ENT000009
Submitted: March 28, 2012

Entergy

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Fred Dacimo
Vice President
License Renewal

NL-09-165

December 11, 2009

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

SUBJECT: License Renewal Application – SAMA Reanalysis Using Alternate Meteorological Tower Data
Indian Point Nuclear Generating Unit Nos. 2 & 3
Docket Nos. 50-247 and 50-286
License Nos. DPR-26 and DPR-64

REFERENCE: 1. Entergy Nuclear Operations Inc. Letter NL-09-151, "Entergy Nuclear Operations Inc. Telephone Conference Call Regarding Met Tower Data for SAMA Analysis" dated November 16, 2009

Dear Sir or Madam:

In Reference 1 above, Entergy Nuclear Operations, Inc (Entergy) committed to providing the following information on or before December 16, 2009.

- The meteorological data and justification supporting its use in the SAMA analysis (e.g., if a single year is used or an average of several years),
- Revised estimates of the offsite population dose and offsite economic costs,
- Identification of the meteorological tower elevation from which meteorological data were obtained and the rationale for selecting the data from that tower elevation,
- Revised SAMA analysis results, specifically for the analysis case discussed in response to RAI 4e, dated February 5, 2008, and
- The complete MACCS2 input file used for the reanalysis (in electronic format).

The purpose of this letter is to transmit the requested information. Attachment 1 provides the SAMA reanalysis using alternate Meteorological Tower Data.

There are no new commitments identified in this submittal. If you have any questions, or require additional information, please contact Mr. Robert Walpole at 914-734-6710.

A128
NRR

I declare under penalty of perjury that the foregoing is true and correct. Executed on
12/11/09.

Sincerely,

FRD/dmt

Enclosure: 1. License Renewal Application– SAMA Reanalysis Using Alternate Meteorological Tower Data

cc: Mr. Samuel J. Collins, Regional Administrator, NRC Region I
Mr. Sherwin E. Turk, NRC Office of General Counsel, Special Counsel
Ms. Kimberly Green, NRC Project Manager
Mr. John Boska, NRR Senior Project Manager
IPEC NRC Resident Inspector's Office
Mr. Paul Eddy, New York State Department of Public Service
Mr. Francis J. Murray, President and CEO, NYSERDA

ATTACHMENT 1 TO NL-09-165

License Renewal Application – SAMA Reanalysis
Using Alternate Meteorological Tower Data

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3
DOCKET NOS. 50-247 AND 50-286
LICENSE NOS. DPR-26 AND DPR-64

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
LICENSE RENEWAL APPLICATION
SAMA Reanalysis Using Alternate Meteorological Tower Data

NRC Requests from November 9, 2009 Teleconference

(1) Provide meteorological data and justification supporting its use in the SAMA analysis (e.g., if a single year is used or an average of several years).

(2) Provide revised estimates of the offsite population dose and offsite economic costs.

(3) Provide identification of the meteorological tower elevation from which meteorological data were obtained and the rationale for selecting the data from that tower elevation.

(4) Provide revised SAMA analysis results, specifically for the analysis case discussed in response to RAI 4e, dated February 5, 2008.

(5) Provide the complete MACCS2 input file used for the reanalysis (in electronic format).

Response

The following document provides responses to the requests listed above.

(1) Section [4] describes and justifies the meteorological data used in the SAMA reanalysis.

(2) Revised estimates of the offsite population dose and offsite economic costs are provided in Tables 1 and 2.

(3) Identification of the meteorological tower elevation from which meteorological data were obtained and the rationale for selecting the data from that tower elevation are provided in Section [2].

(4) Revised SAMA analysis results, specifically for the analysis case discussed in response to RAI 4e, are provided in Tables 4 and 5.

(5) The complete MACCS2 input files used for the SAMA reanalysis listed in Section [10] are provided in electronic format.

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IP2 and IP3 SAMA Reanalysis

[1] Introduction

The IP2 and IP3 Severe Accident Mitigation Alternative (SAMA) analyses originally described in the Environmental Report (ER) of the license renewal application, dated April 3, 2007, used site specific meteorological data (wind speed, wind direction, temperature, and accumulated precipitation) obtained from the IPEC onsite meteorological monitoring system (Reference 1). As permitted by NEI 05-01, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document,"[1] (Reference 4) five years of meteorological data (2000-2004) were averaged and used in the original SAMA analyses. Since the SAMA analyses began in the fall of 2005, these five years were the most recent data available at the time of the original analyses. The five-year data included 43,848 (two leap years) consecutive hourly values of wind speed, wind direction, precipitation, and temperature recorded at the IPEC meteorological tower from January 2000 through December 2004. The results of the original SAMA analyses were reported in the ER and clarified in response to questions from the Nuclear Regulatory Commission (References 2 and 3).

As described above, the original SAMA analyses used five year averages of wind speed, wind direction, precipitation, and temperature. The averaging method for wind direction, however, was determined to be incorrect and, as a result, the averaged wind direction data was not representative of wind direction conditions in the region for the five year period (Reference 5). Therefore, the SAMAs have been reanalyzed using a single representative year of meteorological data as described below. As described further in Section [4] below, Year 2000 was selected as the representative year because, of the five years of data, it is the year that resulted in the most conservative (i.e. largest) calculated population doses. Using one representative year avoids the need to average multiple years of meteorological data, including wind direction.

In accordance with NEI 05-01 recommendations, the original SAMA analyses described in the ER included multiple cases including a baseline case with uncertainty and three sensitivity cases (use of a 3 percent discount rate, use of a longer plant life, and consideration of economic losses by tourism and business). The sensitivity cases in the ER did not identify additional potentially cost beneficial SAMAs beyond those already identified by the baseline with uncertainty case.

During their review, the Nuclear Regulatory Commission (NRC) Staff noted that incorporation of tourism and business losses could result in identification of additional cost beneficial SAMAs if it was considered the baseline case and multiplied to account for uncertainties. Therefore, in response to request for additional information (RAI) 4e, Entergy provided the results of a revised uncertainty analysis in which the impact of lost tourism and business was analyzed as the baseline analysis and multiplied to account for uncertainties (Reference 2). This uncertainty case resulted in the identification of two additional potentially cost beneficial SAMAs for IP2 and one additional potentially cost beneficial SAMA for IP3. Since it resulted in the largest number of potentially cost beneficial SAMAs, the RAI 4e analysis case is the most conservative case. The SAMA reanalysis described below was performed for the same most conservative case;

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1 NEI 05-01 was endorsed by NRC in **Federal Register** / Vol. 72, No. 156 / Tuesday, August 14, 2007.

i.e., the RAI 4e analysis case in which the impact of lost tourism and business was analyzed as the baseline analysis and multiplied to account for uncertainties.

Following the SAMA reanalysis, an additional sensitivity case was analyzed to provide a revised response to Round 2 RAI 5 (Reference 3). This sensitivity case determined the impact of applying values derived from NUREG-1570, Risk Assessment of Severe Accident-Induced Steam Generator Tube Rupture, although final industry consensus on the thermally-induced steam generator tube rupture (TI-SGTR) issue has not yet been reached. See Section [8] for a description of this sensitivity case.

As a result of the SAMA reanalysis and sensitivity case using a conservatively representative, single year of meteorological data (2000), three additional SAMA candidates were found to be potentially cost beneficial for mitigating the consequences of a severe accident for IP2 and three additional SAMA candidates were found to be potentially cost beneficial for IP3 (in addition to those previously designated as cost beneficial in Section 4.21.6 of the ER and References 2 and 3).

[2] Preparation of Annual Meteorological Data

The MACCS2 code accepts 8,760 consecutive hourly values (one year) of meteorological data. Each of the five years of meteorological data used in the original analysis was prepared for input into the MACCS2 code by converting values recorded at the primary meteorological tower at the IPEC site to the units used by MACCS2, assigning an atmospheric stability class based upon the temperature data, and using data substitution to fill in limited missing data.

The primary meteorological tower at IPEC records data on an hourly basis at three elevations, 10m, 60m, and 122m. All available data from the 10m elevation of the primary meteorological tower was used in both the original SAMA analysis and reanalysis because it is closest to the assumed release height of 30m and, therefore, would be most representative of the conditions at the point of release. Both the original SAMA analysis and reanalysis assumed a release height of 30m because it is approximately half the height above grade level of the IP2 and IP3 containment buildings, as recommended by NEI 05-01 to provide adequate dispersion of the plume to the surrounding area. Data from this elevation is also currently used in calculations for the effluent release reports submitted to the NRC pursuant to 10 CFR Part 50.36a and the IPEC emergency plan.

Data substitution methods used in the SAMA reanalysis were in accordance with Environmental Protection Agency (EPA) guidance provided in Reference 6. These methods included substitution of limited missing meteorological data with data interpolated, averaged, or curve-fit from previous and subsequent hours and substitution of valid data collected from the 60m elevation. In the MACCS2 input file for 2000, which was conservatively selected for use in the SAMA reanalysis, the following data substitutions were made.

Seventy-four hours of 10-meter wind direction data was missing for day 316 hour 14 through day 319 hour 15 (in METI00.inp). To maintain consistency and wind variability, data from the 60-meter sensor was substituted for the seventy four hours of missing 10-meter wind direction data.

Eight hours of temperature data was missing for day 95 hours 2 through 9 (in METI00.inp). Values for these eight hours were obtained by linear interpolation of the preceding and subsequent valid temperature values.

Data for all meteorological parameters was missing on day 104 hours 10 and 11, day 104 hour 19, day 255 hours 18 and 19, and day 294 hours 10 and 11 (in METI00.inp). Substitute values were obtained by interpolation, curve-fitting, or averaging the preceding and subsequent valid data values as appropriate.

[3] Non-Meteorological Level 3 Model Inputs

In addition to meteorological data, MACCS2 also uses input data for population, land fraction, watershed class, regional economic data, agriculture data, emergency response assumptions, and source terms. These inputs are described in Sections E.1.5 and E.3.5 of the ER.

For the regional average value of non-farm wealth (VALWNF), a value of $208,838.49/person was used in the SAMA reanalysis consistent with sensitivity case 3 in the ER. As mentioned in Section [1], the RAI 4e analysis case (which is ER sensitivity case 3 multiplied to account for uncertainty) is the most conservative case, resulting in the largest number of potentially cost beneficial SAMAs. The reanalysis was performed for the RAI 4e analysis case in which the impact of lost tourism and business was analyzed as the baseline analysis and multiplied to account for uncertainties. Consequently, the revised benefit results for all SAMAs include the impact of lost tourism and business, as described in the response to request for additional information (RAI) 4e (Reference 2).

The other, non-meteorological data were the same as those described for the baseline case in the ER (described in Sections E.1.5 and E.3.5 of the ER). Since the reanalysis uses the same non-meteorological input data as the original RAI 4e analysis case, the only difference between the original RAI 4e analysis and the reanalysis is the meteorological data.

[4] MACCS2 Analysis and Results

As with the original SAMA analysis, the SAMA reanalysis also used MACCS2 to estimate the mean population dose risk (PDR) and offsite economic cost risk (OECR). Preliminary results from MACCS2 using each of the five years of meteorological data (2000-2004) were compared. Since the dose and economic cost results for all of the individual years were similar, the year that resulted in the most conservative (i.e. largest) doses (year 2000) was selected as the representative year for use in the SAMA reanalysis. This method of choosing a representative year agrees with the example provided in NEI 05-01. The revised estimated mean values of PDR and OECR for IP2 and IP3 using year 2000 meteorological data are presented in Table 1 for IP2 and Table 2 for IP3. Comparison of the values in Tables 1 and 2 with those in ER Tables E.1-14 and E.3-14 shows that the individual year PDR and OECR values are larger than the original ER values due to removal of wind direction biases introduced by the faulty wind direction averaging method.

Table 3 provides a breakdown of the total population dose by containment failure mode, similar to information provided in response to RAI 2a (Reference 2).

Table 1
IP2 Mean PDR and OECR Using Year 2000 Meteorological Data

Release Mode	Frequency (/yr)	Population Dose (person-sv)*	Offsite Economic Cost ($)	Population Dose Risk (PDR) (person-rem/yr)	Offsite Economic Cost Risk (OECR) ($/yr)
NCF	1.19E-05	4.75E+01	9.98E+04	5.64E-02**	1.18E+00
EARLY HIGH	6.50E-07	6.51E+05	2.05E+11	4.23E+01	1.33E+05
EARLY MEDIUM	4.23E-07	1.94E+05	5.87E+10	8.21E+00	2.48E+04
EARLY LOW	1.11E-07	7.93E+04	6.39E+09	8.81E-01	7.10E+02
LATE HIGH	6.88E-07	1.63E+05	4.64E+10	1.12E+01	3.19E+04
LATE MEDIUM	3.43E-06	6.87E+04	6.06E+09	2.36E+01	2.08E+04
LATE LOW	6.43E-07	1.61E+04	6.59E+08	1.04E+00	4.24E+02
LATE LOWLOW	5.82E-08	1.38E+04	5.62E+08	8.04E-02	3.27E+01
			Total	8.74E+01	2.12E+05

* 1 sv = 100 rem
** 5.64E-02 (person-rem/yr) = 1.19E-05 (/yr) x 4.75E+01 (person-sv) x 100 (rem/sv)

Table 2
IP3 Mean PDR and OECR Using Year 2000 Meteorological Data

Release Mode	Frequency (/yr)	Population Dose (person-sv)*	Offsite Economic Cost ($)	Population Dose Risk (PDR) (person-rem/yr)	Offsite Economic Cost Risk (OECR) ($/yr)
NCF	6.30E-06	8.04E+01	2.95E+05	5.06E-02**	1.86E+00
EARLY HIGH	9.43E-07	5.08E+05	1.70E+11	4.79E+01	1.60E+05
EARLY MEDIUM	1.24E-06	2.00E+05	5.55E+10	2.47E+01	6.87E+04
EARLY LOW	1.46E-07	5.21E+04	3.58E+09	7.59E-01	5.21E+02
LATE HIGH	4.23E-07	1.63E+05	4.61E+10	6.89E+00	1.95E+04
LATE MEDIUM	2.01E-06	6.85E+04	6.06E+09	1.37E+01	1.22E+04
LATE LOW	3.75E-07	1.61E+04	6.58E+08	6.03E-01	2.47E+02
LATE LOWLOW	5.66E-08	1.38E+04	5.62E+08	7.81E-02	3.18E+01
			Total	9.48E+01	2.61E+05

* 1 sv = 100 rem
** 5.06E-02 (person-rem/yr) = 6.30E-06 (/yr) x 8.04E+01 (person-sv) x 100 (rem/sv)

Table 3
Breakdown of Population Dose by Containment Failure Mode

Containment Failure Mode	IP2		IP3	
	Population Dose (person-rem/yr)	Percent Contribution	Population Dose (person-rem/yr)	Percent Contribution
Intact containment	0.06	0.06%	0.05	0.05%
Basemat melt-through	4.08	4.67%	2.42	2.56%
Gradual overpressure	28.27	32.35%	16.78	17.70%
Late hydrogen burns	3.55	4.07%	2.11	2.23%
Early hydrogen burns	8.64	9.89%	3.16	3.33%
In-vessel steam explosion	0.57	0.65%	0.21	0.22%
Ex-vessel steam explosion	0.0027	0.00%	0.0010	0.00%
Vessel overpressure	4.10	4.69%	1.50	1.58%
Containment isolation	0.0375	0.04%	0.0137	0.01%
ISLOCA	6.61	7.57%	4.18	4.41%
SGTR	31.46	36.00%	64.35	67.89%
Total	**87.4**	**100**	**94.8**	**100**

[5] Updated Cost Benefit Analysis Results

The cost benefit reanalysis was performed using the MACCS2 results for year 2000. The results are reported in Table 4 for IP2 and in Table 5 for IP3. The assumptions used to determine the change in plant risk that could be realized by implementation of each of the SAMAs originally described in Sections E.2.3 and E.4.3 of the ER and subsequent RAI responses were not altered in this reanalysis. Therefore, the CDF reduction for each SAMA has not been repeated in the tables. The benefit values account for risk reduction in both internal and external events (using multipliers described in Section 4.21.5.4 of the ER) and include the economic impact of lost tourism and business following a severe accident (as discussed in Section [3]). The benefit with uncertainty values account for analysis uncertainties (using multipliers described in Section 4.21.5.4 of the ER). Except as noted with "†" and as described in Section [6], the estimated cost values for SAMA candidates are the same as those reported previously (in Tables E.2-2 and E.4-2 in the ER and References 2 and 3).

[6] Revised Cost Estimates

As described in Sections E.2.3 and E.4.3 of the ER, the original SAMA implementation costs were conceptually estimated to the point where conclusions regarding the economic viability of the proposed modification could be adequately gauged. Specifically, in the original analysis, the initial cost estimate for each SAMA was obtained by applying engineering judgment to determine if the implementation cost was clearly in excess of the estimated attainable benefit or by applying an existing estimate from a previous SAMA analysis. The engineering judgment cost estimates were conservative *i.e.* minimum or low cost estimates to implement the SAMA.

A SAMA that appeared to be cost beneficial with the initial implementation cost estimate was subjected to successively more comprehensive and more precise cost estimating to determine if the SAMA was indeed potentially cost beneficial. Only the final cost estimate for each SAMA was reported in the ER.

This method of cost estimating is consistent with NEI 05-01 guidance which states the following.

> *"As SAMA analysis focuses on establishing the economic viability of potential plant enhancement when compared to attainable benefit, often detailed cost estimates are not required to make informed decisions regarding the economic viability of a particular modification. SAMA implementation costs may be clearly in excess of the attainable benefit estimated from a particular analysis case. For less clear cases, engineering judgment may be applied to determine if a more detailed cost estimate is necessary to formulate a conclusion regarding the economic viability of a particular SAMA. Nonetheless, the cost of each SAMA candidate should be conceptually estimated to the point where economic viability of the proposed modification can be adequately gauged.*
>
> *For hardware modifications, the cost of implementation may be established from existing estimates of similar modifications from previously performed SAMA and SAMDA analyses."*

Comparison of Tables 4 and 5 with the tables provided in response to RAI 4e (Reference 2) shows that the benefit obtained from each of the SAMAs (except those with no benefit) has increased in the reanalysis. Consistent with the approach described in NEI 05-01 and used in the original analysis, SAMAs in the reanalysis that appeared to be cost beneficial with the new benefit estimate and the old implementation cost estimate were subjected to more comprehensive and precise cost estimating techniques to determine if they are indeed potentially cost beneficial. The cost estimates for SAMAs noted with "†" in Table 4 and Table 5 are those that were developed in more detail.

For example, in the reanalysis, IP3 SAMA 040, "Provide automatic nitrogen backup to steam generator atmospheric dump valves," was estimated to have a benefit with uncertainty of $344,225 (see Table 5). If this benefit is compared to the original cost estimate of $214,000, IP3 SAMA 040 appears cost beneficial. A more comprehensive plant-specific cost estimate was performed to determine if IP3 SAMA 040 is indeed potentially cost beneficial. This more comprehensive estimate concluded that a modification to provide automatic nitrogen backup to the steam generator atmospheric dump valves at IP3 would actually cost approximately $950,000 (see Table 5). Since this value is greater than the revised benefit with uncertainty, IP3 SAMA 040 is not potentially cost beneficial.

Also, in the reanalysis IP2 SAMA 062, "Provide a hard-wired connection to an SI pump from ASSS power supply," was estimated to have a benefit with uncertainty of $1,789,822 (See Table 4). If this benefit is compared to the original cost estimate of $722,000, IP2 SAMA 062 appears cost beneficial. The original cost estimate was reviewed and found to have conservatively not included some of the expenses necessary to implement the modification. Therefore, a more comprehensive cost estimate was performed to determine if this SAMA is indeed potentially cost beneficial. This estimate concluded that a modification to provide a hard-wired connection to a safety injection pump from an alternate safe shutdown system power supply would actually cost approximately $1,500,000 (See Table 4). Since the more comprehensive cost estimate is still smaller than the revised benefit, IP2 SAMA 062 is potentially cost beneficial following the reanalysis.

Entergy's standard process for development of conceptual level project estimates was followed for the new, more comprehensive SAMA implementation cost estimates. The estimates capture anticipated expenses by identifying all parts of the organization that must support the proposed SAMA modification from the conceptual perspective. Typical expenses associated with project cost estimating include calculations, drawing updates, specification updates, bid evaluations, contract issuance, design package preparation, walkdowns, planning and scheduling, estimating, procurement, configuration management, as-low-as-reasonably-achievable (ALARA), quality control and quality assurance, training, simulator changes, information technology, design basis update, construction, multi-discipline and independent review of design concepts and calculations, 50.59 review, final safety analysis report (FSAR) update, cost control, contingency, security, procedures, post work testing, and project management and close-out. In addition, the project cost estimates include corporate indirect charges.

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
001 - Create an independent RCP seal injection system with a dedicated diesel.	1.60%	1.42%	$374,757	$788,963	$1,137,000	Not cost effective
002 - Create an independent RCP seal injection system without a dedicated diesel.	1.49%	1.42%	$350,396	$737,676	$1,000,000	Not cost effective
003 - Install an additional CCW pump.	0.00%	0.00%	$0	$0	$1,500,000	Not cost effective
004 - Enhance procedural guidance for use of service water pumps.	0.23%	0.00%	$48,723	$102,574	$1,750,000	Not cost effective
005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	0.34%	0.47%	$105,892	$222,931	$565,000	Not cost effective
006 - Add a diesel building high temperature alarm.	0.11%	0.07%	$30,496	$64,202	$274,000	Not cost effective
007 - Install a filtered containment vent to provide fission product scrubbing.	16.70%	6.13%	$1,725,939	$3,633,555	$5,700,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	47.03%	34.43%	$6,347,528	$13,363,217	$108,000,000	Not cost effective
009 - Create a reactor cavity flooding system.	**47.03%**	**34.43%**	**$6,347,528**	**$13,363,217**	**$4,100,000†**	**Retain**
010 - Create a core melt source reduction system.	47.03%	34.43%	$6,347,528	$13,363,217	$90,000,000	Not cost effective
011 - Provide a means to inert containment.	17.51%	21.23%	$3,091,966	$6,509,402	$10,900,000	Not cost effective
012 - Use the fire protection system as a backup source for the containment spray system.	0.00%	0.00%	$0	$0	$565,000	Not cost effective
013 - Install a passive containment spray system.	0.00%	0.00%	$0	$0	$2,000,000	Not cost effective
014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	11.56%	4.25%	$1,194,251	$2,514,214	>$5,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
015 - Construct a building connected to primary containment that is maintained at a vacuum.	40.50%	35.38%	$5,963,077	$12,553,847	$61,000,000	Not cost effective
016 - Install a redundant containment spray system.	0.00%	0.00%	$0	$0	$5,800,000	Not cost effective
017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	10.07%	11.79%	$1,742,298	$3,667,996	$5,500,000†	Not cost effective
018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	0.46%	0.47%	$73,618	$154,986	$7,400,000	Not cost effective
019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	30.21%	39.15%	$5,594,541	$11,777,981	>$100,000,000†	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
020 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	2.97%	4.25%	$580,766	$1,222,665	$9,700,000	Not cost effective
021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	**11.33%**	**14.62%**	**$2,093,852**	**$4,408,109**	**$3,200,000†**	**Retain (New)**
022 - Add redundant and diverse limit switches to each containment isolation valve.	**5.72%**	**7.55%**	**$1,071,465**	**$2,255,716**	**$2,200,000†**	**Retain (New)**
023 - Increase leak testing of valves in ISLOCA paths.	5.72%	7.55%	$1,071,465	$2,255,716	$7,964,000	Not cost effective
024 - Ensure all ISLOCA releases are scrubbed.	11.33%	14.62%	$2,093,852	$4,408,109	$9,700,000	Not cost effective
025 - Improve MSIV design.	0.57%	0.94%	$122,697	$258,310	$476,000	Not cost effective
026 - Provide additional DC battery capacity.	0.23%	0.00%	$48,723	$102,574	>$1,875,000	Not cost effective
027 - Use fuel cells instead of lead-acid batteries.	0.23%	0.00%	$48,723	$102,574	$2,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
028 - Provide a portable diesel-driven battery charger.	**9.38%**	**7.08%**	**$1,357,046**	**$2,856,939**	**$938,000†**	**Retain**
029 - Increase/ improve DC bus load shedding.	0.23%	0.00%	$48,723	$102,574	$460,000†	Not cost effective
030 - Create AC power cross-tie capability with other unit.	0.23%	0.00%	$56,813	$119,607	$1,156,000	Not cost effective
031 - Create a backup source for diesel cooling (not from existing system).	0.23%	0.00%	$40,632	$85,541	$1,700,000	Not cost effective
032 - Use fire protection system as a backup source for diesel cooling.	0.23%	0.00%	$40,632	$85,541	$497,000	Not cost effective
033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0.00%	0.00%	$0	$0	$1,254,000	Not cost effective
034 - Provide capability for diesel-driven, low pressure vessel makeup.	0.06%	0.05%	$8,180	$17,221	>$632,000	Not cost effective
035 - Provide an additional high pressure injection pump with independent diesel.	0.34%	0.47%	$73,529	$154,798	$5,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	0.46%	0.47%	$138,344	$291,251	>$1,000,000	Not cost effective
037 - Provide capability for alternate injection via diesel-driven fire pump.	0.06%	0.05%	$8,180	$17,221	$750,000	Not cost effective
038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	0.11%	0.07%	$22,405	$47,169	$82,000	Not cost effective
039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	0.34%	0.47%	$73,529	$154,798	$2,000,000	Not cost effective
040 - Create/enhance a reactor coolant depressurization system.	3.20%	3.77%	$572,408	$1,205,070	$2,000,000†	Not cost effective
041 - Install a digital feed water upgrade.	0.92%	0.47%	$179,154	$377,167	$900,000	Not cost effective
042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	0.23%	0.00%	$16,360	$34,441	$214,000	Not cost effective
043 - Add a motor-driven feed water pump.	0.92%	0.47%	$179,154	$377,167	$2,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
044 - Use fire water system as backup for steam generator inventory.	**14.19%**	**9.91%**	**$2,350,530**	**$4,948,485**	**$1,656,000**	**Retain**
045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	3.32%	1.89%	$667,806	$1,405,907	$2,700,000	Not cost effective
046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0.00%	0.00%	$0	$0	$82,000	Not cost effective
047 - Add an independent boron injection system.	0.00%	0.00%	$0	$0	$300,000	Not cost effective
048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	0.46%	0.47%	$105,981	$223,119	$615,000	Not cost effective
049 - Install motor generator set trip breakers in control room.	0.23%	0.00%	$32,541	$68,508	$716,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
050 - Provide capability to remove power from the bus powering the control rods.	0.23%	0.00%	$32,541	$68,508	$90,000	Not cost effective
051- Provide digital large break LOCA protection.	0.00%	0.00%	$0	$0	$2,036,000	Not cost effective
052 - Install secondary side guard pipes up to the MSIVs.	1.72%	1.89%	$294,384	$619,756	$1,100,000	Not cost effective
053 - Keep both pressurizer PORV block valves open.	**3.32%**	**1.89%**	**$659,715**	**$1,388,873**	**$800,000**	**Retain**
054 - Install flood alarm in the 480V switchgear room.	**39.24%**	**28.77%**	**$5,591,781**	**$11,772,170**	**$200,000**	**Retain**
055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0.00%	0.00%	$0	$0	$1,330,000	Not cost effective
056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	**0.23%**	**0.00%**	**$48,723**	**$102,574**	**$82,000**	**Retain**
057 - Provide DC power backup for the PORVs.	0.46%	0.47%	$89,800	$189,052	$376,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0.00%	0.00%	$0	$0	$82,000	Not cost effective
059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	0.23%	0.00%	$24,450	$51,474	$318,000	Not cost effective
060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	**8.92%**	**6.60%**	**$1,275,337**	**$2,684,920**	**$216,000**	**Retain**
061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	**19.34%**	**14.15%**	**$2,754,991**	**$5,799,982**	**$192,000**	**Retain**
062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	**6.06%**	**4.25%**	**$850,165**	**$1,789,822**	**$1,500,000†**	**Retain (New)**

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	0.11%	0.00%	$32,452	$68,320	$324,000	Not cost effective
064 - Provide backup cooling water source for the CCW heat exchangers.	0.23%	0.00%	$40,632	$85,541	$710,000	Not cost effective
065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	**39.24%**	**28.77%**	**$5,591,781**	**$11,772,170**	**$560,000**	**Retain**
066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	8.96%	6.19%	$2,505,846	$5,275,465	$33,500,000†	Not cost effective
067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0.02%	0.00%	$9,727	$20,477	$576,000	Not cost effective
068 - Provide independent source of cooling for the recirculation pump motors.	0.06%	0.01%	$13,408	$28,227	$710,000	Not cost effective

† Cost estimate revised from what was previously reported. See Section [6] for more information.

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
001 - Create an independent RCP seal injection system with a dedicated diesel.	0.74%	0.38%	$236,610	$342,913	$1,137,000	Not cost effective
002 - Create an independent RCP seal injection system without a dedicated diesel.	0.63%	0.38%	$201,222	$291,626	$1,000,000	Not cost effective
003 - Install an additional CCW pump.	0.00%	0.00%	$0	$0	$1,500,000	Not cost effective
004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	0.53%	0.38%	$130,575	$189,240	$565,000	Not cost effective
005 - Install a filtered containment vent to provide fission product scrubbing.	9.60%	2.68%	$1,497,163	$2,169,801	$5,700,000	Not cost effective
006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	24.16%	14.94%	$5,038,071	$7,301,552	$108,000,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
007 - Create a reactor cavity flooding system.	**24.16%**	**14.94%**	**$5,038,071**	**$7,301,552**	**$4,100,000†**	**Retain (New)**
008 - Create a core melt source reduction system.	24.16%	14.94%	$5,038,071	$7,301,552	$90,000,000	Not cost effective
009 - Provide means to inert containment.	8.76%	9.20%	$2,412,095	$3,495,790	$10,900,000	Not cost effective
010 - Use the fire protection system as a backup source for the containment spray system.	0.00%	0.00%	$0	$0	$565,000	Not cost effective
011 - Install a passive containment spray system.	0.00%	0.00%	$0	$0	$2,000,000	Not cost effective
012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	5.59%	1.53%	$867,404	$1,257,107	>$5,000,000	Not cost effective
013 - Construct a building connected to primary containment that is maintained at a vacuum.	21.73%	15.71%	$4,883,602	$7,077,683	$61,000,000	Not cost effective
014 - Install a redundant containment spray system.	0.00%	0.00%	$0	$0	$5,800,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	4.32%	4.21%	$1,140,695	$1,653,182	$5,500,000†	Not cost effective
016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	5.27%	4.98%	$1,401,717	$2,031,473	$7,400,000	Not cost effective
017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	45.15%	53.64%	$13,520,698	$19,595,215	>$100,000,000†	Not cost effective
018 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	11.08%	13.41%	$3,327,028	$4,821,779	$12,000,000†	Not cost effective
019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	**7.07%**	**8.43%**	**$2,126,663**	**$3,082,120**	**$2,800,000†**	**Retain (New)**

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
020 - Add redundant and diverse limit switches to each containment isolation valve.	3.59%	4.21%	$1,069,272	$1,549,670	$4,000,000†	Not cost effective
021 - Increase leak testing of valves in ISLOCA paths.	3.59%	4.21%	$1,069,272	$1,549,670	$10,604,000	Not cost effective
022 - Ensure all ISLOCA releases are scrubbed.	7.07%	8.43%	$2,126,663	$3,082,120	$9,700,000	Not cost effective
023 - Improve MSIV design.	0.00%	0.00%	$0	$0	$476,000	Not cost effective
024 - Provide additional DC battery capacity.	0.11%	0.00%	$47,141	$68,320	>$1,875,000	Not cost effective
025 - Use fuel cells instead of lead-acid batteries.	0.11%	0.00%	$47,141	$68,320	$2,000,000	Not cost effective
026 - Increase/ improve DC bus load shedding.	0.11%	0.00%	$47,141	$68,320	$460,000†	Not cost effective
027 - Create AC power cross-tie capability with other unit.	0.11%	0.00%	$70,647	$102,387	$1,156,000	Not cost effective
028 - Create a backup source for diesel cooling (not from existing system).	0.03%	0.00%	$15,318	$22,199	$1,700,000	Not cost effective
029 - Use fire protection system as a backup source for diesel cooling.	0.03%	0.00%	$15,318	$22,199	$497,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
030 - Provide a portable diesel-driven battery charger.	0.95%	0.38%	$213,363	$309,222	$938,000†	Not cost effective
031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0.53%	0.38%	$118,822	$172,206	$1,254,000	Not cost effective
032 - Provide capability for diesel-driven, low pressure vessel makeup.	0.21%	0.00%	$23,764	$34,441	>$632,000	Not cost effective
033 - Provide an additional high pressure injection pump with independent diesel.	0.42%	0.38%	$118,693	$172,019	$5,000,000	Not cost effective
034 - Create automatic swap-over to recirculation upon RWST depletion.	1.27%	0.77%	$530,551	$768,914	>$1,000,000	Not cost effective
035 - Provide capability for alternate injection via diesel-driven fire pump.	0.21%	0.00%	$23,764	$34,441	$750,000	Not cost effective
036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	0.00%	0.00%	$11,753	$17,033	$82,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	0.42%	0.38%	$118,693	$172,019	$2,000,000	Not cost effective
038 - Create/enhance a reactor coolant depressurization system.	0.95%	0.77%	$237,516	$344,225	$4,600,000	Not cost effective
039 - Install a digital feed water upgrade.	0.95%	0.00%	$271,481	$393,450	$900,000	Not cost effective
040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	0.95%	0.77%	$237,516	$344,225	$950,000†	Not cost effective
041 - Add a motor-driven feedwater pump.	0.95%	0.00%	$271,481	$393,450	$2,000,000	Not cost effective
042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	0.11%	0.00%	$47,141	$68,320	$1,072,000	Not cost effective
043 - Use fire water system as backup for steam generator inventory.	1.58%	1.15%	$450,490	$652,885	$1,656,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	4.75%	4.21%	$1,246,989	$1,807,230	$2,700,000	Not cost effective
045 - Add an independent boron injection system.	0.00%	0.00%	$0	$0	$300,000	Not cost effective
046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	0.74%	0.00%	$224,210	$324,943	$615,000	Not cost effective
047 - Install motor generator set trip breakers in control room.	0.11%	0.00%	$35,388	$51,287	$716,000	Not cost effective
048 - Provide capability to remove power from the bus powering the control rods.	0.11%	0.00%	$35,388	$51,287	$90,000*	Not cost effective
049 - Provide digital large break LOCA protection.	0.00%	0.00%	$0	$0	$2,036,000	Not cost effective
050 - Install secondary side guard pipes up to the MSIVs.	9.07%	8.81%	$2,447,095	$3,546,515	$9,671,000†	Not cost effective
051 - Operator action: Align main feedwater for secondary heat removal.	0.11%	0.00%	$23,635	$34,254	$55,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
052 - Open city water supply valve for alternative AFW pump suction.	**1.05%**	**0.77%**	**$249,398**	**$361,446**	**$50,000**	**Retain**
053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	**2.07%**	**1.51%**	**$498,795**	**$722,892**	**$228,000**	**Retain**
054 - Provide DC power backup for the PORVs.	0.00%	0.00%	$0	$0	$376,000	Not cost effective
055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	**18.35%**	**11.49%**	**$4,073,152**	**$5,903,118**	**$1,288,000**	**Retain**
056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	0.11%	0.00%	$47,141	$68,320	$982,000	Not cost effective
057 - Provide backup cooling water source for the CCW heat exchangers.	0.21%	0.00%	$59,023	$85,541	$109,000	Not cost effective
058 - Provide automatic DC power backup.	0.21%	0.00%	$94,282	$136,640	$1,868,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0.00%	0.00%	$0	$0	$576,000	Not cost effective
060 - Provide independent source of cooling for the recirculation pump motors.	0.00%	0.00%	$0	$0	$710,000	Not cost effective
061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	**19.73%**	**12.26%**	**$4,359,371**	**$6,317,929**	**$560,000**	**Retain**
062 - Install flood alarm in the 480 VAC switchgear room.	**19.73%**	**12.26%**	**$4,359,371**	**$6,317,929**	**$196,800**	**Retain**

* IP3 SAMA 048 – Cost as corrected in response to RAI 4e (Reference 2)
† Cost estimate revised from what was previously reported. See Section [6] for more information.

[7] Main Steam Safety Valve Gagging SAMA (Updated Response to Round 2 RAI 6)

The benefit associated with installing a device to gag a stuck-open main steam safety valve following a steam generator tube rupture (SGTR) was originally assessed in response to Round 2 RAI 6 (Reference 3). In that response, the estimated benefit with uncertainty assuming that this SAMA is fully successful in preventing all thermally-induced steam generator tube ruptures was almost $3 million for IP2 and over $4 million for IP3. As indicated in that response, with an estimated cost of $50,000, this additional SAMA is potentially cost beneficial and it has been submitted for engineering project cost benefit analysis for more detailed examination of viability and implementation cost. With the revised meteorological input data used for the SAMA reanalysis, the total benefit of this SAMA is now estimated to be about $13 million for IP2 and $19 million for IP3.

[8] TI-SGTR Sensitivity Analysis (Revised Response to Round 2 RAI 5)

In response to Round 2 RAI 5 (Reference 3), a sensitivity study was performed to determine the impact of applying values derived from NUREG-1570. The TI-SGTR sensitivity study was performed again, as described below, to determine the impact of applying NUREG-1570 values to the SAMA reanalysis and provide an updated response to Round 2 RAI 5.

The full lists of IP2 and IP3 Phase II SAMAs were reviewed for impact. Of those, the following twenty-seven IP2 SAMAs and twenty-two IP3 SAMAs were identified as potentially impacted by the TI-SGTR assumption.

IP2 SAMAs: 1, 6, 18, 19, 20, 25, 26, 27, 28, 29 ,30, 31, 32, 35, 39, 40, 42, 44, 46, 52, 54, 59, 60, 61, 62, 65, 66
IP3 SAMAs: 1, 16, 17, 18, 23, 24, 25, 26, 27, 28, 29, 30, 33, 38, 40, 42, 43, 55, 56, 58, 61, 62

Since IP2 SAMAs 28, 44, 54, 60, 61, 62 and 65 and IP3 SAMAs 55, 61 and 62 were previously determined to be potentially cost beneficial, they were not re-evaluated. Of the remaining SAMAs, those for which the implementation cost outweighed the benefit by less than a factor of five were re-evaluated. This screening criterion was applied to facilitate the re-evaluation by limiting it to those potentially impacted SAMA candidates with a realistic possibility of becoming cost beneficial. The appropriateness of this screening criterion is justified by the fact that only one of the twelve SAMAs evaluated was found to be potentially cost beneficial following this conservative sensitivity analysis. See paragraph prior to Table 6 for discussion of conservatism.

The SAMAs re-evaluated were:

IP2 SAMAs: 1, 6, 25, 29, 40, 52
IP3 SAMAs: 1, 16, 18, 30, 40, 43

The baseline case (Table 5.8 of NUREG-1570) associated with moderate tube degradation was used for this sensitivity study. The full conditional induced SGTR value (0.25) shown for that case was used. The NUREG-1570 conditional probability was applied to all high/dry sequences in the Level 2 model for each unit; in both station blackout and transient sequences. The benefit values in this sensitivity analysis included the additional impact of the loss of tourism and business. Tables 6 and 7 show the values for the IP2 and IP3 SAMAs evaluated in this sensitivity analysis. While the severe accident costs of both the baseline case and the individual SAMAs increased, the extent to which the revised TI-SGTR assumption impacted the benefit varied, based on the nature of the specific SAMA.

IP3 SAMA 18 was found potentially cost beneficial as a result of this sensitivity analysis.

Although the NUREG-1570 baseline case values were used for this sensitivity analysis, the baseline case applies to a steam generator with a moderate flaw distribution. The IP2 and IP3 steam generators have been replaced and are being maintained in accordance with the stringent standards recommended by NEI 97-06. The IP2 and IP3 steam generators have only 0.19% and 0.12% of the tubes plugged, and would be classified as "pristine" in accordance with generic criteria established by Westinghouse for categorizing steam generator tube integrity. Corrosion has not been observed in either the IP2 or IP3 steam generators. Therefore, use of the baseline case for this sensitivity study is conservative relative to application of the NUREG-1570 results for pristine generators (Table 5.8, Case 8).

Table 6 – IP2 TI-SGTR Sensitivity Results

IP2 Phase II SAMA	Original Benefit with Uncertainty	TI-SGTR Revised Benefit with Uncertainty	Estimated Cost	Conclusion
001 - Create an independent RCP seal injection system with a dedicated diesel.	$788,963	$892,287	$1,137,000	Not cost effective
006 - Add a diesel building high temperature alarm.	$64,202	$223,493	$274,000	Not cost effective
025 - Improve MSIV design.	$258,310	$430,516	$476,000	Not cost effective
029 - Increase/ improve DC bus load shedding.	$102,574	$257,560	$460,000†	Not cost effective
040 - Create/enhance a reactor coolant depressurization system.	$1,205,070	$1,325,614	$2,000,000†	Not cost effective
052 - Install secondary side guard pipes up to the MSIVs.	$619,756	$878,065	$1,100,000	Not cost effective

† Cost estimate revised from what was previously reported. See Section [6] for more information.

Table 7 – IP3 TI-SGTR Sensitivity Results

IP3 Phase II SAMA	Original Benefit with Uncertainty	TI-SGTR Revised Benefit with Uncertainty	Estimated Cost	Conclusion
001 - Create an independent RCP seal injection system with a dedicated diesel.	$342,913	$480,678	$1,137,000	Not cost effective
016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	$2,031,473	$2,289,783	$7,400,000	Not cost effective
018 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	**$4,821,779**	**$14,637,545**	**$12,000,000†**	**Retain (New)**
030 - Provide a portable diesel-driven battery charger.	$309,222	$515,869	$938,000†	Not cost effective
040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	$344,225	$447,549	$950,000†	Not cost effective
043 - Use fire water system as backup for steam generator inventory.	$652,885	$825,091	$1,656,000	Not cost effective

† Cost estimate revised from what was previously reported. See Section [6] for more information.

[9] Conclusion

In the SAMA reanalysis using a conservatively representative, single year of meteorological data (2000), the following additional three SAMA candidates were found to be potentially cost beneficial for mitigating the consequences of a severe accident for IP2 (in addition to those previously designated as cost beneficial in Section 4.21.6 of the ER and References 2 and 3).

021 - Install additional pressure or leak monitoring instrumentation for interfacing system loss of coolant accidents (ISLOCAs)
022 - Add redundant and diverse limit switches to each containment isolation valve
062 - Provide a hard-wired connection to a safety injection (SI) pump from the alternate safe shutdown system (ASSS) power supply

In the SAMA reanalysis using a conservatively representative, single year of meteorological data, the following three SAMA candidates were found to be potentially cost beneficial for mitigating the consequences of a severe accident for IP3 (in addition to those previously designated as cost beneficial in Section 4.21.6 of the ER and References 2 and 3).

007 - Create a reactor cavity flooding system
018 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products (cost beneficial in TI-SGTR sensitivity in Section [8])
019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs

As described in the aging management review results for the integrated plant assessment presented in Sections 3.1 through 3.6 of the license renewal application, IP2 and IP3 have programs for managing aging effects for components within the scope of license renewal (Reference 1). Since these programs are sufficient to manage the effects of aging during the license renewal period without implementation of the above SAMA candidates for IP2 and IP3, these potentially cost beneficial SAMAs need not be implemented as part of license renewal pursuant to 10 CFR Part 54. However, consistent with those SAMAs identified previously as cost beneficial, the above potentially cost beneficial SAMAs have been submitted for engineering project cost benefit analysis.

Since some of the potentially cost beneficial SAMAs address the same risk contributors, implementation of an optimal subset of these SAMAs could achieve a large portion of the total risk reduction at a fraction of the cost, and render the remaining SAMAs no longer cost beneficial.

IP2 SAMAs 54, 65, and the main steam safety valve gagging SAMA have the highest priority for implementation due to their potential for significant risk reduction and relatively low implementation cost (cost estimate is less than 20% of the benefit with uncertainty). SAMAs 9, 21, 28, 44, 53, and 56 would have second priority based on their potential for risk reduction and their mitigation of plant risk contributors not addressed by the highest priority SAMAs. The remaining potentially cost beneficial SAMAs (22, 60, 61, and 62) are considered lowest priority because their benefit and cost estimates are similar or because their benefit is expected to be reduced significantly if the higher priority SAMAs are implemented.

IP3 SAMAs 52, 61, 62, and the main steam safety valve gagging SAMA have the highest priority for implementation due to their potential for significant risk reduction and relatively low implementation cost (cost estimate is less than 20% of the benefit with uncertainty). SAMAs 7, 53, and 55 would have second priority based on their potential for risk reduction and their mitigation of plant risk contributors not addressed by the highest priority SAMAs. The remaining potentially cost beneficial SAMAs (18 and 19) are considered lowest priority because their benefit and cost estimates are similar or because their benefit is expected to be reduced significantly if the higher priority SAMAs are implemented.

[10] MACCS2 Input Files

The following MACCS2 input files, used in the analysis described above, are provided in electronic format.

Filename	Description
siteiec.inp	site input file with loss of tourism and business
meti00.inp	meteorological data for year 2000
chrbiec.inp	chronc input file with loss of tourism and business
earbi-noE.inp	early input file
atmbi2ns.inp	atmos input file for IP2
atmbi3ns.inp	atmos input file for IP3

[11] References

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