Vito A. Kaminskas
Site Vice President

DTE Energy Company
6400 N. Dixie Highway, Newport, MI 48166
Tel: 734.586.6515 Fax: 734.586.4172
Email: kaminskasv@dteenergy.com

10 CFR 54

January 9, 2015
NRC-15-0013

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington D C 20555-0001

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) DTE Electric Company Letter to NRC, "Fermi 2 License Renewal Application," NRC-14-0028, dated April 24, 2014 (ML14121A554)

3) NRC Letter, "Requests for Additional Information for the Review of the Fermi 2 License Renewal Application – Severe Accident Mitigation Alternatives," dated November 18, 2014 (ML14308A358)

Subject: Response to NRC Request for Additional Information for the Review of the Fermi 2 License Renewal Application – Severe Accident Mitigation Alternatives

In Reference 2, DTE Electric Company (DTE) submitted the License Renewal Application (LRA) for Fermi 2. In Reference 3, NRC staff requested additional information regarding the Fermi 2 LRA. The Enclosure to this letter provides the DTE response to the request for additional information (RAI).

The following commitment is being made in this submittal:

> The potentially cost-beneficial Severe Accident Mitigation Alternative (SAMA) candidates (discussed in the responses to RAIs 5.a.vii, 6.h, and 7.b) will be evaluated.

Should you have any questions or require additional information, please contact Lynne Goodman at 734-586-1205.

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

Executed on January 9, 2015

Vito A. Kaminskas
Site Vice President
Nuclear Generation

Enclosure: DTE Response to NRC Request for Additional Information for the Review of the Fermi 2 License Renewal Application – Severe Accident Mitigation Alternatives

cc: NRC Project Manager
NRC License Renewal Project Manager
NRC License Renewal Environmental Project Manager
NRC Resident Office
Reactor Projects Chief, Branch 5, Region III
Regional Administrator, Region III
Michigan Public Service Commission,
Regulated Energy Division (kindschl@michigan.gov)

Enclosure to
NRC-15-0013

Fermi 2 NRC Docket No. 50-341
Operating License No. NPF-43

DTE Response to NRC Request for Additional Information for the Review of the Fermi 2 License Renewal Application – Severe Accident Mitigation Alternatives

RAI 1.a

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

a. The environmental report (ER) states that "No other planned major plant modifications, which could adversely impact the SAMA analysis results, have been identified." Request confirmation that this applies to all planned modifications, major or not, and to changes in operating practices/procedures.

Response:

All plant modifications since the FermiV9 model freeze date have been evaluated. Only one plant modification was identified as having an impact on the Fermi 2 internal events model. This modification was to add a third breaker row to the 345 KV switchyard. Although this modification took place after the FermiV9 model freeze date, it was included in the FermiV9 model due to its impact (primarily on Maintenance Rule (a)(4) risk evaluations). Pending Fukushima modifications will also not have an adverse impact on SAMA. In addition, no operating practice/procedure changes have been identified that would have an adverse impact on SAMA. Additional information is provided in the response to RAI 4.k.

RAI 1.b

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

b. Describe any credit being taken in the FermiV9 PRA for the mitigating strategies required by 10 CFR 50.54(hh)(2).

Response:

There are several instances where B.5.b mitigating strategies are taken credit for in the Fermi 2 Probabilistic Risk Assessment (PRA) model. These strategies are outlined in the Fermi 2 Extreme Damage Mitigation (EDM) procedures. Below is a listing of the instances where B.5.b actions are credited in the model, with accompanying implementing procedure numbers, modeled human action basic events, and associated PRA gate information:

#	Action	Procedure	Human Action	PRA Gate
1	Refilling Condensate Storage Tank (CST) via Fire Protection header	29.EDM.11	HE1RCSTSCSTEDM (OPERATOR FAILS TO FILL CST PER EDMG)	FIRE_WTR_MAKEUP (INADEQUATE FIRE WATER MAKEUP TO CST)
2	Venting the Containment Locally without AC Power	29.EDM.08	HE1FHVNTACVT-- (Failure to Vent Locally without AC power)	HVNT-NOAC (FAILURE OF AC POWER AND LOCAL VENTING ACTION)
3	Alignment of portable power to the SRVs	29.EDM.15	HE1FSRVSPORTPWR (CREW FAILS TO ALIGN PORTABLE POWER TO SRVs)	T-LP-DC (FAILURE TO ALIGN PORTABLE POWER TO SRVs)

#	Action	Procedure	Human Action	PRA Gate
4	Alignment of the B.5.b pump to provide ex-vessel injection via drywell sprays following core damage. Note: Injection to the RPV via the B.5.b pump to prevent core damage is not credited.	29.EDM.05 29.EDM.14	HE1FFPROB5BRPV (OPERATOR FAILS TO ALIGN B5B FOR INJECTION [Late])	B5BINJFAILS-EX (B.5.B PUMP FAILS TO INJECTION TO RPV EX-VESSEL INJ)
5	Replenishment of fuel oil supply to the B.5.b pump. Note: Injection to the RPV via the B.5.b pump to prevent core damage is not credited.	29.EDM.13 29.EDM.14	HE2FFPROB5BFO (FAILURE TO REPLENISH B.5.B FUEL OIL SUPPLY)	B5BPUMPFAILS (B.5.B PUMP FAILS TO DELIVER FLOW)

RAI 1.c

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. <u>Basis:</u> Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

c. Relative to Table D.1-1:
   i. Provide a more detailed listing of the initiating events percentage contribution to the internal events CDF. Include the breakdown of loss of coolant accidents (LOCAs) by size and/or cause and the various contributors to the general transients and special initiator groups.
   ii. Clarify what is meant by the term, "(without LOSP)" for the general transients descriptions. Are consequential losses of offsite power (LOSPs) modeled and not included in this value?
   iii. Discuss briefly the modeling of the LOSP and station blackout (SBO) scenarios including how the combustion turbine generators are incorporated in the model and how common cause loss of alternating current due to weather is considered.

Response:

i. The table below contains a list of initiating events which contribute greater than 1% to the Core Damage Frequency (CDF) solution (Fussel-Vesely > 0.01) at the 1.0E-12/yr truncation limit in the FermiV9 PRA model sorted by Fussel-Vesely (from largest to smallest).

Event Name	Probability	Fus Ves	Description
%LOSP	6.34E-02	1.42E-01	TOTAL LOSS OF OFFSITE POWER
%TX	8.37E-01	1.30E-01	TURBINE TRIP WITH BYPASS INITIATING EVENT
%S1-WA	1.44E-04	1.04E-01	MEDIUM LOCA BELOW TAF (WATER)
%FL-AB-FPRO-RELAY-N	6.70E-06	7.36E-02	Nominal rupture in FPS line in AB propagating to Relay Room
%S1-LP	9.46E-05	6.96E-02	MEDIUM LOCA IN LPCI LINE
%S1-FW	8.72E-05	3.99E-02	MEDIUM LOCA IN FW LINE
%LOCV	1.61E-01	3.54E-02	LOSS OF CONDENSER VACUUM INITIATING EVENT

Event Name	Probability	Fus Ves	Description
%FL-TB-MCWS-TBXX-M	1.25E-03	3.44E-02	Major rupture in Circulating Water pipe or expansion joints in Turbine Building.
%ISLOCA-SDC	5.90E-08	3.41E-02	ISLOCA IN RHR SDC SUCTION LINE (X-12)
%TMS	1.31E+00	2.92E-02	MANUAL SHUTDOWN INITIATING EVENT
%PLOOP301	2.11E-02	2.54E-02	PARTIAL LOSP FOR DIV. 2
%BS301	1.17E-02	2.45E-02	LOSS OF BUS #301 INITIATING EVENT
%FL-AB-ECW2-B20XX-N	1.79E-06	2.20E-02	Nominal rupture in RBCCW/EECW Div 2 line in DC Switchgear Room
%FL-AB-FPRO-RELAY-M	1.46E-06	1.60E-02	Major rupture in FPS line in AB propagating to Relay Room
%S2-WA	3.09E-03	1.58E-02	SMALL LOCA BELOW TAF (WATER)
%LOFW	7.30E-02	1.56E-02	LOSS OF FEEDWATER INITIATING EVENT
%GSW	1.00E+00	1.37E-02	LOSS OF GENERAL SERVICE WATER INITIATING EVENT
%TBCCW	1.00E+00	1.28E-02	LOSS OF TBCCW INITIATING EVENT
%FL-AB-FPRO-CCHV2-N	1.07E-05	1.18E-02	Nominal rupture of Fire protection piping in Div 2 CCHVAC Room.
%RBCCW	1.00E+00	1.18E-02	LOSS OF RBCCW INITIATING EVENT
%BS101	2.34E-02	1.06E-02	LOSS OF BUS #101 INITIATING EVENT

ii. This annotation refers to general transients without a partial loss of offsite power. At Fermi 2, there are two separate switchyards (120kV and 345kV), each of which supply offsite power to a single "division" of Engineered Safety Function (ESF) and Balance of Plant (BOP) power (these are often referred to as "divisional switchyards" and the loss of offsite power initiators are referred to as "divisional Loss of Offsite Power (LOSP)" events). The 120kV switchyard supplies Division 1 power and the 345kV supplies Division 2 power. The partial loss of offsite power events (%PLOOP101, %BS101, %PLOOP301, and %BS301) are processed via the General Transient event tree. Consequential losses of offsite power are modeled as "total" LOSPs and are processed via the LOSP event tree (not in the General Transient event tree).

iii. The effects of a loss of offsite power are evident in its impact on the BOP systems. The feedwater and condensate systems are rendered initially unavailable due to the LOSP initiating event. Similarly, because of the equipment lost when offsite power is interrupted, the main condenser is also initially unavailable for core decay heat removal.

In addition to the impact on BOP systems, the loss of offsite power event challenges the emergency Alternating Current (AC) power systems to provide AC power. The failure of the emergency AC power systems following a LOSP would result in what is commonly referred to as a station blackout (SBO). These conditions are the complete loss of all AC power to the unit. This requires the failure of the following:

1) Emergency diesel available to the unit
2) Interconnection with the on-site gas turbines

The loss of offsite power and station blackout probabilistic evaluations concentrate on the description of possible sequences which may occur during the operator's attempt to successfully maintain the critical safety functions which include core cooling and containment heat removal while attempting to restore AC power and mitigate the challenges of this scenario.

The SBO event tree begins with sequences which are transferred from the LOSP event tree for sequences where a total LOSP (as opposed to a partial LOSP) initiating event occurs and the Emergency Diesel Generators (EDGs) and Combustion Turbine Generators (CTGs) fail to provide onsite AC power to mitigate the event. If at least one EDG or one CTG is available as a source of onsite AC power, the LOSP event tree is utilized (rather than the SBO event tree).

The LOSP event tree is characterized in general terms by evaluating the following mitigating capabilities:

1) The availability of suppression pool cooling early in the sequence.
2) The ability for Direct Current (DC) powered high pressure systems (High Pressure Coolant Injection (HPCI) and/or Reactor Core Isolation Cooling (RCIC)) or Standby Feedwater (SBFW) to provide high pressure Reactor Pressure Vessel (RPV) makeup.
3) Manual depressurization per the Emergency Operating Procedures for scenarios where high pressure injection or early suppression pool cooling is not successful.
4) RPV injection with low pressure systems.
5) Restoration of offsite power (at various time points in the sequence).
6) Long term containment cooling via late suppression pool cooling, shutdown cooling, or venting of the containment.
7) Continued RPV injection following containment failure.

The SBO event tree is characterized in general terms by evaluating the following mitigating capabilities:

1) The ability for DC powered high pressure systems (HPCI and/or RCIC) to provide high pressure RPV makeup.
2) Manual depressurization per the Emergency Operating Procedures.
3) The ability to recover offsite power (at various time points in the sequence).
4) The ability to successfully mitigate core damage in the long term following successful recovery of offsite power. This is accomplished via successful high or low pressure injection followed by either:
   (a) Successful containment cooling (as described for the LOSP event tree).

(b) Continued RPV injection following containment failure.

The combustion turbine generators are modeled with a support system fault tree. They are modeled for the capability to provide onsite AC power to loads supported by the downstream electrical busses. The CTG system model is characterized by the following:

1) Failure to start and failure to run terms for each CTG.
2) Failure to start and failure to run terms for the standby diesel generator which provides blackstart capability to CTGs 11-2, 11-3, and 11-4.
3) Maintenance unavailability terms for each CTG and the standby diesel generator which provides blackstart capability to CTGs 11-2, 11-3, and 11-4.
4) Common cause failure groups for both failure to start and failure to run composed of CTGs 11-1, 11-2, 11-3, and 11-4.
5) Human Failure Event (HFE) to represent the failure to start the CTG from the control room.
6) HFE to represent the failure to locally blackstart CTGs 11-2, 11-3, or 11-4 via the standby diesel generator.
7) Failure of fuel oil delivery.
8) Failure of CTG 11-1 transformer.
9) Failure of busses and breakers which connect the CTG to the downstream electrical distribution system.

Partial loss of offsite power scenarios are addressed via the General Transient event tree. Equipment failures (including failures of onsite AC power systems) are addressed via the supporting system fault tree logic and functional fault tree logic. Since, by definition, a Station Blackout is the loss of all offsite and onsite AC power, a partial loss of offsite power (with power from the opposite divisional switchyard available) does not meet that definition.

Common cause loss of AC power due to weather-related events is included in the model in the following manner:

1) Conditional probabilities for a “weather centered” loss of offsite power event are included in the model as follows:
   (a) Basic event LOOP-IE-SW for total LOSP.
   (b) Basic event CPFFACP1COND-WE for a Division 1 (120 KV Switchyard) partial LOSP.
   (c) Basic event CPFFACP2-COND-WE for a Division 2 (345 KV Switchyard) partial LOSP.
2) The phenomenological failure probability event PHPHCTG1WEATHERLOSP represents the common cause failure of all four CTGs in the event of a weather centered “total” LOSP.
3) The phenomenological failure probability event PHPHCTG1WEATHER101 represents the common cause failure of all four CTGs in the event of a “weather centered” loss of the 120kV (Division 1) Switchyard.

It should be noted that CTG 11-1 has “integral” blackstart capability and is the credited Alternate AC (AAC) power source in the Fermi 2 design basis. CTG 11-2, 11-3, or 11-4 may be “blackstarted” with the aid of a standby diesel generator which is dedicated to the purpose of providing starting power for these CTGs.

RAI 1.d

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

d. The Fermi 2 internal events CDF is considerably lower than those for other boiling-water reactor (BWR) 3/4 units. A comparison of CDFs was to have been made in the resolution of the PRA Peer Review (Item 4-16). Provide a discussion of the Fermi 2 CDF in comparison with other similar units and the reasons for any significant differences.

Response:

The Fermi 2 CDF is lower than other BWR-4s. There are several unique features of the Fermi 2 plant that result in this difference.

- Fermi 2 has a Standby Feedwater system that is not found at other BWRs. This external injection system has the ability to inject to the vessel at high and low pressure. It consists of two motor driven pumps, although only one is needed for most scenarios. One pump is powered by Division 2 and the other pump is powered by Division 1 (which has CTG 11 backup). This system is credited early in general transient and loss of offsite power scenarios and is a backup to HPCI and RCIC.
- Fermi 2 has a Residual Heat Removal (RHR) complex which contains 2 divisions of the ultimate heat sink. This facility contains the Emergency Diesel Generators, the RHR service water pumps, the diesel generator service water pumps, and emergency equipment service water pumps. This building is protected from design basis tornados. The ultimate heat sink has adequate inventory for 7 days without makeup.
- Fermi 2 has two independent switchyards. Division 1 offsite power is provided by a 120 kV switchyard that is fed from three offsite lines. Division 2 offsite power is provided by a 345 kV switchyard which is fed from two offsite lines. These switchyards are electrically and spatially separated. There is the ability to cross-tie from one division to the other using a maintenance tie breaker.
- Fermi 2 has 4 emergency diesel generators (2 support Division 1, 2 support Division 2). One EDG can provide adequate power to shutdown the plant in general transients and loss of offsite power. Fermi 2 also has 4 combustion turbine generators (CTGs). The CTGs provide power to the Division 1 switchyard (which in turn can provide power to the Standby Feedwater system). CTG 11-1 has blackstart capability from the Control

Room for station blackouts and units 11-2, 11-3, and 11-4 can be manually aligned for blackstart using a standby diesel generator.

- Fermi 2 has several closed cooling water systems used to cool plant systems. The benefit is that these closed cooling water systems have a finite amount of water which leads to a reduced internal flooding impact.

RAI 1.e

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

e. Sections D.1.4.3 and D.1.4.4 of the ER list the same model changes from the FermiV2 model for the FermiV3 and FermiV4 models. The CDF for FermiV3 and FermiV4 models are different (3.3E-06 and 5.8E-06, respectively). Clarify the differences between the FermiV3 and FermiV4 models, including the differences between the Equipment Out of Service (EOOS) software and the Computer-Aided Fault Tree Analysis (CAFTA) software used to develop the FermiV3 and FermiV4 models, respectively. Characterize the unavailabilities due to testing and maintenance included in each model and describe the changes to the FermiV4 model resulting from the cited incorporation of recommendations from the prior peer review in the FermiV4 model.

Response:

The FermiV3 and FermiV4 models were similar to one another. The primary motivation for the release of the FermiV3 model was the incorporation of the Level 2 model for the calculation of large early release frequency (LERF) and other Level 2 release terms.

The modeling changes in the FermiV3 model were carried forward to the FermiV4 model; an exception to this is the data analysis methodology employed to calculate the test and maintenance unavailability basic event values. In the FermiV3 model, the test and maintenance unavailability basic event values were calculated based upon data obtained from plant operating experience (this method is consistent with the supporting requirements in the current American Society of Mechanical Engineers (ASME) Standard). Prior to the FermiV4 release, a decision was made by Probabilistic Safety Analysis (PSA) Group supervision to revert to the method of calculating the values for these basic events in the FermiV2 model. In this method the test and maintenance unavailability basic events were set to values based upon the Maintenance Rule (MR) performance criteria (this introduced considerable conservatism, since few of the systems attained unavailability near their MR performance criteria). This utilization of this method introduced considerable conservatism into the FermiV4 model quantification and was the primary reason for the CDF values for the FermiV4 and FermiV3 being different in magnitude.

The practice of using test and maintenance unavailability basic event values derived from MR performance continued until the release of the FermiV9 model. The current modeling practice is to utilize plant data to establish unavailability values; this practice meets the applicable data analysis requirements in the 2009 ASME PRA Standard.

The FermiV3 model being developed for the EOOS software and the FermiV4 model being developed for the CAFTA software had no bearing on the difference in CDF between the two models.

The table below is a summary of the model changes that were incorporated into the FermiV4 PRA model. The addition of the reference leg break initiator was performed specifically to address a 1997 NEI Peer Review item.

ITEM	DESCRIPTION
Fault Tree	Added Linked Level 2 Release Trees
	Added SBFW short term tree. This takes credit for use of SBFW without CST makeup, which permits more time for the operator to depressurize the RPV.
Initiating Events (IE)	Updated IE frequencies utilizing plant specific data
	Divided BOC IE into individual lines.
	Added Instrument line break and Loss of DW Cooling initiators.
T/M Out of Service	Utilized values that were identical or compatible with current MR performance criteria. These values were explicitly modeled in the new fault trees.
Demand Failure Data	Utilized the PLG generic data for all failure data. Then a Bayesian update was performed on the generic data when plant specific CPEP data was available. MOV data from MOV Coordinator was also utilized.
	Demand Data from CPEP for 5 CP systems were used to update basic event values.
Common Cause	Utilized Demand Failure data for updating singletons, then NRC CCF data was used to generate new CCF values
Recovery	Updated Power Recovery for Total Loss of Offsite Power (LOSP)

RAI 1.f

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

f. Section D.1.4.8 of the ER indicates that one of the reasons that the FermiV9 CDF is lower than previous revisions is the update of Level 1 and Level 2 dependent human error probabilities. On ER page D-74, an expert panel review of the human reliability analysis (HRA) dependency was discussed. Specify the latest update and its relationship to the HRA dependency analysis reviewed by the expert panel.

Response:

The Expert Panel reviewed the FermiV9 draft model that was reviewed by the peer review team. The FermiV9 model is the latest update and was used for the SAMA after being finalized. In addition, prior to the peer review another team performed a gap assessment of the draft model to the ASME/ANS requirements. This gap assessment included a review of the human reliability analysis (HRA) dependency analysis.

There was one change to the HRA dependency analysis that was included in the FermiV9 model version (that was used for the SAMA submittal) and was not present in the draft model that was utilized for 2012 Peer Review (on which the expert panel performed its evaluation). This change involved the incorporation of the resolution to Peer Review Finding 3-28.

Finding 3-28 stated that the use of the event HE1FRXPCHSML (a failure to depressurize during a steam loss of coolant accident (LOCA)) to represent cutsets in which HE1FRXPCHWML (a failure to depressurize during a water LOCA) was non-conservative. This finding applied to the use of timing information ascertained from the steam LOCA failure to depressurize basic event (HE1FRXPCHSML) for dependent human error probability (HEP) groupings in which HE1FRXPCHWML (a failure to depressurize water LOCA event) was involved (as one of the single HEPs that was "replaced" by the dependent HEP grouping).

The resolution to this finding involved the creation of a new dependent HEP grouping HE1D-D-HPIMLW (Common Failure to Operate High Pressure Injection Systems Given MLOCA Water). The probability for this dependent HEP was higher than the dependent HEP involving medium steam LOCA. Therefore, this model change contributed (along with other changes discussed in the response to Question 1.g) to an increase in CDF from the draft PRA model used for the 2012

Peer Review to the FermiV9 model (from 1.27E-6/yr to 1.50E-6/yr). The contribution to CDF for this basic event is nearly 5% (FV of 4.86E-2). The resolution of this finding did not result in any methodology changes.

RAI 1.g

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. *Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.*

g. *Page D-73 of the ER states that the Fermi 2 Boiling Water Reactors Owners Group PRA Peer Review was performed during August 2012. The PRA used for the SAMA analysis is FermiV9 issued in March 2013 (ER page D-8). This version is described as a complete upgrade of the previous model (ER page D-72). While the changes made in the FermiV8 model, to produce the FermiV9 model, may or may not be "upgrades" as defined in the American Society of Mechanical Engineers (ASME) PRA standard, the changes appear to be extensive and cover almost all Level 1 and 2 PRA tasks. Provide further justification for the technical adequacy of the FermiV9 model including the applicability of the peer review to the upgraded model for both Levels 1 and 2. If the peer review was performed on a draft version of the FermiV9 model, provide the results of the draft and identify changes to the draft to produce the model used for the SAMA analysis.*

Response:

The draft model that was reviewed during the August 2012 Peer Review was the same model as the FermiV9 model (the model utilized for the SAMA application) with the exception of the items listed below. The reasons for making changes to the draft model were:

1) To respond to Peer Review findings.
2) To correct modeling issues that the Fermi 2 PSA Group deemed significant.

In preparing the Quantification and Summary Notebook for the FermiV9 model release, the Fermi PSA team performed a thorough review of the model to evaluate the effects of these model changes on the final quantification.

Because of the small number of modeling changes (many of which were to resolve findings from the peer review team) when compared to the scope of the model, the relatively small impact of the changes in terms of the effect on risk metrics (as defined in the table below), and the fact that the peer review team evaluated each supporting requirement (SR) in the ASME standard associated with initiating events and internal flooding (no "carryover" from the NEI peer review was credited), the results of the peer review on the draft model are applicable to the FermiV9 model on which the calculations in the SAMA submittal were evaluated.

The CDF and LERF for the draft model used for the 2012 Fermi 2 PRA Peer Review were 1.27E-6/yr and 3.86E-7/yr. The table below is a complete listing of the model changes that were made in the time period between these versions. The final CDF and LERF for the FermiV9 model are 1.50E-06/yr and 3.73E-7/yr. The most significant items below are: 2, 4, 6, 10, 17, and 19.

Item	Change Description	Quantitative Effect
1	Support for the resolution to Finding 1-20. Basic event ATOPB72SS024 and type code ATOP were added to the model and associated database to represent the auto-transfer of the Bus 72S feed from Bus 72M to Bus 72R.	The result of this change is an increase in the frequency for sequences involving basic event ATOPB72SS024. The FV for the basic event is 1.12E-4.
2	Support for the resolution to Finding 1-25. Set the probability of the basic event HE1FRBCW-FL-ISOL-AB3 (FAIL TO TERM. FLOOD FROM EECW IN AN AB3 SWGR ROOM) to 1.0.	There is an increase in CDF associated with this change. The FV for this basic event is 2.25E-2.
3	Support for the resolution to Finding 1-26. The initiating event frequency for the major Circulating Water pipe breaks in the Turbine Building (%FL-TB-MCWS-TBxx-M) is increased by 1E-3/Rx Yr to reflect the calculated maintenance induced failure frequency.	This resulted in an increase in CDF resulting from cutsets involving basic event %FL-TB-MCWS-TBxx-M; the FV for this event is 1.55E-03.
4	Support for the resolution to Finding 3-24. Corrected the calculation for the TPFS HPRI (HPCI/RCIC System Pumps FAIL TO START) failure to start type code failure rate. This resulted in the failure rate increasing from 5.77E-6 to 4.21E-3.	This resulted in an increase in the CDF. The FV values for the basic events which use this type code are: a) TPFSHPCIC001A (Failure to start of HPCI Pump) - 2.30E-02. b) TPFSRCICC001 (Failure to start of RCIC Pump) - 9.20E-4. c) TPFSHPRCCC22_1 (Common Case Failure of the HPCI and RCIC Pumps) - 8.43E-4.

Item	Change Description	Quantitative Effect
5	Support for the resolution to Finding 3-26. Added common cause terms for a) The feedwater check valves (B2100F010A and B2100F010B) failing to close. b) The 4160 V breakers (B6, C6, E6, and F6) which isolate the grid from the diesel supported output busses in the event of a loss of power event.	This resulted in an increase in the CDF. The FV value associated with the common cause failure of the feedwater check valves (basic event CVFORXFWCC22_1) is 1.42E-4. The FV values for basic events associated with the failure of the 4160 V breakers to open and isolate the grid are: a) CHFOTF64CC24_1 - 2.08E-6 b) CHFOTF6XCC24_2 - 5.85E-06 c) CHFOTF6XCC24_3 - 3.24E-05 d) CHFOTF6XCC24_4 - 5.97E-06 e) CHFOTF6XCC24_5 - 2.19E-06 f) CHFOTF65CC24_6 - 5.85E-06 g) CHFOTF6XCC34_6 - 4.43E-06 h) CHFOTF6XCC34_7 - 1.51E-05 i) CHFOTF6XCC34_8 - 1.34E-05 j) CHFOTF6XCC34_9 - 1.51E-05 k) CHFOTF6XCC44_1 - 6.63E-04
6	Support for the resolution to Finding 3-28. The resolution to this finding, i.e. the addition of dependent HEP HE1D-D-HPIMLW (Common Failure to Operate High Pressure Injection Systems Given MLOCA Water), is discussed in detail in the response to RAI 1.f.	This resulted in an increase in the CDF value (basic event HE1D-D-HPIMLW has a FV of 4.86E-2).
7	Support for the resolution to Finding 3-35. The four (4) main steam lines and isolation of the MSIVs are added to the model for containment isolation (failure to close failure mode). The main steam line drain valves (which are normally closed during at power operation) were also added to the model for containment isolation completeness (failure to remain closed failure mode). It should be noted that the failure of the MSIVs to isolate a break outside containment event in the Level 1 PSA model was (and still is) included at the time of the peer review.	This change affected the Level 2 model only. Because the containment isolation failure mode is dominated by pre-existing leakage paths and failure of both inboard and outboard containment isolation valves is a low probability event, no significant quantitative effects result from the addition of these failure modes to the model.

Item	Change Description	Quantitative Effect
8	Support for the resolution to Finding 4-5. This change modified the frequencies for the following initiators: a) %TDCAB (Loss of Multiple 130VDC DC Buses) – From 1.68E-6/rcy to 1.40E-6/rcy. b) %TDC-BOP (Loss of BOPDC Bus) – From 1.35E-3/rcy to 2.34E-3/rcy.	The initiating event frequency for the %TDCAB initiator decreased and the initiating event value for the %TDC-BOP increased (by a higher percentage than the decrease in %TDCAB). This change resulted in an increase in CDF based upon: a) The fact that the initiating event value for %TDCAB was lowered from that in the peer review model but by a lesser magnitude than %TDC-BOP was increased. b) The FV value for %TDC-BOP (3.65E-3).
9	Support for the resolution to Finding 4-8. The Turbine Trip (%TX) initiating event frequency Bayesian update was modified (to incorporate a scram that had occurred during low power operation that may be applicable for at-power operations). The result was an increase in the %TX initiating event frequency from 8.32E-1/rcy to 8.37E-1/rcy.	The model modification resulted in an increase in CDF (as characterized by the fact that the initiating event frequency increased by 0.6%).
10	Support for the resolution to Finding 4-11. The draft peer review model was “blocking” certain SBO sequences from appearing in the cutset solution (specifically, sequences which involved equipment and human action failures following offsite power recovery). The functional fault tree logic was modified to address this issue.	This model modification resulted in an increase in CDF due to the increased contribution from “late SBO” sequences.

Item	Change Description	Quantitative Effect
11	Support for the resolution to Finding 4-12. An operator action HE1FRHRSFILLVENT was added to the HRA calculator and the fault tree model to account for the operators performing a fill and vent to prevent the water hammer of the system following the receipt of a pump restart following a voiding of the system after a previously occurring system stop (e.g. from a loss of offsite power during torus cooling operation followed by a RHR pump start upon power restoration). The resolution of this finding also included two other items. First, the basic event PHPHRHRS – DISCH-J (system train disabled by water hammer) was changed from a value of 1.0E-3 to 1.0E-2. The water hammer phenomenology was also "divisionalized" by explicitly modeling the phenomenology for the water hammer event following Division 2 of RHR being in torus cooling (ZLMMRHRSTC2).	The model modification resulted in an increase in CDF (as characterized by the FV for the three affected basic events): a) HE1FRHRSFILLVENT - 2.48E-3 b) PHPHRHRS-DISCH-J - 3.06E-3 c) ZLMMRHRSTC2 - 2.35E-3
12	Support for the resolution to Finding 7-1. Added modeling for the failure to isolate a flow path between the HPCI room and the Division 2 RHR Room. The implementation in the logic model includes basic event MVFCSUMPT4500F601, which represents the failure to isolate the flow path from the HPCI to the Division 2 RHR Room. Gate B72ENORM_TF65 was added to the model to represent the power dependence of the valve while eliminating circular logic issues; this represents a slight conservative treatment since it only credits offsite power support for Bus 72E. Gate RHR2-HPCI-ISOL, RHR2FLOOD-HPCI, and HPCIFLOOD-RHR2 were added to implement the propagation of flooding from the Division 2 RHR Pump Room to the HPCI Room and from the HPCI Room to the Division 2 RHR Pump Room.	This resulted in an increase in the CDF value (as characterized by basic event MVFCSUMPT4500F601 having a FV of 2.12E-05).

Item	Change Description	Quantitative Effect
13	HEP HE1FMSOVINTLCK (which has a guaranteed probability of failure) was set to "True" in the master quantification flag file.	This modification resulted in a decrease in ATWS CDF and LERF due to the elimination of some non-minimal ATWS combinations.
14	The change removed credit for the torus cooling repair basic event. Basic event CPFFTC12-LO-REC-OVRD was introduced into the model to guarantee failure in each modeled instance of CPFFTC12-LO-REC. CPFFTC12-LO-REC was also set to "True" in the master flag file.	This modification resulted in a CDF increase for instances where the repair was credited (typically long term loss of decay heat removal sequences).
15	Created conditional probability basic events for weather centered PLOOP101, switchyard centered LOSP, and switchyard centered PLOOP101 in a similar manner as for weather centered LOSP. Basic events PHPHCTG1WEATHER101 and PHPHCTG1SWYD101 were added to the model. Also, a separate equipment failure related CTG complex failure gate (CTG1EQMT) was created to eliminate non-minimal cutsets for grid centered LOSP.	This modification resulted in an increase in the frequency for partial LOSP sequences. The FVs for the basic events which were added to the model are: a) PHPHCTG1WEATHER101 - 4.83E-05 b) PHPHCTG1SWYD101 - 3.54E-05
16	Added dependencies for BOP DC Power to gates CSTSEPMP and CNDS-QUV (gates which credit the operation of the emergency hotwell supply pump).	This modification resulted in an increase in frequency for sequences where BOP DC batteries are lost (independent of a loss of power to AC busses which support the emergency hotwell supply pump).
17	Created new gate RWLCHI_BATT, which is not supported by battery chargers to represent DC power input to the HPCIST and RCICST trees. Also changed the titles to HPI-4HR and T-HPI-4HR. This corrected a modeling issue where the HPCI and RCIC systems would fail in four hours (or less) due to a failure of the Level 8 trip logic in gate RWLCHI (which contained battery charger and AC power dependencies). The insertion of gate RWLCHI_BATT into these sequences resulted in a dependency on the DC batteries for the short term operation of these systems.	This change resulted in a decrease in the frequency for sequences where short term HPCI and RCIC operation is credited (typically LOSP and SBO scenarios).

Item	Change Description	Quantitative Effect
18	Changed the calculation method for basic events PVTSHPCIF035 and PVTSRCICF015 from Method 5 (periodic test) to calculation method 3 (mission time).	This change resulted in a decrease in frequency for cutsets involving these basic events (since the basic event values decreased). The FV for these basic events are listed below: a) PVTSHPCIF035 - 4.83E-05 b) PVTSRCICF015 - 0.0
19	Increased the scenario time for HRA event HE1FRXPCHWML (based upon an examination of MAAP runs). This resulted in a decrease in the HEP value from 4.6E-2 to 2.3E-2.	This change resulted in a decrease in the frequency for medium break LOCA sequences. Note that the FV value for HE1FRXPCHWML is 9.30E-2.
20	Implementation of EDP 36567. This modification inserted the modeling for the plant modification that inserted the 3rd row of breakers to the ring bus in the 345 kV switchyard.	There is no effect on CDF for this change. This is evidenced by the fact that the basic events are not present in the cutset report (e.g. have a FV of 0.0) for the baseline model CDF calculation at a 1.0E-12/yr truncation limit.
21	This change modified the gate T-HPCI-LOCA for medium LOCA below TAF to preclude credit for SBFW as a successful RPV depressurization mechanism.	This increased the frequency of medium "water LOCA" sequences due to the removal of SBFW credit.

RAI 1.h

Request the following information regarding the Probabilistic Risk Assessment (PRA) used for the Severe Accident Mitigation Alternative (SAMA) analysis. Basis: Applicants for license renewal are required by Title 10 of the Code of Federal Regulations (CFR) 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of internal events and calculation of core damage frequency (CDF) in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

h. *For the peer review findings discussed in Table D.1-21 of the ER:*
   i. *The resolution of Item 3-26 is a repeat of the finding. Provide the resolution of this item.*
   ii. *For Item 4-23, confirm that there are no floor drains from one flood zone to another that have check valves but no sump pump.*

Response:

i. Below is the resolution of this finding.

   A search was performed to determine instances where common cause failures, specifically those for check valves and circuit breakers, were improperly screened. In general, the screening was found to be appropriate.

   Two instances were found where the common cause failures were screened improperly. These are discussed below.

   The feedwater line injection check valve 2/2 common cause failure (B2100F010 A/B) would, in fact, fail HPCI, RCIC, SBFW, and condensate injection (in the event of a loss of feedwater). An exception to the modeling assumption used in the Fermi 2 PRA for subsuming common cause check valve failures into the other common cause terms used for multiple train systems (consistent with the guidance provided in ASME/ANS PRA Standard Supporting Requirement SY-A15a) is the treatment of these two FW injection check valves F010A and F010B. The common cause failure of these two check valves to open would preclude success of the following systems:

   1) Main Feedwater
   2) Condensate
   3) HPCI
   4) RCIC
   5) SBFW

Based on this scope of failures, a common cause failure mode for this particular group of two check valves was added to the PRA model.

There was one instance where it was deemed appropriate to model common cause for breaker failure. The breakers (B6, C6, E6, and F6), which isolate the Engineered Safeguard System (ESS) busses 64B, 64C, 65E, and 65F from the grid when the respective diesel is demanded to support these busses, are required for the EDG to perform its mission. These breakers receive an auto-open signal as part of the response to an undervoltage signal on the supported bus and manual operation is not credited. Common cause events were inserted into the model under the Gates CHFOTF64S001BB6, CHFOTF64S001CC6, CHFOTF65S001EE6, and CHFOTF65S001FF6.

ii. The blanket statement that was made in Item 2 in the peer review finding resolution Table D.1-21 for Finding 4-23 (e.g. "The check valves in the drainage system are associated with sump pump discharge") does not properly characterize the resolution to the finding. A search of every drainage system check valve in the plant was not performed to verify this statement when the flooding model was developed. Rather, the check valves which were not screened from the evaluation based upon other considerations were examined to determine the presence of sump pumps in conjunction with the check valves. The considerations that were used to limit the scope of examination were:

1) The potential for backflow was analyzed per Section 3.4.4.4.1 of the Fermi 2 Updated Final Safety Analysis Report (UFSAR); the following attributes were included in the equipment and floor drain system designs to prevent backflow flooding through the equipment and floor drainage systems:
   a) Independence of building systems to negate the possibility of abnormal occurrences in one building from affecting normal operation in other buildings
   b) Check valves and manual isolation valves in each sump pump discharge line to prevent backflow to the sump
   c) Redundant check valves and a manual isolation valve located in both the equipment drain and floor drain 6-inch transfer lines near the secondary containment boundary to prevent backflow into secondary containment.
2) In turbine building scenarios, no credit is taken for the drainage system; therefore, any postulated backflow returning water to the turbine building would merely result in damage to equipment that has already been postulated as failing in the turbine building flooding scenarios (this statement is found in Item 3 of the Finding 4-23 resolution in Table D.1-21 in the Environmental Report (ER)). It should be noted that the Turbine Building and Radwaste Building are connected at the basement level. The SBFW pumps are located in the Turbine Building and are considered to be failed for major Turbine and Radwaste Building Flooding scenarios.
3) Major or moderate severity flooding scenarios in the Radwaste Building result in flooding of the lower levels of the Radwaste and/or Turbine Building. The Radwaste Building is the location to which the sump pumps in the Turbine and Reactor Buildings discharge their flow. Additional equipment failures do not occur as a result of backflow

in the these scenarios, since mitigating equipment on the lower levels of the Turbine Building and Radwaste Building is already assumed to fail as a direct effect of the scenario. The potential for backflow to the Reactor Building from the Radwaste Building is addressed in Item 7 of the Finding 4-23 resolution in Table D.1-21 in the Environmental Report.

4) The Reactor Building consists largely of "general areas" on the upper floors. These floors are connected to one another and to the basement and sub-basement levels by open stairwells (which direct water to the sub-basement level where water accumulation takes place). The reactor building drainage system is designed to route water from flooding in an "unimpeded fashion" to the reactor building sumps located on the sub-basement level of the reactor building. Therefore, the search for check valves failing to close with the potential to adversely affect reactor building flooding scenarios was limited to the sub-basement level.
5) Flooding in the Auxiliary Building results in direct propagation and/or propagation via the floor/equipment drains to the Turbine Building and/or Reactor Building sumps in a similar manner as described for the Reactor Building (it should be noted that there is more potential for flood water "holdup" in the Auxiliary Building due to some of the rooms being "enclosed"). Backflow through check valves has no impact on equipment in the Auxiliary Building during flooding scenarios.

To ensure that the process for screening check valves was appropriately applied, a search for check valves in the Floor and Equipment Drain system was performed from the Fermi 2 equipment list to ensure that there were no outliers. The search confirms that there were no check valves that were omitted from the assessment of potential for backflow.

RAI 2.a

Request the following information relative to the Level 2 analysis. *<u>Basis:</u>* *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.*

a. *The ER states that FermiV9 upgrade included the conversion of the Risk Management (RISKMAN)-based CAFTA Level 2 to an upgraded CAFTA Level 2 model (based on first principles). Request more detail on the extent of use of the RISKMAN software based individual plant examination (IPE) Level 2 model in the current model and on subsequent changes to the RISKMAN IPE model.*

Response:

The original Fermi 2 RISKMAN individual plant examination (IPE) Level 2 PRA model was developed by the same technical lead that developed the Fermi 2 CAFTA Level 2 model. There has been significant evolution in procedures since the IPE was submitted, particularly in the replacement of the EPG Rev. 4 containment flood contingency with the Emergency Procedure Guidelines/Severe Accident Guidelines (EPG/SAGs). This significant improvement in severe accident response coupled with plant modifications and improved understanding of severe accident core melt progression have led to changes in the Fermi 2 Level 2 CAFTA model.

The failure modes, phenomenological effects, and dependencies (including HRA) are treated in a similar manner in both models. There is consistency in the treatment of these model aspects. Some model changes were incorporated based upon updated severe accident core melt progression based on the use of MAAP 4 deterministic code calculations in lieu of the older MAAP 3B code.

The following similarities between the RISKMAN IPE Level 2 and the latest CAFTA Level 2 are noted as follows:

- Event trees have the same basic structure
- The Level 1 and Level 2 models remain linked to ensure that dependencies on Level 1 failures and successes are appropriately accounted for
- The same end state characterization scheme based on a radionuclide release magnitude and time of release are used
- Success criteria are essentially the same
- The level of detail is the same
- The nodal functional fault trees are similar

- Documentation of the model remains at a very detailed level

Differences between the RISKMAN Level 2 IPE and the updated CAFTA Level 2 include the following:

- The RISKMAN "equations and rules" are replaced with fault tree logic that provides the dependency connections in CAFTA (i.e. fault tree linking)
- The evacuation time and Emergency Action Levels are updated to the latest available for Fermi 2
- Radionuclide releases are based on MAAP 4 instead of MAAP 3B. This affects the following:
  - Core melt progression times
  - RPV breach time
  - Containment failure time
  - Radionuclide release magnitude
- Significant differences in the SAGs relative to EPG Rev. 4 containment flood contingency have been incorporated in the CAFTA Level 2 model. This includes no RPV venting for RPV breach cases, more controlled containment flooding, and increased assurance that drywell (DW) sprays will be operated if RPV breach is anticipated.
- The Level 1 model that feeds into the Level 2 was updated to incorporate plant modifications, procedure changes, changes in plant specific data, and common cause data plus the shift to a CAFTA model format
- The HRA is updated based on the latest procedures, SAGs, crew interviews, and simulator observations
- No credit for Reactor Building decontamination factor for containment failure cases is provided in the CAFTA model compared to modest credit included in the RISKMAN IPE Level 2

Information from the RISKMAN Level 2 model was used for several different purposes:

1) To provide a template for the CAFTA event tree attributes (number of event trees, “functional top” nodes, etc.).
2) To provide for a starting point for the creation of CAFTA “functional fault tree” logic from RISKMAN equations.
3) To provide an input (along with other sources) for the development of phenomenological failure events and their associated probabilities.

The course of the Level 2 model development for the PRA upgrade, however, was treated as the development of a completely new model from first principles. In many instances, new model logic was put into place which was not present in the RISKMAN templates. The Level 2 model documentation was completely rewritten.

A full internal review of the newly created Level 2 model and associated documentation was performed by DTE (with no reliance on the attributes of the RISKMAN model). The 2012 PRA

Review in 2012 examined each of the Level 2 supporting requirements with respect to the upgraded CAFTA model and associated documentation; none of the SR evaluations were "carried over" from previous peer reviews.

Since the Level 2 model and associated documentation were completely rewritten from first principals, no comparison to the RISKMAN Level 2 model was made and no "change log" was maintained.

RAI 2.b

Request the following information relative to the Level 2 analysis. *Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.*

b. Request more information on the containment event trees (CETs) utilized in the Level 2 analysis including the number of CETs, the sequences handled by each CET, and how LOSP and SBO sequences are addressed.

Response:

The containment event trees utilized in the Level 2 analysis are:

Containment Event Tree for Class I and III Sequences (CET1)
Containment initially intact

Containment Event Tree for Class II and IV Sequences (CET2)
Containment initially breached

LOCA Outside Containment Level 2 Event Tree for Class V Sequences (CET3)
Break outside containment

There are several nodes where AC power recovery can be crucial to the assessment of core melt progression and radionuclide releases. These nodes are in-vessel recovery (RX), debris cooling recovery (SI), containment flooding (FC), containment venting (VC), makeup remains available (MU), and containment heat removal maintained (HR).

The time to recover AC power is credited in the SI, FC, VC, MU, and HR node.

There may be an infinite number of times when power recovery can be achieved and accounted for in the model. However, consistent with the approach taken in most published PRAs this continuous spectrum has been discretized into a small number of time phases. Ideally, the number of time phases should be on the order of 3 to 5 depending on the degree of conservatisms that can be accepted. The four principal time phases are:

Recovery of AC power during in-vessel core melt progression, when the recovery of AC power could result in halting the melt progression without RPV breach.

Recovery of AC power before RPV breach such that water injection would be available to debris as it exits the RPV (SI Node).

Recovery of AC power before the time when high drywell temperature will result in drywell head failure and potential for direct release to the refueling floor (FC, VC, HR).

Recovery of AC power very late for the purposes of restoring containment heat removal capability (FC, VC, HR, MU).

Recovery of offsite power in RX is subsumed into the SI node. This simplification is possible because of the short time frame available in RX.

The time available for AC power recovery during the in-vessel core melt progression and prior to containment shell debris attack is estimated based upon Fermi 2 specific MAAP calculations.

The probability of AC recovery is based on the use of generic offsite AC power recovery applied to Fermi 2 and segregated by cause of the loss of offsite AC power.

The following information is used to develop the Level 2 fault trees to properly account for the AC recovery credited in the Level 1 PRA and the conditional probability of additional AC recovery in the various nodes/Level 2:

- The time credited in Level 1 for offsite AC power recovery
- The associated probability of AC offsite non-recovery already credited in Level 1 (for the grid, switchyard, plant, and weather related cases)
- The allowed cumulative time for AC recovery in Level 2
- The associated probability of offsite AC non-recovery
- The conditional probability of offsite AC non-recovery that is to be credited in the appropriate nodes given the Level 1 credit already assigned

Assumptions
The following assumptions are used in the SBO analysis for the CET:

Class IB means that there is a loss of all power to the 4 safety-related buses and balance of plant (BOP) power
Bus failures are always asked in Level 1

The rules only allow recovery of offsite AC if all four emergency buses are without AC power.

Recovery of offsite power in RX is subsumed into the SI node. This simplification is possible because of the short time frame available in RX.

Power Recovery
AC power recovery actions are important in the assessment of accident sequences involving the loss of AC power support to key frontline systems. This section discusses the AC power recovery attributes as they apply to the CET evaluation in Level 2. As such, there is a strong dependence on the interface of these recoveries that have previously been credited in the Level 1 PRA.

The LOSP/SBO event trees are designed to provide a realistic assessment of the postulated sequences including AC power recovery. As is usual in current PRA technology, there is some binning of similar accident conditions to allow the representation of the infinite set of accident conditions by a finite group of sequences. As a result, the selected sequences subsume a spectrum of conditions. For the timing for AC non-recovery in Level 1, critical times are used:

30 min. for sequences for which no RPV injection is available. This subsumes:

- Cases with and without RPV depressurization
- Cases with HPCI and RCIC run failures

4 hr. for sequences with successful HPCI/RCIC operation but battery depletion at 4 hours. This subsumes:

- Cases with and without RPV depressurization on the heat capacity limit, pressure suppression pressure
- Cases with 36 gpm to 120 gpm recirc seal leaks

12 hr. for sequences that have RPV injection but heat removal is required via RHR or venting. This is assumed limited by the time to reach primary containment pressure limit.

RAI 2.c

Request the following information relative to the Level 2 analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.

- *c. Relative to the CET functional nodes and descriptions presented in Table D.1-4:*
  - *i. Discuss the treatment of containment isolation failure sequences and if subsequent early containment failure is modeled.*
  - *ii. Discuss the treatment of, and the nature of, credit taken for containment sprays in the Level 2 model.*

Response:

i. Containment isolation failure is the first functional node in the containment event trees (with the exception of the containment event trees for core damage accident classes where containment failure has already occurred prior to or in conjunction with core damage). Failure of containment isolation in conjunction with core damage is assumed to result in a High-Early (LERF) release.

   For sequences where containment isolation is successful, several other event tree nodes described in Table D.1-4 of the submittal involve phenomenology that contributes to "early" containment failure ("early" for the purpose of response to this question being defined as phenomena that occur prior to or at RPV breach). These event tree nodes are:
   1) OP – Depressurization of the RPV
   2) RX – Core Melt arrested in-vessel
   3) GV – Initiation of Combustible Gas Venting
   4) CZ – Containment Intact Before and at RPV Breach

ii. The Fermi 2 containment drywell sprays provide a means for both pressure and temperature control using a number of sources with a variety of pumps. When RHR pumps are available, the containment sprays can be manually initiated rapidly from the control room. As part of the Severe Accident Guidelines (SAG) development, additional sources of DW spray are identified (e.g., RHRSW, and B.5.b portable pump).

   The drywell sprays have a significantly increased role in accident mitigation with the advent of the SAGs. They provide the following:
   1) Radionuclide scrubbing
   2) Debris cooling in the drywell

3) Potential path for containment flooding
4) Containment pressure and temperature mitigation

Torus sprays could be useful to a limited extent. However, the low flow rate and the inability to cool debris make them of relatively low importance for the risk analyses. Drywell spray is considered in the evaluation of the CET nodes as described below.

1) SI (Drywell Shell Remains Intact and Ex-vessel Debris Coolability)

   Success at this node requires that water is available (greater than 1000 gpm) to the core debris at the time of vessel failure. Shell failure can occur relatively quickly (i.e., minutes) following RPV failure if water is not available to quench the core debris. It is assumed in the model that the core debris will come in contact with and fail the drywell shell if water is not available.

   Ex-vessel core debris coolability can be considered to be successful if very high containment temperatures, core concrete ablation, and substantial non-condensable gas generation that can result from poorly cooled debris can be prevented. These are considered preventable if on a best estimate basis a continuous water supply is available to the debris with a flow rate of greater than 1000 gpm. The two methods that may provide adequate coolant injection to the debris bed include continued make-up to the RPV and initiation of drywell sprays.

2) FC (Containment Flooding Initiated)

   Drywell Spray mode of RHR is one of the methods available to accomplish flooding of the containment.

3) HR (Post Core Damage Containment Heat Removal)

   Drywell spray is considered one method for injection into the containment to establish containment cooling. It should be noted that in addition to an operating RHR pump and a path for RHR to inject into the containment, the following must be present for drywell spray to facilitate containment heat removal:

   a) A flow path from the suppression pool must be established
   b) An RHR heat exchanger must be in service
   c) RHR service water (RHRSW) must be available to provide cooling to the RHR heat exchanger.

Drywell spray is credited as directed by Severe Accident Guidelines in the Level 2 and associated MAAP analysis. However, the impact of the containment pressure reduction associated with running drywell spray prior to RPV breach is a small contributor to the magnitude of the pressure spike (and associated early [energetic] containment failure phenomenology) compared to other factors such as the RPV pressure at the time of breach. It is noted that the primary functions of Drywell spray in the Level 2 model are to a) put water on the containment floor, b) quench ex-vessel debris following vessel breach, and c) to "scrub" fission products from the containment atmosphere.

RAI 2.d

Request the following information relative to the Level 2 analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.

d. Relative to the definition of accident classes provided in Table D.1-8 of the ER, the accident subclasses for Class IV appear to be combined and subsequently modeled as a single class having a frequency that is 13.3 percent of the total CDF. Request additional information supporting this treatment and the meaning of "(not used)" in the class definitions.

Response:

Subclass IVT represents sequences involving the failure of adequate shutdown reactivity with the RPV initially intact with core damage induced post high containment pressure; this subclass is designated as "not used." This designation is not utilized because it is conservatively assumed in the MAAP analysis and subsequently in the accident sequence analysis that the containment will fail at a torus temperature of 260 °F (before the containment fails on overpressure).

Subclass IVV represents sequences involving the failure of adequate shutdown reactivity with the containment vent operating as designed and the loss of RPV makeup occurring at some time following vent initiation. The suppression pool is saturated but intact in this subclass. This subclass is designated as not used because the containment vent is not credited in ATWS sequences (due to the rapid degradation in containment conditions and the short time available for the operating crew to operate the vent).

Subclass IVA represents sequences involving the failure of adequate shutdown reactivity with the RPV initially intact with core damage induced post containment failure. Subclass IVL represents sequences involving the failure of adequate shutdown reactivity with the RPV initially breached (e.g. LOCA or SORV) with core damage induced post containment failure. These accident subclasses are merged into one class (IV). This merging is performed because the modeling of these two subclasses in the Level 2 model is very similar.

RAI 2.e

Request the following information relative to the Level 2 analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.

e. Page D-56 of the ER describes a situation in which the release category frequency used in the SAMA analysis is less than that in the Fermi PRA documentation. This is described as due to addressing "an issue with under counting of Class II contribution" in the PRA. Explain the cause of this "undercounting" and its potential impact on the SAMA analysis.

Response:

The quantification truncation level of 1E-12/yr for the Level 2 sequences resulted in under counting of the total release frequency for Class II sequences when compared to the Class II CDF. When the Level 1 and Level 2 Class 2 sequences were recalculated at a lower truncation of 1E-14/yr, the Class 2 undercounting issue was resolved. The base truncation level of 1E-12 truncates out some of the Class 2 releases causing the calculated releases to be slightly less than the incoming CDF. This was resolved in the quantification notebook Level 2 results by adding the frequency of the truncated cutsets to Moderate/Early release category. As discussed on page D-56 of the ER, the exclusion of these truncated cutsets has a minimal impact on the overall consequences. The impact is further reduced when considering that in the SAMA process, the cost benefit is determined by calculating the Maximum Averted Cost Risk (MACR) of a SAMA and then subtracting it from the base model MACR.

The release category frequencies provided in the MAAP to MACCS2 interface notebook (Reference D.1-31 of the ER) are different from the values provided in the PRA quantification document and those used in the SAMA analysis. The release category frequencies used in the MAAP to MACCS2 interface notebook were based on the draft August 2012 model. However, those frequencies were not utilized in developing the relevant release category information that was used in the SAMA analysis. The SAMA frequencies were based on the FermiV9 model which resolved the findings of the peer review. The relevant information utilized from the MAAP to MACCS2 interface notebook was release timing, energy of the release, and the radionuclide release fractions for each release category.

RAI 2.f

Request the following information relative to the Level 2 analysis. <u>*Basis:*</u> *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.*

f. Describe briefly the basis for determining the release category for each of the CET end points without the need for Modular Accident Analysis Program (MAAP) analysis for each of the CET end points.

Response:

Level 2 sequence end states were assigned to a release category based on key attributes of the Level 2 sequence (e.g., accident class, mitigating strategies employed, location of release point out of containment) that ultimately impact the timing and magnitude of a release. Based on the body of Fermi 2 specific deterministic calculations available (approximately 57 individual Level 2 MAAP cases) and assignment "rules", an understanding of accident phenomenology was inferred to allow the available MAAP 4.0.7 calculations to be used to support the determination of radionuclide release end states for all Level 2 sequences with non-negligible frequency. Representative MAAP cases were then assigned to the release categories. As noted in ER Section D.1.2.2.5, Appendix D of the Fermi Level 2 PRA Notebook describes which MAAP case(s) support the assignment of each CET end state. Appendix D of the Fermi Level 2 PRA Notebook also lists the individual rules used for assigning timing and release magnitude. See the response to RAI 2.g for representative sequences.

RAI 2.g

Request the following information relative to the Level 2 analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.

g. *Provide a discussion of the representative accident scenarios used for the determination of the release characteristics for each of the release categories including:*
   i. *A description of each scenario*
   ii. *Bases for the selection of the representative scenarios*
   iii. *Steps taken to ensure that the benefit of a SAMA is not underestimated, particularly for scenarios impacted by the SAMA that may not have the dominant frequency but may have a significantly larger consequence than that for the representative scenario. See for example, the situation that might occur if a SAMA impacted the High Early (H/E) release category scenario represented by MAAP case EF120521 with a cesium iodine (CsI) release fraction of 0.72 (see ER Reference D.1-31 "Fermi 2 Nuclear Power Station – Preparation of Input for Ex-Plant Consequence Analysis MAAP to MACCS2 Interface Notebook"), which is modeled in the ER using MAAP case EF120520 with a CsI release fraction of 0.24.*

Response:

Table 2g-1 provides a summary description of the MAAP scenarios chosen to represent each Fermi 2 Level 2 release category. This table also includes the rationale for choosing the selected MAAP scenario. Note that MAAP scenarios are chosen based on a frequency weighted approach (i.e., the MAAP scenario representing the most dominant sequence(s) or bounding the most dominant sequence is typically chosen). Choosing the scenario with the very most conservative conditions (e.g., highest CsI release fraction) may not best represent the release category.

As part of the SAMA evaluation, an uncertainty sensitivity analysis was performed, as documented in Section D.2.4 of the ER. One of the sensitivity cases evaluated uses a multiplier of 2.5 upon the CDF to examine the impact of uncertainty in the PRA model at a holistic level. This multiplier can be viewed as addressing a wide range of uncertainties associated with the PRA model, including uncertainty associated with release magnitudes for individual release categories, their underlying accident sequences, and the effectiveness of the SAMA candidates upon those sequences. This uncertainty sensitivity analysis helps insure that the benefit of a particular SAMA candidate is not underestimated.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
H/E-BOC - High Magnitude / Early Release (Accident Class V, Unisolated LOCA Outside Containment)	EF120524	MAAP case EF120524 represents an H/E release following a Main Steam Line break outside of containment. This MAAP case adequately represents an H/E release with an unisolated LOCA outside of containment (Class V accident). This is the only MAAP scenario representative of this release category.
H/E – High/Early Release (With Containment Isolation)	EF120520	The H/E bin is dominated by Class IV (ATWS) sequences. The H/E frequency evolves primarily from sequences IVA-037 and IVA-012. Sequence IVA-037 represents an ATWS event with successful RPV depressurization but failure of the wetwell airspace and eventual drywell shell failure; sequence IVA-012 represents an ATWS event with successful RPV depressurization with the wetwell airspace initially intact leading to a failure of the drywell shell. The reference MAAP cases for these sequences are EF120519 (CsI release fraction (RF) of 2.6E-2) and EF120520 (CsI RF of 0.24) for sequences IVA-012 and IVA-037, respectively. MAAP cases EF120521(CsI RF of 0.72) and EF120522 (CsI RF of 0.10) could also represent this release category bin with similar accident sequences, but case EF120520 is chosen as the representative sequence for the H/E release category bin as it represents one of the primary sequences and the CsI release fraction (0.24) falls between that of cases EF120521 and EF120522. Use of the EF120521 MAAP case (CsI RF 0.72) would be overly conservative since it represents a very small portion of the H/E release category frequency (i.e., <1%).

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
H/I - High/Intermediate Release	EF120532	The H/I bin is driven by Classes IBL and ID. The dominant sequences leading to the H/I end state are the IBL-040 sequence and ID-040 sequence. The IBL-040 and ID-040 sequences are characterized by successful RPV depressurization followed by a failure of the drywell shell due to shell melt-through. The reference MAAP cases for these sequences are EF120504 (CsI RF of 9.5E-2), EF120504A (CsI RF of 2.8E-2), and EF120504B (CsI RF of 0.12). Cases EF120504 and EF120504A represent moderate magnitude releases and therefore do not provide adequate release fractions to represent a high magnitude release. Case EF120504B does not provide adequate information to develop plume characteristics for this bin due to the lack of a plateau for the CsI and CsOH release fractions over an acceptable run time. However, case EF120532 has a high magnitude CsI release fraction (0.26) in the intermediate time period and adequately represents (conservatively bounds) this release category bin. It is noted that the reference MAAP cases in the Level 2 analysis are not necessarily exact models of the sequence, but are instead used along with the Level 2 Release Category rules to assign an appropriate end state to the Level 2 sequence.
H/L - High/Late Release	EF120504C	The H/L bin is composed entirely of the IIIC-027 sequence (100% of the H/L frequency). The sequence represents a LOCA scenario with reactor makeup available but without successful containment venting thereby leading to a containment failure. The reference MAAP case for sequence IIIC-027 is case EF120504C which models a drywell shell failure following core damage and SBFW injection. This case has a 0.34 CsI release fraction to the environment. This is a direct representation of the only release category sequence.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
M/E - Moderate/Early Release	EF120519	The M/E bin is dominated by the Class IIA sequences. The dominant sequence, IIA-012, represents a loss of decay heat removal with successful RPV depressurization that leads to a failure of the drywell shell. The reference MAAP case for sequence IIA-012 is EF120514 (CsI RF of 0.48), which is noted in the Level 2 analysis to be a surrogate reference case because it did not include RPV depressurization during the core melt progression. Experience with MAAP has indicated that if RPV depressurization occurs prior to core melt progression then the radionuclide release will be significantly reduced. The end state for sequence IIA-012 is an M/E release because there is successful RPV depressurization prior to core melt progression. This end state for the representative sequence has been confirmed with a MAAP case that included successful RPV depressurization. MAAP cases in the Level 2 analysis are not necessarily exact models of the sequence, but are instead used along with the Level 2 Release Category rules to assign an appropriate end state to the Level 2 sequence. This reference case results in a release magnitude that is not moderate. A MAAP case representing a moderate release is required. MAAP case EF120519 represents an ATWS scenario with no SLC injection quickly leading to a wetwell airspace failure and eventual drywell shell failure. This MAAP case results in a moderate release. This MAAP case can adequately represent the IIA-012 as the selected MAAP case has similar but shorter release timing compared to the IIA-012 sequence. The CsI release fraction for this MAAP case is 2.6E-2. This case is selected for the M/E end state because it well represents the magnitude of moderate release.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
M/I - Moderate/ Intermediate Release	EF120501A	The M/I bin is dominated by the Class IIIC and IA sequences, primarily IIIC-005 and IA-052. Sequence IIIC-005 represents a LOCA event with successful RPV depressurization and containment venting but no inventory makeup. Sequence IA-052 represents a loss of RPV injection with failure to depressurize the RPV (core melt arrested in-vessel) leading to a loss of containment integrity via a small drywell head failure (27 in^2). The reference MAAP case for sequence IIIC-005 is EF120517C (CsI RF of 1.4E-2). However, this MAAP case results in an early release (vent at 4.0 hours). A MAAP case with an intermediate release is required. It should be noted that the reference MAAP cases in the Level 2 analysis are not necessarily exact models of the sequence, but are instead used along with the Level 2 Release Category rules to assign an appropriate end state to the Level 2 sequence. No other representative MAAP cases exist for the Class IIIC sequences. The reference MAAP case for sequence IA-052 is EF120502 (CsI RF of 1.1E-2). MAAP case EF120501A (CsI RF of 1.5E-2) is similar to EF120502 except containment failure occurs via a large drywell failure (2 ft^2). Both model the use of drywell sprays until containment failure. The release timing of EF120501A and EF120502 is intermediate. Case EF120501A is chosen as the representative release fraction for the M/I group since it reasonably bounds the most dominant Class IA sequence.
M/L - Moderate/Late Release	N/A	The M/L bin release frequency was calculated as negligible in the Fermi 2 Level 2 PRA model. This group is subsumed by the M/I end state.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
L/E - Low/Early Release	EF120529	The L/E release frequency is dominated by the Class ID and IA sequences. The end states are driven by sequences (primarily IIIB-061 and ID-022) leading to successful drywell venting with concurrent containment flooding. The reference MAAP cases for sequences IIIB-061 and ID-022 are cases EF120534 (CsI RF of 7.7E-3) and EF120534A (CsI RF of 3.5E-7). However, case EF120534 does not adequately plateau over the MAAP run and as such does not provide adequate information for plume characteristic development. Case EF120534A results in a low-low magnitude release that does not have appropriate release fractions to represent a low magnitude release. It should be noted that the reference MAAP cases in the Level 2 analysis are not necessarily exact models of the sequence, but are instead used along with the Level 2 Release Category rules to assign an appropriate end state to the Level 2 sequence. MAAP case EF120529 represents a sequence ending with containment flooding and venting and is judged to adequately represent the L/E release category bin. This MAAP case represents a low magnitude release (CsI RF of 1.5E-3) with early timing. This MAAP case is also similar to the dominant sequences of this release category bin with regards to containment flooding and venting. Therefore, case EF120529 is chosen.
L/I - Low/Intermediate Release	EF120534B	The L/I bin is dominated by the Class IIIC and IA sequences. The dominant sequence of the Class IIIC contribution, IIIC-022, represents a LOCA scenario ending with successful containment venting and flooding. The dominant sequence of the Class IA contribution, IA-004, represents a sequence with successful RPV depressurization followed by a loss of containment integrity with makeup available.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
L/I - Low/Intermediate Release (Cont'd)		The reference MAAP case for sequence IA-004 is EF120501B (CsI RF of 1.8E-3). The listed MAAP cases for sequence IIIC-022 are EF120534 and EF120534A (CsI RF of 3.5E-7). MAAP case EF120501B results in release fractions that do not provide adequate plume characteristic information due to the absence of a release fraction plateaus over the MAAP run time. MAAP case EF120534A results in a low-low magnitude release and is not appropriate for a low magnitude bin. MAAP case EF120534 represents a Class ID sequence ending with successful RPV depressurization, containment flooding via the RHRSW system, and a controlled containment vent from the drywell. This MAAP case results in a low magnitude release. This MAAP case was modified to properly capture the release fractions from containment to the environment (i.e., avoid non-conservative release fractions when run beyond the typical Level 2 end point). This case is titled EF120534B (CsI RF of 1.0E-2). It should be noted that the reference MAAP cases in the Level 2 analysis are not necessarily exact models of the sequence, but are instead used along with the Level 2 Release Category rules to assign an appropriate end state to the Level 2 sequence. A more conservative MAAP case is appropriate if it bounds the reference MAAP case and is similar to the dominant sequence(s).
L/L - Low/Late Release	N/A	The L/L bin release frequency was calculated as negligible in the Fermi 2 Level 2 PRA model. This group is subsumed by the L/I end state.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
LL/E - Low-Low/Early Release	EF120534A	The LL/E frequency is dominated entirely by the Class IA sequence IA-001 which represents a loss of RPV injection and successful containment combustible gas venting without suppression pool bypass. The reference MAAP case for sequence IA-001 is EF120507B. However, this MAAP case represents an "OK" end state with negligible radioisotope release. MAAP case EF120534A represents a scenario with no RPV injection coupled with containment vent and concurrent containment flooding. This MAAP case adequately represents sequence IA-001 as containment flooding provides radioisotope scrubbing similar to that of the suppression pool during a combustible gas vent without suppression pool bypass. The CsI RF of 3.5E-7 for this case is representative of the LL/E end state and conservatively bounding of the one dominant sequence.
LL/I - Low-Low/Intermediate Release	EF120507C	The LL/I bin is dominated by the Class ID and IA sequences ID-029, ID-031, and ID-024. These three sequences represent successful depressurization of the RPV ending in either containment failure or containment venting with and without makeup available. The reference MAAP case for sequences ID-029 and ID-024 is EF120507 which represents failure of RPV injection resulting in containment failure but with drywell sprays available. This MAAP case was rerun for longer than the original run time of 40 hours as well as modified to continue operation of the drywell sprays indefinitely to more thoroughly examine release characteristics for plume definition. RHRSW can be credited for makeup for the dominant Class ID sequences (ID-029, ID-031, and ID-024). This case is titled EF120507C (CsI RF of 2.4E-5) and adequately models this release category.
LL/L - Low-Low/Late Release	N/A	Due to the very low frequency of the LL/L frequency, this end state is subsumed into the LL/I end state bin. There are no representative MAAP cases for the LL/L release category bin.

Table 2g-1
RELEASE CATEGORY BIN MAAP CASE SELECTION BASIS

Release Category Bin	MAAP Scenario Assigned	Assignment Basis
CI – Containment Intact	EF120525	MAAP case EF120525 is chosen as the MAAP case to represent Tech Spec leakage out of an intact containment. The MAAP case simulates a Tech Spec leakage of 0.5% from the drywell. This case is chosen over the MAAP case simulating a Tech Spec leakage of 0.5% from the torus airspace as the DW leakage case results in a higher CsI release fraction (CsI RF of 1.5E-6).

The CsI and CsOH release groups are characteristic of key contributors to early and latent health effects and experience has shown they are key contributors to MACCS2 dose and cost results. Three radionuclide release categories (i.e., H/E-BOC, H/E, and H/I)[1] compose 92% of the MACCS2 offsite population dose risk and cost risk. Each of the other release categories individually contributes only about 3% or less to the dose risk and cost risk. Table 2g-2 identifies the dominant accident sequences for the three significant release categories. The relative contribution of each sequence to the release category along with the sequence's representative MAAP scenario (including the CsI and CsOH release fractions) is included in the table. The highlighted rows indicate the sequence/MAAP case selected to represent the release category. Note that the sequence totals for each release category in the table are less than 100%. Those sequences representing <2% of the release category frequency were not included since they represent non-dominant scenarios that have negligible impact on dose risk and cost risk.

The H/E-BOC release category has one representative MAAP scenario and is therefore adequately represented by that case.

The H/E release category representative MAAP scenario (EF120520) has CsI and CsOH release fractions that bound those of other H/E sequences with frequency contributions of 51% and 78%, respectively. For comparison, calculation of frequency weighted CsI and CsOH release fractions from the dominant H/E sequences in the table yields values of 0.28 and 0.18, respectively. Considering this, the calculated frequency weighted CsI release fraction is approximately 17% greater than the representative H/E MAAP case, but the representative H/E MAAP case CsOH release fraction is approximately 70% greater than the frequency weighted value. Experience has shown that CsOH is a dominant contributor in terms of land contamination that drives cost risk. The representative CsOH release would be expected to lead to a significantly higher cost risk relative to the weighted value since the representative release is significantly larger (~70%).

[1] "H/E" refers to the to the radionuclide release category with High Magnitude (H) and Early Release Timing (E). "I" refers to an Intermediate Release Timing (I). "H/E-BOC" refers to the category of H/E releases that are the result of a break outside containment (BOC) sequence.

This cost risk difference would likely bound any impact from the representative CsI release that is slightly lower than the weighted CsI release.

Table 2g-3 provides the representative MAAP case, release start time, and CsI and CsOH release fractions at 48 and 72 hours for the three (3) dominant Class II sequences that contribute to the H/E release category. The scenario run time for each of these scenarios is 72 hours. However, per SOARCA assumptions, mitigating equipment would be available to mitigate any fission product releases after 48 hours. The weighted CsI and CsOH release fractions after 48 hours for these three cases are 0.45 and 0.20, respectively, and these sequences make up about 17% of the H/E release category frequency. The calculated Class II frequency weighted CsI release fraction is approximately 88% greater than the representative H/E MAAP case but the representative MAAP case CsOH release fraction is approximately 55% greater than the frequency weighted value and therefore significantly offsets the difference in the CsI release fractions.

Table 2g-4 provides an estimation of the total cost and dose risk from all release categories if the Class II H/E sequences are considered as a separate category consisting of 17% of the total H/E frequency. The Class II sequence H/E category is conservatively assumed to have the characteristic results (i.e., MACCS2 conditional population dose and offsite economic costs) of the H/E-BOC scenario. This results in a 15% increase in total dose risk but only a 0.6% increase in cost risk over the base case values of 4.91 person-rem/yr and 15,600 \$/yr, respectively. Since the offsite exposure cost is only approximately 34% of the baseline maximum averted cost risk (MACR), this dose risk increase would be much less significant to the total MACR. This increase would not significantly impact the SAMA analysis. It is also noted that inclusion of the Class II accident sequences into an “early” release timing is judged conservative. For the three Class II sequences, the release start time for each MAAP case is more than 29 hours following accident initiation. This time period between accident initiation and fission product release provides a considerable amount of time (e.g., more than 29 hours) for consideration of emergency response actions to mitigate release impacts (e.g., declare a general emergency (GE)). Although the Fermi 2 emergency action levels (EALs) provide flexibility for the Emergency Director to declare a GE earlier than reactor conditions reaching quantitative set points defined in the EALs (e.g., RPV water level and containment pressure), it has not been credited in the Fermi 2 Level 2 PRA model.

Based on reasonably bounding representative CsI and CsOH release fractions for the H/E release category and the relatively minor contribution of the Class II sequences to the H/E release category, MAAP case EF120520 with its associated CsI and CsOH release fractions is judged to adequately represent the H/E release category.

The H/I release category is conservatively represented by MAAP scenario EF120532 that bounds all the dominant H/I sequence CsI and CsOH release fractions.

Table 2g-2

Dominant Release Category Sequence Contributions and Representative MAAP Cases(1)

Sequence	Percent of Sequence Contribution to Release Category	Representative MAAP Case	CsI Release Fraction	CsOH Release Fraction
Release Category H/E-BOC				
V-003	100%	EF120524	0.34	0.24
Release Category H/E				
IVA-037	27%	EF120520	0.24	0.31
IVA-012	18%	EF120519	0.03	0.04
IVA-050	9%	EF120523	0.58	0.16
IIA-063	7%	EF120516	0.60	0.35
IIA-024	6%	EF120514	0.49	0.12
IVA-024	6%	EF120522	0.10	0.05
IA-041	4%	EF120500	0.44	0.19
IIA-037	4%	EF120509	0.33	0.17
IIID-008	4%	EF120517B	0.25	0.08
Release Category H/I(2)				
IBL-040	55%	EF120504	0.11	0.23
		EF120504A	0.03	0.06
		EF120504B	0.12	0.14
ID-040	38%	*Same as IBL-040*		
IIIC-007	3%	EF120517C	0.02	0.01
Class IBL sequence(2)		EF120532	0.32	0.84

<u>Notes to Table 2g-2:</u>

(1) Other release categories (i.e., H/L, M/E, M/I, L/E, L/I, LL/E, LL/I, CI) are not included because of their low contribution to dose risk and cost risk (<=3%)

(2) A MAAP scenario was chosen for the H/I release category that bounds the dominant sequence representative MAAP scenario release fractions. The MAAP scenario, EF120532, represents an IBL scenario which is the dominant accident class for the release category.

Table 2g-3

REPRESENTATIVE MAAP SCENARIOS FOR THE DOMINANT CLASS II SEQUENCES OF THE H/E RELEASE CATEGORY

Sequence	Representa-tive MAAP Case	Release Start Time (Hours)	Release Fraction at 48 Hours		Release Fraction at 72 Hours	
			CsI	CsOH	CsI	CsOH
IIA-063 (7% of H/E frequency)	EF120516	33	0.58	0.32	0.60	0.35
IIA-024 (6% of H/E frequency)	EF120514	33	0.42	0.10	0.49	0.12
IIA-037 (4% of H/E frequency)	EF120509	29	0.28	0.16	0.33	0.17

Table 2g-4
FERMI 2 SAMA Dose RISK and Cost Risk with Separate Class II H/E Release Category

Characteristics of Release Mode		Population Dose	Offsite Economic Cost	Population Dose Risk	Offsite Economic Cost Risk
Release Category	**yr^{-1}**	**person-rem**	**$**	**person-rem/yr**	**$/yr**
H/E-BOC	5.93E-08	2.18E+07	3.03E+10	1.29E+00	1.80E+03
H/E Class II	5.32E-08	2.18E+07	3.03E+10	1.16E+00	1.61E+03
H/E Other	2.60E-07	8.10E+06	2.80E+10	2.11E+00	7.28E+03
H/I	7.20E-08	9.52E+06	5.26E+10	6.86E-01	3.79E+03
H/L	2.46E-10	8.98E+06	1.67E+10	2.21E-03	4.11E+00
M/E	6.17E-08	2.48E+06	8.39E+09	1.53E-01	5.18E+02
M/I	3.71E-08	2.76E+06	6.10E+09	1.03E-01	2.27E+02
L/E	4.36E-08	2.26E+05	2.26E+07	9.85E-03	9.85E-01
L/I	5.46E-08	2.14E+06	8.25E+09	1.17E-01	4.51E+02
LL/E	5.02E-10	1.31E+04	3.81E+05	6.57E-06	1.91E-04
LL/I	7.75E-08	1.29E+05	4.05E+06	1.00E-02	3.14E-01
Cl	7.83E-07	6.46E+01	1.96E+00	5.06E-05	1.54E-06
Totals				5.64E+00	1.57E+04

RAI 2.h

Request the following information relative to the Level 2 analysis. <u>Basis:</u> Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.

h. Provide the duration of the MAAP analysis for each release category and provide an assessment of the adequacy of the time to characterize the releases over the full accident duration.

Response:

The MAAP scenario run times are a minimum of approximately 36 hours following core damage. This time (36 hours after core damage) is set based on the clear actions that have been taken within 36 hours for disasters such as Chernobyl, Fukushima, and other non-nuclear evacuation events. In addition, the NRC has also adopted a release duration of approximately 48 hours after accident initiation in NUREG-1935 (SOARCA) as the basis for their radionuclide release duration calculations. The SOARCA analysis assumes adequate mitigating measures could be brought onsite and be connected and functioning within 48 hours. For Fermi 2 many of the radionuclide release categories have their calculations extend well beyond 48 hours because no release fraction plateau is reached or the plateau is reached more than 36 hours beyond core damage. A time of approximately 36 hours following core damage or at least 40 hours from accident initiation as used in some of the radionuclide release categories is a reasonable estimate considering the high probability of mitigating equipment to mitigate an active release after this time.

The assumption is also supported by the US nuclear industry's FLEX strategy. Portable site equipment in addition to readily available offsite resources following a severe accident lend credibility to the likelihood that containment or RPV injection can be provided to cool core debris in a reasonable time period.

The adequacy of the MAAP scenario run time is based primarily on the reduction in rate of release associated with the CsI and CsOH release fractions as a function of time (i.e., a "plateau" is reached). These two release groups are characteristic of key contributors to early and latent health effects and experience has shown they are key contributors to MACCS dose and cost results. In most cases, the release fractions have reached a plateau by the end of the MAAP run. In those cases where the release fractions have not fully plateaued by the end of the MAAP run, either the release categories are small contributors to the overall results or a considerable amount of time has passed (i.e., much greater than 48 hours) and mitigation actions not explicitly modeled in the PRA are expected to reduce the scenario impacts.

Table 2h-1 provides the MAAP scenario run times for the representative MAAP scenarios for those release categories that are risk significant to the SAMA analysis (i.e., >3% of the total dose or cost risk). The three release categories of H/E-BOC, H/E, and H/I compose 92% of the SAMA offsite dose risk and cost risk. An assessment of the adequacy of the time to characterize the release over the accident duration for these three release categories is provided. For the H/I release category the MAAP case duration was 191 hours. This scenario run time is assumed to be adequate per the SOARCA assumptions noted above. For the H/E-BOC and H/E, release categories the MAAP cases were re-run with a duration of 48 hours to examine the impact to the release fractions. The CsI and CsOH release fractions are reported for the original scenario run time and 48 hours after accident initiation. These additional run durations demonstrate that release fractions associated with the risk dominant release categories do not exhibit any significant additional release between their original end time and 48 hours. Therefore, the use of the 40 hour case run time is adequate.

Table 2h-1
SAMA MAAP Case Adequacy Assessment[1]

Release Category Bin	MAAP Cases Designator	Case Run Time	Release Fractions at End of Scenario		Release Fractions at 48 Hours		Adequacy Assessment
			CsI	CsOH	CsI	CsOH	
H/E-BOC	EF120524	40 hr	0.34	0.24	0.35	0.25	CsI and CsOH release fractions increase slightly between 40 and 48 hours. Trends indicate relative plateau is reached by 40 hours and run time of 40 hours is acceptable.
H/E	EF120520	40 hr	0.24	0.31	0.25	0.32	CsI and CsOH release fractions increase by a negligible amount between 40 and 48 hours. Trends indicate relative plateau is reached by 40 hours and run time of 40 hours is acceptable.
H/I	EF120532	191 hr	Not applicable. Runtime is greater than 48 hours.				

Notes to Table 2h-1:
[1] Other release categories were not recalculated because of their low contribution to offsite dose risk and cost risk (<=3%)

RAI 2.i

Request the following information relative to the Level 2 analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.

i. Clarify whether plant-specific fission product masses of the relevant fission product elements were used in the MAAP 4.0.7 analyses instead of the isotopic activity of those elements recommended by the MAAP Users Group.

Response:

MAAP 4.0.7 allows users to utilize the input of particular fission product element mass only (input FFPIN=0) or a combination of fission product element masses and fission product nuclide activities (input FFPIN=1). The Fermi 2 MAAP 4.0.7 analysis utilizes both element masses and nuclide activities (input FFPIN = 1) in the MAAP calculations as recommended by the MAAP 4.0.7 code. Use of both element masses and nuclide activities is consistent with the guidance in MAAP-FLAASH #68.

RAI 2.j

Request the following information relative to the Level 2 analysis. *Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of accident propagation and radionuclide release in the Level 2 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Level 2 PRA model for supporting the SAMA evaluation.*

j. Specify the design basis leakage for containment and compare that leakage rate to the release fractions for the containment intact release category.

Response:

The maximum allowable technical specification leakage (Tech. Spec. 5.5.12.c) from the Fermi 2 containment is 0.5% of the containment air weight per day. The Containment Intact MAAP scenario (EF120525) assumes the same leakage rate of 0.5% per day. The MAAP scenario selected therefore appropriately models the maximum allowable leakage out of containment (i.e., directly represents a maximum containment leakage scenario).

RAI 3.a

Request the following information with regard to the treatment and inclusion of external events in the SAMA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of external events in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

a. The Fermi 2 license renewal application utilizes a seismic CDF from the Generic Safety Issue (GSI) 199 assessment in developing the external events multiplier used in the SAMA analysis. In response to NRC requests following the accident at the Fukushima Daiichi Nuclear Power Plant, new seismic hazard curves have been developed for each nuclear power plant site. Based on this information, the Electric Power Research Institute has produced updates to the GSI-199 seismic CDFs. Discuss the impact of using the updated Fermi 2 seismic CDF on the Fermi 2 SAMA analysis.

Response:

The seismic CDF used in the Fermi 2 SAMA analysis was based on the Generic Issue (GI) 199 assessment and was determined to be 4.2E-06. Since that time EPRI has produced new hazard estimates for Fermi 2. Using the same method used for the GI-199 assessment and the new hazard estimates a CDF of 2.26E-06 was calculated. This would result in a reduction to the external events multiplier. Since the new seismic CDF is lower than the seismic CDF used in the SAMA analysis, the SAMA analysis is conservative.

RAI 3.b

Request the following information with regard to the treatment and inclusion of external events in the SAMA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's treatment of external events in the Level 1 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the sufficiency of the applicant's Level 1 PRA model for supporting the SAMA evaluation.

b. As noted in the NRC staff's evaluation report on the individual plant examination of external events (IPEEE), and as can be seen in the IPEEE (Tables 4-6 and 4-13), there is a 1.5E-05/year CDF from the remaining areas screened (with CDFs less than 1E-06/year) that was subjected to the same detailed analysis as the unscreened areas. Because this 1.5E-05/year CDF was not included in the 2.15E-05/year CDF from the unscreened fire areas, provide justification for not including it in the total fire CDF used in the SAMA analysis and/or assess the impact on the SAMA cost-benefit evaluation, particularly with respect to determining the external events multiplier.

Response:

It was determined that a sensitivity should be performed by using the CDF contribution from the screened fire compartments in the individual plant examination of external events (IPEEE). This was accomplished by adjusting the fire CDF reduction factor that is included in calculation of the External Event multiplier (EEM). Note that for these calculations the new seismic CDF of 2.26E-06 (based on latest EPRI seismic hazard curves) was used.

For the first calculation the fire CDF continued to use the factor of two reduction, this time including the screened areas from the FIVE analysis:

The revised fire CDF is then calculated as follows:

$$CDF_{fire} = R * (CDF_{unscreened} + CDF_{screened}) = 0.5 * (2.15E\text{-}5/yr + 1.50E\text{-}5/yr) = 1.83E\text{-}05$$

The revised EEM is then calculated as follows:

EEM = (Internal Event CDF + Seismic CDF + Fire CDF) / Internal Event CDF

EEM = (1.5E-06 + 2.26E-06 + 1.83E-05)/1.5E-06 = 14.7

For the next calculation the scaling factor for the fire event contribution was based on the exact ratio of internal event CDF values from the model used for the SAMA analysis (FermiV9) to the

IPE model (compatible with the quantitative evaluation for the IPEEE). Note that internal flood hazards were removed from the FermiV9 CDF as they were not included in the IPEEE model.

Rfire = CDFV9noflood / CDFIPE = 1.27E-06 / 5.7E-06 = 0.223

The revised fire CDF is then calculated as follows:

CDFfire = Rfire * (CDF unscreened + CDF screened) = 0.223 * (2.15E-05 + 1.50 E-05) = 8.1E-06

The revised EEM is then calculated as follows:

EEM = (Internal Event CDF + Seismic CDF + Fire CDF) / Internal Event CDF

EEM = (1.5E-06 + 2.26E-06 + 8.1E-06)/1.5E-06 = 7.9

So averaging the two External Event Multipliers results:

EEM = (14.7 + 7.9) / 2 = 11.3

The results of this sensitivity yield a result that is approximately equal to the EEM value of 11 that is used in the submittal. Therefore, the EEM value used in the submittal is deemed to be appropriate.

RAI 4.a

Request the following information relative to the Level 3 PRA analysis. Basis: *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

a. Section D.1.5.2.3 of the ER indicates that a watershed index of 1 (drained by rivers) was used for all spatial elements for conservatism. Explain why drainage by rivers is conservative compared to drainage by large water bodies.

Response:

This is conservative as it assumes that all radionuclides that contaminate a specific area remain in that area and therefore increase dose to the population. Larger bodies of water would be more effective at washing off contamination.

RAI 4.b

Request the following information relative to the Level 3 PRA analysis. <u>Basis:</u> Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.

b. The offsite economic cost risk calculation includes an assumption that all crops exposed to radiation are destroyed.
   i. Specify the distances from the point of release that apply to this assumption.
   ii. Clarify if the assumption includes destroying crops grown in contaminated soil in the years following the radioactive release and/or crops not grown in contaminated soils.

Response:

i. This applies to all crops within a 50 mile radius of the plant site. Crops outside of a 50 mile radius of the plant site are assumed to be unaffected.

ii. Milk and crop disposal costs are calculated only for the year of the accident. Beginning in the second year after the accident, acceptability of food production is evaluated by comparing the projected individual dose for year 2 with DOSELONG (in "Chronic" file, 0.005 effective and 0.15 thyroid dose, Sieverts).

    If the projected individual dose for the second year exceeds the dose criteria DOSELONG, the loss of crop production for that year is included in the cost. If the projected individual dose for the second year does not exceed the dose criterion, the production of that year's agricultural production and the production from all subsequent years is allowed. Implicit in the model is the assumption that the food doses resulting from successive years of production do not increase with time. Also, just as with the MACCS food-chain model, the long-term interdiction of farmland applies to all crop categories, and there is no provision for long-term interdiction of a subset of the crops.

    If the projected individual dose from the second year of agricultural production exceeds the dose criterion, the projected doses from up to eight successive annual periods are each examined in order to determine if production can be resumed within the first 9 years after the accident. If production cannot be resumed, the crop loss is included in the cost. If the projected doses in each of the years 2 through 9 exceed DOSELONG, no further tests are performed and the farmland is treated as if it were condemned. When farmland is condemned, the associated cost is the market value of the farmland with the dollar values for market value reported on the output listing as FARM DEPENDENT CONDEMNATION COST. If the projected doses for one of the years examined satisfy the long-term dose criterion, agricultural production is assumed to resume in that year. In that case, societal ingestion doses are assessed for the period ending with the duration of the ingestion dose period “LASTACUM”.

For example, if DOSELONG is satisfied in year 3, and LASTACUM has a value of 10, societal doses are accrued for the period denoted as years 3–10, an exposure period with a duration of 8 years. Since agricultural production was not allowed in the first and second years, economic costs for 2 years of interdiction are assessed using the WASH-1400 economic cost model for farmland. The WASH-1400 model calculates the cost of temporary interdiction as the depreciation of the farm's land and improvements (see variables VALWF and FRFIM, from SECPOP), and as specified by the depreciation rates for land and improvements (see input variables DSRATE and DPRATE, from NUREG-1150).

RAI 4.c

Request the following information relative to the Level 3 PRA analysis. *Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

c. Specify the dollar-to-hectare values and data sources used for farm and nonfarm land in the analysis.

Response:

The dollar-to-hectare values for farm land range from $5610/ha to $17,934/ha with an average of $9,335/ha. The dollar-to-hectare values for non-farm land range from $198,181/ha to $322,884/ha with an average of $223,430/ha.

Farmland and non-farmland data is taken from SECPOP2000 v3.13.1 county level data from 2002. This data is then multiplied by a factor of 2.1384 to account for inflation from 2002 to 2045. The factor was calculated by extrapolating the consumer price index (i.e. inflation) from current data through 2045 assuming linear growth.

RAI 4.d

Request the following information relative to the Level 3 PRA analysis. <u>*Basis:*</u> *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

d. For each assessed year, indicate the percentage of missing meteorological data replaced with data substitution.

Response:

The meteorological data for the assessed years is as follows:

2003 – 96.41% valid data (3.59% replaced with substitution)
2005 – 99.65% valid data (0.35% replaced with substitution)
2007 – 98.12% valid data (1.88% replaced with substitution)

RAI 4.e

Request the following information relative to the Level 3 PRA analysis. *Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

e. Explain how precipitation events were modeled in the analysis. For rainy days, indicate the duration of precipitation events used in the consequence modeling and if precipitation was spatially dependent. Clarify if there were any assumptions for precipitation in outer boundary cells in the calculation and describe the included assumptions.

Response:

Rainfall duration is not an input to the MACCS2 code. For Fermi 2, the weather bin sampling method using full years of meteorological data was used (see Section 5.16 of NUREG/CR-6613). Input of meteorological data into the MACCS2 code is via the ATMOS input file. This file provides the following input data to the MACCS2 codes:

1. Site specific meteorological data file. Three MET files (i.e., 2003, 2005, and 2007) were used in the analysis.
2. Morning and afternoon seasonal mixing heights.
3. Boundary weather parameters:
   - Boundary weather mixing layer height = 1000 meters
   - Boundary weather stability class index = 4
   - Boundary weather rain rate = 5 mm/hr
   - Boundary weather wind speed = 5 m/sec
4. Washout Coefficients (median values from NUREG/CR-6244)
   - Washout Coefficients Number One, Linear Factor = 1.89E-05
   - Washout Coefficients Number Two, Exponential Factor = 0.664
5. Rain Parameters (recommended values taken from NUREG-1150)
   - Number of rain distance intervals for binning = 5
   - Endpoints of the rain distance intervals (km) = 3.2187, 6.4374, 11.2654, 20.9215, and 32.1869
   - Number of rain intensity breakpoints = 3
   - Rain intensity breakpoints for weather binning (mm/hr) - 2, 4 and 6

This data is used by the MACCS2 code to internally determine the rain duration in seconds for the current hour and the rain intensity in millimeters per hour. These values are then used to determine the fraction of the release remaining airborne after wet deposition. These internally calculated values are not provided in the MACCS2 output file. The above data is also used by the MACCS2 code to determine the rainfall intensity distribution for the 16 compass directions and the specified rain distance intervals given above. This rainfall distribution is provided in MACCS2 output. No spatial assumptions were made. Therefore the rainfall distribution determined internally by the MACCS2 code is unchanged. For the precipitation boundary cells, no assumptions were made or input into the MACCS2 code. The only input provided relative to the boundary weather cells is as given in item 3, above.

RAI 4.f

Request the following information relative to the Level 3 PRA analysis. *<u>Basis:</u>* *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

f. Estimate the sensitivity of the Level 3 results to the assumed plume heat value of 10 megawatts that was used in the consequence analysis.

Response:

A sensitivity analysis was performed looking at 0, 10, and 20 MW plume energy releases. The results are shown below:

Plume Energy (MW)	Modified Maximum Averted Cost Risk ($/yr)	Difference (%)
0	$3,395,276	0.76%
10	$3,369,832	0.00%
20	$3,325,351	-1.32%

RAI 4.g

Request the following information relative to the Level 3 PRA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.

g. *Explain how the network-wide evacuation speed was computed and how it factored into the total time estimated for evacuation. Indicate if this evacuation speed or time reflects radial distance traveled and if population weighting was included.*

Response:

A DYNEV II analysis was performed in 2010 for the Emergency Response Organization to understand evacuation time estimates. The DYNEV traffic simulation model is a macroscopic model that describes the operations of traffic flow in terms of aggregate variables: vehicles, flow rate, mean speed, volume, density, queue length, on each link, for each turn movement, during each Time Interval (simulation time step). The model generates trips from "sources" and from Entry Links and introduces them onto the analysis network at rates specified by the analyst based on the mobilization time distributions. The model simulates the movements of all vehicles on all network links over time until the network is empty.

The computational procedure is outlined as follows:

- A link-node representation of the highway network is coded. Each link represents a unidirectional length of highway; each node usually represents an intersection or merge point. The capacity of each link is estimated based on the field survey observations and on established traffic engineering procedures.
- The evacuation trips are generated at locations called "zonal centroids" located within the emergency planning zone (EPZ) and Shadow Region. The trip generation rates vary over time reflecting the mobilization process, and from one location (centroid) to another depending on population density and on whether a centroid is within, or outside, the impacted area. The population density by sector and road capabilities are all considered in this evaluation. This confirms that the analysis is spatially dependent. The average evacuation speed identified in the SAMA includes these factors.
- The evacuation model computes the routing patterns for evacuating vehicles that are compliant with federal guidelines (outbound relative to the location of the plant), then simulates the traffic flow movements over space and time. This simulation process estimates the rate that traffic flow exits the impacted region.

RAI 4.h

Request the following information relative to the Level 3 PRA analysis. <u>Basis:</u> Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.

h. Specify software codes and the versions used for calculating the core inventory.

Response:

Core inventory is taken from DC-6120, Fermi-2 Core Inventory of Accident Source Terms based on NEDC-33043P BWROG Generic BWR Source Terms. This used SCALE 4.4 SAS2H methodology [XSDRNPM, ORIGEN-S] to develop bounding BWR fuel design.

RAI 4.i

Request the following information relative to the Level 3 PRA analysis. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.

i. Provide the basis for the selection of radionuclides listed in the core inventory. For example, radioisotopes for cobalt are not included in Table D.1-23.

Response:

Core inventory is taken from the site MAAP parameter file which references DC-6120, Fermi-2 Core Inventory of Accident Source Terms based on NEDC33043P BWROG Generic BWR Source Terms. Source terms developed in this calculation are utilized by Fermi 2 in development of Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.

Cobalt is not included in the core inventory as it is not a fission product or a transuranic. Radioactive cobalt in the primary system is primarily due to the presence of stellite in valve seats. Small amounts of cobalt can be released from the stellite which can be activated in the core and lead to an increase in operational dose. Therefore, it is not considered part of the core inventory.

RAI 4.j

Request the following information relative to the Level 3 PRA analysis. <u>*Basis:*</u> *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

j. Confirm if any changes in future fuel management practices or fuel design are planned or being considered that would influence the core inventory.

Response:

There are no changes in future fuel management practices or fuel design planned or being considered. The plan is to continue with 18 month fuel cycles and using GE-14 fuel.

RAI 4.k

Request the following information relative to the Level 3 PRA analysis. <u>*Basis:*</u> *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's analysis of consequences in the Level 3 PRA model. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's Level 3 PRA model for supporting the SAMA evaluation.*

d. Specify the thermal power level for the core inventory shown in Table D.1-23. Indicate if changes to this thermal power are anticipated and provide any implications on the cost-benefit conclusions for the SAMA analysis due to differences in the thermal power level.

Response:

The core inventory used in the SAMA analysis was based on 3430 MWt, which was the licensed power level at the time of the most recent version of the PRA and at the time the SAMA analysis was performed. In 2014, a license amendment was approved authorizing a Measurement Uncertainty Recapture (MUR) uprate to 3486 MWt. There are no plans currently for further power uprate at Fermi 2.

A sensitivity analysis was performed to determine the impact of the increased power level on the Level 3 consequences analysis and thus impacts on the averted cost risk for each SAMA. The revised SAMA analyses based on the increased thermal power level did not result in any SAMA becoming cost beneficial that was previously not identified as such, including the 95th percentile uncertainty.

RAI 5.a

Request the following information with regard to the selection and screening of Phase I SAMA candidates. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's basis for the selection and screening Phase I SAMA candidates. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Phase I SAMA selection and screening process for the SAMA evaluation.

a. *Relative to Table D.1-2 of the ER:*
   i. *SAMA 001, regarding the addition of direct current power supplies, is identified to mitigate event BTTSEDCSCC33_1 (p. D-11) "CC GROUP DC BATTERY FAILS DURING OPERATION 2A, 2B, 2C" and others. This is not a Phase II SAMA, as it was screened out on the basis of being already implemented per DTE Electric Company (DTE) addressing NRC Order 12-049 requirements with a FLEX portable, direct current generator. Confirm that the generator is large enough to carry direct current loads without relying on batteries. If not, consider other potential cost-beneficial SAMAs, such as increasing the size of the FLEX generator to carry direct current loads or the use of fuel cells.*
   ii. *For event HE1FUHS1AC001 (p. D-13) "Operators manually start MDCT fan," consider a SAMA to automate the starting of the mechanical draft cooling tower (MDCT) fan, unless the design already includes automatic starting.*
   iii. *SAMA 129 is cited in the disposition of event %FL-TB-MCWS-TBXX-M (p. D-14) "Major rupture in Circulating Water pipe or expansion joints in Turbine Building" and others. This SAMA is apparently addressed through the External Surfaces Monitoring Program for External Degradation and the Internal Surfaces Miscellaneous Piping and Ducting Components Program for internal degradation. Clarify if this is an existing program and if the benefit of this program is incorporated in the current Fermi 2 PRA. Identify other actions that might be taken to mitigate this flood event.*
   iv. *SAMA 031 is cited in the disposition of event CPFFHPCIMLTSTART (p. D-15) "HPCI fails during subsequent cycles, FW cntl = F, L8 trip =S." In Table D.1-2, SAMA 031 is said to evaluate upgrading high-pressure coolant injection (HPCI) throttling capability to reduce the number of start/stops required. The title or purpose of SAMA 031, as given in ER Section D.2.3 and in NEI 05-01, is to revise procedures to allow intermittent operations of HPCI and reactor core insulation coolant (RCIC). While a SAMA for upgrading HPCI (and RCIC) throttling capability to reduce the number of start/stops required would mitigate this basic event, SAMA 031 would not. Identify and evaluate a SAMA that would improve current design or operation that would mitigate this basic event.*
   v. *SAMA 009 to reduce the DC dependence between high pressure injection and ADS is cited to mitigate event TPFSHPCIC001A for "failure of the turbine-driven high*

pressure coolant injection pump to start" (p. D-18). Explain how this SAMA mitigates the event because common cause failure of direct current would not be included in this event. Include other potential SAMAs that might be applicable in the discussion.

vi. SAMA 101 for "improving leak detection procedures" is cited for a number of events (e.g., %FL-AB-FPRO-RELAY-N) in Tables D.1-2 and D.1-5. This SAMA is not included as a Phase II SAMA in the cost benefit evaluation in Section D.2.3. Clarify if this treatment is because of the currently in progress implementation of a risk informed in-service inspection program based on ASME Code Case N-716, which explicitly addresses internal flooding initiators for inclusion in the in-service inspection program. Because internal flooding is a significant contributor to the CDF, discuss the impact of the risk-informed in-service inspection program on this contribution and the potential that other mitigating actions might be cost beneficial.

vii. Discuss the potential for a flood barrier to prevent flood propagation to adjacent flood areas through openings and/or failed flood doors for flood events such as %FL-AB-FPRO-RELAY-N "Nominal rupture in FPS line in AB propagating to Relay Room," %FL-TB-MCWS-TBXX-M "Major rupture in Circulating Water pipe or expansion joints in Turbine Building," and %FL-AB-ECW2-B20XX-N, "Nominal rupture in RBCCW/EECW Div 2 line in DC Switchgear Room."

viii. The DTE response to EA-12-050, which is stated to include measures that would increase the likelihood of successful containment venting to prevent containment overpressure, is cited in the disposition of event CPFFRBLDFAILDUCTL1 "COND. PROB. THAT ADVERSE ENVIRONMENT FAILS EQUIPMENT IN RB BASEMENT (LEVEL 1)" (p. D-28). Describe the specifics of this response that would impact this basic event.

Response:

i. FLEX, uses a 550 kW AC generator to provide power to key loads, including the DC battery chargers, instrument panels, Residual Heat Removal (RHR) complex and Reactor Recirculation system valves. The FLEX strategy includes capability for refueling the diesel generators so that AC power can be provided to the battery chargers throughout Phase 2 until additional offsite resources become available (i.e., at least 72 hours or longer). The chargers are sized so that any charger is able to recharge a totally discharged battery in 24 hours while supplying maximum predicted load.

The 550 kw AC generator is adequate to carry the necessary loads to mitigate the consequences of an accident. A DC generator, therefore, is not necessary and the high cost of fuel cells makes fuel cells not cost effective.

ii. The benefit for automated starting of the mechanical draft cooling tower fans was conservatively evaluated by setting the probability for basic event HE1FUHS1AC001 (Operators fails to manually start MDCT fans) to 0.0 (guaranteed success) for LOSP scenarios.

The resulting CDF from the above model change is 1.441E-06/yr. The averted risk cost relative to the base case for this change is $272,772. The averted cost when considering uncertainty is $681,930. Implementation of this modification will require a significant engineering effort for revision of the load shedding and sequencing logic as well as re-examination of various electrical calculations to confirm the adequacy of the EDG to support the additional load during the load sequencing evolution in addition to the required field modifications. The logic also needs to ensure the fans would not automatically start when ambient temperature is low to prevent damage to the cooling towers due to icing. Based on this effort this modification is estimated to be approximately $2.4 million. As such, the SAMA is considered not cost beneficial.

iii. The Circulating Water pipe and expansion joints will be subject to inspection in accordance with the requirements of the Internal Surfaces Miscellaneous Piping and Ducting Components Program and the External Surfaces Monitoring Program. These programs will be fully implemented prior to the Period of Extended Operation. Neither monitoring program is credited in the Fermi 2 PRA model.

Using motor-operated valves in place of fast-acting hydraulic or pneumatic positioners has minimized the potential for water hammer in the circulating water piping and the associated rupture of expansion joints.

Also, if the failure were to occur in a circulating water line because of a pressure surge, that same surge would probably trip off the circulating water pumps by means of the pressure switches that protect the system. Flooding would thus not occur.

Another consideration is that part of the response to SOER 85-005, “Internal Flooding of Power Plant Buildings” (DER 88-0069) included creation of preventive maintenance (PM) events AD70 and AD71 to visually examine the Condenser circulating water inlet and outlet Expansion joints. These events are performed every other outage (2R). Acceptance criteria for these inspections were established by Engineering in memorandum NEPJ-90-0113.

Finally, any of three Turbine Building sump alarms (5D11-RWC, 5D13-RWC, 5D3-RWC) or one Radwaste Building sump alarm (5D19-RWC) would activate in the Radwaste Control Room indicating a leak. Response procedures for each of these alarms direct the operator to investigate the source of the leak. In addition, plant operating procedure 23.702.01, “Plant Systems Leak Check Procedure,” provides a systematized approach for identifying abnormal inputs into the Radwaste Systems.

Therefore, in light of the design features currently installed to minimize or mitigate the consequences of an expansion joint failure together with an established monitoring program, additional programs to be added, and multiple alarms to alert the Operations staff of an abnormal leakage condition, the additional costs to modify the expansion joint to suppress leakage is not warranted.

iv. A cost-benefit evaluation was performed that addressed a site specific vulnerability, specifically basic events CPFFHPCIMLTSTART and PFFRCICMLTSTART. These basic events are HPCI and Reactor Core Isolation Cooling (RCIC) fail during subsequent cycles, respectively.

Current operating procedures allow for cycling of the HPCI/RCIC (on at Level 2 and off at Level 8) before operators take manual control of the pumps to throttle flow and maintain RPV water at a constant level, thus preventing additional cycling. The proposed SAMA to address these site specific basic events is to revise procedures and training to allow operators to take manual control of HPCI/RCIC earlier in the event in order to prevent cycling on and off of the pumps.

Evaluation of the proposed SAMA in this manner is specifically important to Fermi 2 as failure of HPCI during subsequent cycles (CPFFHPCIMLTSTART) appears in the list of Level 1 Risk Significant Terms. The benefit of the proposed SAMA, performed as stated above to prevent subsequent failures of HPCI/RCIC during subsequent cycles, resulted in an averted cost risk of $15,700 ($39,250 including 95th percentile uncertainty). Since the minimum cost of implementation is assumed to be $50,000 for procedure change, this SAMA is not cost-beneficial.

v. DTE agrees that this basic event is not addressed by SAMA 009. However, another SAMA (SAMA 196) performed an analysis that can be used to determine the benefit of an alternative SAMA which would mitigate this basis event. The analysis of SAMA 196 evaluated an improvement in the HPCI pump's starting performance by a reduction of the HPCI pump failure probability of approximately 40%. SAMA 196 resulted in an averted cost risk of less than $5,000 ($12,500 including 95th percentile uncertainty). There are no credible SAMAs that could be implemented for less than $50,000, and thus no cost-beneficial SAMA is possible to mitigate basic event TPFSHPCIC001A.

vi. SAMA 101 is not evaluated in Phase II because Fermi 2 is in the process of implementing an ASME Code Case N-716 risk informed in-service inspection program. N-716 includes risk informed criteria to provide a method of ensuring that any plant-specific piping locations that are important to safety are identified. Therefore, even though ASME Section XI does not include or require any non-destructive examination (NDE) requirements for Safety Class 3 and non-nuclear safety class piping, N-716 would add such piping if it were determined to be high safety significant based on the results of an internal flooding PRA. However, based on the Fermi 2 PRA results that it is not likely that the important internal flooding initiators will meet the criteria for inclusion into the N-716 program, a new SAMA has been evaluated.

The SAMA would be the implementation of an inspection program for the piping associated with the risk significant internal flooding initiators. This change would be implemented by adding visual inspection of these pipes to the regular shift rounds procedure. The SAMA was evaluated by assuming the inspections would result in a 25% reduction in the initiating event frequency for these initiators. The resulting CDF from this model change is 1.454E-06/yr. The calculated averted risk cost relative to the base case is $41,651. There averted risk cost for the uncertainty case is $104,128. The cost of implementation is estimated considering both the development of the procedure change and the actual manpower required to perform the visual inspections on a regular and continuing basis. Use of visual inspections takes credit for the "leak before break" concept and would involve walking down the risk significant internal flooding piping segments to visually identify any leakage from these piping segments. Identification of leakage would allow repair prior to further degradation that results in more significant leakage and an internal flooding initiator. Assuming that this activity requires 15 minutes per day for one individual to perform the inspection at a cost of $150 per hour, the yearly additional cost of these inspections would be $13,687. The present value of this yearly expense using a discount rate of 7% is $158,600. Assuming a minimum procedure cost of $50,000, the total cost of implementation is $208,600. Therefore, this SAMA is not cost beneficial when considering the base case and the uncertainty case.

vii. The potential for use of flood barriers to prevent flood propagation to adjacent flood areas for these initiators was assessed as described below.

<u>Event %FL-AB-FPRO-RELAY-N</u> – Nominal rupture in FPS line in AB propagating to Relay Room

This event is used to model propagation of a flooding from a fire protection system line rupture in the Auxiliary Building to the Relay Room. Event %FL-AB-FPRO-RELAY-M, Major rupture in FPS line in AB propagating to Relay Room, models a similar but larger flooding event. The use of a flood/watertight door between the AB and Relay Room was modeled by setting the two events to false in the fault tree model. This action removes Relay Room failures due to flooding propagating from the AB in the results. Quantification of the revised model resulted in a CDF reduction of 1.35E-07/yr. The averted risk cost of this change was determined to be $44,267 ($110,667 when including 95th percentile uncertainty). While the averted cost risk (including uncertainty) for this SAMA is greater than the minimum hardware cost ($100,000), a detailed cost estimate would likely drive the implementation cost for this SAMA above $110,000 such that this SAMA would remain not cost beneficial.

<u>Event %FL-TB-MCWS-TBXX-M</u> – Major rupture in Circulating Water pipe or expansion joints in Turbine Building

This event is used to model a major rupture of circulating water pipe in the Turbine Building. The event would flood the basement of the turbine building up to an elevation of

583 ft at which point the water would run out of the building. A watertight door in the AB provides protection from flooding up to Elevation 588 ft. This door is modeled in the PRA as event CPFFTBLDDOORFAIL, Turbine Building to Auxiliary Building Isolation Door Fails, and has a failure probability of 1E-04. The model was revised to simulate no failure of this door by setting the basic event to false. Quantification of the revised model resulted in a CDF reduction of 4.9E-08/yr. The averted risk cost of this change was determined to be \$22,721 (\$56,802 when including 95th percentile uncertainty). The averted cost risk of this SAMA is less than the minimum hardware costs of \$100,000 and would therefore not be cost beneficial.

<u>Event %FL-AB-ECW2-B20XX-N</u> – Nominal rupture in RBCCW/EECW Div 2 line in DC Switchgear Room

A conservative assumption is made in the current PRA model of record (to simplify the modeling) regarding the ability of the operator to terminate a flood emanating from RBCCW/EECW piping in the scenarios of interest before the equipment is flooded in the room to which the flood propagates. The human action HE1FRBCW-FL-ISOL-AB3 is set to 1.0 (guaranteed failure) to simplify modeling in the scenarios for which it could potentially be credited, specifically:

1) Floods which emanate in the DC switchgear and propagate through a breached door to the Division 2 AC Switchgear Room (terminating the flood would prevent damage to the equipment in the AC Switchgear Room following the equalization of flooding level in the combined rooms following door breach).
2) Floods which emanate from the Division 2 AC Switchgear Room and propagate to the DC Switchgear Room (terminating the flood will prevent the breach of the door to the DC Switchgear Room).

Of the two scenarios listed above, Scenario #1 is the most bounding with respect to HRA timing, since the timing to irrecoverable failure is shorter (62 minutes).

To examine the quantitative significance of this event, a more realistic formulation for the HEP for event HE1FRBCW-FL-ISOL-AB3 is derived to establish a new baseline for the SAMA evaluation since the event is set to 1.0 to simplify modeling in the base PRA. A screening value of 0.2 is assigned for this purpose based upon the following:

1) The value is deemed conservative in lieu of the long scenario time and the close proximity of the area to the control room.
2) The cue to the operator (low head tank level) occurs quickly.
3) There are secondary operator cues from the loss of electrical equipment in the room where the flooding begins.
4) The value accounts for the generalized process that would lead to the isolation of the flood (the search for system leakage without specific guidance for targeting

areas where the impact of flooding is significant and without explicit isolation instructions).

5) The elevated value implicitly addresses any HRA dependencies associated with the event.

The benefits for physical modifications are examined with respect to the revised baseline (HE1FRBCW-FL-ISOL-AB3 = 0.2) by assuming that the propagation between the switchgear rooms is always prevented (HE1FRBCW-FL-ISOL-AB3 = 0.0).

The result of the SAMA analysis with the above changes is an averted cost of $89,872 dollars. The averted cost for the uncertainty sensitivity is $224,680. While the averted cost is less than the minimum estimated cost of a hardware change ($100,000), the averted cost with uncertainty is greater than the minimum hardware cost. Given that the addition of a curb could conceivably be designed and installed with a cost range of $100,000 to $200,000, this SAMA would be potentially cost beneficial based on the uncertainty sensitivity.

viii. Event CPFFRBLDFAILDUCTL1 is a conditional failure that is applied when valve T4600-F407, RBHVAC to SGTS isolation valve, fails to close. The failure of this valve to close will provide a pathway for steam and other releases to the third floor Reactor Building which results in the potential for damage to important mitigation equipment.

The NRC has rescinded Order EA-12-050 and replaced it with Order EA-13-109, "Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions." The Order establishes numerous functional requirements for a hardened containment venting system (HCVS) including the following:

- Performance objectives

  - Minimize the reliance on operator actions
  - Minimize plant operators' exposure to occupation hazards
  - Account for radiological conditions that would impede personnel actions for event response
  - Controls and indications shall be accessible and functional during severe accident conditions, extended loss of AC power (ELAP) and inadequate containment cooling conditions

- Design features

  - Vent 1% rated power, restore and maintain containment pressure below the design pressure
  - Discharge the effluent to a release point above the main plant structures
  - Minimize unintended cross flow of vented fluids within a unit and between units

- Sustained manual operation from a control panel located in the main control room or a remote but readily accessible location
- Capable of manual operation (e.g., reach-rod or manual operation of pneumatic supply valves from shielded location), accessible to operators during sustained operations
- Capable of operating with dedicated and permanently installed equipment for at least 24 hours following loss of normal power or loss of pneumatic supplies for air operated components during an ELAP
- Include means to prevent inadvertent actuation
- Include means to monitor the status of the vent system (e.g., valve position indication) from the control panel during ELAP
- Include means to monitor the effluent discharge for radioactivity with indication at the control panel during an ELAP
- Withstand and remain functional during severe accident conditions
- Designed and operated to ensure the flammability limits of gases in the system are not reached or designed to withstand dynamic loading from deflagration and detonation
- Minimize the potential for hydrogen gas migration and ingress into the reactor building or other buildings
- Includes features and provisions for operation, testing, inspection and maintenance adequate to ensure that reliable function and capability are maintained

Development of a HCVS system, whether by modification of the existing system or installation of new system, which meets the above requirements will result in a robust and reliable venting system and will also mitigate event CPFFRBLDFAILDUCTL1. Specifically, compliance with the requirements to minimize unintended cross flow of vented fluids within a unit and to minimize the potential for hydrogen gas migration and ingress into the reactor building will prevent or significantly reduce the likelihood of this event since the flow path from the vent to the reactor building HVAC system will be reduced.

RAI 5.b

Request the following information with regard to the selection and screening of Phase I SAMA candidates. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's basis for the selection and screening Phase I SAMA candidates. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Phase I SAMA selection and screening process for the SAMA evaluation.

b. *ER Section D.2.1 indicates that documentation for 11 previous industry SAMA analyses were reviewed to identify potential SAMA candidates. Discuss how SAMAs from these sources were selected for incorporation into the Fermi 2 Phase I SAMA identification.*

Response:

The review of industry SAMA analyses was focused on identifying SAMA candidates that proved to be potentially cost-beneficial for other plants. These SAMA candidates were then screened based on their applicability to the Fermi 2 plant design, if they had already been implemented, or if they were covered by a SAMA candidate already retained for a cost-benefit analysis. Potentially cost-beneficial SAMA candidates for other sites were not screened from analysis based on implementation costs.

RAI 5.c

Request the following information with regard to the selection and screening of Phase I SAMA candidates. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's basis for the selection and screening Phase I SAMA candidates. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Phase I SAMA selection and screening process for the SAMA evaluation.

c. Documentation on the identification and disposition of all Phase I potential candidate SAMAs does not address vulnerabilities or enhancements from the IPE. While no vulnerabilities were found in the IPE, several opportunities for enhancements were identified. The status of these enhancements is not addressed in the license renewal application ER nor elsewhere in the cited supporting documents. The NRC staff Safety Evaluation Report on the IPE notes that the hard-piped containment venting was installed but indicates that several potential plant improvements were identified for further consideration. Confirm whether or not all IPE identified "enhancements" have been implemented and further consider those that may not have been implemented.

Response:

Actions were taken to implement potential improvements identified for further consideration in the Fermi 2 Individual Plant Examination (IPE). The identified enhancements and actions taken are described below:

IPE-Identified Improvement Item (verbatim)

"To enhance the recovery potential from a divisionalized loss of offsite power, instructions for inter-divisional cross tying of the power supply for the standby feedwater system were added to the appropriate abnormal operating procedure dealing with loss of electrical buses (Such provisions already existed in a standard operating procedure)."

How Addressed

Revision 6 of 20.300.05 "Loss of 4160V BOP Busses" was issued 7/30/1992. This implemented the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To enhance the recovery potential from a divisionalized loss of off-site power, the overall procedural and training guidance will be evaluated to see if effective improvements to more explicitly deal with divisional losses can be made to the extensive provisions currently in place for loss of power events. This is expected to be complete by the end of 1993. In addition, a potentially misleading statement concerning the electrical load capability of the maintenance cross-tie of safety buses was identified in a procedure and will be corrected by October 5, 1992."

How Addressed

Two new abnormal operating procedures were developed to deal with divisional loss of offsite power: 20.300.13, Rev 0 and 20.300.14, Rev 0. Additionally SOP 23.321 was revised to correct the potentially misleading statement. These actions implemented the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To further enhance the understanding of severe accidents on an operational level, selected insights derived from the IPE are to be incorporated into licensed operator training. This is expected to be made available by the end of 1993."

How Addressed

Licensed operator requalification training was performed in 1994 under cycle 1 training. Additionally, the Probabilistic Safety Assessment group performs training for licensed operator requalification and initial licensed operator training classes following major model releases. This implements the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To further enhance the understanding of severe accidents by the Nuclear Generation Organization in general, presentation and training on Fermi 2 IPE insights will be given to selected audiences. For example, such a segment will be included in the Technical Staff and Managers Continuing Training courses scheduled in 1993. Appropriate training will also be developed for technical support personnel in the Emergency Response Organization."

How Addressed

IPE training for technical staff and managers was completed September 1993. This implements the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To further enhance the ability to prevent the occurrence and mitigate the effect of severe accidents, the results of the IPE will be used in conjunction with BWROG severe accident guidelines now under development to develop Fermi 2 specific accident management plans in accordance with the expected NRC generic letter on accident management."

How Addressed

Fermi 2 has site-specific accident management plans. Fermi 2 also participates in the BWROG Emergency Procedures Committee. This implemented the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To help maintain the interfacing LOCA initiating frequency at its current low value, administrative controls will be reviewed to assure that the current practice of testing selected pressure boundary valves only at shutdown is maintained."

How Addressed

The requirement to test the valves during shutdown is in the Inservice Inspection – Inservice Testing (ISI-IST) program and implemented in valve testing procedures (e.g. 24.204.04 "RHR Shutdown Cooling Valve Operability" at the time of the IPE). This requirement is still in effect. This implemented the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To minimize system unavailability effects on the potential for core damage, the PRA model will be used to provide more explicit quantified risk impacts of system outages."

How Addressed

This improvement was implemented first through the use of a risk matrix and since by implementation of the Maintenance Rule and procedure MMR12 "Equipment Out of Service Risk Management." This implemented the IPE identified improvement item.

IPE-Identified Improvement Item (verbatim)

"To minimize the potential of misalignment of key standby safety systems, the latest procedures that affect the system alignment will be reviewed to ensure confidence that adequate administrative controls on equipment status are included."

How Addressed

A review that included general administrative controls on system alignments was performed and the Fermi 2 commitment tracking system documents the basis to close the commitment to perform the improvement item. This implemented the IPE identified improvement item.

RAI 5.d

Request the following information with regard to the selection and screening of Phase I SAMA candidates. <u>*Basis:*</u> *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's basis for the selection and screening Phase I SAMA candidates. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's Phase I SAMA selection and screening process for the SAMA evaluation.*

d. Relative to the Phase I screening of candidate SAMAs, Phase I SAMA 086 to install a filtered containment vent to remove decay heat was combined with SAMA 123 for an anticipated transient without scram (ATWS) sized filtered containment vent. Because a filtered vent to remove decay heat is considerably smaller than that required for an ATWS event, the evaluation of SAMA 123 does not appear to be valid for SAMA 086. Provide an evaluation of SAMA 086.

Response:

The cost provided in Table D.2-1 for SAMA 123 –" Install an ATWS sized filtered containment vent to remove decay" heat was a rough conceptual cost of $40,000,000, which was estimated from industry group participation in 2013 in discussion of a filtered vent. At that time the cost was assumed to be in the range of $40,000,000 to $50,000,000; the lower cost was used in the SAMA to be conservative for the cost/benefit comparison, and because the estimates were considered very rough. There was no increase in cost assumed to handle an ATWS sized filtered containment vent, since the rough estimate of the cost of the filtered vent was such that the SAMA was not cost beneficial.

On May 31, 2014, NEI on behalf of the industry, submitted a cost estimate for a filtered vent with a small filter and severe accident capable water makeup and for a large filter with severe accident capable water makeup, in response to an NRC request. Neither size filter was sized for an ATWS, the smaller filter capacity was assumed sufficient to maintain high effectiveness for scenarios where the suppression pool has initially captured early fission releases while the wetwell vent is in use, while the large filter would have capacity for fission product inventory that would be released without credit for retention in the suppression pool (wetwell) (i.e. a filter that is used from the drywell airspace). The cost estimates provided were conceptual in nature. With contingency, and subtracting the estimated $3.7M dollar cost of the water makeup, the small filter cost was $31.7M, and the large filter estimate was $51.2M. These cost estimates were based on incremental costs of filter installation relative to current conceptual designs planned for hardened containment vent in compliance with NRC Order EA-13-109.

Since these estimates are for a vent that is not specifically sized for an ATWS, the cost is appropriate to SAMA 086 and is lower than what it would cost for an ATWS sized vent. Even considering the cost for the smaller filter of $31.7M, SAMA 086 is not cost beneficial.

RAI 6.a

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

a. Identify what is included and what is not included in the Fermi 2-specific cost estimates, including such things as contingency, replacement power, lifetime maintenance, etc.

Response:

Fermi 2 specific cost estimates were developed based on initial hardware and installation costs only, not reoccurring costs. Items such as lifetime maintenance, procedure changes, and replacement power costs were conservatively not included in the cost estimate to reduce the estimated cost.

The only exceptions are the cost estimates for SAMA 145 (Increase training and operating experience feedback to improve operator response) and the SAMA evaluated in response to RAI 5.a.vi. The site specific cost estimate for SAMA 145 assumed additional operator training for the life of the plant. However, contingency and replacement costs were not assumed. The cost estimate for the SAMA addressed in response to RAI 5.a.vi included recurring costs for walking down the risk significant internal flooding piping segments.

RAI 6.b

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

b. For SAMA 012 to improve the 4.16-kV cross-tie ability, describe the existing Fermi 2 cross-tie capability, what the SAMA involves, and how it compares to the cited source for the cost estimate.

Response:

A manual bus tie connects the Division I bus to the alternate division transformer SS65, and a manual tie connects the Division II buses to the alternate division transformer SS64. The tie is made through two breakers, one at each end of the bus tie with both breakers normally open and racked out. The Fermi 2 analysis for implementation of this SAMA assumed that both the Division I and Division II crossties never failed, including operator actions to complete the transfer and sufficient power from the breakers.

The cited source for the cost estimate was developed based on increasing the capability through procedure changes and minimal hardware modifications. The proposed changes included providing a mechanism to easily bypass the emergency 4 kV AC feeder breaker interlocks such that new procedures would allow the operator to crosstie buses which share a common emergency transformer. The cited cost estimate was deemed applicable to Fermi 2 as it is anticipated that some hardware modifications would be required to gain any measureable increase in crosstie ability. In addition, it is noted that the assessed benefit (including uncertainty) would remain below the cost of implementation for Procedure Changes with Engineering and Training required.

RAI 6.c

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

c. *For SAMA 023 on developing procedures to repair or replace failed 4 kV breakers, the benefit is estimated by eliminating failure of the operator to cross tie non-emergency buses, failure to recover AC power from plant and switchyard-centered events, as well as failure during operation of non-emergency 4.16-kV buses. Are there other 4-kV breaker failures that can be mitigated by this SAMA?*

Response:

The source for SAMA 023 of NEI 05-01 is from NUREG-1560 Volume 2. NUREG-1560 Volume 2 references a vulnerability identified by the Beaver Valley 1 IPE, specifically "Failure of breakers that perform transfer of 4.16 kV non-emergency buses from unit station service transformers to system station service transformers, can lead to loss of emergency AC power if the diesel generators also fail." Beaver Valley's approach to resolving this vulnerability was to develop procedures and training to repair or change out failed breakers.

The Fermi 2 4.16 kV emergency buses are normally powered from offsite sources, not from the unit generator, so there is no need to transfer the power supply from a unit station service transformer to a system station service transformer when the plant shuts down. Following a partial or complete loss of offsite power, EDGs will automatically start and resupply the ESF buses. There are no capabilities to provide power to the ESF buses from non-emergency buses. Therefore, this SAMA (SAMA 023) should have been originally screened during Phase 1 as "Not Applicable."

It should be noted that SAMA 012, SAMA 014, SAMA 016, SAMA 024, and SAMA 026 evaluate improvements to the emergency ESF bus supplies.

RAI 6.d

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

d. The title of SAMA 031, "Revise procedures to allow intermittent operations of HPCI and RCIC," is not consistent with the intent of the SAMA as inferred by the description of the analysis of this SAMA. SAMA 031 is indicated to involve the elimination of intermittent operation of HPCI/RCIC by allowing flow to be throttled thus preventing intermittent starts and stops. Clarify the description and intent of this SAMA and provide a consistent evaluation of its cost benefit.

Response:

NEI 05-01 references NUREG-1560 Volume 2 as the source document for SAMA 031. The SAMA "Revise procedures to allow intermittent operation of HPCI and RCIC" is intended to result in extended operation of HPCI and RCIC. Upon further review of NUREG-1560 Volume 2, the direct source and purpose of this SAMA was not identified. However, NUREG-1560 does state that the "FitzPatrick and Vermont Yankee [IPE] submittals mention the evaluation of procedure improvements to lessen the chance of loss of HPCI and RCIC when performing emergency depressurization." Based on this discussion from NUREG-1560, and since the term intermittent operation is not defined and open to interpretation, the interpretation by DTE of the purpose of this SAMA would be to operate HPCI or RCIC in such a manner to slow the rate of depressurization of the RPV, thereby maintaining the vessel at a higher pressure and extending the duration at which RPV pressure can support successful operation of HPCI/RCIC (i.e., sufficient turbine speed).

1) The importance of HPCI/RCIC availability is lower at Fermi 2 due to the availability of the Standby Feedwater System (SBFW). The SBFW system at Fermi 2 consists of two motor driven pumps that provide an additional source of water to the RPV to maintain core cooling during plant transients. The availability of the SBFW system provides an additional method of reactor makeup should HPCI/RCIC become unavailable later in the event.
2) For Station Blackout (SBO) scenarios, both SBFW and Suppression Pool Cooling (SPC) would be unavailable due to loss of AC power. For scenarios where suppression pool cooling is not available "early" (i.e. before the Heat Capacity Limit (HCL) is reached) there is no benefit for "intermittent operation", since depressurization on HCL is required in approximately 5 hours into the scenario (much earlier than any loss of RPV pressure).

3) For scenarios where suppression pool cooling is available early, HPCI and/or RCIC are shown in MAAP runs to run for the 24 hour PRA mission time without loss of RPV pressure becoming a concern. Furthermore, hot shutdown conditions (a safe and stable end state) are achieved in these scenarios with HPCI and/or RCIC without accounting for "intermittent operation" (note that hot shutdown is considered a successful end state in the Fermi PRA model). Current operating procedures allow for cycling of the HPCI/RCIC (on at Level 2 and off at Level 8) before operators take manual control of the pumps to throttle flow and maintain RPV water at a constant level, thus preventing additional cycling. However, the MAAP runs that were utilized to analyze these scenarios essentially model "intermittent operation" in that they allow HPCI/RCIC to cycle between Level 2 and Level 8 without operator intervention.

In summary, the SBFW system reduces the importance of HPCI/RCIC because it provides a similar function; in SBO sequences there is no benefit to extending operation of HPCI/RCIC because lack of suppression pool cooling leads to emergency depressurization and loss of steam for HPCI/RCIC due to HCL in 5 hours; and HPCI/RCIC operation in scenarios with suppression pool cooling operating will extend to 24 hours with operators allowing several “cycles” before they take manual control. Based on this information, the PRA supporting analyses essentially models “intermittent operation” of HPCI and/or RCIC by allowing reactor vessel level to cycle between Level 2 and Level 8 and includes extended HPCI/RCIC operation when appropriate. Therefore, there is no additional quantifiable impact beyond the averted cost risk in SAMA 031.

RAI 6.e

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

e. For SAMA 074 to improve pneumatic components of safety relief valves (SRVs) and main steam isolation valves (MSIVs), explain how eliminating the air dependency of these valves models improvement of the reliability of SRVs and MSIVs and confirm that all of the pneumatic components and the important relevant failure modes of the valves are considered in the evaluation.

Response:

The original evaluation of SAMA 074 eliminated the basic event that resulted in MSIVs transferring closed and removed the air dependency of the valves. The failures of pneumatic components of MSIVs are not individually modeled. Therefore, removing the air dependency of the valves was selected as an alternate method of improving the overall reliability of the valves.

For SRVs, the analysis conservatively eliminated the failure of all equipment supporting air supply to the valves, including accumulators, check valves, ESF AC power, MPUs, normal air supply and nitrogen backup. Similar to the MSIVs, since pneumatic components of the valves are not individually modeled, eliminating the failures listed above was selected as an alternate method of improving the overall reliability of the valves.

The SAMA was evaluated again by assuming the hardware failure probabilities of the MSIVs to close and SRVs to open (including AC and DC power supplies) were improved by 15% in addition to those changes made in the original SAMA evaluation. Common cause failure event probabilities for both the MSIVs and SRVs were also reduced by 15%. The resulting averted cost was determined to be $943. The averted cost for the 95th percentile uncertainty case was $2358. These costs are the same as those from the original SAMA evaluation. Therefore, the SAMA remains not cost beneficial.

RAI 6.f

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

f. Provide further information and justification for the modeling of the benefit of SAMA 078 to enable flooding of the drywell head seal, including the expected containment failure location(s) and why only Class II and IV large rupture sequences were considered. Explain why the benefit is so small considering that Class IV (anticipated transients without scram sequences) would be expected to make up a significant part of release category H/E, which is the major contributor to risk.

Response:

The drywell head leakage failure mode percentage is highly dependent upon containment temperature (being a dominant failure mode for intermediate temperature and high temperature cases).

The benefit of SAMA 078 is expected to be smaller for Class II and IV accident classes, because these classes involve containment failure before core damage (by definition for Class II and due to hydrodynamic loading and overpressure phenomenon for Class IV). The containment failures assumed in the PRA model are large for these accident classes (guaranteed failure for the NC [containment failure is large] node). Large containment failures (e.g. containment rupture) involve phenomenology that seal cooling could not mitigate. Also, the containment temperatures at the time of failure for these cases are considered "low" (<500 F) and thus the impact of drywell seal flooding would be negligible on Class II or Class IV accident sequences. Also, failure at the drywell head seal is actually beneficial in Level 1 PRA sequences compared to failure at other locations (due to the much lower profile for damage to mitigating equipment as a result of adverse environmental conditions for mitigating equipment at the lower levels of the Reactor Building). Therefore, there is no impact on the CDF risk metric for the implementation of SAMA 078.

An alternative method for evaluating the effectiveness of this SAMA is to examine the effect that prevention of drywell head seal leakage would have on Level 2 containment failure scenarios where containment temperatures could become elevated into the "high" or "intermediate" ranges. In this assessment, the impact of Accident Class I, II, III, and IV is considered (Class V is not considered since the containment has been bypassed at the time of core damage). A conservative method to model this SAMA is by assuming that the "Drywell Intact" (DI) node is always successful (i.e. the drywell does not fail) when questioned.

The total averted cost for this method is $97,454. With uncertainty the averted cost is $243,636. The cost estimate for a plant modification to install drywell head seal flooding capability is $1,000,000 based upon the Vermont Yankee LRA. Thus the SAMA would not be cost-beneficial.

RAI 6.g

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

g. For SAMA 154, "Modify procedures to allow switching of the combustion turbines to buses while running," explain how eliminating all failures during operation of the combustion turbine generators (CTGs), including the startup diesel generator and failures of the CTG transformers during operation, relates to the impact of the SAMA.

Response:

The CTGs fulfill the following functions:

- Dedicated Shutdown
- Appendix R Applications
- Station Blackout Recovery
- DTE System Support

The CTGs normally self synchronize to their respective buses (1-2A or 3-4A). However, manual synchronization can also be performed. If the CTGs are operating for testing or peaking purposes there is a procedure in place to hot transfer the power from the normal "D" breaker to the alternative "A-6" breaker. Therefore, the intent of this SAMA is currently met and the SAMA should have been screened during the Phase 1 screening process as "Already Implemented."

In the event of an unstable grid or blackout event it is expected that the CTG(s) would trip on frequency instabilities. To protect the blackstart unit, Operations is directed to open the three off-site power feeds if grid instability occurs. The CTG(s) could be restarted and plant loads added in a controlled manner to minimize frequency fluctuations.

The PSA model assumes the CTGs are available during CTG operation during testing or peaking purposes.

RAI 6.h

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

h. SAMAs 165 and 166 both address mitigating the failure of emergency core cooling system low pressure permissives with a stated order-of-magnitude improvement by operator action to bypass the low pressure permissives (p. D-121). With an associated CDF reduction of 3 percent, explain why the human error probability for this operator action does not appear in the Level 1 importance list.

Response:

The human failure event HE1FLPISBYPLPP was inadvertently omitted from the Level 1 importance list. The human failure event was assumed to be a flag event because of its probability of 1.0. This basic event should have been included in the Level 1 importance list.

A review of basic events with a probability of 1.0 in the Level 1 and LERF results were reviewed to identify if any other important events originally thought to be "Flag" events were inadvertently overlooked. One additional Level 1 basic event was identified: HE1FRBCW-FL-ISOL-AB3, "Fail to Term. Flood from EECW in an AB3 SWGR Room." This event was originally credited in the PRA. The probability of the event was calculated based on the assumption that credited actions all occur in the MCR. During the peer review it was determined that there is the potential for water accumulation in one or both of these rooms to fail power to the valves required to isolate the flood. To address this finding in the model, the value for this HEP was set to 1.0 in the model. A new SAMA evaluation was performed for this event to evaluate the potential improvement from crediting a new procedure for manually closing the valves that isolate the flood. The probability of the event was changed from 1.0 to 0.1 for this evaluation. The result of the evaluation is an averted cost of $120,688 and $301,719 when considering uncertainty. Based on the uncertainty averted cost, this SAMA would be considered potentially cost beneficial even when assuming a cost in the high range for procedures (e.g., $200,000).

The review of the LERF events identified four additional events that should be considered. They are:

- PHPHGVFAIL — Failure of Combustible Gas Venting
- PHPHCNTM-BURN — Hydrogen Deflagration Occurs Globally

- PHPHL2CZMELT Control Rods Melt Prior To Fuel Rods
- PHPHDWVTPCISOL Operator Fails To Isolate Path Given Isolation Signal Fails

The first event, PHPHGVFAIL, will be addressed by implementation of NRC Order EA-13-109, “Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions.” Compliance with this order will result in a robust and reliable venting system for Fermi 2. DTE intends to comply with the Order, so there is no need to address this event with a specific SAMA.

Event PHPHCNTM-BURN, is addressed by SAMAs 93 (Provide post-accident containment inerting capability) and 103 (Install a passive hydrogen control system). A bounding analysis was performed for these SAMAs by eliminating all hydrogen deflagrations that result in containment or drywell failures. Neither of these SAMAs were found to be cost beneficial.

A new SAMA evaluation was performed for event PHPHL2CZMELT to evaluate replacing the current control rods with rods that have metal cladding with a higher melting point than the fuel. This was evaluated by revising the probability of PHPHL2CZMELT from 1.0 to 5E-2 and re-quantifying the model. The result was an averted cost of $13,082 and $32,706 when uncertainty was considered. The cost of replacing control rods and disposing of the existing rods is estimated to greatly exceed the benefit of this SAMA so this SAMA is not cost beneficial.

A new SAMA evaluation was performed for event PHPHDWVTPCISOL, which represents the failure to isolate containment bypass paths. The probability of the event was revised from 1.0 to 0.1 for the evaluation. The result of the evaluation was an averted cost of $11,948 and $29,870 when considering uncertainty. This SAMA is not cost beneficial even when considering low cost changes such as new procedures.

RAI 6.i

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. <u>Basis:</u> Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

i. *The cost for SAMA 176 to develop a procedure to open the door to the emergency diesel generator buildings upon the high temperature alarm is given as $200,000 based on a Sequoyah Nuclear Power Plant (Sequoyah) estimate. Because this cost exceeds other typical procedure implementation costs, identify the specific source of this estimate in the Sequoyah documentation and provide additional justification on its relevance to Fermi 2.*

Response:

In addition to revising or developing procedures, the cost of implementation is driven by the supporting analysis that would be required to determine the viability of opening doors or temporary ventilation with respect to timing and the effectiveness of such measures. The specific analysis in the Sequoyah documentation is from Sequoyah SAMA 268 "Perform an Evaluation of the CCS/AFW Area Cooling Requirements." From the Sequoyah ER, "A realistic room heat-up analysis would determine the cooling requirements that are currently performed by the CCS and AFW Space Coolers and establish whether or not these coolers are required for the PRA mission time of 24 hours." The stated cost for implementation of this SAMA at Sequoyah is approximately $300,000. This implementation cost is deemed applicable to Fermi 2 since, in addition to procedures changes and training, an evaluation would be required to determine if opening doors would provide sufficient ventilation in the time required. It is noted that the planned Sequoyah analysis encompasses both Unit 1 and Unit 2 equipment in the shared Auxiliary Building. Since the Sequoyah analysis may be more complex given the larger area, the cost of implementation for this SAMA at Fermi 2 was reduced to $200,000. This cost of implementation is also consistent with the assumed range for procedural changes with engineering and testing/training required.

RAI 6.j

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

j. SAMAs 183 and 187 both involve improvements to the alternate shutdown panel. DTE assumed that this reduced the conditional core damage probability (CCDP) of operation from the alternate shutdown panel by a factor of 10. Table D.1-2 includes basic event HE1FRSP-CNTRL "Operators fail to shutdown from outside the main control room" (p. D-10), which is described as included in an internal flood scenario. Provide additional information on how the benefit of these SAMAs was determined including the potential for impacting both fire risk and internal event risk.

Response:

The evaluation of SAMAs 183 and 187 only addressed potential improvements for fire initiated scenarios which required control room (CR) evacuation. The benefit was determined by calculating the reduction in fire CDF that would result in a reduced core damage probability of the failure of operation from the alternate shutdown panel. The first step was to determine the CR complex (09AB) fire CDF and the portion of that frequency associated with evacuation of the control room. As a result of IPEEE RAIs (Reference 1 of this response), the control room CDF was revised to 7.36E-06/yr as documented in Reference 1. From the original IPEEE (Reference 2 of this response, Section 4B.2.3.11), the unsuccessful suppression (e.g., CR evacuation required) portion of the CR CDF is 3.27E-07/yr. Improvement of the alternate shutdown panel reduces this part of the CDF. Assuming an order of magnitude reduction, the new CDF for CR evacuation is 3.27E-08/yr for a reduction in CDF of 2.94E-7/yr (3.27E-07 – 3.27E-08). As discussed in Section D.1.3.4 of SAMA analysis, the IPEEE fire CDFs are reduced by 50% for use in the SAMA analysis. Therefore total fire CDF reduction for this SAMA is 1.47E-07/yr.

In order to determine the benefit of this reduction it was necessary to calculate a reduction factor using the SAMA CDF reduction and the Fermi 2 CDF with external events.

$$Factor = {(CDF_{With\ EE} - CDF_{SAMA\ Reduction})}/{CDF_{With\ EE}}$$

The resulting factor (0.991) was then applied to each of the base release category frequencies in order to determine the new MACR for this SAMA. This method was necessary because the

IPEEE used the FIVE methodology. The SAMA MACR was then subtracted from the base case MACR to determine the total benefit for the SAMA.

In order to address alternate shutdown panel improvements for the combination of internal flooding and fire, an evaluation reducing flooding event HE1FRSP-CNTRL is first performed by reducing this event by an order of magnitude and then re-quantifying the model. The fire reduction factor will then be applied to the new CDF and release categories to determine the benefit for both flooding and fire events. When this is done, the benefit when considering both fire and flooding is determined to be $81,192 ($204,730 including 95th percentile uncertainty). This is an increase in benefit compared to the benefit for addressing fire alone ($30,330). The cost of implementation for SAMAs 183 and 187 (improve alternate shutdown panel) is estimated to be $790,000. Therefore, implementation of this SAMA would not be cost-beneficial when including both fires and flooding.

References

1. Letter NRC-99-0051, "Detroit Edison Response to NRC Request for Additional Information (RAI) on Fermi 2 IPEEE Report," July 22, 1999.
2. Letter NRC-96-0037, "Submittal of the Detroit Edison Individual Plant Examination for External Events (IPEEE) Report – Response to Generic Letter 88-20, Supplement 4", March 29, 1996.

RAI 6.k

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

- k. *Provide additional information on how the benefit was determined for SAMAs mitigating internal fires (e.g., SAMAs 183, 187, and 206 through 211) including the determination of the change in fire CDF and how this was used to determine the cost-risk benefit. The information should include:*
  - i. *The differing assumptions in the SAMAs concerning the reduction in CCDP due to the modifications ("... reduced to that for non-severe fires" versus "... being reduced by an order of magnitude").*
  - ii. *The specific source, values, and calculations used to determine the reduced fire CDF for at least one example SAMA.*
  - iii. *How the cost risk benefit was obtained from the reduction in fire CDF.*

Response:

i. Because the Fermi 2 IPEEE Fire analysis was performed using FIVE and there is not an integrated quantitative model, it was necessary to estimate the reduction in fire CDF based on the IPEEE compartment scenario analysis. The resulting reduction in CDF is used to determine a reduction factor that is uniformly applied to the CDF and release category frequencies. See the response to RAI 6.j for additional discussion of this method.

   The differing assumptions were necessarily based on the analyses provided in the IPEEE. Non-severe fires are those that are assumed to fail the equipment associated with the initiating fire only and not propagate to nearby equipment. Severe fires will fail the equipment and propagate to nearby equipment. For example, a non-severe cabinet fire will fail all equipment supported by that cabinet (e.g., Div. 1 Residual Heat Removal (RHR)). A severe fire in the same cabinet is assumed to fail the Div. 1 RHR and also propagate and fail other equipment (e.g., Div. 2 RHR). Not all IPEEE scenarios credit or consider the distinction between severe and non-severe fires. When a distinction was made in severity, the scenario identified conditional core damage probabilities (CCDP) for both the severe fire and the non-severe fire which were used in the SAMA analysis. For those scenarios where the fires were not characterized for severity, the assumption was the non-severe fire CCDP is an order of magnitude lower than the severe fire CCDP. This is supported by those scenarios for which this information is available.

The major assumption in performing the fire SAMAs was that the addition of successful detection and fire suppression would convert a severe fire into a non-severe fire. The suppressed fire does not propagate and its CCDP is lower than the CCDP of the severe fire. Since it is assumed that the probability of successful detection and suppression is 0.95, the remaining, non-suppressed portion (0.05) of the fire retains the severe fire CCDP. Therefore, for a given component, the existing severe fire scenarios were split into two scenarios: 1) Successful suppression scenario, with a 0.95 probability of success and a lower CCDP, and 2) Non-successful suppression scenario, with a 0.05 probability of failure and the original, severe CCDP. An example evaluation is provided in the response to RAI 6.k.ii.

ii. The SAMA evaluations were performed using spreadsheet calculations and information for the Fermi 2 IPEEE. The evaluation for SAMA 207 is provided below.

SAMA 207—Div 1 Switchgear Room (04ABN)

	Severity Factor	**Cubicle Factor**	**Ignition Frequency**	**Prob of Supp**	**CCDP**	**IPEEE CDF w/ Mod**	**IPEEE Total**
480V 72C Bus/Trans Fire						9.88E-08	1.06E-06
Scenario 1a(1)	0.1		3.00E-04	0.95	1.60E-04	4.56E-09	
Scenario 1b(2)				0.05	3.40E-02	5.10E-08	
Scenario 2 & 3	0.9		3.00E-04	1	1.60E-04	4.32E-08	
480V 72B Bus/Trans Fire						9.28E-08	1.05E-06
Scenario 1a(1)	0.1		3.00E-04	0.95	1.40E-04	3.99E-09	
Scenario 1b(2)				0.05	3.40E-02	5.10E-08	
Scenario 2 & 3	0.9		3.00E-04	1	1.40E-04	3.78E-08	
480V 64C Bus/Trans Fire						4.29E-08	3.74E-07
Scenario 1a(1)	0.1		1.00E-04	0.95	1.64E-04	1.56E-09	
Scenario 1b(2)				0.05	3.40E-02	1.70E-08	
Scenario 2	0.9	0.14	1.00E-04	1	1.93E-03	2.43E-08	
Scenario 3	0.9	0.86	1.00E-04	1	1.64E-04	1.27E-08	
4160V 64B Bus Fire						3.02E-08	4.96E-07
Scenario 1a(1)	0.1		1.40E-04	0.95	1.40E-04	1.86E-09	
Scenario 1b(2)				0.05	3.40E-02	2.38E-08	
Scenario 2	0.9	0.1	1.40E-04	1	3.60E-04	4.54E-09	
Scenario 3	0.9	0.9	1.40E-04	1	1.40E-04	1.59E-08	
Total for Above Scenarios						2.65E-07	2.98E-06
IPEEE Total for 04ABN							4.51E-06
IPEEE Total for 04ABN with modification						1.79E-06	
IPEEE Fire Delta CDF						2.72E-06	
SAMA Fire Delta CDF(3)						1.36E-06	

Table Notes
(1) Revised scenario with successful detection and suppression.
(2) Revised scenario with failed detection and suppression.
(3) The Fermi 2 Fire CDF has been adjusted lower by a factor of 2 for use in the SAMA analysis. Therefore, the CDF contribution for the subject failure has also been reduced by a factor of two.

The information in columns Severity Factor, Cubicle Factor, Ignition Frequency, CCDP and IPEEE Total was extracted from the IPEEE report. For example, the information for these columns for the 480V 72C Bus/Transformer Fire scenarios is found on Page 4-100 of the IPEEE. Scenarios 1a and 1b replace IPEEE Scenario 1 for the SAMA evaluation. Scenario 1a is the successful suppression scenario which incorporates a 0.95 probability for success and uses the non-severe CCDP. Scenario 1b is the failed suppression scenario which incorporates a 0.05 probability for failure of suppression and the higher, severe CCDP from the original scenario. Scenarios 2 & 3 did not change for the SAMA evaluation because they already were considered to be non-severe scenarios which do not result in propagation to other components. The IPEEE CDF w/Mod column tabulates the individual scenario CDFs for each and provides the sum of those CDFs in the cell above the scenario values.

The other cabinet scenarios are evaluated using the same methods. The fifth row from the bottom of the table (Total for Above Scenarios) provides a comparison of the fire CDF for the evaluated cabinets for the IPEEE CDF w/Mod and IPEEE Total. The next row, IPEEE Total for 04ABN, shows total CDF for the entire auxiliary building fire compartment (04ABN). The following row, IPEEE Total for 04ABN with modification, shows the CDF for the entire compartment with the addition of fire detection and suppression for the evaluated cabinets. The next to last row provides the delta in IPEEE CDF for the SAMA modification compared to the IPEEE compartment CDF. As previously discussed the fire CDF in the SAMA is 50% of the IPEEE fire CDF. Therefore the fire CDF reduction for the SAMA is provided in the last row.

iii. In order to determine the benefit of this reduction it was necessary to calculate a reduction factor using the SAMA CDF reduction and the Fermi 2 CDF with external events.

$$Factor = {(CDF_{With\ EE} - CDF_{SAMA\ Reduction})}\Big/{CDF_{With\ EE}}$$

$$= {(1.65 \times 10^{-5} - 1.36 \times 10^{-6})}\Big/{1.65 \times 10^{-5}}$$

$$= 0.92$$

This factor is applied to each of the base release category frequencies and then used to calculate a new maximum averted cost risk (MACR) for the SAMA. Inherent in this method is the assumption that the CDF and all release category frequencies are reduced by the same percentage. This is a spreadsheet calculation with all costs calculated based on the release category frequencies and the Level 1 CDF along with various constants determined by the Level 3 analysis.

RAI 6.l

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. *<u>Basis:</u> Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.*

l. The SAMA costs for fire-related SAMAs 207 through 211 are from two sources, "Fermi Estimate" and "Implementation Cost from Cooper." Explain the reasons that the costs differ significantly between the two sources.

Response:

The cost estimates for SAMAs 207 through 209 were developed by Fermi. The total cost included equipment, design engineering, construction and material for the three areas. The construction and material costs were apportioned to the different SAMAs based on the engineering estimated for each SAMA. The Cooper estimate was actually based on a Brunswick estimate for medium sized, moderate complexity automatic fire water suppression systems. The primary difference in cost is the use of incipient detection for the Fermi 2 estimates as neither Cooper nor Brunswick included incipient detection.

RAI 6.m

Request the following information with regard to the Phase II cost-benefit analysis and site-specific cost estimations. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff evaluates the applicant's cost-benefit analysis of Phase II SAMAs. The requested information is needed in order for the NRC staff to reach a conclusion on the acceptability of the applicant's cost estimations for individual SAMAs and the cost-benefit analysis.

m. SAMAs 213 and 214 both involve providing leak detection and automatic isolation valves for emergency equipment cooling water (EECW) piping in the direct current switchgear room or the Division 2 switchgear room, respectively. The benefit for each was indicated to be based on the assumption that a flood from the piping failure would not result in the failure of any electrical equipment in the switchgear room in which the flood occurred. These SAMAs were identified to mitigate important flooding events whose disposition in ER Table D.1-2 indicated that the flood would or could cause failures in adjacent electrical rooms. Confirm that the benefit assessment included the elimination of failures in the adjacent rooms.

Response:

It is correct that the analyses for these two SAMAs eliminated failures of equipment in the flood location room as well as due to propagation of the flood outside of the room in which it occurs.

SAMA 213 – The analysis for SAMA 213 (flooding in DC switchgear room) included elimination of failures in adjacent rooms (both AC and DC equipment) due to the flood. The only failures that remained were of the system piping where the flooding occurs or systems that rely on that system (i.e., EECW and reactor building closed cooling water (RBCCW)).

SAMA 214 – The analysis for SAMA 214 (flooding in Division 2 switchgear room) included elimination of failures in adjacent rooms (both AC and DC equipment) due to the flood. The only failures that remained were of the system piping where the flooding occurs or systems that rely on that system (i.e., EECW and RBCCW).

RAI 7.a

For certain SAMAs considered in the Fermi 2 ER, there may be lower-cost or more effective alternatives that could achieve much of the risk reduction. In this regard, provide an evaluation of the following SAMAs. <u>*Basis:*</u> *Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff considers additional SAMAs that may be more effective or have lower implementation costs than the other SAMAs evaluated by the applicant. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's determination of cost-beneficial SAMAs.*

a. For basic event HE1FRSP-CNTRL "Operators fail to shutdown from outside the main control room" (p. D-10), consider improvements to training for this specific event as opposed to SAMA 145, which is much broader in scope.

Response:

With a risk reduction worth of 1.13, the risk significance of this basic event is well known. This event is specific to flooding events which require abandonment of the Main Control Room (MCR). A sensitivity analysis was performed to determine the benefit from increased training specifically for this event. The evaluation assumed a 50% decrease in the failure probability to shutdown from outside the MCR. The analysis resulted in an assessed benefit of $28,481. The sensitivity analyses resulted in assessed benefits of $36,239 (discount rate) and $71,201 (95th percentile uncertainty).

Since a simple procedure change is not anticipated to result in significant improvement for this operator action, procedure changes with training would be required. Therefore, implementation of this SAMA would not be cost-beneficial.

RAI 7.b

For certain SAMAs considered in the Fermi 2 ER, there may be lower-cost or more effective alternatives that could achieve much of the risk reduction. In this regard, provide an evaluation of the following SAMAs. Basis: Applicants for license renewal are required by 10 CFR 51.53(c)(3)(ii)(L) to consider SAMAs if not previously considered in an environmental impact assessment, related supplement, or environmental assessment for the plant. As part of its review of the Fermi 2 SAMA analysis, NRC staff considers additional SAMAs that may be more effective or have lower implementation costs than the other SAMAs evaluated by the applicant. The requested information is needed in order for the NRC staff to reach a conclusion on the adequacy of the applicant's determination of cost-beneficial SAMAs.

b. Discuss the potential for cost-beneficial SAMAs that include only leak detection as alternatives to SAMAs 213 and 214, both of which involve providing leak detection and automatic isolation valves for EECW piping. Leak detection might provide sufficient time for manual actions to isolate the flood source thereby limiting the failures due to flooding, particularly in adjacent rooms.

Response:

The Division 2 Switchgear Room (A3G10) and the DC Switchgear Room (B20), located on Elevation 643' of the Auxiliary Building are separated by an existing double door. EECW piping runs through both of these rooms. Several cost-benefit evaluations were previously performed for floods in these two rooms.

Flood Door

SAMA 197 evaluated upgrading the existing double door to a flood door in order to prevent propagation between these two rooms. The analysis was performed by assuming that the new flood door never failed. The averted cost risk was determined to be $89,655 ($224,137 including 95th percentile uncertainty). The cost of implementation was estimated to be $418,720.

Leak Detection and Automatic Isolation Valves

SAMA 213 evaluated installing leak detection and automatic isolation valves on EECW piping in the DC Switchgear Room (B20). The analysis was performed by modifying the model to prevent propagation of the flooding from room B20 to adjacent areas. The averted cost risk was determined to be $98,645 ($246,612 including 95th percentile uncertainty). The cost of implementation was estimated to be $377,000. The analysis for SAMA 213 (flooding in DC switchgear room) included elimination of failures in adjacent rooms (both AC and DC equipment) due to the flood. The only failures that remained were of the system piping where the flooding occurs or systems that rely on that system (i.e., EECW and RBCCW).

SAMA 214 evaluated installing leak detection and automatic isolation valves on EECW piping in the Division 2 Switchgear Room (A3G10). The analysis was performed by modifying the model to prevent propagation of the flooding from room A3G10 to adjacent areas. The averted cost risk was determined to be $44,438 ($111,095 including 95th percentile uncertainty). The cost of implementation was estimated to be $377,000. The analysis for SAMA 214 (flooding in Division 2 switchgear room) included elimination of failures in adjacent rooms (both AC and DC equipment) due to the flood. The only failures that remained were of the system piping where the flooding occurs or systems that rely on that system (i.e., EECW and RBCCW).

Leak Detection

The implementation cost for SAMAs 213 and 214 could be lowered by eliminating the automatic isolation valves and only installing leak detection and/or relying on existing level instrumentation in the RBCCW Makeup Tank and EECW Makeup Tank. It must be noted that the internal flooding analysis did not take any credit for the existing drains in these rooms when determining the minimum time before equipment damage and propagation may occur. The EECW piping in area A3G10 (associated with room coolers) is wrapped and situated over a curbed area, each with a 4” drain. Water is assumed to accumulate to a level of 12” and challenge the door to area B20 in 78 minutes.

The EECW piping in area B20 is wrapped, and some of the piping is located within HVAC ducting with a built in drain. However, for a rupture scenario, the EECW piping is assumed to fail and direct water out to the floor area where there are no drains. Water is assumed to quickly fail the DC equipment in this room. Water is assumed to accumulate to a level of 12” and challenge the door to area A3G10 in 46 minutes, and accumulate to a level of 6” in area A3G10 in 62 minutes at which equipment in this area is assumed to fail.

In addition the hardware costs for installing leak detection (which alarms in the MCR), the cost of implementation for this SAMA would also require procedure changes and enhanced training (a continuing cost) for operators on how to respond to the alarm and take action in sufficient time to prevent equipment damage. Furthermore, considerations must be given in procedures/training as to the other impacts that isolating EECW would have on the plant. EECW is essential in providing cooling to plant loads, and isolating this system could result in loss of other equipment and adverse impacts to the plant. Based on the analysis above, installing leak detection in these rooms (specifically the DC Switchgear Room) could be potentially cost-beneficial. However, a lower cost SAMA (procedure changes) is addressed below. Therefore, installing leak detection is not considered any further.

Procedure Changes

There are several existing control room indications that indicate that there is leakage in RBCCW/EECW piping (note that the systems share a great deal of common piping, including that for the flooding scenarios in question). These indications are:

a) RBCCW Makeup Tank Level Low

b) Divisional EECW Makeup Tank Level Low Alarms

The Division 2 Switchgear Room (A3G10) and the DC Switchgear Room (B20) are located very close to the Main Control Room. These indications are effective in indicating to the operators that the system is losing inventory. However, past operating experience has shown that the makeup valve position for these tanks has been somewhat unreliable. Excessive opening of the makeup valve will be indicative of a substantial system leak, but minor positioning of the valve (indicative of a minor leak) may not be sufficient indicator for operators that a leak has occurred.

Based on the proximity of these rooms to the MCR, and the availability of existing alarms, revising existing Alarm Response Procedures (ARPs) to direct operators to these rooms following indication of leakage in RBCCW/EECW piping could be a potentially cost-beneficial SAMA and will be retained for further evaluation.