for at least one hour. Therefore, if operators trip the RCPs within one hour of loss of CCW, an RCP seal LOCA is not a risk concern. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CW-09	Additional training on loss of CCW.	Criterion D Very Low Benefit	Seal LOCA is not a concern at Davis-Besse if the RCPs are tripped. On loss of CCW, the makeup pumps can continue operation for at least one hour. Therefore, if operators trip the RCPs within one hour of loss of CCW, an RCP seal LOCA is not a risk concern. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
CW-12	Increase charging pump lube oil capacity.	Criterion D Very Low Benefit	Davis-Besse makeup pumps can operate for at least one hour on loss of CCW. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to charging (make-up) pump performance has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
CW-15	Use existing hydro test pump for RCP seal injection.	Criterion D Very Low Benefit	Seal LOCA is not a concern at Davis-Besse if the RCPs are tripped. On loss of CCW, the makeup pumps can continue operation for at least one hour. Therefore, if operators trip the RCPs within one hour of loss of CCW, an RCP seal LOCA is not a risk concern. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
CW-18	Prevent make-up pump flow diversion through the relief valves.	Criterion D Very Low Benefit	The make-up system is continuously operating. Malfunctions of relief valves would be immediately detected during operation and corrected. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related make-up flow diversion has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
Enhancements Related to Internal Flooding			
FL-01	Improve inspection of rubber expansion joints on main condenser.	*Revised to read:* Criterion F Considered for Further Evaluation	A large circulating water flood in the turbine building has associated basic event FL7 that is above the minimum cost of a procedure change (although less that a hardware modification). This SAMA candidate will be considered for further evaluation.
Enhancements Related to Fire Risk			
FR-01	Replace mercury switches in fire protection system.	Criterion D Very Low Benefit	Inadvertent actuation of fire protection water is not considered risk significant and currently not modeled in the PRA. Any fire protection system water should be handled by existing drains and is not considered a significant flooding threat. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
FR-02	Upgrade fire compartment barriers.	Criterion D Very Low Benefit	The Davis-Besse IPEEE did not identify any weakness in the fire barrier performance. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
FR-03	Install additional transfer and isolation switches.	Criterion D Very Low Benefit	Currently, isolation switches exist for a control evacuation. Some manual actions beyond operation of isolation switches are required (e.g., plugging connectors, removing/inserting fuse blocks). Adding additional transfer/isolation switches is not considered to be of significant benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
FR-04	Enhance fire brigade awareness.	Criterion D Very Low Benefit	The Davis-Besse IPEEE did not identify any weakness in fire brigade performance. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
FR-05	Enhance control of combustibles and ignition sources.	Criterion D Very Low Benefit	The Davis-Besse IPEEE did not identify any weakness in the combustible control program. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
Enhancements Related to Feedwater and Condensate			
FW-03	Install an independent diesel for the CST make-up pumps.	Criterion D Very Low Benefit	Davis-Besse has the capability of replenishing the CST using fire protection water. This can be done even on loss of AC power. Adding diesel for condensate makeup pumps would add little benefit. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
FW-05	Install manual isolation valves around the TDAFW pump steam admission valves.	Criterion D Very Low Benefit	The purpose of the SAMA candidate was to reduce dual turbine-driven pump maintenance unavailability. Although manual isolation valves do not exist, Davis-Besse has valves within the steam lines that allow isolation of one TDAFW pump for maintenance while leaving the second TDAFW pump available. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
FW-07	Install a new condensate storage tank (AFW storage tank).	Criterion D Very Low Benefit	Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to CST performance has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
FW-12	Change failure position of condenser make-up valve if the condenser make-up valve fails open on loss of air or power.	Criterion D Very Low Benefit	On loss of air or electric power, several components required for secondary heat removal would be lost; therefore the state of the condenser make-up valve is not relevant. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
FW-15	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.	Criterion D Very Low Benefit	Failure of the PORV to open only shows up in the Level 1 PRA importance measures with a RRW of 1.006 (cutoff 1.005). It does not show up in the top cutsets or the LERF importance list. Therefore, it is judged to be very low benefit. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to PORV opening or capacity has an RRW value above the minimum cost of a hardware modification *This SAMA should remain Criterion D.*
Enhancements Related to Heating, Ventilation and Air Conditioning (HVAC)			
HV-04	Add a switchgear room high temperature alarm.	Criterion D Very Low Benefit	The high voltage switchgear rooms do not require forced ventilation. Low voltage switchgear rooms require forced ventilation. Operators monitor the temperature of the low voltage switchgear rooms during their plant tours. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to switchgear ventilation has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
HV-05	Create ability to switch emergency feedwater room fan power supply to station batteries in an SBO.	Criterion D Very Low Benefit	Loss of ventilation to AFW is not a risk significant contributor at Davis-Besse. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
HV-06	Provide procedural guidance for establishing an alternate means of room ventilation to the service water pump room.	Criterion D Very Low Benefit	Service water ventilation includes four 50% fans. Loss of service water ventilation is not a significant risk contributor at Davis-Besse. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to service water room ventilation has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
Enhancements Related to Instrument Air and Nitrogen Supply			
IA-02	Modify procedure to provide ability to align diesel power to more air compressors.	Criterion D Very Low Benefit	Service Air and Instrument Air are not significant risk contributors based on top cutsets and risk importance measures. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to air compressors has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*
IA-03	Replace service and instrument air compressors with more reliable compressors that have self-contained air cooling by shaft-driven fans.	Criterion D Very Low Benefit	Service Air and Instrument Air are not significant risk contributors based on top cutsets and risk importance measures. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to service or instrument air compressors has an RRW value above the minimum cost of a hardware modification *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
Enhancements Related to Seismic Risk			
SR-01	Increase seismic ruggedness of plant components.	Criterion D Very Low Benefit	The Seismic Qualifications Utility Group (SQUG) previously identified the need for additional seismic restraints in the plant. These restraints have already been added. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
SR-02	Provide additional restraints for CO_2 tanks.	Criterion D Very Low Benefit	The CO_2 tanks are located outdoors. These tanks supply only the turbine generator. No other components are protected with CO_2. A seismic failure of the CO_2 tanks has minimal risk. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
Other Enhancements			
OT-01	Install digital large break LOCA protection system.	Criterion D Very Low Benefit	Large break LOCA is not a significant risk contributor (0.2% CDF). Davis-Besse has a Containment Leakage Detection System (FLUS) to identify leaks from vessel penetrations and nozzles. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*
OT-04	Improve maintenance procedures.	Criterion D Very Low Benefit	Davis-Besse has a qualified Maintenance Rule program in place. No deficiencies in maintenance practices have been identified. This conclusion remains valid for the 95% CDF uncertainty case. *This SAMA should remain Criterion D.*

Table 6.k-3: Re-evaluation of SAMA Candidates Screened as "Very Low Benefit" (continued)			
SAMA ID	**Modification (Potential Enhancement)**	**Screening Criteria**	**Basis for Screening/Modification Enhancements**
OT-05	Increase training and operating experience feedback to improve operator response.	*Revised to read:* Criterion B Already Implemented	FENOC provides PRA information, such as risk-significant initiating events, high worth operator actions and high worth equipment, to various departments, including Operations Training, and presents this information on posters throughout the plant.
OT-07	Install secondary side guard pipes up to the MSIVs.	Criterion D Very Low Benefit	Steam line breaks are not a significant contributor to CDF or LERF based on top cutsets or basic event importance. The derived benefit would not justify the implementation cost required. Based on the basic event RRW results from the 95% CDF uncertainty case, no basic event related to main steam breaks has an RRW value above the minimum cost of a hardware modification. *This SAMA should remain Criterion D.*

<u>Item 7</u>

For certain SAMAs considered in the ER, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, discuss whether any lower-cost alternatives to those Phase II SAMAs considered in the ER would be viable and potentially cost-beneficial. Evaluate the following SAMAs (previously found to be potentially cost-beneficial at other Babcock and Wilcox plants), or indicate if the particular SAMA has already been considered. If the latter, indicate whether the SAMA has been implemented or has been determined to not be cost-beneficial at Davis-Besse Nuclear Power Station.

Question RAI 7.a

Automate reactor coolant pump trip on high motor bearing cooling temperature.

RESPONSE RAI 7.a

A SAMA candidate (CW-26R) to provide an automatic reactor coolant pump trip on loss of cooling to the RCP seal thermal barrier cooler and loss of seal injection flow was evaluated for Davis-Besse. Table 7.a-1 and Table 7.a-2, below, provide the internal event and total benefit results for SAMA candidate CW-26R, respectively. Table 7.a-3, below, provides the final results for the ten sensitivity cases for SAMA candidate CW-26R. The implementation cost for this SAMA candidate was estimated as $1,500,000. Therefore, this SAMA candidate is not cost-beneficial at Davis-Besse.

Table 7.a-1: Internal Events Benefit Results for SAMA Candidate CW-26R

Case	CW-26R (Auto_RCP)
Off-site Annual Dose (rem)	2.27E+00
Off-site Annual Property Loss ($)	1.79E+03
Comparison CDF	1.0E-05
Comparison Dose (rem)	2.30E+00
Comparison Cost ($)	1.80E+03
Enhanced CDF	7.7E-06
Reduction in CDF	**23.00%**
Reduction in Off-site Dose	**1.30%**
Immediate Dose Savings (On-site)	$186
Long Term Dose Savings (On-site)	$812
Total Accident Related Occupational Exposure **(AOE)**	$998
Cleanup/Decontamination Savings (On-site)	$30,443
Replacement Power Savings (On-site)	$30,801
Averted Costs of On-site Property Damage **(AOSC)**	$61,244
Total On-site Benefit	**$62,242**
Averted Public Exposure **(APE)**	$736
Averted Off-site Damage Savings **(AOC)**	$123
Total Off-site Benefit	**$859**
Total Benefit (On-site + Off-site)	**$63,101**

Table 7.a-2: Total Benefit Result for SAMA Candidate CW-26R

	CW-26R (Auto_RCP)
Internal Events	$63,101
Fires, Seismic, Other	$290,265
Total Benefit	$353,366

Table 7.a-3: Final Results of the Sensitivity Cases for SAMA Candidate CW-26R

SAMA ID	Repair Case	Low Discount Rate Case	High Discount Rate Case	On-site Dose Case	On-site Clean-up Case
CW-26R	$215,378	$533,291	$242,495	$359,021	$410,194

SAMA ID	Replacement Power Case	Multiplier Case	Evacuation Speed	Off-site Economic Cost	95th CDF Case
CW-26R	$469,142	$504,809	$354,741	$384,287	$512,381

Question RAI 7.b

Use the decay heat removal (DHR) system as an alternate suction source for high pressure injection (HPI).

RESPONSE RAI 7.b

The Davis-Besse design and PRA already include use of the DHR system as a suction source for HPI. For cases in which RCS pressure is too high for adequate flow, the HPI pumps can be aligned to take suction from the discharge of the DHR pumps; this is possible with the BWST as the suction source or with the containment sump as the suction source.

Question RAI 7.c

Automate HPI injection on low pressurizer level (in loss of secondary side heat removal cases where the reactor coolant system (RCS) pressure remains high while the RCS level drops) -Three Mile Island SAMA 16.

RESPONSE RAI 7.c

This SAMA candidate considers automating HPI injection on low pressurizer level following a loss of secondary side heat removal where RCS pressure remains high while level drops. This SAMA was a viable consideration for Three Mile Island (TMI) based on plant design and system configuration. At TMI, the HPI system is also the makeup system – there is a single Makeup and Purification system that provides normal makeup as well as standby Engineered Safety Actuation Signal (ESAS)-selected pumps which automatically inject high-pressure water into the RCS from the BWST in mitigation of LOCA scenarios. In addition, as discussed in Volume 3 of the B&W Emergency Operating Procedure Technical Basis Document (EOP TBD), (Chapter III.C, Lack of Adequate Primary to Secondary Heat Transfer), for all plants except Davis-Besse, HPI cooling must not be intentionally delayed if feedwater is not available. HPI cooling must be established in a timely manner to assure adequate core cooling; it must be started early enough to slow RCS inventory depletion so that HPI cooling will match decay heat before the core is uncovered.

At Davis-Besse, however, the plant design and systems are different from those at TMI. Davis-Besse has a separate HPI safety system in addition to the normally operating makeup system. The Davis-Besse HPI system is not capable of injecting water into the RCS until pressure reaches ~1600psig. In addition, because Davis-Besse has two makeup pumps, makeup/HPI cooling can be delayed until the core outlet temperature reaches 600°F provided the RCS PT limit is not exceeded. Although the Davis-Besse PRA considers makeup/HPI cooling in response to a loss of feedwater, and the associated operator actions, automating this function was not considered because of the complexity associated with the number of options and systems involved (e.g., pumps, valves and alignment options, injection line options, bleed options). Consequently, this SAMA candidate was not considered for Davis-Besse.

Question RAI 7.d

Automate refill of the borated water storage tank (BWST).

RESPONSE RAI 7.d

A SAMA candidate (CC-22R) to provide an automatic refill of the borated water storage tank was evaluated for Davis-Besse. Table 7.d-1 and Table 7.d-2, below, provide the internal event and total benefit results for SAMA candidate CC-22R, respectively. Table 7.d-3, below, provides the final results for the ten sensitivity cases for SAMA candidate CC-22R. The implementation cost for this SAMA candidate was estimated as $2,200,000. Therefore, this SAMA candidate is not cost-beneficial at Davis-Besse.

Table 7.d-1: Internal Events Benefit Results for SAMA Candidate CC-22R

Case	CC-22R (Auto_BWST)
Off-site Annual Dose (rem)	2.30E+00
Off-site Annual Property Loss ($)	1.80E+03
Comparison CDF	1.0E-05
Comparison Dose (rem)	2.30E+00
Comparison Cost ($)	1.80E+03
Enhanced CDF	1.0E-05
Reduction in CDF	**0.00%**
Reduction in Off-site Dose	**0.00%**
Immediate Dose Savings (On-site)	$0
Long Term Dose Savings (On-site)	$0
Total Accident Related Occupational Exposure **(AOE)**	$0
Cleanup/Decontamination Savings (On-site)	$0
Replacement Power Savings (On-site)	$0
Averted Costs of On-site Property Damage **(AOSC)**	$0
Total On-site Benefit	**$0**
Averted Public Exposure **(APE)**	$0
Averted Off-site Damage Savings **(AOC)**	$0
Total Off-site Benefit	**$0**
Total Benefit (On-site + Off-site)	**$0**

Table 7.d-2: Total Benefit Result for SAMA Candidate CC-22R

	CC-22R (Auto_BWST)
Internal Events	$0
Fires, Seismic, Other	$0
Total Benefit	$0

Table 7.d-3: Final Results of the Sensitivity Cases for SAMA Candidate CC-22R

SAMA ID	Repair Case	Low Discount Rate Case	High Discount Rate Case	On-site Dose Case	On-site Clean-up Case
CC-22R	$0	$0	$0	$0	$0

SAMA ID	Replacement Power Case	Multiplier Case	Evacuation Speed	Off-site Economic Cost	95th CDF Case
CC-22R	$0	$0	$1,374	$30,920	$0

Question RAI 7.e

Automate start of auxiliary feedwater (AFW) pump in the event the automated emergency feedwater (EFW) system is unavailable.

RESPONSE RAI 7.e

A SAMA candidate (FW-17R) to automatically start the auxiliary feedwater pump when the emergency feedwater system is unavailable was evaluated for Davis-Besse. Based on the Davis-Besse design, this SAMA was interpreted as automatically starting the motor driven feedwater pump in the event both turbine-driven auxiliary feedwater pumps were not available. Table 7.e-1 and Table 7.e-2, below, provide the internal event and total benefit results for SAMA candidate FW-17R, respectively. Table 7.e-3, below, provides the final results for the ten sensitivity cases for SAMA candidate FW-17R. The implementation cost for this SAMA candidate was estimated as $2,800,000. Therefore, this SAMA candidate is not cost-beneficial at Davis-Besse.

Table 7.e-1: Internal Events Benefit Results for SAMA Candidate FW-17R

Case	**FW-17R (Auto_MDFP)**
Off-site Annual Dose (rem)	2.18E+00
Off-site Annual Property Loss ($)	1.69E+03
Comparison CDF	1.0E-05
Comparison Dose (rem)	2.30E+00
Comparison Cost ($)	1.80E+03
Enhanced CDF	7.5E-06
Reduction in CDF	**25.00%**
Reduction in Off-site Dose	**5.22%**
Immediate Dose Savings (On-site)	$202
Long Term Dose Savings (On-site)	$882
Total Accident Related Occupational Exposure **(AOE)**	$1,085
Cleanup/Decontamination Savings (On-site)	$33,091
Replacement Power Savings (On-site)	$33,479
Averted Costs of On-site Property Damage **(AOSC)**	$66,570
Total On-site Benefit	**$67,655**
Averted Public Exposure **(APE)**	$2,945
Averted Off-site Damage Savings **(AOC)**	$1,350
Total Off-site Benefit	**$4,294**
Total Benefit (On-site + Off-site)	**$71,949**

Table 7.e-2: Total Benefit Result for SAMA Candidate FW-17R

	FW-17R (Auto_MDFP)
Internal Events	$71,949
Fires, Seismic, Other	$330,966
Total Benefit	$402,915

Table 7.e-3: Final Results of the Sensitivity Cases for SAMA Candidate FW-17R

SAMA ID	Repair Case	Low Discount Rate Case	High Discount Rate Case	On-site Dose Case	On-site Clean-up Case
FW-17R	$252,928	$608,721	$277,988	$409,062	$464,684

SAMA ID	Replacement Power Case	Multiplier Case	Evacuation Speed	Off-site Economic Cost	95th CDF Case
FW-17R	$528,758	$575,593	$404,289	$433,835	$584,227

Question RAI 7.f

Purchase or manufacture of a "gagging device" that could be used to close a stuck-open steam generator safety valve for a SGTR event prior to core damage.

RESPONSE RAI 7.f

A SAMA candidate (CB-22R) to use a "gagging" device that could be used to close a stuck-open steam generator safety valve for a SGTR was evaluated for Davis-Besse. Table 7.f-1 and Table 7.f-2, below, provide the internal event and total benefit results for SAMA candidate CB-22R, respectively. Table 7.f-3, below, provides the final results for the ten sensitivity cases for SAMA candidate CB-22R. The implementation cost for this SAMA candidate was estimated as $4,600,000. The high implementation cost of this SAMA candidate is based on replacement of the safety valves with a new design that includes a gagging feature. Therefore, this SAMA candidate is not cost-beneficial at Davis-Besse.

Table 7.f-1: Internal Events Benefit Results for SAMA Candidate CB-22R

Case	CB-22R (Gagging_Device)
Off-site Annual Dose (rem)	2.04E+00
Off-site Annual Property Loss ($)	1.56E+03
Comparison CDF	1.0E-05
Comparison Dose (rem)	2.30E+00
Comparison Cost ($)	1.80E+03
Enhanced CDF	9.7E-06
Reduction in CDF	**3.00%**
Reduction in Off-site Dose	**11.30%**
Immediate Dose Savings (On-site)	$24
Long Term Dose Savings (On-site)	$106
Total Accident Related Occupational Exposure **(AOE)**	$130
Cleanup/Decontamination Savings (On-site)	$3,971
Replacement Power Savings (On-site)	$4,018
Averted Costs of On-site Property Damage **(AOSC)**	$7,988
Total On-site Benefit	**$8,119**
Averted Public Exposure **(APE)**	$6,380
Averted Off-site Damage Savings **(AOC)**	$2,945
Total Off-site Benefit	**$9,325**
Total Benefit (On-site + Off-site)	**$17,444**

Table 7.f-2: Total Benefit Result for SAMA Candidate CB-22R

	CB-22R (Gagging_Device)
Internal Events	$17,444
Fires, Seismic, Other	$80,241
Total Benefit	$97,685

Table 7.f-3: Final Results of the Sensitivity Cases for SAMA Candidate CB-22R

SAMA ID	Repair Case	Low Discount Rate Case	High Discount Rate Case	On-site Dose Case	On-site Clean-up Case
CB-22R	$79,687	$149,212	$71,121	$98,423	$105,097

SAMA ID	Replacement Power Case	Multiplier Case	Evacuation Speed	Off-site Economic Cost	95^{th} CDF Case
CB-22R	$112,786	$139,550	$99,059	$128,605	$141,643

Enclosure

Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS)

Letter L-11-154

Amendment No. 10 to the DBNPS License Renewal Application

License Renewal Application Environmental Report (ER) Sections Affected

Environmental Report	Section E.4.2	Table E.3-29
Section 4.20	Section E.4.5	Table E.3-30
Table 6.1-1	Section E.5.6	Table E.3-31
	Section E.9	Table E.3-32
ER Attachment D		Table E.3-33
Section D.2.1	**Section E.10**	Table E.4-1
	Table E.3-11	Table E.5-3
ER Attachment E	Table E.3-21	Table E.5-4
Executive Summary	Table E.3-22	Table E.6-1
Section E.3.1.1.1	Table E.3-23	Table E.7-2
Section E.3.1.2.4	Table E.3-24	Table E.7-3
Section E.3.2.1	Table E.3-25	Table E.7-5
Section E.3.4.2	Table E.3-26	Table E.8-1
Section E.3.5.2.4	Table E.3-27	
Section E.4.1	Table E.3-28	Section E.11

The Enclosure identifies the change to the License Renewal Application (LRA) by Affected LRA Section, LRA Page No., and Affected Paragraph and Sentence. The count for the affected paragraph, sentence, bullet, etc. starts at the beginning of the affected Section or at the top of the affected page, as appropriate. Below each section the reason for the change is identified, and the sentence affected is printed in *italics* with deleted text *~~lined-out~~* and added text *underlined*.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section 4.20	**4.20-3 & 4.20-4**	**Final paragraph**

In response to RAIs 4.b and 5.c, Environmental Report (ER) Section 4.20, "Severe Accident Mitigation Alternatives," final paragraph, is replaced in its entirety, and now reads:

The results of the evaluation of 168 SAMA candidates identified one cost-beneficial enhancement at Davis Besse. Assuming a lower discount rate, higher dose rates, higher onsite clean-up cost, increased replacement power costs, increased external event multiplier, increased off-site economic impact, and reduced evacuation speed identified the same SAMA candidate to be cost-beneficial. The SAMA candidate identified in the base case and sensitivity cases is not related to plant aging. Therefore, the identified cost-beneficial SAMA candidate is not a required modification for the license renewal period. Nevertheless, this SAMA candidate will be considered through the normal FENOC processes for evaluating possible modifications to the plant.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Table 6.1-1	**6.1-5**	**Row 76, Environmental Impact column**

In response to RAI 4.b, ER Table 6.1-1, "Environmental Impacts Related to License Renewal at Davis-Besse," Row 76, Environmental Impact column, is revised to read:

No.	Category 2 Issue	Environmental Impact
Postulated Accidents		
76	Severe accident mitigation alternatives **10 CFR 51.53(c)(3)(ii)(L)**	**SMALL**. No impact from continued operation. FENOC ~~*did not identify any*~~ *identified one* cost-beneficial enhancement~~*s, but did identify one potential cost-beneficial SAMA candidate*~~, which FENOC will consider through normal processes for evaluating possible changes to the plant.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section D.2.1	**D-10**	**4th bullet on page**

In response to RAI 4.b, ER Section D.2.1, "Environmental Impacts – Background Information," last bullet in the Section, is revised to read:

- Severe accidents – The NRC determined that the license renewal impacts from severe accidents would be small, but that applicants should perform site-specific analyses of ways to further mitigate impacts. *Results from the FENOC severe accident mitigation alternatives (SAMA) analysis ~~have not~~ identified ~~any~~ one cost-beneficial enhancement~~s to~~ that may further mitigate risk to public health and the economy in the area of the plant, including the coastal zone, due to potential severe accidents at Davis Besse.*

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Attachment E – Executive Summary	**E-9**	**4th and 5th paragraphs**

In response to RAIs 4.b and 5.c, the Executive Summary of ER Attachment E, "Severe Accident Mitigation Alternatives Analysis," paragraphs four and five, are revised to read:

The cost-benefit evaluation of SAMA candidates performed for Davis-Besse provides significant insight into the continued operation of Davis-Besse. *The results of the evaluation of ~~167~~ 168 SAMA candidates indicate ~~no enhancements~~ one enhancement to be cost-beneficial for implementation at Davis-Besse. The cost-beneficial SAMA candidate is AC/DC-03, which adds a portable diesel-driven battery charger to the DC system.*

~~However, the~~ The sensitivity cases performed for this analysis found ~~one~~ the same SAMA candidate (AC/DC-03) to be cost-beneficial for implementation at Davis-Besse under the assumptions of ~~three of the sensitivity cases (lower discount rate, replacement power, and multiplier). SAMA candidate AC/DC-03 considered the addition of a portable diesel-driven battery charger for the DC~~

~~system.~~ *lower discount rate, higher dose rates, higher onsite clean-up cost, increased replacement power costs, increased external event multiplier, increased off-site economic impact, and reduced evacuation speed sensitivity cases.* While the identified SAMA candidate is not related to plant aging and therefore not required to be resolved as part of the relicensing effort, FENOC will, nonetheless, consider implementation of this candidate through normal processes for evaluating possible changes to the plant.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.3.1.1.1	**E-19**	**Second paragraph, first sentence**

In response to RAI 1.e, ER Section E.3.1.1.1, "Description of Level 1 Internal Events PRA Model," second paragraph, first sentence, is replaced in its entirety, and now reads:

The Davis Besse Level 1 PRA internal events CDF, including internal flooding, is estimated to be 9.2E-06/yr, and when also including high winds, the CDF is estimated to be 9.8E-06/yr.

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Section E.3.1.2.4	**E-28**	**Entire section**

In response to RAI 3.c, ER Section E.3.1.2.4, "External Event Severe Accident Risk," is deleted in its entirety, as follows:

~~*E.3.1.2.4 External Event Severe Accident Risk*~~

~~*This section describes the method used to address external events risk.*~~

~~*As discussed in Section E.3.1.2.2, Davis Besse used the SMA to evaluate the risk from seismic events. While this methodology does not provide a quantitative result, the resolution of outliers ensures that the seismic risk is low and further cost-beneficial seismic improvements are not expected. Also, as discussed in Section E.3.1.2.3, no other external events were found to exceed the screening criteria. Therefore, the FIVE results were used as a measure of total external events risk.*~~

~~*As discussed in Section E.3.1.2.1, using the EPRI FIVE methodology, Davis Besse conservatively estimated the Fire CDF to be 2.5E-05/yr. Since the FIVE methodology contains numerous conservatisms, a more realistic assessment could result in a substantially lower fire CDF. As noted in NEI 05-01 (Reference 2), the NRC staff has accepted that a more realistic fire CDF may be a factor of three less than the screening value obtained from a FIVE analysis.*~~

~~*Based on the Davis Besse FIVE CDF of 2.5E-05/yr, a factor of three reduction would result in a fire CDF of approximately 8.3E-06/yr. This value is the same order of magnitude as the internal events CDF of 9.2E-06/yr. Therefore, this justifies use of an external events multiplier of three to the averted cost estimates (for internal events) to represent the additional SAMA benefits in external events.*~~

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Section E.3.2.1	**E-30**	**Last paragraph**

In response to RAI 2.a, ER Section E.3.2.1, "Description of the Level 2 PRA Model," the last paragraph of the Section on page E-30, is revised to read:

The SAMA analysis model calculated a LERF of 6.6E-07/year. Table E.3-8 ranks the top 30 components for Level 2 PRA based on Fussell-Vesely importance measure. Table E.3-9 provides the top ten operator actions for Level 2 PRA ranked by Fussell-Vesely importance measure. *LERF was quantified using a truncation cutoff frequency of 5.0E-13/yr.*

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Section E.3.4.2	**E-34**	**1st paragraph**

In response to RAI 4.b, ER Section E.3.4.2, "Population Data," first paragraph, is revised to read:

The population data were extracted using SECPOP2000 (Reference 18) with 2000 census data for Davis Besse sited at latitude of 41 degrees, 35 minutes, 50 seconds, and longitude of 83 degrees, 5 minutes, 11 seconds. *To the SECPOP2000 population, Canadian population data in sectors 30-40 miles/N, 30-40 miles/NNE, 30-40 miles/NE, 40-50 miles/N, 40-50 miles/NNE, and 40-50 miles/NE were added. The Canadian population was estimated by subtracting the SECPOP2000 population data from the total population in the 50-mile radius of Davis-Besse, as reported in Environmental Report Table 2.6-1. Population was assigned to each of the affected six sectors normalized by the land fraction in each of the sectors.* The population data were adjusted to account for the transient population within 10 miles of Davis Besse. The transient population segment, includes seasonal residents, transient population, and boating population. The population escalation factor was developed considering different sets of population data, e.g., state-wide versus within a 50-mile radius of the plant.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.3.5.2.4	**E-45**	**New paragraph**

In response to RAI 4.b, ER Section E.3.5.2.4, "Early," a new paragraph for sensitivity case E3 is added to the end of the section, which reads:

Case E3 *– The base case was performed with an evacuation speed of 0.58 meters/second, based on Davis-Besse-specific evaluation information, without any correction factor to account for the escalated population. In response to an NRC request for additional information, this sensitivity case was performed to gauge the sensitivity of reducing the evacuation speed. As the population was increased 4.7 percent per decade for the 20 years of license renewal (total increase of 9.6 percent), it was assumed for this sensitivity case that the increase in population was directly proportional to the decrease in evacuation speed. The evacuation speed for this sensitivity is a 9.6 percent decrease from the base case, i.e., 0.52 meters/second. This change resulted in a minor increase in the consequence values, as shown in Table E.3-33. This is expected as slower evacuation should remove the population from the radiological damage less quickly.*

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.4.1	**E-47**	**1st paragraph on page**

In response to RAI 4.b, ER Section E.4.1, "Off-site Exposure Cost," the first paragraph on page E-47, is revised to read:

Table E.3-21 provides the off-site dose for each release category obtained for the base case of the Davis Besse Level 3 PRA weighted by the release category frequency. *The total off-site dose for internal events (Dt) was estimated to be ~~2.0~~ 2.30 person-rem/year.* The APE cost was determined using Equation E.4-2 (Reference 1, Section 5.7.1).

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.4.1	**E-48**	**Equations E.4-6 and E.4-7**

In response to RAI 4.b, ER Section E.4.1, "Off-site Exposure Cost," equations E.4-6 and E.4-7, are replaced in their entirety, and now read:

$$Z_{pha} = \left(2{,}000 \frac{\$}{\text{person} - \text{rem}}\right)\left(2.30 \frac{\text{person} - \text{rem}}{\text{yr}}\right) = \$4600/\text{yr} \qquad \underline{\textit{(E.4-6)}}$$

<u>*where,*</u>

<u>*R = $2,000/person-rem*</u>

<u>*Dt = 2.30 person-rem/year*</u>

<u>*The values for the base case are:*</u>

<u>*C = 12.27 yr*</u>

<u>*Zpha = $4,600/yr*</u>

$$\text{APE} = (12.27\text{yr})\left(\frac{\$4600}{\text{yr}}\right) = \$56{,}442 \qquad \underline{\textit{(E.4-7)}}$$

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Section E.4.2	**E-49**	**1st paragraph and equations E.4-8 and E.4-9**

In response to RAI 4.b, ER Section E.4.2, "Off-site Economic Cost," the first paragraph and equations E.4-8 and E.4-9, are revised to read:

The term used for off-site economic cost is designated as averted off-site property damage costs (AOCs). The off-site economic loss for a 50-mile radius of the site was determined using the MACCS2 model developed for the Davis Besse Level 3 PRA in Section E.3.4. Table E.3-21 provides the economic loss for each release category obtained for the base case of the Level 3 PRA weighted by the release category frequency. *The total economic loss from internal events (It) was estimated to be ~~$1,600~~ $1,800 per year.* The averted cost was determined using Equation E.4-8 from Reference (1), Section 5.7.5.

$$AOC = (C)(I_t) \quad \text{(E.4-8)}$$

where,

AOC = off-site economic costs associated with a severe accident ($)

C = present value factor (yr)

I_t = monetary value of economic loss per year from internal events before discounting ($/yr)

The values for the base case are:

C = 12.27 yr

I_t = *~~$1,600/yr~~ $1,800/yr*

$$AOC = (12.27\text{yr})\left(1800\frac{\$}{\text{yr}}\right) = \$22,086 \quad \text{(E.4-9)}$$

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.4.5	**E-55**	**Entire section, including equations**

In response to RAIs 3.c and 4.b, ER Section E.4.5, "Total Cost of Severe Accident Risk," is revised to read:

The total cost of severe accident impact for internal events was calculated by summing the public exposure cost, off-site property damage cost, occupational exposure cost, and on-site economic cost. *The cost of the impact of a severe accident for internal events was ~~$339,331~~ $349,147 as shown in Table E.4-1. Davis Besse does not have external events (fire, seismic, other external events) PRA from which risk contributors could be combined with the internal events risk. ~~This analysis assumed that the benefit from each hazard group's (i.e., fire, seismic, and other external events) contribution is equivalent to that of internal events. This approach is conservative, based on the discussion in Section E.3.1.2. Therefore, the cost of SAMA candidate implementation was compared with a benefit value of four times (i.e., 1x for internal events plus 3x for external events) that calculated for internal events to include the contribution from internal events, fire, seismic, and other hazard groups.~~ Based on the NRC staff's best estimate, the fire CDF for Davis-Besse is 2.9x10-5/yr [39]. To account for the risk contribution from the fire hazard, a ratio between the fire CDF and internal events CDF was used to determine a fire multiplier of 2.90 (see equation E.4-24).*

$$\frac{\text{Fire CDF}}{\text{Internal Events CDF}} = \frac{2.9\text{x}10^{-5}/\text{yr}}{1.0\text{x}10^{-5}/\text{yr}} = 2.90 \qquad (E.4\text{-}24)$$

Based on updated probabilistic seismic hazard estimates due to Generic Issue 199, the NRC staff estimated a "weakest link model" seismic CDF for Davis-Besse of $6.7\text{x}10^{-6}$/yr [40]. To account for the risk contribution from the seismic hazard, a ratio between the seismic CDF and internal events CDF was used to determine a seismic multiplier of 0.67 (see equation E.4-25).

$$\frac{\text{Seismic CDF}}{\text{Internal Events CDF}} = \frac{6.7\text{x}10^{-6}/\text{yr}}{1.0\text{x}10^{-5}/\text{yr}} = 0.67 \qquad (E.4\text{-}25)$$

This analysis conservatively assumed that the benefit from other hazard groups contribution is equivalent to that of internal events. Therefore, the other hazard groups multiplier is 1.0.

To determine the multiplier to account for fire, seismic, and other hazard groups, the individual multipliers are summed; the resulting multiplier is 4.6.

This approach provided a comparison of the cost to the risk reduction estimated for internal and external events for each SAMA candidate. *The maximum benefit for Davis Besse was ~~$1,357,324~~ $1,955,223 as shown in Table E.4-1.*

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.5.6	**E-63**	**1st sentence**

In response to RAIs 4.b and 5.c, ER Section E.5.6, "Initial SAMA Candidate List," the first sentence in the section is revised to read:

Based on the review of the aforementioned sources, an initial list of ~~167~~ 168 SAMA candidates was assembled.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.9	**E-74**	**1st and 2nd paragraphs**

In response to RAIs 4.b and 5.c, the first and second paragraphs of ER Section E.9, "Conclusions," are revised to read:

The cost-benefit evaluation of SAMA candidates performed for the Davis-Besse license renewal process provided significant insight into the continued operation of Davis-Besse. *The results of the evaluation of ~~167~~ 168 SAMA candidates indicated ~~no enhancements to be potentially~~ one enhancement to be cost-beneficial for implementation at Davis-Besse. The cost-beneficial SAMA candidate is AC/DC-03, which adds a portable diesel-driven battery charger to the DC system.*

~~However, the~~ The sensitivity cases performed for this analysis found ~~one~~ the same SAMA candidate (AC/DC-03) to be ~~potentially~~ cost-beneficial for implementation at Davis-Besse under the assumptions of the second (lower discount rate), fourth (higher discount rate), fifth (higher on-site clean-up cost), sixth (increased replacement power costs), seventh (increased external event multiplier), eighth (increased off-site economic impact), and ninth (reduced evacuation speed) sensitivity cases. ~~three of the sensitivity cases (low discount rate, replacement power, and multiplier). SAMA candidate AC/DC-03 considered the addition of a portable diesel-driven battery charger for the DC system.~~ While the identified SAMA candidate is not related to plant aging and therefore not a required modification for the license renewal period, FENOC will, nonetheless, consider implementation of this candidate through the normal processes for evaluating possible plant modifications.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Section E.11	**E-194**	**New references**

In response to RAI 3.c, ER Section E.11, "References," is revised to include two new references cited in revised ER Section E.4.5, as follows:

39. Nuclear Regulatory Commission, "Requests for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit 1, License Renewal Application," Accession Number ML110910566, April 20, 2011.

40. Nuclear Regulatory Commission, Results of Safety/Risk Assessment of Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," Accession Number ML100270582, September 7, 2010.

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Table E.3-11	**E-86**	**3 rows**

In response to RAI 4.b, three rows (i.e., N, NNE, and NE) in ER Table E.3-11, "Total (Permanent and Transient) Escalated Population (50-Mile Radius – Davis Besse) for the Year 2040," are revised to include the Canadian population within the Davis-Besse 50-mile Emergency Planning Zone, and now reads:

Table E.3-11: Total (Permanent and Transient) Escalated Population (50-Mile Radius – Davis-Besse) for the Year 2040

Sector	1 mile	2 miles	3 miles	4 miles	5 miles	10 miles	20 miles	30 miles	40 miles	50 miles
N	0	0	0	0	0	0	0	0	*151518*	*448232*
NNE	6	0	0	0	0	0	0	0	*154651*	*193313*
NE	0	0	0	0	0	0	0	0	*38663*	*96657*
ENE	0	0	0	0	0	0	828	0	0	0
E	0	0	0	0	0	0	2229	219	0	13561
ESE	0	0	320	0	0	0	11198	50152	20763	104445
SE	662	661	0	0	6786	27558	7443	9301	35612	11828
SSE	661	729	60	71	109	1593	2075	23880	6229	20419
S	4	12	55	328	651	1680	34083	7301	34694	7138
SSW	17	5	82	79	482	5743	4141	6025	26881	12565
SW	37	20	20	469	197	1728	9970	9130	7669	64607
WSW	0	50	0	35	84	1050	8246	12404	47735	14163
W	0	53	72	66	87	847	19318	259606	102087	25871
WNW	683	723	156	0	7274	4821	7009	207932	58896	13460
NW	0	165	595	0	0	1763	0	53092	20356	25771
NNW	20	138	0	0	0	0	0	20080	77289	233548

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Table E.3-21	**E-98**	**Entire table**

In response to RAI 4.b, ER Table E.3-21, "Base Case Results for Internal Events at 50 Miles," is replaced in its entirety, and now reads:

Table E.3-21: Base Case Results for Internal Events at 50 Miles

Release Category	Whole Body Dose (50, rem)/yr	Economic Impact (50, $)/yr
1.1	4.91E-02	4.77E+01
1.2	3.07E-02	2.93E+01
1.3	1.37E+00	1.33E+03
1.4	3.66E-03	2.86E+00
2.1	3.25E-02	2.42E+01
2.2	5.56E-01	2.64E+02
3.1	2.20E-03	1.09E+00
3.2	1.35E-04	1.11E-01
3.3	2.16E-05	1.07E-02
3.4	1.23E-02	7.85E+00
4.1	3.73E-05	8.67E-03
4.2	3.57E-02	1.86E+01
4.3	7.01E-07	1.19E-04
4.4	1.08E-02	8.09E+00
5.1	9.77E-03	2.85E+00
5.2	1.32E-02	1.12E+01
5.3	9.41E-04	2.66E-01
5.4	7.36E-03	3.84E+00
6.1	5.50E-04	4.44E-01
6.2	6.07E-05	5.21E-02
6.3	4.01E-05	5.81E-03
6.4	1.90E-02	7.38E+00
7.1	5.63E-07	3.05E-05
7.2	7.35E-05	2.63E-02
7.3	5.37E-09	3.45E-07
7.4	8.09E-06	7.13E-04
7.5	3.75E-08	0.00E+00
7.6	6.57E-03	1.64E+00
7.7	2.90E-08	2.32E-07
7.8	1.92E-02	7.48E+00
8.1	1.20E-04	7.25E-04
8.2	1.01E-01	2.89E+01
9.1	2.03E-03	1.10E-04
9.2	2.09E-02	1.30E+00
Total	**2.30E+00**	**1.80E+03**

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Table E.3-22	**E-99**	**Entire table**

In response to RAI 4.b, ER Table E.3-22, "Base Case Consequence Input to SAMA Analysis," is replaced in its entirety, and now reads:

Table E.3-22: Base Case Consequence Input to SAMA Analysis

Release Category	Whole Body Dose (50, rem)	Economic Impact (50, $)
1.1	2.23E+06	2.17E+09
1.2	2.36E+06	2.25E+09
1.3	2.32E+06	2.26E+09
1.4	3.05E+06	2.38E+09
2.1	5.41E+06	4.04E+09
2.2	1.03E+07	4.89E+09
3.1	8.81E+05	4.34E+08
3.2	4.83E+06	3.97E+09
3.3	8.63E+05	4.27E+08
3.4	7.22E+06	4.62E+09
4.1	3.73E+04	8.67E+06
4.2	1.05E+06	5.46E+08
4.3	6.37E+04	1.08E+07
4.4	1.40E+06	1.05E+09
5.1	3.37E+05	9.84E+07
5.2	3.47E+06	2.96E+09
5.3	3.36E+05	9.50E+07
5.4	8.27E+06	4.32E+09
6.1	1.25E+06	1.01E+09
6.2	1.84E+06	1.58E+09
6.3	8.91E+03	1.29E+06
6.4	6.12E+05	2.38E+08
7.1	4.02E+04	2.18E+06
7.2	1.29E+05	4.62E+07
7.3	2.44E+03	1.57E+05
7.4	3.37E+03	2.97E+05
7.5	1.39E+03	0.00E+00
7.6	3.46E+05	8.64E+07
7.7	8.05E+02	6.45E+03
7.8	1.96E+05	7.63E+07
8.1	1.90E+03	1.15E+04
8.2	7.79E+05	2.22E+08
9.1	2.67E+02	1.45E+01
9.2	1.49E+04	9.27E+05
Total	**5.97E+07**	**3.98E+10**

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Tables E.3-23 through E.3-32	**E-100 & E-101**	**Entire tables (10 tables)**

In response to RAI 4.b, ER Tables E.3-23 through E.3-32 are replaced in their entirety, and now read:

Table E.3-23: Comparison of Base Case and Case S1

	Internal Events		
	Base	**S1**	**% diff.**
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.52E+00	9.6%
Economic Impact (50) ($/yr)	1.80E+03	1.96E+03	8.9%

Table E.3-24: Comparison of Base Case and Case S2

	Internal Events		
	Base	**S2**	**% diff.**
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.05E+00	-10.9%
Economic Impact (50) ($/yr)	1.80E+03	1.61E+03	-10.6%

Table E.3-25: Comparison of Base Case and Case S3

	Internal Events		
	Base	**S3**	**% diff.**
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.37E+00	3.0%
Economic Impact (50) ($/yr)	1.80E+03	1.80E+03	0.0%

Table E.3-26: Comparison of Base Case and Case M1

	Internal Events		
	Base	**M1**	**% diff.**
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.36E+00	2.6%
Economic Impact (50) ($/yr)	1.80E+03	1.81E+03	-0.6%

Table E.3-27: Comparison of Base Case and Case M2

	Internal Events		
	Base	M2	% diff.
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.20E+00	-4.3%
Economic Impact (50) ($/yr)	1.80E+03	1.78E+03	-1.1%

Table E.3-28: Comparison of Base Case and Case A1

	Internal Events		
	Base	A1	% diff.
Whole Body Dose (50) (person-rem/yr)	2.30E+00	1.75E+00	-23.9%
Economic Impact (50) ($/yr)	1.80E+03	1.42E+03	-21.1%

Table E.3-29: Comparison of Base Case and Case A2

	Internal Events		
	Base	A2	% diff.
Whole Body Dose (50) (person-rem/yr)	2.30E+00	0.30E+00	0.0%
Economic Impact (50) ($/yr)	1.80E+03	1.80E+03	0.0%

Table E.3-30: Comparison of Base Case and Case A3

	Internal Events		
	Base	A3	% diff.
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.31E+00	0.4%
Economic Impact (50) ($/yr)	1.80E+03	1.80E+03	0.0%

Table E.3-31: Comparison of Base Case and Case E1

	Internal Events		
	Base	E1	% diff.
Whole Body Dose (50) (person-rem/yr)	2.30E+00	2.28E+00	-0.9%
Economic Impact (50) ($/yr)	1.80E+03	1.80E+03	0.0%

Table E.3-32: Comparison of Base Case and Case E2

	Internal Events		
	Base	E2	% diff.
Whole Body Dose (50) (person-rem/yr)	2.30E+00	1.86E+00	-19.1%
Economic Impact (50) ($/yr)	1.80E+03	1.38E+03	-23.3%

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Table E.3-33	**E-101**	**New table**

In response to RAI 6.j, new ER Table E.3-33, "Comparison of Base Case and Case E3," is added to the ER, which reads:

Table E.3-33: Comparison of Base Case and Case S1

-	*Internal Events*		
-	***Base***	***S1***	***% diff.***
Whole Body Dose (50) (person-rem/yr)	*2.30E+00*	*2.31E+00*	*0.4%*
Economic Impact (50) ($/yr)	*1.80E+03*	*1.80E+03*	*0.0%*

Affected LRA Section	LRA Page No.	Affected Paragraph and Sentence
ER Table E.4-1	**E-101**	**Entire table**

In response to RAIs 3.c and 4.b, ER Table E.4-1, "Total Cost of Severe Accident Impact," is replaced in its entirety, and now reads:

Table E.4-1: Total Cost of Severe Accident Impact

APE	$56,442
AOC	$22,086
AOE	$4,340
AOSC	$266,279
Severe Accident Impact (Internal Events)	$349,147
Fire, Seismic, Other	$1,606,076
Maximum Benefit (Internal Events, Fire, Seismic, Other)	$1,955,223

Affected LRA Section	**LRA Page Nos.**	**Affected Paragraph and Sentence**
ER Table E.5-3	**E-136 - 139**	**Entire table**

In response to RAI 2.e, ER Table E.5-3, "Basic Event LERF Importance," is replaced in its entirety, and now reads:

Table E.5-3: Basic Event LERF Importance

Event Name	F-V	RRW	Description
R	9.00E-01	10.031	Steam generator tube rupture <initiating event>
XHAMUCDE	6.04E-01	2.526	Operators fail to attempt cooldown via makeup/HPI cooling.
CHASGDPE	5.35E-01	2.151	Operators fail to cooldown during a steam generator tube rupture
LHAMSIVE	4.92E-01	1.970	Failure to close MSIV and isolate steam generator containing ruptured tube
AASGTR11	4.80E-01	1.925	SGTR occurs on OTSG 1-1 <split fraction>
AASGTR12	3.93E-01	1.647	SGTR occurs on OTSG 1-2 <split fraction>
FMM00003	7.88E-02	1.086	Any MSSVs on SG1 fail to reseat
VD-IEF	7.47E-02	1.081	ISLOCA due to internal rupture of DHR suction valves
FLCO101F	7.24E-02	1.078	Logic Card Fails during operation - MSIV 101 fails to close
LPPNISOZ	7.11E-02	1.077	ISLOCA occurs in non-isolable portion of DHR system
FMM00004	6.80E-02	1.073	Any MSSVs on SG2 fail to reseat
QHAMDFPE	6.80E-02	1.073	Failure to start MDFP as backup to turbine-driven feedwaer pumps for transient, Small LOCA or SGTR events
FLC0100F	6.07E-02	1.065	Logic Card Fails during operation - MSIV 100 fails to close
EC1ZXXXN-CC_1_2	5.18E-02	1.055	CCF of two components: EC1Z089N & EC1Z100N
LPSRC2BH	4.88E-02	1.051	Press switch PSH RC2B4 fails high – fails DHR
LPSZ416H	4.88E-02	1.051	Press switch PSH 7531A fails high - fails DHR
LMVF012R	4.49E-02	1.047	Internal rupture of DH 12 (annual frequency)
LMBCWRT1	4.09E-02	1.043	CWR Train 1 unavailable due to maintenance
EDG0012F	3.44E-02	1.036	EDG 1-2 fails to run

Table E.5-3: Basic Event LERF Importance (continued)			
Event Name	**F-V**	**RRW**	**Description**
FCIRCTMP	3.27E-02	1.034	Circ water temperature not acceptable
FVV011BT	3.02E-02	1.031	AVV ICS11B fails to reseat after steam release
LMVF011R	2.98E-02	1.031	Internal rupture of DH 11 (annual frequency)
ELOOPRT	2.91E-02	1.030	LOOP given reactor trip
EHAD2DGE	2.73E-02	1.028	Operators fail to align power from EDG 1-1 or EDG 1-2 to supply MDFP given LOOP
EHASBDGE	2.76E-02	1.028	Operators fail to align power from station blackout diesel generator to supply MDFP given LOOP
FVV011AT	2.60E-02	1.027	AVV ICS11A fails to reseat after steam release
LMVU011R	2.39E-02	1.024	Internal rupture of DH 11 since cold shutdown
LMVU012R	2.39E-02	1.024	Internal rupture of DH 12 since cold shutdown
LMBCWRT2	2.14E-02	1.022	CWR Train 2 unavailable due to maintenance
FLC011BF	1.95E-02	1.020	ICS logic card fails ICS11B (AVV SG1) fails to open
FLC011AF	1.83E-02	1.019	ICS logic card fails ICS11A (AVV SG2) fails to open
EC1Z100N	1.79E-02	1.018	Breaker HX11B fails to open – fails power from SU1 and SU2 to Bus B
EC1Z153C	1.79E-02	1.018	Breaker HX02B fails to close - fails power from SU1 to Bus B
XHOS-CCW1RUN2STBY	1.67E-02	1.017	CCW Pump 1 running, Pump 2 in standby
XHOS-CCW2RUN1STBY	1.65E-02	1.017	CCW Pump 2 running, Pump 1 in standby
EHASBD1E	1.61E-02	1.016	Operators fail to start SBODG and align to bus D1
ET4DF12F	1.53E-02	1.016	Transformer DF 1-2 local faults
LAV1761N	1.55E-02	1.016	Air-operated valve WC 1761 fails to open
EHAD1ACE	1.45E-02	1.015	Failure to lineup alternate source to bus D1
LMV0011H	1.50E-02	1.015	Motor-operated valve DH 11 fails to hold on high exposure
EB200D1F	1.30E-02	1.013	Bus D1 local faults not including fire
EDG0SBOF	1.31E-02	1.013	SBO diesel generator fails to run
LXV0125C	1.11E-02	1.011	Manual valve WC 125 fails to close – makeup to BWST for SGTR
LXV0169N	1.11E-02	1.011	Manual valve WC 169 fails to close – makeup to BWST for SGTR

Table E.5-3: Basic Event LERF Importance (continued)			
Event Name	**F-V**	**RRW**	**Description**
LXV0171C	1.11E-02	1.011	Manual valve WC 171 fails to close – makeup to BWST for SGTR
LXV0172C	1.11E-02	1.011	Manual valve WC 172 fails to close – makeup to BWST for SGTR
LXVBW15C	1.11E-02	1.011	Manual valve BW 15 fails to close – makeup to BWST for SGTR
LXVBW16N	1.11E-02	1.011	Manual valve BW 16 fails to close – makeup to BWST for SGTR
LXVSF79N	1.11E-02	1.011	Manual valve SF 79 fails to open – makeup to BWST for SGTR
LXVSF80C	1.11E-02	1.011	Manual valve SF 80 fails to open – makeup to BWST for SGTR
LXVSF87N	1.11E-02	1.011	Manual valve SF 87 fails to open – makeup to BWST for SGTR
LXVSF92C	1.11E-02	1.011	Manual valve SF 92 fails to close – makeup to BWST for SGTR
LXVWC44N	1.11E-02	1.011	Manual valve WC 44 fails to open – makeup to BWST for SGTR
EDG0SBOA	1.00E-02	1.010	SBO diesel generator fails to start
FIV0101C	1.02E-02	1.010	MS 101 (MSIV SG1) fails to close
VHAISOLR	1.02E-02	1.010	Operators fail to attempt to close DH1A to isolate ISLOCA
ZHAISOLR	1.02E-02	1.010	Failure to find and isolate ISLOCA resulting from reverse flow through LPI injection line
FIV0100C	8.43E-03	1.009	MS100 (MSIV SG2) fails to close
UHAMUHPE	8.89E-03	1.009	Failure to initiate makeup/HPI cooling after loss of all feedwater coincident with reactor trip
ZOP007BR	9.15E-03	1.009	Failure to recover offsite power within one hour to prevent loss of DC
EMBEDG12	7.76E-03	1.008	EDG Train 2 in maintenance
QMBAFP12	7.56E-03	1.008	AFW train 2 in maintenance
XHABWMUE	7.86E-03	1.008	Operators fail to initiate makeup to the BWST during a SGTR.
EB300F1F	6.47E-03	1.007	Bus F1 local faults
EDG0012A	6.55E-03	1.007	EDG 1-2 fails to start
EMBSBODG	7.22E-03	1.007	SBO diesel generator in maintenance
LMV0011N	7.02E-03	1.007	Motor-operated valve DH 11 fails to open
LMV0012N	7.02E-03	1.007	Motor-operated valve DH 12 fails to open
QMBAFP11	6.87E-03	1.007	AFW train 1 in maintenance
XHOS-AMB->40F	7.16E-03	1.007	Ambient temperature is > 40
EC1BET9N	6.03E-03	1.006	CCF for failure of 13.8 kV breakers to open
EC1CC09N	6.03E-03	1.006	Breaker HX11A OR HX11B fails to open
EC2Z012R	5.52E-03	1.006	Breaker AD1DF12 fails to remain closed

Table E.5-3: Basic Event LERF Importance (continued)			
Event Name	**F-V**	**RRW**	**Description**
LMV0011X	5.96E-03	1.006	Motor-operated valve DH 11 fails to close while indicating closed
LMV0012X	5.96E-03	1.006	Motor-operated valve DH 12 fails to close while indicating closed
VL10-IEF	6.39E-03	1.006	ISLOCA via Train 1 injection line reverse flow (initiating event)
VL20-IEF	6.41E-03	1.006	ISLOCA via Train 2 injection line reverse flow (initiating event)
EDG0011F	5.35E-03	1.005	EDG 1-1 fails to start
FMFWTRIP	4.70E-03	1.005	MFW/ICS faults following trip
LCVF030R	5.37E-03	1.005	Internal leak develops in check valve CF 30 (per year)
LCVF031R	5.35E-03	1.005	Internal leak develops in check valve CF 31 (per year)

Affected LRA Section	**LRA Page Nos.**	**Affected Paragraph and Sentence**
ER Table E.5-4	**E-144 - 154**	**6 rows revised; 1 new row**

In response to RAIs 5.c and 5.f, ER Table E.5-4, "List of Initial SAMA Candidates," is revised as follows:

Table E.5-4: List of Initial SAMA Candidates

SAMA Candidate Identifier	SAMA Candidate Description	Derived Benefit	Source
CB-21	Install pressure measurements between the two DHR suction valves in the line from the RCS hot leg.	This SAMA candidate would provide indication of failure of inboard isolation valves allowing time to initiate mitigating actions to prevent ISLOCA.	[2, Table 14] *[Table E.5-2]*
CC-19	Provide automatic switchover of HPI and LPI suction from the BWST to containment sump for LOCAs.	This SAMA candidate will increase the reliability of switchover of suction from the BWST to the containment sump by providing both manual and automatic switchover.	*[Table E.5-1]*
CP-19	Install a redundant containment fan system.	This SAMA candidate would increase containment heat removal ability. *SAMA candidate CP-19 was added as a variation to CP-18 to provide a redundant containment cooling function, in the form of containment fan coolers.*	*Davis-Besse containment cooling design*
CW-24	Replace the standby CCW pump with a pump diverse from the other two CCW pumps.	This SAMA candidate would improve CCW reliability by reducing the likelihood of a CCF of all three CCW pumps.	*[Table E.5-1]* *[Table E.5-2]*
CW-25	Provide the ability to cool make-up pumps using fire water in the event of loss of CCW.	This SAMA candidate would allow continued injection of RCP seal water in the event of loss of CCW.	*[Table E.5-1]* *[Table E.5-2]*
FW-16	Perform surveillances on manual valves used for backup AFW pump suction.	This SAMA candidate would improve the success probability for providing an alternate water supply to the AFW pumps.	~~[2, Table 14]~~ *[Table E.5-1]* *[Table E.5-2]*
OT-09R	*Provide operator training with PRA-identified high risk important human actions to be emphasized in training.*	*PRA results show that operator actions are significant contributors to overall plant risk. By highlighting those operator actions shown to have the highest risk importance, the reliability of those actions will be improved.*	*Table E.5-2*

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Table E.6-1	**E-155 – E-180**	**6 rows revised; 1 new row**

In response to RAIs 5.c, 5.g, 5.h, 6.b, and 6.k, ER Table E.6-1, "Qualitative Screening of SAMA Candidates," is revised as follows:

Table E.6-1: Qualitative Screening of SAMA Candidates

SAMA ID	Modification (Potential Enhancement)	Screening Criteria	Basis for Screening/Modification Enhancements
CB-08	Improve operator training on ISLOCA coping.	~~*Criterion E*~~ ~~*Subsumed*~~ *Criterion B* *Already Implemented*	~~*This SAMA would reduce the risk of ISLOCA events by improving the likelihood of timely identification and diagnosis of ISLOCA events and thereby increasing the likelihood of successful mitigating actions. This SAMA will be subsumed in CB-07.*~~ *Davis-Besse has several procedures in place to address small and interfacing system LOCAs. Operators receive training on LOCAs, and there are a number of indications to support the likelihood and timely identification and diagnosis of ISLOCA events (including tank level indications, lifting relief valves, and running sump pumps).*
CC-08	Add the ability to automatically align ECCS to recirculation mode upon BWST depletion.	Criterion E Subsumed	Davis-Besse currently has the ability to initiate automatic switchover from the BWST to the containment sump on low BWST level, but this feature has been deactivated. ~~*The cost would by minor to reactivate this feature.*~~ This SAMA candidate will be subsumed in SAMA candidate CC-19.
CC-19	Provide automatic switchover of HPI and LPI suction from the BWST to containment sump for LOCAs.	Criterion F Considered for Further Evaluation	Davis-Besse currently has the ability to initiate automatic switchover from the BWST to the containment sump on low BWST level, but this feature has been deactivated. ~~*The cost would by minor to reactivate this feature.*~~ Therefore, this SAMA candidate is considered for further evaluation.

Table E.6-1: Qualitative Screening of SAMA Candidates (continued)

SAMA ID	Modification (Potential Enhancement)	Screening Criteria	Basis for Screening/Modification Enhancements
FL-01	Improve inspection of rubber expansion joints on main condenser.	~~*Criterion D*~~ ~~*Very Low Benefit*~~ *Criterion B* *Already Implemented*	~~*Based on the top 100 cutsets and component basic event importance, circulating water breaks are not a significant risk contributor at Davis-Besse.*~~ *The circulating water joints are currently inspected during outages, and include both interior and exterior inspections. Exterior inspections of the visible portion of the expansion joint are performed during Engineering system walkdowns and Operator tours. Additionally, the expansion joints are periodically replaced.*
OT-05	Increase training and operating experience feedback to improve operator response.	~~*Criterion D*~~ ~~*Very Low Benefit*~~ *Criterion B* *Already Implemented*	~~*No deficiencies in operator training or feedback are identified.*~~ *FENOC provides PRA information, such as risk-significant initiating events, high worth operator actions and high worth equipment, to various departments, including Operations Training, and presents this information on posters throughout the plant.*
OT-07	Install secondary side guard pipes up to the MSIVs.	Criterion D Very Low Benefit	*Steam line breaks are not a significant contributor to CDF or LERF.* The derived benefit would not justify the implementation cost required.
OT-09R	*Provide operator training with PRA-identified high risk important human actions to be emphasized in training.*	*Criterion B* *Already Implemented*	*Davis-Besse provides PRA information such as risk significant initiating events, high worth operator actions and high worth equipment. This information is provided to various departments and is presented on posters throughout the plant.*

Affected LRA Section	**LRA Page No.**	**Affected Paragraph and Sentence**
ER Table E.7-2	**E-183 - 185**	**Entire table**
ER Table E.7-3	**E-186**	**Entire table**
ER Table E.7-5	**E-188**	**Entire table**
ER Table E.8-1	**E-189 - 190**	**Entire table**

In response to RAIs 3.c and 4.b, ER Tables E.7-2, E.7-3, E.7-5 and E.8-1 are replaced in their entirety, and now read as shown on the following pages:

Table E.7-2: Internal Events Benefit Results for Analysis Case

Case	Maximum Benefit	AC/DC-01 (DCBattery)	AC/DC-03 (Battery Charger)	AC/DC-14 (GasTurbineGen)
Off-site Annual Dose (rem)	2.30E+00	2.28E+00	2.07E+00	2.05E+00
Off-site Annual Property Loss ($)	$1,800	$1,790	$1,610	$1,650
Comparison CDF[4]	----	1.0E-05	1.0E-05	1.0E-05
Comparison Dose (rem)	----	2.30E+00	2.30E+00	2.30E+00
Comparison Cost ($)	----	$1,800	$1,800	$1,800
Enhanced CDF	----	9.4E-06	7.8E-06	9.0E-06
Reduction in CDF	----	**6.00%**	**22.00%**	**10.00%**
Reduction in Off-site Dose	----	**0.87%**	**10.00%**	**10.87%**
Immediate Dose Savings (On-site)	$810	$49	$178	$81
Long Term Dose Savings (On-site)	$3,530	$212	$777	$353
Total Accident Related Occupational Exposure **(AOE)**	$4,340	$260	$955	$434
Cleanup/Decontamination Savings (On-site)	$132,362	$7,942	$29,120	$13,236
Replacement Power Savings (On-site)	$133,917	$8,035	$29,462	$13,392
Averted Costs of On-site Property Damage **(AOSC)**	$266,279	$15,977	$58,581	$26,628
Total On-site Benefit	**$270,619**	**$16,237**	**$59,536**	**$27,062**
Averted Public Exposure **(APE)**	$56,442	$491	$5,644	$6,135
Averted Off-site Damage Savings **(AOC)**	$22,086	$123	$2,331	$1,841
Total Off-site Benefit	**$78,528**	**$614**	**$7,976**	**$7,976**
Total Benefit (On-site + Off-site)	**$349,147**	**$16,851**	**$67,512**	**$35,037**

[4] The sum of the Containment Systems State frequencies calculated by the Level 2 PRA model is slightly different than the CDF calculated by the Level 1 PRA due to the delete term approximation and the additional systems included in the Level 2 models.

Table E.7-2: Internal Events Benefit Results for Analysis Case (continued)

Case	AC/DC-19 (FireWaterBackup)	AC/DC-21 (RepairBreakers)	AC/DC-25 (DedDCPower)	AC/DC-26 (Generator_TDAFW)
Off-site Annual Dose (rem)	2.28E+00	2.29E+00	2.25E+00	2.25E+00
Off-site Annual Property Loss ($)	$1,790	$1,790	$1,780	$1,780
Comparison CDF[4]	1.0E-05	1.0E-05	1.0E-05	1.0E-05
Comparison Dose (rem)	2.30E+00	2.30E+00	2.30E+00	2.30E+00
Comparison Cost ($)	$1,800	$1,800	$1,800	$1,800
Enhanced CDF	9.8E-06	9.7E-06	8.5E-06	8.5E-06
Reduction in CDF	**2.00%**	**3.00%**	**15.00%**	**15.00%**
Reduction in Off-site Dose	**0.87%**	**0.43%**	**2.17%**	**2.17%**
Immediate Dose Savings (On-site)	$16	$24	$121	$121
Long Term Dose Savings (On-site)	$71	$106	$529	$529
Total Accident Related Occupational Exposure **(AOE)**	$87	$130	$651	$651
Cleanup/Decontamination Savings (On-site)	$2,647	$3,971	$19,854	$19,854
Replacement Power Savings (On-site)	$2,678	$4,018	$20,088	$20,088
Averted Costs of On-site Property Damage **(AOSC)**	$5,326	$7,988	$39,942	$39,942
Total On-site Benefit	**$5,412**	**$8,119**	**$40,593**	**$40,593**
Averted Public Exposure **(APE)**	$491	$245	$1,227	$1,227
Averted Off-site Damage Savings **(AOC)**	$123	$123	$245	$245
Total Off-site Benefit	**$614**	**$368**	**$1,472**	**$1,472**
Total Benefit (On-site + Off-site)	**$6,026**	**$8,487**	**$42,065**	**$42,065**

[4] The sum of the Containment Systems State frequencies calculated by the Level 2 PRA model is slightly different than the CDF calculated by the Level 1 PRA due to the delete term approximation and the additional systems included in the Level 2 models.

Table E.7-2: Internal Events Benefit Results for Analysis Case (continued)

Case	AC/DC-27 (SBO_DieselTank)	CB-21 (DHR_valves)	CC-01 (HPI_System)	CC-04 (LPI_pump)
Off-site Annual Dose (rem)	2.30E+00	2.11E+00	2.29E+00	2.30E+00
Off-site Annual Property Loss ($)	$1,800	$1,710	$1,790	$1,800
Comparison CDF[4]	1.0E-05	1.0E-05	1.0E-05	1.0E-05
Comparison Dose (rem)	2.30E+00	2.30E+00	2.30E+00	2.30E+00
Comparison Cost ($)	$1,800	$1,800	$1,800	$1,800
Enhanced CDF	1.0E-05	1.0E-05	1.0E-05	1.0E-05
Reduction in CDF	**0.00%**	**0.00%**	**0.00%**	**0.00%**
Reduction in Off-site Dose	**0.00%**	**8.26%**	**0.43%**	**0.00%**
Immediate Dose Savings (On-site)	$0	$0	$0	$0
Long Term Dose Savings (On-site)	$0	$0	$0	$0
Total Accident Related Occupational Exposure **(AOE)**	$0	$0	$0	$0
Cleanup/Decontamination Savings (On-site)	$0	$0	$0	$0
Replacement Power Savings (On-site)	$0	$0	$0	$0
Averted Costs of On-site Property Damage **(AOSC)**	$0	$0	$0	$0
Total On-site Benefit	**$0**	**$0**	**$0**	**$0**
Averted Public Exposure **(APE)**	$0	$4,663	$245	$0
Averted Off-site Damage Savings **(AOC)**	$0	$1,104	$123	$0
Total Off-site Benefit	**$0**	**$5,767**	**$368**	**$0**
Total Benefit (On-site + Off-site)	**$0**	**$5,767**	**$368**	**$0**

[4] The sum of the Containment Systems State frequencies calculated by the Level 2 PRA model is slightly different than the CDF calculated by the Level 1 PRA due to the delete term approximation and the additional systems included in the Level 2 models.

Table E.7-2: Internal Events Benefit Results for Analysis Case (continued)

Case	CC-05 (LPI_Diesel_pump)	CC-19 (BWST_to_Sump)	HV-01 (Redundant_HVAC)	HV-03 (Backup_fans)
Off-site Annual Dose (rem)	2.30E+00	2.30E+00	2.30E+00	2.30E+00
Off-site Annual Property Loss ($)	$1,800	$1,800	$1,800	$1,800
Comparison CDF[4]	1.0E-05	1.0E-05	1.0E-05	1.0E-05
Comparison Dose (rem)	2.30E+00	2.30E+00	2.30E+00	2.30E+00
Comparison Cost ($)	$1,800	$1,800	$1,800	$1,800
Enhanced CDF	1.0E-05	9.9E-06	1.0E-05	1.0E-05
Reduction in CDF	**0.00%**	**1.00%**	**0.00%**	**0.00%**
Reduction in Off-site Dose	**0.00%**	**0.00%**	**0.00%**	**0.00%**
Immediate Dose Savings (On-site)	$0	$8	$0	$0
Long Term Dose Savings (On-site)	$0	$35	$0	$0
Total Accident Related Occupational Exposure **(AOE)**	$0	$43	$0	$0
Cleanup/Decontamination Savings (On-site)	$0	$1,324	$0	$0
Replacement Power Savings (On-site)	$0	$1,339	$0	$0
Averted Costs of On-site Property Damage **(AOSC)**	$0	$2,663	$0	$0
Total On-site Benefit	**$0**	**$2,706**	**$0**	**$0**
Averted Public Exposure **(APE)**	$0	$0	$0	$0
Averted Off-site Damage Savings **(AOC)**	$0	$0	$0	$0
Total Off-site Benefit	**$0**	**$0**	**$0**	**$0**
Total Benefit (On-site + Off-site)	**$0**	**$2,706**	**$0**	**$0**

[4] The sum of the Containment Systems State frequencies calculated by the Level 2 PRA model is slightly different than the CDF calculated by the Level 1 PRA due to the delete term approximation and the additional systems included in the Level 2 models.

Table E.7-3: Total Benefit Results for Analysis Cases

	Maximum Benefit	AC/DC-01 (DCBattery)	AC/DC-03 (Battery Charger)	AC/DC-14 (GasTurbineGen)	AC/DC-19 (FireWaterBackup)	AC/DC-21 (RepairBreakers)	AC/DC-25 (DedDCPower)
Internal Events	$349,147	$16,851	$67,512	$35,037	$6,026	$8,487	$42,065
Fires, Seismic, Other	$1,606,076	$77,513	$310,553	$161,172	$27,719	$39,039	$193,500
Total Benefit	**$1,955,223**	**$94,363**	**$378,065**	**$196,209**	**$33,745**	**$47,525**	**$235,565**

	AC/DC-26 (Generator_TDAFW)	AC/DC-27 (SBO_DieselTank)	CB-21 (DHR_valves)	CC-01 (HPI_System)	CC-04 (LPI_pump)	CC-05 (LPI_Dieselpump)	CC-19 (BWST_to_Sump)
Internal Events	$42,065	$0	$5,767	$368	$0	$0	$2,706
Fires, Seismic, Other	$193,500	$0	$26,528	$1,693	$0	$0	$12,448
Total Benefit	**$235,565**	**$0**	**$32,295**	**$2,061**	**$0**	**$0**	**$15,155**

	HV-01 (Redundant_HVAC)	HV-03 (Backup_fans)
Internal Events	$0	$0
Fires, Seismic, Other	$0	$0
Total Benefit	**$0**	**$0**

Table E.7-5: Final Results of Cost Benefit Evaluation

SAMA Candidate ID	Modification	Estimated Benefit	2009 Estimate Cost	Conclusion
AC/DC-01	Provide additional DC battery capacity.	$94,363	$1,750,000	Not Cost Effective
AC/DC-03	Add a portable, diesel-driven battery charger to existing DC system.	$378,065	$330,000	Cost Effective
AC/DC-14	Install a gas turbine generator.	$196,209	$2,000,000	Not Cost Effective
AC/DC-19	Use fire water system as a backup source for diesel cooling.	$33,745	$700,000	Not Cost Effective
AC/DC-21	Develop procedures to repair or replace failed 4kV breakers.	$47,525	$100,000	Not Cost Effective
AC/DC-25	Provide a dedicated DC power system (battery/battery charger) for the TDAFW control valve and NNI-X for steam generator level indication.	$235,565	$2,000,000	Not Cost Effective
AC/DC-26	Provide an alternator/generator that would be driven by each TDAFW pump.	$235,565	$2,000,000	Not Cost Effective
AC/DC-27	Increase the size of the SBO fuel oil tank.	$0	$550,000	Not Cost Effective
CB-21	Install pressure measurements between the two DHR suction valves in the line from the RCS hot leg.	$32,295	$550,000	Not Cost Effective
CC-01	Install an independent active or passive HPI system.	$2,061	$6,500,000	Not Cost Effective
CC-04	Add a diverse LPI system.	$0	$5,500,000	Not Cost Effective
CC-05	Provide capability for alternate LPI via diesel-driven fire pump.	$0	$6,500,000	Not Cost Effective
CC-19	Provide automatic switchover of HPI and LPI suction from the BWST to containment sump for LOCAs.	$15,155	$1,500,000	Not Cost Effective
HV-01	Provide a redundant train or means of ventilation.	$0	$50,000	Not Cost Effective
HV-03	Stage backup fans in switchgear rooms.	$0	$400,000	Not Cost Effective

Table E.8-1: Final Results of the Sensitivity Cases

SAMA Candidate ID	Repair Case	Low Discount Rate Case	High Discount Rate Case	On-site Dose Case	On-site Cleanup Case	Replacement Power Case	2009 Estimated Cost	Conclusion
AC/DC-01	$58,367	$142,486	$64,929	$95,839	$109,188	$124,566	$1,750,000	Not Cost Effective
AC/DC-03	$246,076	$571,954	$262,617	$383,474	$432,421	$488,806	$330,000	Cost Effective
AC/DC-14	$136,214	$297,589	$138,018	$198,668	$220,917	$246,546	$2,000,000	Not Cost Effective
AC/DC-19	$21,746	$51,031	$23,396	$34,237	$38,686	$43,812	$700,000	Not Cost Effective
AC/DC-21	$29,527	$71,774	$32,727	$48,263	$54,938	$62,626	$100,000	Not Cost Effective
AC/DC-25	$145,573	$355,685	$162,059	$239,253	$272,626	$311,071	$2,000,000	Not Cost Effective
AC/DC-26	$145,573	$355,685	$162,059	$239,253	$272,626	$311,071	$2,000,000	Not Cost Effective
AC/DC-27	$0	$0	$0	$0	$0	$0	$550,000	Not Cost Effective
CB-21	$32,295	$49,858	$24,719	$32,295	$32,295	$32,295	$550,000	Not Cost Effective
CC-01	$2,061	$3,182	$1,578	$2,061	$2,061	$2,061	$6,500,000	Not Cost Effective
CC-04	$0	$0	$0	$0	$0	$0	$5,500,000	Not Cost Effective
CC-05	$0	$0	$0	$0	$0	$0	$6,500,000	Not Cost Effective
CC-19	$9,155	$22,864	$10,383	$15,401	$17,625	$20,188	$1,500,000	Not Cost Effective
HV-01	$0	$0	$0	$0	$0	$0	$50,000	Not Cost Effective
HV-03	$0	$0	$0	$0	$0	$0	$400,000	Not Cost Effective

Table E.8-1: Final Results of the Sensitivity Cases (continued)

SAMA Candidate ID	Multiplier Case	Evacuation Speed	Off-site Economic Cost	2009 Estimated Cost	Conclusion
AC/DC-01	$134,805	$125,284	$95,738	$1,750,000	Not Cost Effective
AC/DC-03	$540,092	$408,985	$379,439	$330,000	Cost Effective
AC/DC-14	$280,299	$227,130	$197,583	$2,000,000	Not Cost Effective
AC/DC-19	$48,207	$64,665	$35,119	$700,000	Not Cost Effective
AC/DC-21	$67,893	$78,446	$48,899	$100,000	Not Cost Effective
AC/DC-25	$336,521	$266,485	$236,939	$2,000,000	Not Cost Effective
AC/DC-26	$336,521	$266,485	$236,939	$2,000,000	Not Cost Effective
AC/DC-27	$0	$30,920	$1,374	$550,000	Not Cost Effective
CB-21	$46,135	$63,215	$33,669	$550,000	Not Cost Effective
CC-01	$2,945	$32,982	$3,436	$6,500,000	Not Cost Effective
CC-04	$0	$30,920	$1,374	$5,500,000	Not Cost Effective
CC-05	$0	$30,920	$1,374	$6,500,000	Not Cost Effective
CC-19	$21,649	$46,075	$16,529	$1,500,000	Not Cost Effective
HV-01	$0	$30,920	$1,374	$50,000	Not Cost Effective
HV-03	$0	$30,920	$1,374	$400,000	Not Cost Effective