ENCLOSURE 2 TO NL-17-039

ENTERGY ENGINEERING REPORT NO. IP-RPT-16-00078,

"INDIAN POINT RAI CLI-16-07 SAMA COST-BENEFIT SENSITIVITIES,"

REV. 1 (MARCH 23, 2017)

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
DOCKET NOS. 50-247 AND 50-286

Entergy

ENTERGY NUCLEAR

Engineering Report Cover Sheet

Engineering Report Title:
Indian Point RAI CLI-16-07 SAMA Cost-Benefit Sensitivities

Engineering Report Type:

New ☐ Revision ☒ Cancelled ☐ Superseded ☐
Superseded by: _____

Applicable Site(s)

IP1	☐	IP2	☒	IP3	☒	JAF	☐	PNPS	☐	VY	☐	WPO	☐
ANO1	☐	ANO2	☐	ECH	☐	GGNS	☐	RBS	☐	WF3	☐	PLP	☐

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REVISION DESCRIPTION SHEET

Revision Number	Description	Pages and/or Sections Revised
0	Initial Issue	All
1	Changed the period of time used in the SAMA cost-benefit sensitivities to reflect the revised license renewal period. The original analyses used a 20 year license renewal period. However, on February 8, 2017, Entergy filed an amendment to its pending license renewal application for IP2 and IP3 to update the proposed term of the renewed licenses from 20 years for each unit to the periods ending April 30, 2024 for IP2 and April 30, 2025 for IP3. Since the original license expiration dates were September 2013 for IP2 and December 2015 for IP3, the license renewal period has been changed to 11 years for IP2 and 10 years for IP3.	Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0 and associated tables. Changes were made in Sections 1.0 and 2.0 to provide the Rev. 1 results and to refer the reader to Sections 6.0 and 7.0. References were added in Section 3.0.

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1.0 Purpose

This report documents a revised baseline SAMA cost-benefit analysis and SAMA cost-benefit sensitivity cases that were performed to support the response to an NRC Staff Request for Additional Information (RAI) pertaining to the NRC Commission Decision CLI-16-07 for Indian Point Energy Center (IPEC).

On May 4, 2016, the Commission issued a decision (CLI-16-07) in the Indian Point Nuclear Generating Unit Nos 2 and 3 (IP2 and IP3) license renewal proceeding, in which it directed the NRC staff to supplement the IP2 and IP3 Severe Accident Mitigation Alternatives (SAMA) analysis with additional sensitivity analyses. Specifically, the Commission held that documentation was lacking for two inputs – decontamination time (TIMDEC) and cost to decontaminate non-farmland (CDNFRM) -- used in the MELCOR Accident Consequence Code (MACCS) computer analyses, and that uncertainties in those input values could potentially affect the SAMA analysis cost-benefit conclusions. The Commission therefore directed the NRC staff to perform additional sensitivity analyses. (Reference 1)

In an RAI letter dated September 12, 2016, the NRC staff requested the following additional information (Reference 2):

> 1. Entergy Nuclear Operations, Inc. (Entergy) is requested to scale up the value of nonfarm wealth (VALWNF) input to the SAMA analysis' base-year dollars (see pp. 41-42 of CLI-16-07), and to re-run its base analyses using this corrected VALWNF input. Entergy is requested to evaluate how the change in VALWNF may affect its identification of potentially cost-beneficial SAMAs.
>
> 2. Using the revised baseline from Request 1, Entergy is requested to run supplemental sensitivity analyses using the input values specified in CLI-16-07. Specifically:
>
> > a. Apply the maximum values specified by the Commission and allowed by the MACCS code for TIMDEC and CDNFRM values (one year (365 days) and $100,000, respectively) for "heavy decontamination" (i.e., the decontamination/dose reduction factor of 15).
> >
> > b. Exercise the additional option to explain, with sufficient justification, its rationale for choosing any additional values for the TIMDEC and CDNFRM inputs for its sensitivity analyses.
>
> Entergy at a minimum should run its sensitivity analyses for the four worst release categories, as specified in CLI-16-07. Entergy is requested to evaluate how these sensitivity analyses may affect its identification of potentially cost-beneficial SAMAs.
>
> 3. Upon completing these additional analyses, Entergy is requested to submit the input and output files for the IP2 and IP3 MACCS code. Additionally, Entergy is requested to submit the spreadsheet (or equivalent table if another method is used) that conveys the population dose and off-site economic cost for each release category and integrates the results into a Population Dose Risk and an Offsite Economic Cost Risk for IP2 and IP3.

On February 8, 2017 Entergy filed an amendment to its pending license renewal application for Indian Point IP2 and IP3 to update the proposed term of the renewed licenses from 20 years for each unit to the periods ending April 30, 2024 for IP2 and April 30, 2025 for IP3 (Reference 10). Since the original license expiration dates were September 2013 for IP2 and December 2015 for IP3, the license renewal period has been changed to 11 years for IP2 and 10 years for IP3. Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0.

2.0 Summary of Results

The results of this analysis provide the following information requested in the RAI letter dated September 12, 2016 (Reference 2).

Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0 and show the following.

- With an 11 year license renewal period for IP2 and a 10 year license renewal period for IP3, the baseline analysis has two less potentially cost-beneficial SAMAs (IP2-028, *"Provide a portable diesel-driven battery charger,"* and IP2-062, *"Provide a hard-wired connection to an SI pump from ASSS power supply,"* are not potentially cost-beneficial).

- Also, Sensitivity Case 7 shows that with this new baseline and a change to VDEPOS along with escalation of VALWNF and VNFRM, SAMA IP2-044, *"Use fire water system as backup for steam generator inventory,"* is not potentially cost-beneficial.

- Finally, none of the sensitivity cases adds any potentially cost-beneficial SAMAs.

Response to RAI 1:

Entergy Nuclear Operations, Inc. (Entergy) scaled up the value of nonfarm wealth (VALWNF) input to the SAMA analysis' base-year (2005) dollars (Reference 4). VALWNF is used in the CHRONC input file and represents an average value for the 50 mile region.

- Original (without lost tourism/business) VALWNF = $163,631/person. This was developed using SECPOP2000 and its economic database from the 1997 Census of Agriculture.

- Original VALWNF with lost tourism / business = $208,838/person. The lost tourism / business component is based on 2004 data. The lost tourism/business component is $45,207/person.

Consumer Price Index Values (Series CUUR0000SA0, All Urban Consumers) are used for escalation purposes:

- Annual 1997 CPI = 160.5

- Annual 2004 CPI = 188.9

- Annual 2005 CPI = 195.3

- Escalation Factor 1997-2005 = 1.22

- Escalation Factor 2004-2005 = 1.03

2005 VALWNF is calculated as follows:

- VALWNF without lost tourism/business = $163,631/person * 1.22 = $199,630/person
- Lost tourism / business component = $45,207/person * 1.03 = $46,563/person
- Total with lost tourism/ business (2005 dollars)= $246,193/person, rounded up to **$247,000/person**

Entergy also scaled up the individual county average VNFRM values of nonfarm wealth used in the SITE input file. The same approach and CPI escalation values developed for the VALWNF calculation are applied at the county level data. The values for each county are shown in Table 1 (Reference 4).

Table 1 – Original and Escalated VNFRM County-Level Values

	Basis Year for Dollar Values:	1997	1997, 2004	2004	2005
Region	County	Original No Tourism VNFRM ($)	Original With Tourism VNFRM ($)	Tourism Portion ($)	With Tourism VNFRM ($)
1	FAIRFIELD	232659	287881	55222	340723
2	BERGEN	205863	262186	56323	309166
3	LITCHFIELD	148522	186016	37494	219816
4	NEWHAVEN	144105	192427	48322	225580
5	ESSEX	147351	197400	50049	231319
6	DUTCHESS	129000	169417	40417	199010
7	MORRIS	213389	277661	64272	326535
8	PASSAIC	121880	161864	39984	189877
9	SUSSEX	136197	165741	29544	196591
10	UNION	160860	209708	48848	246563
11	KINGS	104714	123701	18987	147308
12	NASSAU	192755	239932	47177	283753
13	ORANGE	113976	148873	34897	174995
14	PUTNAM	154926	180274	25348	215118

Table 1 – Original and Escalated VNFRM County-Level Values

	Basis Year for Dollar Values:	1997	1997, 2004	2004	2005
Region	County	Original No Tourism VNFRM ($)	Original With Tourism VNFRM ($)	Tourism Portion ($)	With Tourism VNFRM ($)
15	QUEENS[1]	169126	226728	57602	265664
16	ROCKLAND	163105	203359	40254	240450
17	SUFFOLK	149615	192471	42856	226672
18	SULLIVAN	104859	139374	34515	163478
19	ULSTER	104090	138739	34649	162678
20	WESTCHESTER	217278	263389	46111	312573

Entergy re-ran the baseline analyses using the VALWNF and VNFRM values escalated to 2005 dollar values. Table 2 and Table 3 show the resulting Population Dose Risk (PDR) and Offsite Economic Risk (OECR) for the revised baseline. Comparison of these results to the baseline results in the 2009 analysis (Reference 3) shows a modest OECR increase of approximately 9-10% and no appreciable change in the PDR.

Table 2 - IP2 Escalated VALWNF and VNFRM MACCS2 Results[2]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	6.50E-07	6.51E+07	4.23E+01	48.44%	2.27E+11	1.48E+05	63.33%
H/L	6.88E-07	1.63E+07	1.12E+01	12.84%	5.04E+10	3.47E+04	14.88%
M/E	4.23E-07	1.94E+07	8.21E+00	9.39%	6.36E+10	2.69E+04	11.55%
M/L	3.43E-06	6.87E+06	2.36E+01	26.98%	6.59E+09	2.26E+04	9.70%
L/E	1.11E-07	7.94E+06	8.81E-01	1.01%	6.93E+09	7.69E+02	0.33%
L/L	6.43E-07	1.61E+06	1.04E+00	1.19%	7.15E+08	4.60E+02	0.20%
LL/L	5.82E-08	1.38E+06	8.03E-02	0.09%	6.10E+08	3.55E+01	0.02%

[1] The Queens economic region comprises four very small counties within New York city (New York, Hudson, Queens, Bronx counties) combined as a weighted average to be certain that economic information pertaining to New York City was included in the analysis. (Reference 9)

[2] Table 2E in IP-RPT-16-00077 (Reference 4)

NCF	1.19E-05	4.75E+03	5.65E-02	0.06%	1.07E+05	1.27E+00	0.00%
Total	1.79E-05	--	8.74E+01	100%	--	2.33E+05	100%

Table 3 – IP3 Escalated VALWNF and VNFRM MACCS2 Results[3]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	9.43E-07	5.09E+07	4.80E+01	50.55%	1.86E+11	1.75E+05	61.50%
H/L	4.23E-07	1.63E+07	6.89E+00	7.26%	5.00E+10	2.12E+04	7.42%
M/E	1.24E-06	2.00E+07	2.48E+01	26.12%	6.01E+10	7.45E+04	26.13%
M/L	2.01E-06	6.85E+06	1.38E+01	14.50%	6.59E+09	1.32E+04	4.64%
L/E	1.46E-07	5.21E+06	7.61E-01	0.80%	3.87E+09	5.65E+02	0.20%
L/L	3.75E-07	1.61E+06	6.04E-01	0.64%	7.14E+08	2.68E+02	0.09%
LL/L	5.66E-08	1.38E+06	7.81E-02	0.08%	6.10E+08	3.45E+01	0.01%
NCF	6.30E-06	8.04E+03	5.07E-02	0.05%	3.17E+05	2.00E+00	0.00%
Total	1.15E-05	--	9.50E+01	100%	--	2.85E+05	100%

Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0 and show the following.

- With an 11 year license renewal period for IP2 and a 10 year license renewal period for IP3, the baseline analysis has two less potentially cost-beneficial SAMAs (IP2-028, *"Provide a portable diesel-driven battery charger,"* and IP2-062, *"Provide a hard-wired connection to an SI pump from ASSS power supply,"* are not potentially cost-beneficial).

- Also, Sensitivity Case 7 shows that with this new baseline and a change to VDEPOS along with escalation of VALWNF and VNFRM, SAMA IP2-044, *"Use fire water system as backup for steam generator inventory,"* is not potentially cost-beneficial.

- Finally, none of the sensitivity cases adds any potentially cost-beneficial SAMAs.

[3] Table 3E in IP-RPT-16-00077 (Reference 4)

Response to RAI 2.a:

Using the revised baseline from RAI 1, Entergy ran supplemental sensitivity analyses using the input values specified in CLI-16-07. Specifically, the maximum values specified by the Commission and allowed by the MACCS2 code for TIMDEC and CDNFRM values (one year (365 days) and $100,000, respectively) for "heavy decontamination" (i.e., the decontamination/dose reduction factor of 15) were applied. The parameter value changes are applied to all release categories for consistency, (i.e., not just the four worst release categories as specified in the RAI.)

Table 4 and Table 5 show the PDR and OECR results when the TIMDEC and CDNFRM values are increased to the maximum MACCS2 allowed values as stipulated in the RAI, with the revised baseline. Comparison of these results to the baseline results in the 2009 analysis (Reference 3) shows that the OECR increases approximately 126-133%. Also, the PDR increase is much smaller, approximately 11-12%.

Table 4 - IP2 Increased TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM) MACCS2 Sensitivity Results[4]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	6.50E-07	7.90E+07	5.14E+01	52.57%	5.03E+11	3.27E+05	68.35%
H/L	6.88E-07	1.69E+07	1.16E+01	11.90%	8.56E+10	5.89E+04	12.31%
M/E	4.23E-07	2.06E+07	8.71E+00	8.92%	1.25E+11	5.29E+04	11.05%
M/L	3.43E-06	6.97E+06	2.39E+01	24.48%	1.09E+10	3.74E+04	7.82%
L/E	1.11E-07	8.03E+06	8.91E-01	0.91%	1.12E+10	1.24E+03	0.26%
L/L	6.43E-07	1.63E+06	1.05E+00	1.07%	1.45E+09	9.32E+02	0.19%
LL/L	5.82E-08	1.39E+06	8.09E-02	0.08%	1.24E+09	7.22E+01	0.02%
NCF	1.19E-05	4.75E+03	5.65E-02	0.06%	1.07E+05	1.27E+00	0.00%
Total	1.79E-05	--	9.77E+01	100%	--	4.78E+05	100%

[4] Table 2F in IP-RPT-16-00077 (Reference 4)

Table 5 - IP3 Increased TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM) MACCS2 Sensitivity Results[5]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	9.43E-07	5.95E+07	5.61E+01	53.42%	4.51E+11	4.25E+05	69.93%
H/L	4.23E-07	1.69E+07	7.15E+00	6.81%	8.52E+10	3.60E+04	5.93%
M/E	1.24E-06	2.12E+07	2.63E+01	25.03%	9.95E+10	1.23E+05	20.29%
M/L	2.01E-06	6.95E+06	1.40E+01	13.30%	1.09E+10	2.19E+04	3.60%
L/E	1.46E-07	5.30E+06	7.74E-01	0.74%	6.15E+09	8.98E+02	0.15%
L/L	3.75E-07	1.63E+06	6.11E-01	0.58%	1.45E+09	5.44E+02	0.09%
LL/L	5.66E-08	1.39E+06	7.87E-02	0.07%	1.24E+09	7.02E+01	0.01%
NCF	6.30E-06	8.04E+03	5.07E-02	0.05%	3.17E+05	2.00E+00	0.00%
Total	1.15E-05	--	1.05E+02	100%	--	6.08E+05	100%

Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0 and show the following.

- With an 11 year license renewal period for IP2 and a 10 year license renewal period for IP3, the baseline analysis has two less potentially cost-beneficial SAMAs (IP2-028, *"Provide a portable diesel-driven battery charger,"* and IP2-062, *"Provide a hard-wired connection to an SI pump from ASSS power supply,"* are not potentially cost-beneficial).

- Also, Sensitivity Case 7 shows that with this new baseline and a change to VDEPOS along with escalation of VALWNF and VNFRM, SAMA IP2-044, *"Use fire water system as backup for steam generator inventory,"* is not potentially cost-beneficial.

- Finally, none of the sensitivity cases adds any potentially cost-beneficial SAMAs.

[5] Table 3F in IP-RPT-16-00077 (Reference 4)

Response to RAI 2.b:

RAI 2.b gives Entergy the additional option to explain, with sufficient justification, its rationale for choosing any additional values for the TIMDEC and CDNFRM inputs for its sensitivity analyses. Entergy does not propose additional values for the TIMDEC and CDNFRM inputs. However, Entergy does propose an alternate value for variable VDEPOS, dry deposition velocity.

In Entergy's original SAMA analysis, the dry deposition velocity, VDEPOS, was set to 0.010 m/sec in the ATMOS input file. The recent NRC's State-of-the-Art Reactor Consequence Analyses (SOARCA) Project found a value of 0.003m/sec to be the dominant or average value for use in SOARCA. Thus, 0.003m/sec is viewed as more representative than the value of 0.010m/sec used in the NUREG-1150 studies.

Entergy ran an alternative revised baseline using the VALWNF and VNFRM values escalated to 2005 dollar values, as described in the response to RAI 1, but with a VDEPOS value of 0.003m/sec (Reference 4). Table 6 and Table 7 show the resulting PDR and OECR for the alternative revised baseline. Comparison of these results to those in Table 2 and Table 3 shows that the lower deposition velocity more than offsets the increase associated with escalating the value of non-farm wealth to 2005 values. Comparison of these results to the baseline results in the 2009 analysis (Reference 3) shows that the OECR decreases between 10-17% compared to the SAMA basecase. The PDR value changes a small amount (2.5% decrease for IP-2; 1.8% increase for IP-3).

Table 6 - IP2 Escalated VALWNF and VNFRM and Revised VDEPOS MACCS2 Results[6]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	6.50E-07	6.85E+07	4.45E+01	52.30%	1.94E+11	1.26E+05	66.34%
H/L	6.88E-07	1.60E+07	1.10E+01	12.93%	3.71E+10	2.55E+04	13.43%
M/E	4.23E-07	1.90E+07	8.04E+00	9.44%	4.28E+10	1.81E+04	9.52%
M/L	3.43E-06	5.80E+06	1.99E+01	23.37%	5.71E+09	1.96E+04	10.30%
L/E	1.11E-07	6.40E+06	7.10E-01	0.83%	4.67E+09	5.18E+02	0.27%
L/L	6.43E-07	1.33E+06	8.55E-01	1.00%	3.72E+08	2.39E+02	0.13%
LL/L	5.82E-08	1.12E+06	6.52E-02	0.08%	3.19E+08	1.86E+01	0.01%
NCF	1.19E-05	3.25E+03	3.87E-02	0.05%	4.00E+03	4.76E-02	0.00%
Total	1.79E-05	--	8.51E+01	100%	--	1.90E+05	100%

[6] Table 2H in IP-RPT-16-00077 (Reference 4)

Table 7 - IP3 Escalated VALWNF and VNFRM and Revised VDEPOS MACCS2 Results[7]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	9.43E-07	5.49E+07	5.18E+01	53.59%	1.45E+11	1.37E+05	62.57%
H/L	4.23E-07	1.60E+07	6.77E+00	7.01%	3.71E+10	1.57E+04	7.18%
M/E	1.24E-06	2.03E+07	2.52E+01	26.06%	4.36E+10	5.41E+04	24.74%
M/L	2.01E-06	5.79E+06	1.16E+01	12.05%	5.71E+09	1.15E+04	5.25%
L/E	1.46E-07	4.48E+06	6.54E-01	0.68%	2.85E+09	4.16E+02	0.19%
L/L	3.75E-07	1.33E+06	4.99E-01	0.52%	3.72E+08	1.40E+02	0.06%
LL/L	5.66E-08	1.12E+06	6.34E-02	0.07%	3.19E+08	1.81E+01	0.01%
NCF	6.30E-06	5.54E+03	3.49E-02	0.04%	1.17E+04	7.37E-02	0.00%
Total	1.15E-05	--	9.66E+01	100%	--	2.19E+05	100%

Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0 and show the following.

- With an 11 year license renewal period for IP2 and a 10 year license renewal period for IP3, the baseline analysis has two less potentially cost-beneficial SAMAs (IP2-028, *"Provide a portable diesel-driven battery charger,"* and IP2-062, *"Provide a hard-wired connection to an SI pump from ASSS power supply,"* are not potentially cost-beneficial).

- Also, Sensitivity Case 7 shows that with this new baseline and a change to VDEPOS along with escalation of VALWNF and VNFRM, SAMA IP2-044, *"Use fire water system as backup for steam generator inventory,"* is not potentially cost-beneficial.

- Finally, none of the sensitivity cases adds any potentially cost-beneficial SAMAs.

Using the alternative revised baseline (with escalated VALWNF and VNFRM and revised VDEPOS), Entergy ran supplemental sensitivity analyses using the input values specified in CLI-16-07 (Reference 4). Specifically, the maximum values specified by the Commission and allowed by the MACCS code for TIMDEC and CDNFRM values (one year (365 days) and $100,000, respectively) for "heavy decontamination" (i.e., the decontamination/dose reduction factor of 15) were applied. The parameter value changes are applied to all release categories for consistency, (i.e., not just the four worst release categories as specified in the RAI.) Table 8 and Table 9 show the PDR and OECR results, when the TIMDEC and CDNFRM values are increased to the maximum MACCS2 allowed values as stipulated in the RAI, with the alternate revised baseline. Comparison of these results to the baseline results in the

[7] Table 3H in IP-RPT-16-00077 (Reference 4)

2009 analysis (Reference 3) shows that the OECR increases approximately 82-91%. The PDR increase is much smaller, approximately 7-10%.

Table 8 - IP2 Increased TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM and Revised VDEPOS) MACCS2 Sensitivity Results[8]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	6.50E-07	7.90E+07	5.14E+01	55.22%	4.49E+11	2.92E+05	72.05%
H/L	6.88E-07	1.66E+07	1.14E+01	12.28%	7.10E+10	4.88E+04	12.06%
M/E	4.23E-07	1.99E+07	8.42E+00	9.05%	7.96E+10	3.37E+04	8.31%
M/L	3.43E-06	5.87E+06	2.01E+01	21.65%	8.57E+09	2.94E+04	7.26%
L/E	1.11E-07	6.45E+06	7.16E-01	0.77%	7.02E+09	7.79E+02	0.19%
L/L	6.43E-07	1.33E+06	8.55E-01	0.92%	7.21E+08	4.64E+02	0.11%
LL/L	5.82E-08	1.12E+06	6.52E-02	0.07%	6.09E+08	3.54E+01	0.01%
NCF	1.19E-05	3.25E+03	3.87E-02	0.04%	4.00E+03	4.76E-02	0.00%
Total	1.79E-05	--	9.30E+01	100%	--	4.05E+05	100%

Table 9 - IP3 Increased TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM and Revised VDEPOS) MACCS2 Sensitivity Results[9]

Release Category	Frequency (per yr)	Population Dose (p-rem)	Population Dose Risk (p-rem/yr)	PDR % of Total	Offsite Economic Cost ($)	Offsite Economic Cost Risk ($/yr)	OECR % of Total
H/E	9.43E-07	6.16E+07	5.81E+01	55.72%	3.59E+11	3.39E+05	71.22%
H/L	4.23E-07	1.65E+07	6.98E+00	6.70%	7.10E+10	3.00E+04	6.32%
M/E	1.24E-06	2.11E+07	2.62E+01	25.10%	7.15E+10	8.87E+04	18.65%
M/L	2.01E-06	5.85E+06	1.18E+01	11.28%	8.56E+09	1.72E+04	3.62%
L/E	1.46E-07	4.52E+06	6.60E-01	0.63%	4.10E+09	5.99E+02	0.13%
L/L	3.75E-07	1.33E+06	4.99E-01	0.48%	7.21E+08	2.70E+02	0.06%
LL/L	5.66E-08	1.12E+06	6.34E-02	0.06%	6.09E+08	3.45E+01	0.01%
NCF	6.30E-06	5.54E+03	3.49E-02	0.03%	1.17E+04	7.37E-02	0.00%
Total	1.15E-05	--	1.04E+02	100%	--	4.75E+05	100%

[8] Table 2I in IP-RPT-16-00077 (Reference 4)
[9] Table 3I in IP-RPT-16-00077 (Reference 4)

Section 6.0 was added in Revision 1 of this report to describe the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0 and show the following.

- With an 11 year license renewal period for IP2 and a 10 year license renewal period for IP3, the baseline analysis has two less potentially cost-beneficial SAMAs (IP2-028, *"Provide a portable diesel-driven battery charger,"* and IP2-062, *"Provide a hard-wired connection to an SI pump from ASSS power supply,"* are not potentially cost-beneficial).

- Also, Sensitivity Case 7 shows that with this new baseline and a change to VDEPOS along with escalation of VALWNF and VNFRM, SAMA IP2-044, *"Use fire water system as backup for steam generator inventory,"* is not potentially cost-beneficial.

- Finally, none of the sensitivity cases adds any potentially cost-beneficial SAMAs.

Response to RAI 3:

The input and output files for the IP2 and IP3 MACCS code are provided. Additionally, the tables in the prior responses convey the population dose and off-site economic cost for each release category and integrate the results into a Population Dose Risk and an Offsite Economic Cost Risk for IP2 and IP3.

3.0 References

1. ML16125A150, NRC Commission Memorandum and Order (CLI-16-07), May 4, 2016
2. ML16232A119, "Request for Additional Information Related to the Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal Application Environmental Review, Severe Accident Mitigation Alternatives", NRC, September 12, 2016
3. IP-RPT-09-00044, "Re-analysis of IP2 and IP3 Severe Accident Mitigation Alternatives (SAMAs)," Rev. 0, December 2009
4. IP-RPT-16-00077, "Indian Point RAI CLI-16-07 MACCS2 Sensitivities," Rev. 0, December 2016
5. ML14337A042, Entergy letter NL-14-143, Reply to Request for Additional Information Regarding the License Renewal Application, Indian Point Nuclear Generating Unit Nos. 2 and 3, November 20, 2014
6. IP-RPT-07-00007, "IP2 Cost-Benefit Analysis of Severe Accident Mitigation Alternatives," Rev. 0, April 2007
7. IP-RPT-07-00008, "IP3 Cost-Benefit Analysis of Severe Accident Mitigation Alternative," Rev. 0, April 2007
8. IPEC-CALC-09-00265, "Re-analysis of MACCS2 Models for IPEC," Rev. 0, December 2009
9. ENERCON, "Site-Specific MACCS2 Input Data for Indian Point Energy Center," Rev. 1, December 2009
10. Entergy letter NL-17-029, Amendment to License Renewal Application – Reflecting Shortened License Renewal Terms for Units 2 and 3, February 8, 2017
11. NEI 05-01 [Rev A], "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document," November 2005
12. NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook, U.S. Nuclear Regulatory Commission," January 1997

4.0 Assumptions

4.1. Assumptions utilized in IP-RPT-09-00044 (Reference 3), the prior SAMA cost-benefit analysis of record, are carried forward to this calculation.

4.2. Assumptions utilized in IP-RPT-16-00077 (Reference 4), the MACCS2 analysis of sensitivities for the RAI response, are carried forward to this calculation.

5.0 Evaluation of Potentially Cost-Beneficial SAMAs for the Sensitivity Cases

5.1 MACCS2 Sensitivity Cases

In IP-RPT-16-00077 (Reference 4), a series of MACCS2 sensitivity cases are performed with adjustments to select MACCS2 parameter input values. For each sensitivity case, the MACCS2 results for total 50-mile offsite costs and 50-mile population dose for each release category are multiplied by the applicable release category frequency to calculate the SAMA metrics of Offsite Economic Cost Risk (OECR) and Population Dose Risk (PDR). The OECR and PDR of the various sensitivity cases are then compared against applicable reference cases to determine the impact of the revised parameters.

More MACCS2 cases are documented in IP-RPT-16-00077 than are strictly required to address the RAI response. To expedite the evaluation, these additional cases were not carried through the SAMA cost-benefit analysis. Thus, the evaluation of potentially cost-beneficial SAMAs was only performed for the following MACCS2 cases.

For each IPEC unit, the following MACCS2 sensitivity cases are evaluated.

- Case 0
  - SAMA Base Case Check
  - This case confirms that the results of IP-RPT-09-00044 (Reference 3) can be reproduced with the applicable MACCS2 files upon which the sensitivity cases are built.
- Case 4
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values. VALWNF is used in the CHRONC input file and represents an average value for the 50 mile region. VNFRM is used in the SITE input file and is calculated on a county basis. Calculation of these values is presented below.
  - This case addresses Part 1 of the RAI (i.e., corrected VALWNF), and represents the "revised baseline" as specified in the RAI.
- Case 5
  - TIMDEC is escalated to one year (365 days) and CDNFRM is escalated to $100,000/person for DF=15 in the CHRONC input file.
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values in the CHRONC and SITE input files, respectively.
  - This case addresses Part 2(a) of the RAI.
- Case 7
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values in the CHRONC and SITE input files, respectively.

- The dry deposition velocity, VDEPOS, is set to 0.003 m/sec in the ATMOS input file rather than the value of 0.010 m/sec. The value of 0.003m/sec is documented by the recent NRC's State-of-the-Art Reactor Consequence Analyses (SOARCA) Project to be the dominant or average value for use in SOARCA and is viewed as more representative than the value of 0.010m/sec used in the NUREG-1150 studies.
- Similar to Case 4, Case 7 addresses Part 1 of the RAI (i.e., corrected VALWNF), and represents the "revised baseline" as specified in the RAI, except with an updated dry deposition velocity.

- Case 8
  - TIMDEC is escalated to one year (365 days) and CDNFRM is escalated to $100,000/person for DF=15 in the CHRONC input file.
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values in the CHRONC and SITE input files, respectively.
  - The dry deposition velocity, VDEPOS, is set to 0.003 m/sec in the ATMOS input file rather than the value of 0.010 m/sec.
  - Similar to Case 5, Case 8 addresses Part 2(a) of the RAI (i.e., corrected VALWNF, increased TIMDEC & CDNFRM), as specified in the RAI, except with an updated dry deposition velocity.

5.2 Sensitivity Case 0 – Original Baseline

A. Base Case for the Majority of the SAMAs

The SAMA cost-benefit analyses in IP-RPT-09-00044 (Reference 3) were performed using un-linked spreadsheets in which some data was inserted manually. See Attachment 1 for a list of the spreadsheets. To facilitate the evaluation of multiple sensitivity cases, a combined spreadsheet was created, named "Case 0 IPEC SAMA Sensitivities."

This spreadsheet contains a worksheet, "Spreadsheet Conversion," documenting the conversion from the 2009 vintage worksheets and confirming that the combined spreadsheet calculates the 2009 benefit value for each SAMA. For a limited number of SAMAs, the combined spreadsheet calculates a slightly different benefit value from that calculated in 2009. These instances occur because the combined spreadsheet rounds values consistently for all of the SAMAs, which was not the case in the un-linked spreadsheets.

The combined spreadsheet facilitates sensitivity evaluations for the majority of the SAMAs because the PDR and OECR values from the sensitivity cases in IP-RPT-16-00077 (Reference 4) can be placed in worksheets "IP2 MACCS2 Output" and "IP3 MACCS2 Output" and the benefit values are automatically re-calculated and populated in columns C and D of the "Case # (cost-benefit)" worksheet for comparison with the implementation cost estimates. Columns G and H of the "Case # (cost-benefit)" worksheet contain the implementation cost estimates from IP-RPT-09-00044 (Reference 3) and NL-14-143 (Reference 5), respectively.

B. Base Case for SAMAs IP2-020 and IP3-018

SAMA IP2-020, "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," does not use the same MACCS2 output as the other SAMAs. As described in Appendix B of IP-RPT-04-00007 (Reference 6), analysis case 16 was used to evaluate SAMA IP2-020. A bounding analysis was performed by reducing SGTR accident progression source terms by a factor of 2.

The source terms used for the IP2-020 analysis are contained in file "IP2 SAMA Radionuclide Release Results-Level2-20.xls." A comparison of the IP2-020 source terms with those in Table A-10 of IP-RPT-07-00007 shows that the only differences are the release fractions for the Early High (H-E), Early Medium (M-E), and Early Low (L-E) release categories. This is reasonable, since SGTR accidents are bypass events, which contribute to early release categories.

Since the source term is different for this SAMA, the MACCS2 output is also different for this SAMA. Therefore, the MACCS2 Case 0, Case 4, Case 5, Case 7, and Case 8 sensitivities were reevaluated with the IP2-020 source term information (Reference 4). An additional worksheet, "IP2-020 MACCS2 Output," was added to the combined spreadsheet, "Case 0 IPEC SAMA Sensitivities," to calculate the base case benefits and facilitate the sensitivity evaluations for IP2-020.

SAMA IP3-018, "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," does not use the same MACCS2 output as the other SAMAs. As described in Appendix B of IP-RPT-04-00008 (Reference 7), analysis case 14 was used to evaluate SAMA IP3-018. A bounding analysis was performed by reducing SGTR accident progression source terms by a factor of 2.

The source terms used for the IP3-018 analysis are contained in file "IP3 SAMA Radionuclide Release Results-Level2-18.xls." A comparison of the IP3-018 source terms with those in Table A.10 of IP-RPT-07-00008 shows that the only differences are the release fractions for the Early High (H-E), Early Medium (M-E), and Early Low (L-E) release categories. This is reasonable, since SGTR accidents are bypass events, which contribute to early release categories.

Since the source term is different for this SAMA, the MACCS2 output is also different for this SAMA. Therefore, the MACCS2 Case 0, Case 4, Case 5, Case 7, and Case 8 sensitivities were reevaluated with the IP2-020 source term information (Reference 4). An additional worksheet, "IP3-018 MACCS2 Output," was added to the combined spreadsheet, "Case 0 IPEC SAMA Sensitivities," to calculate the base case benefits and facilitate the sensitivity evaluations for IP3-018.

C. Altered Base Case for TI-SGTR SAMAs

Section 3.6 of IP-RPT-09-00044 (Reference 3) describes the analysis performed to evaluate the impact of more pessimistic assumptions regarding scenarios that involve the potential for a thermally induced steam generator tube rupture (TI-SGTR). The NUREG-1570 full conditional induced SGTR value (0.25) for moderate tube degradation was applied to all high/dry sequences in the Level 2 model for each unit; in both station blackout and transient sequences.

In the TI-SGTR analysis, 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, a detailed evaluation was performed for those for which the cost outweighed the benefit by less than a factor of five. 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 unscreened IP2 SAMAs were SAMAs 1, 6, 25, 29, 40 and 52.

The unscreened IP3 SAMAs were SAMAs 1, 16, 18, 30, 40 and 43.

The source terms used for the IP2 TI-SGTR analysis are contained in file "IP2 Radionuclide Release Results-Base-RAI#5.xls." The source terms used for the IP3 TI-SGTR analysis are contained in file "IP3 Radionuclide Release Results-Base-RAI#5.xls." A comparison of the TI-SGTR source terms with those in Table A-10 of IP-RPT-07-00007 and Table A.10 of IP-RPT-07-00008 shows that the only differences are the timing and release fractions for the Early High (H-E) release category. This is reasonable, since high/dry sequences would be expected to contribute to this release category.

Since the source term is different for these SAMAs, the MACCS2 output is also different for these SAMAs. Therefore, the MACCS2 Case 0, Case 4, Case 5, Case 7, and Case 8 sensitivities were reevaluated with the TI-SGTR source term information (Reference 4). Additional worksheets (IP2 TI-SGTR Base, IP2 TI-SGTR MACCS2 Output, IP3 TI-SGTR Base, IP3 TI-SGTR MACCS2 Output, and individual TI-SGTR SAMA worksheets) were added to the combined spreadsheet, "Case 0 IPEC SAMA Sensitivities," to calculate the base case benefits and facilitate the sensitivity evaluations for the TI-SGTR SAMAs.

5.3 Sensitivity Case 4 – Revised Baseline (Escalated VALWNF and VNFRM)

- Case 4
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values. VALWNF is used in the CHRONC input file and represents an average value for the 50 mile region. VNFRM is used in the SITE input file and is calculated on a county basis.
  - This case addresses Part 1 of the RAI (i.e., corrected VALWNF), and represents the "revised baseline" as specified in the RAI.

The following steps were performed to evaluate Sensitivity Case 4.

1. Copied combined spreadsheet and renamed, "Case 4 IPEC SAMA Sensitivities.xlsx."

2. Renamed worksheet "Case 0 (cost-benefit)" to "Case 4 (cost-benefit)" and deleted columns J and K from this worksheet.

3. Copied PDR and OECR values from the sensitivity cases in IP-RPT-16-00077 into the appropriate worksheets in Case 4 IPEC SAMA Sensitivities.xlsx (see table below).

Worksheet in Case 4 IPEC SAMA Sensitivities.xlsx	Spreadsheet from IP-RPT-16-00077	Worksheet in IP-RPT-16-00077 Spreadsheet
IP2 MACCS2 Output	2016 IPEC MACCS2 Sens – RevD.xlsx	U2 Results Detailed
IP2-020 MACCS2 Output		
IP2 TI-SGTR MACCS2 Output		
IP3 MACCS2 Output		U3 Results Detailed
IP3-018 MACCS2 Output		
IP3 TI-SGTR MACCS2 Output		

4. The benefit values were automatically re-calculated and populated in columns C and D of the "Case 4 (cost-benefit)" worksheet for comparison with the implementation cost estimates.

5. Since Case 4 is considered a "new baseline," the SAMAs potentially impacted by the TI-SGTR assumption were re-screened consistent with the screening in IP-RPT-09-00044 and described in Section 5.2.C above.

   In the TI-SGTR analysis, 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, a detailed evaluation was performed for those for which the cost outweighed the benefit by less than a factor of five. [Column J of the "Case 4 (cost-benefit)" worksheet was used for this screening.] 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.

   In Case 0, the unscreened IP2 SAMAs were SAMAs 1, 6, 25, 29, 40 and 52.
   In Case 4, the unscreened IP2 SAMAs are SAMAs 1, 25, 29, 40 and 52.

   In Case 0, the unscreened IP3 SAMAs were SAMAs 1, 16, 18, 30, 40 and 43.
   In Case 4, the unscreened IP3 SAMAs are SAMAs 1, 16, 17, 30, 40 and 43.

6. As described in Section 5.2.C above for the other TI-SGTR SAMAs, an additional worksheet was added to the Case 4 spreadsheet to evaluate the IP3-017 TI-SGTR benefit. The "Case 4 (cost-benefit)" worksheet was adjusted accordingly.

7. SAMA IP2-006 does not meet the screening criterion in Case 4 due to rounding of the benefit values. However, the TI-SGTR analysis for this SAMA was retained in the Case 4 spreadsheet.

8. SAMA IP3-018 does not meet the screening criterion in Case 4 due to the new implementation cost estimate reported in NL-14-143 (Reference 5). Nevertheless, the TI-SGTR analysis for this SAMA was retained in the Case 4 spreadsheet. This SAMA does not become cost-beneficial in Case 4 or Case 5, so there is no impact from keeping the TI-SGTR analysis.

5.4 Sensitivity Case 5 – Revised TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM)

- Case 5
  - TIMDEC is escalated to one year (365 days) and CDNFRM is escalated to $100,000/person for DF=15 in the CHRONC input file.
  - VALWNF and VNFRM (including lost tourism and business) are escalated to 2005 values in the CHRONC and SITE input files, respectively.
  - This case addresses Part 2(a) of the RAI.

The following steps were performed to evaluate Sensitivity Case 5.

1. Copied Case 4 spreadsheet and renamed, "Case 5 IPEC SAMA Sensitivities.xlsx."

2. Renamed worksheet "Case 4 (cost-benefit)" to "Case 5 (cost-benefit)."

3. Cleared the contents of columns D and F and revised equations in column I to use the values in columns C and E for comparison. Since Case 5 is a sensitivity analysis on the revised baseline from Case 4, the 95th percentile uncertainty sensitivity does not also need to be calculated. Also, deleted column J since the TI-SGTR screening was performed in Case 4.

4. Copied PDR and OECR values from the sensitivity cases in IP-RPT-16-00077 into the appropriate worksheets in Case 5 IPEC SAMA Sensitivities.xlsx (see table below).

Worksheet in Case 5 IPEC SAMA Sensitivities.xlsx	Spreadsheet from IP-RPT-16-00077	Worksheet in IP-RPT-16-00077 Spreadsheet
IP2 MACCS2 Output	2016 IPEC MACCS2 Sens – RevD.xlsx	U2 Results Detailed
IP2-020 MACCS2 Output		
IP2 TI-SGTR MACCS2 Output		
IP3 MACCS2 Output		U3 Results Detailed
IP3-018 MACCS2 Output		
IP3 TI-SGTR MACCS2 Output		

5. The benefit values were automatically re-calculated and populated in columns C and E of the "Case 5 (cost-benefit)" worksheet for comparison with the implementation cost estimates.

6. A few of the IP2 SAMAs showed a negative benefit in the Case 5 results. This occurred because the SAMAs had no benefit and the release mode frequencies for the individual SAMAs carried more digits than the release mode frequencies for the IP2-Base Benefit. The release mode frequencies from the IP2-Base Benefit worksheet were copied over the release mode frequencies in worksheets IP2-033, IP2-046, IP2-047, IP2-051, IP2-055, and IP2-058. This corrects the SAMA benefits in the Case 5 (Cost-Benefit) worksheet so that they are zero, rather than negative.

5.5 Sensitivity Case 7 – Alternate Revised Baseline (Escalated VALWNF and VNFRM and revised VDEPOS)

- Case 7
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values in the CHRONC and SITE input files, respectively.
  - The dry deposition velocity, VDEPOS, is set to 0.003 m/sec in the ATMOS input file rather than the IP-CALC-09-00265 (Reference 8) value of 0.010 m/sec. The value of 0.003m/sec is documented by the recent NRC's State-of-the-Art Reactor Consequence Analyses (SOARCA) Project to be the dominant or average value for use in SOARCA and is viewed as more representative than the value of 0.010m/sec used in the NUREG-1150 studies.
  - Similar to Case 4, Case 7 addresses Part 1 of the RAI (i.e., escalated VALWNF), and represents the "revised baseline" as specified in the RAI, except with an updated dry deposition velocity.

The following steps were performed to evaluate Sensitivity Case 7.

1. Copied combined spreadsheet and renamed, "Case 7 IPEC SAMA Sensitivities.xlsx."

2. Renamed worksheet "Case 0 (cost-benefit)" to "Case 7 (cost-benefit)" and deleted columns J and K from this worksheet.

3. Copied PDR and OECR values from the sensitivity cases in IP-RPT-16-00077 into the appropriate worksheets in Case 7 IPEC SAMA Sensitivities.xlsx (see table below).

Worksheet in Case 4 IPEC SAMA Sensitivities.xlsx	Spreadsheet from IP-RPT-16-00077	Worksheet in IP-RPT-16-00077 Spreadsheet
IP2 MACCS2 Output	2016 IPEC MACCS2 Sens – RevD.xlsx	U2 Results Detailed
IP2-020 MACCS2 Output		
IP2 TI-SGTR MACCS2 Output		
IP3 MACCS2 Output		U3 Results Detailed
IP3-018 MACCS2 Output		
IP3 TI-SGTR MACCS2 Output		

4. The benefit values were automatically re-calculated and populated in columns C and D of the "Case 7 (cost-benefit)" worksheet for comparison with the implementation cost estimates.

5. A few of the IP2 SAMAs showed a negative benefit in the Case 7 results. This occurred because the SAMAs had little or no benefit and the release mode frequencies for the individual SAMAs carried more digits than the release mode frequencies for the IP2-Base Benefit. The release mode frequencies from the IP2-Base Benefit worksheet were copied over the release mode frequencies in worksheets IP2-012, IP2-013, IP2-016, IP2-033, IP2-046, IP2-047, IP2-051, IP2-055, and IP2-058. Also, the IP2-Base Benefit release frequencies for the non-NCF release modes were copied over the release mode frequencies in worksheet IP2-067. This corrects the SAMA benefits in the Case 5 (Cost-Benefit) worksheet so that they are non-negative.

6. Since Case 7 is a proposed, alternate "new baseline," the SAMAs potentially impacted by the TI-SGTR assumption were re-screened consistent with the screening in IP-RPT-09-00044 and described in Section 5.2.C above.

   In the TI-SGTR analysis, 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, 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, a detailed evaluation was performed for those for which the cost outweighed the benefit by less than a factor of five. [Column J of the "Case 7 (cost-benefit)" worksheet was used for this screening.] 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.

   In Case 0, the unscreened IP2 SAMAs were SAMAs 1, 6, 25, 29, 40 and 52.
   In Case 7, the unscreened IP2 SAMAs are SAMAs 1, 25, 40, 52, and 62.

   In Case 0, the unscreened IP3 SAMAs were SAMAs 1, 16, 18, 30, 40 and 43.
   In Case 7, the unscreened IP3 SAMAs are SAMAs 1, 16, 30, 40 and 43.

7. As described in Section 5.2.C above for the other TI-SGTR SAMAs, an additional worksheet was added to the Case 7 spreadsheet to evaluate the IP2-062 TI-SGTR benefit. The "Case 7 (cost-benefit)" worksheet was adjusted accordingly. [IP2-062 was not evaluated for TI-SGTR in Case 0 because it was cost-beneficial in Case 0. However, IP2-062 is not cost-beneficial in Case 7, so it is included in the TI-SGTR evaluation.]

8. Similar to Case 4, SAMAs IP2-006, IP2-029, and IP3-018 do not meet the screening criterion in Case 7. However, the TI-SGTR analyses for these SAMAs were retained in the Case 7 spreadsheet.

5.6 Sensitivity Case 8 – Alternate Revised TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM and revised VDEPOS)

- Case 8
  - TIMDEC is escalated to one year (365 days) and CDNFRM is escalated to $100,000/person for DF=15 in the CHRONC input file.
  - VALWNF & VNFRM (including lost tourism and business) are escalated to 2005 values in the CHRONC and SITE input files, respectively.
  - The dry deposition velocity, VDEPOS, is set to 0.003 m/sec in the ATMOS input file rather than the IP-CALC-09-00265 (Reference 8) value of 0.010 m/sec.
  - Similar to Case 5, Case 8 addresses Part 2(a) of the RAI (i.e., corrected VALWNF, increased TIMDEC & CDNFRM), as specified in the RAI, except with an updated dry deposition velocity.

The following steps were performed to evaluate Sensitivity Case 8.

1. Copied Case 7 spreadsheet and renamed, "Case 8 IPEC SAMA Sensitivities.xlsx."
2. Renamed worksheet "Case 7 (cost-benefit)" to "Case 8 (cost-benefit)."
3. Cleared the contents of columns D and F and revised equations in column I to use the values in columns C and E for comparison. Since Case 8 is a sensitivity analysis on the alternate revised baseline in Case 7, the 95th percentile uncertainty sensitivity does not also need to be calculated. Also, deleted column J since the TI-SGTR screening was performed in Case 7.
4. Copied PDR and OECR values from the sensitivity cases in IP-RPT-16-00077 into the appropriate worksheets in Case 8 IPEC SAMA Sensitivities.xlsx (see table below).

Worksheet in Case 5 IPEC SAMA Sensitivities.xlsx	Spreadsheet from IP-RPT-16-00077	Worksheet in IP-RPT-16-00077 Spreadsheet
IP2 MACCS2 Output	2016 IPEC MACCS2 Sens – RevD.xlsx	U2 Results Detailed
IP2-020 MACCS2 Output		
IP2 TI-SGTR MACCS2 Output		
IP3 MACCS2 Output		U3 Results Detailed
IP3-018 MACCS2 Output		
IP3 TI-SGTR MACCS2 Output		

5. The benefit values were automatically re-calculated and populated in columns C and E of the "Case 8 (cost-benefit)" worksheet for comparison with the implementation cost estimates.

6.0 Revision to Reflect Shortened License Renewal Period

On February 8, 2017 Entergy filed an amendment to its pending license renewal application for Indian Point IP2 and IP3 to update the proposed term of the renewed licenses from 20 years for each unit to the periods ending April 30, 2024 for IP2 and April 30, 2025 for IP3 (Reference 10). Since the original license expiration dates were September 2013 for IP2 and December 2015 for IP3, the license renewal period has been changed to 11 years for IP2 and 10 years for IP3. Section 6.0 describes the changes necessary for the SAMA cost-benefit sensitivities to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3). Results of the revised analysis are provided in Section 7.0.

The license renewal period impacts the SAMA analysis in two ways. First, it defines the year to which the population projections for the 50-mile region around the plant are extrapolated. Second, it is used in the calculations of onsite and offsite exposure costs and economic costs following a severe accident to take into account the time value of money.

For the Indian Point SAMA analyses, the population in the 50-mile region was projected to the year 2034 to encompass the license renewal period for both units (Reference 3). With a shorter license renewal period (ending in 2024 for IP2 and 2025 for IP3), the population in the region would generally be expected to be lower. However, the many MACCS2 cost input values are based on present dollars not future dollars (Reference 11), so they are not impacted by the duration of the license renewal period. Since the only change to the MACCS2 analyses would be the population, and re-projecting the population is a time consuming task, Entergy has decided to conservatively retain the 2034 population in Revision 1 of this report. Therefore, the results of the MACCS2 sensitivity cases described in Section 5.1 and presented in Tables 2 through 9 remain unchanged. Also, the escalated VALWNF described in Section 2.0 and the VNFRM values in Table 1 remain unchanged.

This revision accounts for the impact on the onsite and offsite exposure costs and economic costs following a severe accident from the reduced license renewal period (11 years for IP2 and 10 years for IP3) as describe below.

6.1 On-site and Offsite Exposure and Economic Costs Following a Severe Accident

The onsite and offsite exposure and economic costs following a severe accident were calculated as shown in Section 3.2.5 of Reference 3. They are recalculated below using the new license renewal period for each unit. The parameter "t_f" is used for the license renewal period (years) and is included in several of the equations to take into account the time value of money. These calculations provide the costs for each unit without implementation of any SAMAs. Thus, they establish the maximum benefit that a SAMA could achieve if it eliminated all risk due to at-power internal events. Each of the cost categories is discussed followed by a summary table for each unit.

6.1.1 Accident-Related Off-Site Dose Costs (APE)

The Level 3 baseline analysis resulted in an annual off-site exposure risk of 87.4 person-rem for IP2 and 94.8 person-rem for IP3. This value was converted to its monetary equivalent (dollars) via application of the $2,000 per person-rem conversion factor from the *Regulatory Analysis Technical Evaluation Handbook* (Reference 12). The monetary equivalent was then discounted to present value using the following equation.

$$APE = (F_S D_{P_S} - F_A D_{P_A}) R \left(\frac{1 - e^{-rt_f}}{r} \right)$$

Where,

APE = monetary value of accident risk avoided from population does, after discounting ($)

R = monetary equivalent of unit dose ($/person-rem)

F = accident frequency (events/year)

D_P = population dose factor (person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate

t_f = license renewal period (years)

Because there are eight accident releases considered in this study, the product FD_P which represents population dose risk (PDR), was estimated by summing the product of the release frequency of each accident release and population dose over all eight releases.

For **IP2**, using an 11-year license renewal period, a 7% discount rate, assuming F_A is zero, and the baseline PDR value of 87.4 person-rem/yr resulted in the monetary equivalent value of $1,340,933.

For **IP3**, using a 10-year license renewal period, a 7% discount rate, assuming F_A is zero, and the baseline PDR value of 94.8 person-rem/yr resulted in the monetary equivalent value of $1,363,535.

6.1.2 Accident-Related Off-Site Property Damage Costs (AOC)

The Level 3 baseline analysis resulted in an annual off-site economic risk monetary equivalent of $212,000 for IP2 and $261,000 for IP3. This value was discounted in the same manner as the public health risks in accordance with the following equation:

$$AOC = (F_S P_{D_S} - F_A P_{D_A}) \left(\frac{1 - e^{-rt_f}}{r} \right)$$

Where,

AOC = monetary value of risk avoided from off-site property damage, after discounting ($)

P_D = off-site property loss factor ($/event)

F = accident frequency (events/year)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate

t_f = license renewal period (years)

The product FP_D, which represents off-site economic cost risk (OECR), was estimated by summing the product of the release frequency of each accident release and off-site economic costs over all eight releases.

For **IP2**, using previously defined values and the baseline OECR value of $212,000/yr, the resulting monetary equivalent is $1,626,303.

For **IP3**, using previously defined values and the baseline OECR value of $261,000/yr, the resulting monetary equivalent is $1,877,018.

6.1.3 Total Accident-Related Occupational Exposures (AOE)

The values for occupational exposure associated with severe accidents were not derived from the PSA model, but from information in the *Regulatory Analysis Technical Evaluation Handbook* (Reference 12). The values for occupational exposure consist of "immediate dose" and "long-term dose." The best estimate value provided for immediate occupational dose is 3,300 person-rem, and long-term occupational dose is 20,000 person-rem (over a ten year clean-up period). The following equations were used to estimate monetary equivalents.

Immediate Dose

$$W_{IO} = (F_S D_{IO_S} - F_A D_{IO_A}) R \left(\frac{1 - e^{-rt_f}}{r} \right)$$

Where,

W_{IO} = monetary value of accident risk avoided from immediate doses, after discounting ($)

IO = immediate occupational dose

R = monetary equivalent of unit dose ($/person-rem)

F = accident frequency (events/year)

D_{IO} = immediate occupational dose (person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate

t_f = license renewal period (years)

The values used in the analysis were:

R = $2,000/person-rem

r = 0.07

D_{IO} = 3,300 person-rem/accident

t_f = 11 years for IP2 and 10 years for IP3

For the basis discount rate, assuming F_A is zero, the bounding monetary value of the immediate dose is as follows.

For **IP2**, the baseline CDF is 1.79X10^{-5}/ry, and W_{IO} = $906.

For **IP3**, the baseline CDF is 1.15X10^{-5}/ry, and W_{IO} = $546.

Long-Term Dose

$$W_{LTO} = (F_S D_{LTO_S} - F_A D_{LTO_A}) R * \frac{(1 - e^{-rt_f})}{r} * \frac{(1 - e^{-rm})}{rm}$$

Where,

W_{LTO} = monetary value of accident risk avoided from long-term doses, after discounting ($);

LTO = long-term occupational dose

m = years over which long-term doses accrue

R = monetary equivalent of unit dose ($/person-rem)

F = accident frequency (events/year)

D_{LTO} = long-term occupational dose (20,000 person-rem/event)

S = status quo (current conditions)

A = after implementation of proposed action

r = discount rate

t_f = license renewal period (years)

The values used in the analysis were:

R = $2,000/person-rem

r = 0.07

D_{LTO} = 20,000 person-rem/accident

m = 10 years

t_f = 11 years for IP2 and 10 years for IP3

For the basis discount rate, assuming F_A is zero, the bounding monetary value of the long-term dose associated with accident risk is as follows.

For **IP2**, the baseline CDF is 1.79X10^{-5}/ry, and W_{LTO} = $3,950.

For **IP3**, the baseline CDF is $1.15X10^{-5}$/ry, and W_{LTO} = $2,379.

Total Occupational Exposures

The total exposure (AOE) is obtained by summing the immediate monetary value of on-site exposure after discounting (W_{IO}) and the long-term monetary value of on-site exposure after discounting (W_{LTO}).

The bounding value for occupational exposure (AOE) for **IP2** is $4,856.

The bounding value for occupational exposure (AOE) for **IP3** is $2,925.

6.1.4 Averted Costs Associated with Accident-Related On-Site Property Damage (AOSC)

Clean-up/Decontamination

The total cost of clean-up/decontamination of a power reactor facility subsequent to a severe accident is estimated in the *Regulatory Analysis Technical Evaluation Handbook* (Reference 12) to be $1.5X10^9$; this same value was adopted for these analyses. Considering a 10-year cleanup period, the present value of this cost is:

$$PV_{CD} = \left(\frac{C_{CD}}{m}\right)\frac{(1 - e^{-rm})}{r}$$

Where,

PV_{CD} = present value of the cost of cleanup/decontamination ($)

CD = clean-up/decontamination

C_{CD} = total cost of the cleanup/decontamination effort ($1.5X10^9$)

m = cleanup period (10 years)

r = discount rate

Based upon the values previously assumed, PV_{CD} = $1.08E+9.

This cost is integrated over the term of the proposed license extension as follows:

$$U_{CD} = PV_{CD}\frac{(1 - e^{-rt_f})}{r}$$

Where,

U_{CD} = total cost of clean-up/decontamination over the life of the plant

t_f = license renewal period (years)

Using the 7% discount rate and t_f = 11 years for IP2 and 10 years for IP3, the U_{CD} for **IP2** is $8.29E+9 and the U_{CD} for **IP3** is $7.77E+9.

Replacement Power Costs

Replacement power costs were estimated in accordance with the *Regulatory Analysis Technical Evaluation Handbook* (Reference 12). Since replacement power will be needed for the time period following a sever accident, for the remainder of the expected generating plant life, long-term power replacement calculations have been used. The present value of replacement power was estimated as follows:

$$PV_{RP} = \left(\frac{\$1.2x10^8}{r}\right)(1 - e^{-rt_f})^2$$

Where,

PV_{RP} = present value of the cost of replacement power for a single event ($);

r = discount rate

t_f = license renewal period (years)

The $\$1.2x10^8$ value has no intrinsic meaning, but is a substitute for a string of non-constant replacement power costs that occur over the lifetime of a "generic" reactor after an event. This equation was developed in the *Regulatory Analysis Technical Evaluation Handbook* (Reference 12) for discount rates between 5% and 10% only.

Using the 7% discount rate and t_f = 11 years for IP2 and 10 years for IP3, the PV_{RP} for **IP2** is $4.94E+8 and the PV_{RP} for **IP3** is $4.34E+8.

To account for the lifetime of the facility, U_{RP} was then calculated from PV_{RP} as follows:

$$U_{RP} = \frac{PV_{RP}}{r}(1 - e^{-rt_f})^2$$

Where,

U_{RP} = present value of the cost of replacement power over the remaining life ($);

r = discount rate

t_f = license renewal period (years)

Based upon the values previously assumed, and the power correction factor of 1.177 discussed below, the U_{RP} for **IP2** is $2.82E+9 and the U_{RP} for **IP3** is $3.28E+9.

Since net generation can vary based on plant demands, a power level of 1071 MWe, which reflects typical gross generation levels, was used to conservatively bound the net generated power that would need to be replaced at either IP2 or IP3. Thus, a correction factor to account for the difference in typical gross power generation level used for IP2 and IP3, and the generic reactor described in the *Regulatory Analysis Technical Evaluation Handbook* (i.e., 1071MWe/910MWe = 1.177) was used.

Total On-site Property Damage Costs

Combining the cleanup/decontamination and replacement power costs, using delta (ΔF) to signify the difference in accident frequency resulting from the proposed actions, and using the above numerical values, the best-estimate value of averted on-site property damage costs can be expressed as:

$$AOSC = \Delta F(U_{CD} + U_{RP})$$

Where,

ΔF = difference in annual accident frequency resulting from the proposed action

For **IP2**, the baseline CDF is 1.79X10-5/ry, and the AOSC is $191,201.

For **IP3**, the baseline CDF is 1.15X10-5/ry, and the AOSC is $110,609.

6.1.5 Total On-site and Off-site Exposure and Economic Costs Following a Severe Accident

The following tables summarize the results above as well as the results reported in the Indian Point SAMA reanalysis (Reference 3), using t_f = 20 years.

Estimated Present Dollar Value Equivalent of Internal Events CDF at IP2		
Parameter	**Present Dollar Value ($) for 20-yr License Renewal Period**	**Present Dollar Value ($) for 11-yr License Renewal Period**
Off-site population dose	$1,881,355	$1,340,933
Off-site economic costs	$2,281,735	$1,626,303
On-site dose	$6,814	$4,856
On-site economic costs	$374,303	$191,201
TOTAL	$4,544,208	$3,163,294

Estimated Present Dollar Value Equivalent of Internal Events CDF at IP3		
Parameter	**Present Dollar Value ($) for 20-yr License Renewal Period**	**Present Dollar Value ($) for 10-yr License Renewal Period**
Off-site population dose	$2,040,646	$1,363,535
Off-site economic costs	$2,809,117	$1,877,018
On-site dose	$4,377	$2,925
On-site economic costs	$240,475	$110,609
TOTAL	$5,094,615	$3,354,087

6.2 Evaluation of Potentially Cost-Beneficial SAMAs for the Shortened License Renewal Period Sensitivity Cases

The equations in Section 6.1 are already within the analysis case spreadsheets, which were created as described in Sections 5.2 through 5.6. Within each analysis case spreadsheet, in the worksheets labeled "IP2-Base Benefit" and "IP3-Base Benefit", cell B-3 contains the value for the license renewal period (t_f). Likewise, in the worksheets for the individual SAMAs, cell B-3 contains the value for the license renewal period (t_f). Thus, the analyses performed in Sections 5.2 and 5.6 are revised to reflect the new license renewal period by changing the value of t_f in these worksheets. They were revised as follows.

6.2.1 Sensitivity Case 0 – Shortened License Renewal Period Baseline

The baseline calculations in Section 5.2 were revised as follows to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3).

1. Copied Spreadsheet "Case 0 IPEC SAMA Sensitivities.xlsx" to a new spreadsheet named "Case 0 IPEC SAMA Sensitivities_R1.xlsx."
2. Added worksheet "License Renewal Period" containing the revised license renewal period for each unit.
3. Linked cell B-3 in worksheet "IP2-Base Benefit" and in each of the individual IP2 SAMA worksheets to the IP2 value in worksheet "License Renewal Period."
4. Linked cell B-3 in worksheet "IP3-Base Benefit" and in each of the individual IP3 SAMA worksheets to the IP3 value in worksheet "License Renewal Period."
5. The benefit values were automatically re-calculated and populated in columns D and F of the "Case 0 (Cost-Benefit)" worksheet for comparison with the implementation cost estimates.

6.2.2 Sensitivity Case 4 – Shortened Renewal Period Revised Baseline (Escalated VALWNF and VNFRM)

The Sensitivity Case 4 calculations in Section 5.3 were revised as follows to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3).

1. Copied Spreadsheet "Case 4 IPEC SAMA Sensitivities.xlsx" to a new spreadsheet named "Case 4 IPEC SAMA Sensitivities_R1.xlsx."
2. Added worksheet "License Renewal Period" containing the revised license renewal period for each unit.
3. Linked cell B-3 in worksheet "IP2-Base Benefit" and in each of the individual IP2 SAMA worksheets to the IP2 value in worksheet "License Renewal Period."

4. Linked cell B-3 in worksheet "IP3-Base Benefit" and in each of the individual IP3 SAMA worksheets to the IP3 value in worksheet "License Renewal Period."

5. The benefit values were automatically re-calculated and populated in columns D and F of the "Case 4 (Cost-Benefit)" worksheet for comparison with the implementation cost estimates.

6.2.3 Sensitivity Case 5 – Shortened License Renewal Period Revised TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM)

The Sensitivity Case 5 calculations in Section 5.4 were revised as follows to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3).

1. Copied Spreadsheet "Case 5 IPEC SAMA Sensitivities.xlsx" to a new spreadsheet named "Case 5 IPEC SAMA Sensitivities_R1.xlsx."

2. Added worksheet "License Renewal Period" containing the revised license renewal period for each unit.

3. Linked cell B-3 in worksheet "IP2-Base Benefit" and in each of the individual IP2 SAMA worksheets to the IP2 value in worksheet "License Renewal Period."

4. Linked cell B-3 in worksheet "IP3-Base Benefit" and in each of the individual IP3 SAMA worksheets to the IP3 value in worksheet "License Renewal Period."

5. The benefit values were automatically re-calculated and populated in columns C and E of the "Case 5 (Cost-Benefit)" worksheet for comparison with the implementation cost estimates.

6.2.4 Sensitivity Case 7 – Shortened License Renewal Period Alternate Revised Baseline (Escalated VALWNF and VNFRM and revised VDEPOS)

The Sensitivity Case 7 calculations in Section 5.5 were revised as follows to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3).

1. Copied Spreadsheet "Case 7 IPEC SAMA Sensitivities.xlsx" to a new spreadsheet named "Case 7 IPEC SAMA Sensitivities_R1.xlsx."

2. Added worksheet "License Renewal Period" containing the revised license renewal period for each unit.

3. Linked cell B-3 in worksheet "IP2-Base Benefit" and in each of the individual IP2 SAMA worksheets to the IP2 value in worksheet "License Renewal Period."

4. Linked cell B-3 in worksheet "IP3-Base Benefit" and in each of the individual IP3 SAMA worksheets to the IP3 value in worksheet "License Renewal Period."

5. The benefit values were automatically re-calculated and populated in columns D and F of the "Case 7 (Cost-Benefit)" worksheet for comparison with the implementation cost estimates.

6.2.5 Sensitivity Case 8 – Shortened License Renewal Period Alternate Revised TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM and revised VDEPOS)

The Sensitivity Case 8 calculations in Section 5.6 were revised as follows to reflect the revised license renewal period (11 years for IP2 and 10 years for IP3).

1. Copied Spreadsheet "Case 8 IPEC SAMA Sensitivities.xlsx" to a new spreadsheet named "Case 8 IPEC SAMA Sensitivities_R1.xlsx."
2. Added worksheet "License Renewal Period" containing the revised license renewal period for each unit.
3. Linked cell B-3 in worksheet "IP2-Base Benefit" and in each of the individual IP2 SAMA worksheets to the IP2 value in worksheet "License Renewal Period."
4. Linked cell B-3 in worksheet "IP3-Base Benefit" and in each of the individual IP3 SAMA worksheets to the IP3 value in worksheet "License Renewal Period."
5. The benefit values were automatically re-calculated and populated in columns C and E of the "Case 8 (Cost-Benefit)" worksheet for comparison with the implementation cost estimates.

7.0 Conclusions for Shortened License Renewal Period

7.1 Sensitivity Case 0 – Shortened License Renewal Period Baseline

The baseline analysis shows that two SAMAs that were potentially cost-beneficial with a 20 year license renewal period are not potentially cost-beneficial using the shortened license renewal period of 11 years for IP2 and 10 years for IP3. Specifically, SAMAs IP2-028, *"Provide a portable diesel-driven battery charger,"* and IP2-062, *"Provide a hard-wired connection to an SI pump from ASSS power supply,"* are not potentially cost-beneficial with the shortened license renewal period.

Table 10 provides the Sensitivity Case 0 (Baseline) SAMA results using the shortened license renewal period.

7.2 Sensitivity Case 4 – Shortened License Renewal Period Revised Baseline (Escalated VALWNF and VNFRM)

The revised baseline with escalation of VALWNF and VNFRM did not result in additional potentially cost-beneficial SAMAs.

Table 11 provides the Sensitivity Case 4 SAMA results using the shortened license renewal period.

7.3 Sensitivity Case 5 – Shortened License Renewal Period Revised TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM)

Increasing TIMDEC and CDNFRM (with escalated VALWNF and VNFRM) did not result in additional potentially cost-beneficial SAMAs.

Table 12 provides the Sensitivity Case 5 SAMA results using the shortened license renewal period.

7.4 Sensitivity Case 7 – Shortened License Renewal Period Alternate Revised Baseline (Escalated VALWNF and VNFRM and revised VDEPOS)

Sensitivity Case 7 shows that one SAMA that was potentially cost-beneficial in the Shortened License Renewal Period Baseline (Case 0 above) is not potentially cost-beneficial with the change to VDEPOS along with escalation of VALWNF and VNFRM. Specifically, SAMA IP2-044, *"Use fire water system as backup for steam generator inventory,"* is not potentially cost-beneficial in this case with the shortened license renewal period.

Sensitivity Case 7 did not result in additional potentially cost-beneficial SAMAs.

Table 13 provides the Sensitivity Case 7 SAMA results using the shortened license renewal period.

7.5 Sensitivity Case 8 – Shortened License Renewal Period Alternate Revised TIMDEC and CDNFRM (with Escalated VALWNF and VNFRM and revised VDEPOS)

Increasing TIMDEC and CDNFRM (with escalated VALWNF and VNFRM and revised VDEPOS) did not result in additional potentially cost-beneficial SAMAs.

Table 14 provides the Sensitivity Case 8 SAMA results using the shortened license renewal period.

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	239,830	504,906	239,830	504,906	1,137,000	n/a	Not Beneficial
IP2-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	225,676	475,107	n/a	n/a	1,000,000	n/a	Not Beneficial
IP2-003	003 - Install an additional CCW pump.	0	0	n/a	n/a	1,500,000	n/a	Not Beneficial
IP2-004	004 - Enhance procedural guidance for use of service water pumps.	28,309	59,597	n/a	n/a	1,750,000	n/a	Not Beneficial
IP2-005	005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	67,452	142,004	n/a	n/a	565,000	n/a	Not Beneficial
IP2-006	006 - Add a diesel building high temperature alarm.	14,154	29,799	49,135	103,443	274,000	n/a	Not Beneficial
IP2-007	007 - Install a filtered containment vent to provide fission product scrubbing.	1,230,160	2,589,811	n/a	n/a	5,700,000	n/a	Not Beneficial
IP2-008	008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	4,524,192	9,524,614	n/a	n/a	108,000,000	n/a	Not Beneficial
IP2-009	009 - Create a reactor cavity flooding system.	4,524,192	9,524,614	n/a	n/a	4,100,000	1,741,724	Retained
IP2-010	010 - Create a core melt source reduction system.	4,524,192	9,524,614	n/a	n/a	90,000,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-011	011 - Provide a means to inert containment.	2,203,794	4,639,567	n/a	n/a	10,900,000	n/a	Not Beneficial
IP2-012	012 - Use the fire protection system as a backup source for the containment spray system.	0	0	n/a	n/a	565,000	n/a	Not Beneficial
IP2-013	013 - Install a passive containment spray system.	0	0	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-014	014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	851,201	1,792,002	n/a	n/a	5,000,000	n/a	Not Beneficial
IP2-015	015 - Construct a building connected to primary containment that is maintained at a vacuum.	4,250,175	8,947,737	n/a	n/a	61,000,000	n/a	Not Beneficial
IP2-016	016 - Install a redundant containment spray system.	0	0	n/a	n/a	5,800,000	n/a	Not Beneficial
IP2-017	017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	1,241,821	2,614,359	n/a	n/a	5,500,000	n/a	Not Beneficial
IP2-018	018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	52,471	110,466	n/a	n/a	7,400,000	n/a	Not Beneficial
IP2-019	019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	3,979,478	8,377,849	n/a	n/a	100,000,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-020	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.	413,940	871,453	n/a	n/a	9,700,000	n/a	Not Beneficial
IP2-021	021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	1,489,181	3,135,117	n/a	n/a	3,200,000	4,632,227	Not Beneficial
IP2-022	022 - Add redundant and diverse limit switches to each containment isolation valve.	762,081	1,604,381	n/a	n/a	2,200,000	7,692,784	Not Beneficial
IP2-023	023 - Increase leak testing of valves in ISLOCA paths.	762,081	1,604,381	n/a	n/a	7,964,000	n/a	Not Beneficial
IP2-024	024 - Ensure all ISLOCA releases are scrubbed.	1,489,181	3,135,117	n/a	n/a	9,700,000	n/a	Not Beneficial
IP2-025	025 - Improve MSIV design.	87,452	184,110	134,093	282,302	476,000	n/a	Not Beneficial
IP2-026	026 - Provide additional DC battery capacity.	28,309	59,597	n/a	n/a	1,875,000	n/a	Not Beneficial
IP2-027	027 - Use fuel cells instead of lead-acid batteries.	28,309	59,597	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-028	028 - Provide a portable diesel-driven battery charger.	952,792	2,005,877	n/a	n/a	938,000	2,154,767	Not Beneficial
IP2-029	029 - Increase/ improve DC bus load shedding.	28,309	59,597	57,460	120,967	460,000	n/a	Not Beneficial
IP2-030	030 - Create AC power cross-tie capability with other unit.	32,471	68,360	n/a	n/a	1,156,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-031	031 - Create a backup source for diesel cooling (not from existing system).	24,147	50,835	n/a	n/a	1,700,000	n/a	Not Beneficial
IP2-032	032 - Use fire protection system as a backup source for diesel cooling.	24,147	50,835	n/a	n/a	497,000	n/a	Not Beneficial
IP2-033	033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0	0	n/a	n/a	1,254,000	n/a	Not Beneficial
IP2-034	034 - Provide capability for diesel-driven, low pressure vessel makeup.	5,830	12,274	n/a	n/a	632,000	n/a	Not Beneficial
IP2-035	035 - Provide an additional high pressure injection pump with independent diesel.	50,803	106,954	n/a	n/a	5,000,000	n/a	Not Beneficial
IP2-036	036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	85,768	180,565	n/a	n/a	1,000,000	n/a	Not Beneficial
IP2-037	037 - Provide capability for alternate injection via diesel-driven fire pump.	5,830	12,274	n/a	n/a	750,000	n/a	Not Beneficial
IP2-038	038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	9,992	21,036	n/a	n/a	82,000	n/a	Not Beneficial
IP2-039	039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	50,803	106,954	n/a	n/a	2,000,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-040	040 - Create/enhance a reactor coolant depressurization system.	404,774	852,156	433,925	913,526	2,000,000	n/a	Not Beneficial
IP2-041	041 - Install a digital feed water upgrade.	113,251	238,423	n/a	n/a	900,000	n/a	Not Beneficial
IP2-042	042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	11,660	24,548	n/a	n/a	214,000	n/a	Not Beneficial
IP2-043	043 - Add a motor-driven feed water pump.	113,251	238,423	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-044	044 - Use fire water system as backup for steam generator inventory.	1,580,668	3,327,723	n/a	n/a	1,656,000	3,073,130	Retained
IP2-045	045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	423,027	890,584	n/a	n/a	2,700,000	n/a	Not Beneficial
IP2-046	046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0	0	n/a	n/a	82,000	n/a	Not Beneficial
IP2-047	047 - Add an independent boron injection system.	0	0	n/a	n/a	300,000	n/a	Not Beneficial
IP2-048	048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	69,120	145,515	n/a	n/a	615,000	n/a	Not Beneficial
IP2-049	049 - Install motor generator set trip breakers in control room.	19,985	42,073	n/a	n/a	716,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-050	050 - Provide capability to remove power from the bus powering the control rods.	19,985	42,073	n/a	n/a	90,000	n/a	Not Beneficial
IP2-051	051- Provide digital large break LOCA protection.	0	0	n/a	n/a	2,036,000	n/a	Not Beneficial
IP2-052	052 - Install secondary side guard pipes up to the MSIVs.	208,217	438,352	295,669	622,462	1,100,000	n/a	Not Beneficial
IP2-053	053 - Keep both pressurizer PORV block valves open.	418,865	881,821	n/a	n/a	800,000	1,471,234	Not Beneficial
IP2-054	054 - Install flood alarm in the 480V switchgear room.	3,927,770	8,268,989	n/a	n/a	200,000	458,843	Retained
IP2-055	055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0	0	n/a	n/a	1,330,000	n/a	Not Beneficial
IP2-056	056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	28,309	59,597	n/a	n/a	82,000	1,704,938	Not Beneficial
IP2-057	057 - Provide DC power backup for the PORVs.	60,796	127,991	n/a	n/a	376,000	n/a	Not Beneficial
IP2-058	058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0	0	n/a	n/a	82,000	n/a	Not Beneficial
IP2-059	059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	15,822	33,310	n/a	n/a	318,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-060	060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	896,158	1,886,649	n/a	n/a	216,000	721,303	Retained
IP2-061	061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	1,934,734	4,073,125	n/a	n/a	192,000	943,792	Retained
IP2-062	062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	596,327	1,255,425	n/a	n/a	1,500,000	1,662,692	Not Beneficial
IP2-063	063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	18,317	38,561	n/a	n/a	324,000	n/a	Not Beneficial
IP2-064	064 - Provide backup cooling water source for the CCW heat exchangers.	24,147	50,835	n/a	n/a	710,000	n/a	Not Beneficial
IP2-065	065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	3,927,770	8,268,989	n/a	n/a	560,000	1,859,587	Retained
IP2-066	066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	1,542,146	3,246,622	n/a	n/a	33,500,000	n/a	Not Beneficial
IP2-067	067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	4,162	8,762	n/a	n/a	576,000	n/a	Not Beneficial
IP2-068	068 - Provide independent source of cooling for the recirculation pump motors.	4,162	8,762	n/a	n/a	710,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	13,000,000	n/a	n/a	50,000	453,745	Retained
IP3-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	138,872	201,264	178,570	258,797	1,137,000	n/a	Not Beneficial
IP3-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	120,033	173,961	n/a	n/a	1,000,000	n/a	Not Beneficial
IP3-003	003 - Install an additional CCW pump.	0	0	n/a	n/a	1,500,000	n/a	Not Beneficial
IP3-004	004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	84,845	122,964	n/a	n/a	565,000	n/a	Not Beneficial
IP3-005	005 - Install a filtered containment vent to provide fission product scrubbing.	1,000,386	1,449,834	n/a	n/a	5,700,000	n/a	Not Beneficial
IP3-006	006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	3,366,377	4,878,808	n/a	n/a	108,000,000	n/a	Not Beneficial
IP3-007	007 - Create a reactor cavity flooding system.	3,366,377	4,878,808	n/a	n/a	4,100,000	1,874,933	Retained
IP3-008	008 - Create a core melt source reduction system.	3,366,377	4,878,808	n/a	n/a	90,000,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-009	009 - Provide means to inert containment.	1,611,732	2,335,844	n/a	n/a	10,900,000	n/a	Not Beneficial
IP3-010	010 - Use the fire protection system as a backup source for the containment spray system.	0	0	n/a	n/a	565,000	n/a	Not Beneficial
IP3-011	011 - Install a passive containment spray system.	0	0	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-012	012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	579,589	839,983	n/a	n/a	5,000,000	n/a	Not Beneficial
IP3-013	013 - Construct a building connected to primary containment that is maintained at a vacuum.	3,263,163	4,729,221	n/a	n/a	61,000,000	n/a	Not Beneficial
IP3-014	014 - Install a redundant containment spray system.	0	0	n/a	n/a	5,800,000	n/a	Not Beneficial
IP3-015	015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	762,199	1,104,636	n/a	n/a	5,500,000	n/a	Not Beneficial
IP3-016	016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	929,399	1,346,956	969,097	1,404,489	7,400,000	n/a	Not Beneficial
IP3-017	017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	9,010,330	13,058,450	n/a	n/a	100,000,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-018	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.	2,223,079	3,221,854	6,708,936	9,723,095	12,000,000	35,691,159	Not Beneficial
IP3-019	019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	1,416,203	2,052,468	n/a	n/a	2,800,000	6,369,223	Not Beneficial
IP3-020	020 - Add redundant and diverse limit switches to each containment isolation valve.	712,071	1,031,987	n/a	n/a	4,000,000	n/a	Not Beneficial
IP3-021	021 - Increase leak testing of valves in ISLOCA paths.	712,071	1,031,987	n/a	n/a	10,604,000	n/a	Not Beneficial
IP3-022	022 - Ensure all ISLOCA releases are scrubbed.	1,416,203	2,052,468	n/a	n/a	9,700,000	n/a	Not Beneficial
IP3-023	023 - Improve MSIV design.	0	0	n/a	n/a	476,000	n/a	Not Beneficial
IP3-024	024 - Provide additional DC battery capacity.	24,289	35,201	n/a	n/a	1,875,000	n/a	Not Beneficial
IP3-025	025 - Use fuel cells instead of lead-acid batteries.	24,289	35,201	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-026	026 - Increase/ improve DC bus load shedding.	24,289	35,201	n/a	n/a	460,000	n/a	Not Beneficial
IP3-027	027 - Create AC power cross-tie capability with other unit.	35,188	50,997	n/a	n/a	1,156,000	n/a	Not Beneficial
IP3-028	028 - Create a backup source for diesel cooling (not from existing system).	5,450	7,898	n/a	n/a	1,700,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-029	029 - Use fire protection system as a backup source for diesel cooling.	5,450	7,898	n/a	n/a	497,000	n/a	Not Beneficial
IP3-030	030 - Provide a portable diesel-driven battery charger.	132,953	192,685	188,530	273,231	938,000	n/a	Not Beneficial
IP3-031	031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	79,396	115,066	n/a	n/a	1,254,000	n/a	Not Beneficial
IP3-032	032 - Provide capability for diesel-driven, low pressure vessel makeup.	15,879	23,013	n/a	n/a	632,000	n/a	Not Beneficial
IP3-033	033 - Provide an additional high pressure injection pump with independent diesel.	76,906	111,458	n/a	n/a	5,000,000	n/a	Not Beneficial
IP3-034	034 - Create automatic swap-over to recirculation upon RWST depletion.	300,013	434,801	n/a	n/a	1,000,000	n/a	Not Beneficial
IP3-035	035 - Provide capability for alternate injection via diesel-driven fire pump.	15,879	23,013	n/a	n/a	750,000	n/a	Not Beneficial
IP3-036	036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	5,450	7,898	n/a	n/a	82,000	n/a	Not Beneficial
IP3-037	037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	76,906	111,458	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-038	038 - Create/enhance a reactor coolant depressurization system.	156,301	226,524	n/a	n/a	4,600,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-039	039 - Install a digital feed water upgrade.	147,751	214,132	n/a	n/a	900,000	n/a	Not Beneficial
IP3-040	040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	156,301	226,524	188,060	272,550	950,000	n/a	Not Beneficial
IP3-041	041 - Add a motor-driven feedwater pump.	147,751	214,132	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-042	042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	24,289	35,201	n/a	n/a	1,072,000	n/a	Not Beneficial
IP3-043	043 - Use fire water system as backup for steam generator inventory.	281,784	408,383	321,482	465,916	1,656,000	n/a	Not Beneficial
IP3-044	044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	821,205	1,190,152	n/a	n/a	2,700,000	n/a	Not Beneficial
IP3-045	045 - Add an independent boron injection system.	0	0	n/a	n/a	300,000	n/a	Not Beneficial
IP3-046	046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	120,973	175,323	n/a	n/a	615,000	n/a	Not Beneficial
IP3-047	047 - Install motor generator set trip breakers in control room.	18,839	27,303	n/a	n/a	716,000	n/a	Not Beneficial
IP3-048	048 - Provide capability to remove power from the bus powering the control rods.	18,839	27,303	n/a	n/a	90,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-049	049 - Provide digital large break LOCA protection.	0	0	n/a	n/a	2,036,000	n/a	Not Beneficial
IP3-050	050 - Install secondary side guard pipes up to the MSIVs.	1,623,102	2,352,321	n/a	n/a	9,671,000	n/a	Not Beneficial
IP3-051	051 - Operator action: Align main feedwater for secondary heat removal.	13,389	19,405	n/a	n/a	55,000	n/a	Not Beneficial
IP3-052	052 - Open city water supply valve for alternative AFW pump suction.	164,241	238,030	n/a	n/a	50,000	138,378	Retained
IP3-053	053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	328,482	476,061	n/a	n/a	228,000	344,599	Retained
IP3-054	054 - Provide DC power backup for the PORVs.	0	0	n/a	n/a	376,000	n/a	Not Beneficial
IP3-055	055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	2,675,964	3,878,208	n/a	n/a	1,288,000	1,601,888	Retained
IP3-056	056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	24,289	35,201	n/a	n/a	982,000	n/a	Not Beneficial
IP3-057	057 - Provide backup cooling water source for the CCW heat exchangers.	32,228	46,707	n/a	n/a	109,000	n/a	Not Beneficial
IP3-058	058 - Provide automatic DC power backup.	48,577	70,402	n/a	n/a	1,868,000	n/a	Not Beneficial
IP3-059	059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0	0	n/a	n/a	576,000	n/a	Not Beneficial

Table 10 – Case 0 Results – Baseline Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-060	060 - Provide independent source of cooling for the recirculation pump motors.	0	0	n/a	n/a	710,000	n/a	Not Beneficial
IP3-061	061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	2,864,024	4,150,759	n/a	n/a	560,000	2,282,668	Retained
IP3-062	062 - Install flood alarm in the 480 VAC switchgear room.	2,864,024	4,150,759	n/a	n/a	196,800	496,071	Retained
IP3-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	19,000,000	n/a	n/a	50,000	453,745	Retained

(1) Legend: green highlight = SAMAs retained in Case 0, baseline case using 20 year license renewal period.
lavender highlight = SAMAs evaluated for TI-SGTR.
red text = SAMAs with NL-14-143 estimated costs.

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	239,830	504,906	239,830	504,906	1,137,000	n/a	Not Beneficial
IP2-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	225,676	475,107	n/a	n/a	1,000,000	n/a	Not Beneficial
IP2-003	003 - Install an additional CCW pump.	0	0	n/a	n/a	1,500,000	n/a	Not Beneficial
IP2-004	004 - Enhance procedural guidance for use of service water pumps.	28,309	59,597	n/a	n/a	1,750,000	n/a	Not Beneficial
IP2-005	005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	67,452	142,004	n/a	n/a	565,000	n/a	Not Beneficial
IP2-006	006 - Add a diesel building high temperature alarm.	14,154	29,799	19,985	42,073	274,000	n/a	Not Beneficial
IP2-007	007 - Install a filtered containment vent to provide fission product scrubbing.	1,259,311	2,651,181	n/a	n/a	5,700,000	n/a	Not Beneficial
IP2-008	008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	4,699,096	9,892,834	n/a	n/a	108,000,000	n/a	Not Beneficial
IP2-009	009 - Create a reactor cavity flooding system.	4,699,096	9,892,834	n/a	n/a	4,100,000	1,741,724	Retained
IP2-010	010 - Create a core melt source reduction system.	4,699,096	9,892,834	n/a	n/a	90,000,000	n/a	Not Beneficial
IP2-011	011 - Provide a means to inert containment.	2,349,548	4,946,417	n/a	n/a	10,900,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-012	012 - Use the fire protection system as a backup source for the containment spray system.	0	0	n/a	n/a	565,000	n/a	Not Beneficial
IP2-013	013 - Install a passive containment spray system.	0	0	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-014	014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	851,201	1,792,002	n/a	n/a	5,000,000	n/a	Not Beneficial
IP2-015	015 - Construct a building connected to primary containment that is maintained at a vacuum.	4,425,079	9,315,956	n/a	n/a	61,000,000	n/a	Not Beneficial
IP2-016	016 - Install a redundant containment spray system.	0	0	n/a	n/a	5,800,000	n/a	Not Beneficial
IP2-017	017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	1,329,273	2,798,469	n/a	n/a	5,500,000	n/a	Not Beneficial
IP2-018	018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	52,471	110,466	n/a	n/a	7,400,000	n/a	Not Beneficial
IP2-019	019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	4,241,835	8,930,178	n/a	n/a	100,000,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-020	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.	460,581	969,645	n/a	n/a	9,700,000	n/a	Not Beneficial
IP2-021	021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	1,576,633	3,319,227	n/a	n/a	3,200,000	4,632,227	Not Beneficial
IP2-022	022 - Add redundant and diverse limit switches to each containment isolation valve.	791,232	1,665,751	n/a	n/a	2,200,000	7,692,784	Not Beneficial
IP2-023	023 - Increase leak testing of valves in ISLOCA paths.	791,232	1,665,751	n/a	n/a	7,964,000	n/a	Not Beneficial
IP2-024	024 - Ensure all ISLOCA releases are scrubbed.	1,576,633	3,319,227	n/a	n/a	9,700,000	n/a	Not Beneficial
IP2-025	025 - Improve MSIV design.	87,452	184,110	134,093	282,302	476,000	n/a	Not Beneficial
IP2-026	026 - Provide additional DC battery capacity.	28,309	59,597	n/a	n/a	1,875,000	n/a	Not Beneficial
IP2-027	027 - Use fuel cells instead of lead-acid batteries.	28,309	59,597	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-028	028 - Provide a portable diesel-driven battery charger.	981,942	2,067,247	n/a	n/a	938,000	2,154,767	Not Beneficial
IP2-029	029 - Increase/ improve DC bus load shedding.	28,309	59,597	28,309	59,597	460,000	n/a	Not Beneficial
IP2-030	030 - Create AC power cross-tie capability with other unit.	32,471	68,360	n/a	n/a	1,156,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-031	031 - Create a backup source for diesel cooling (not from existing system).	24,147	50,835	n/a	n/a	1,700,000	n/a	Not Beneficial
IP2-032	032 - Use fire protection system as a backup source for diesel cooling.	24,147	50,835	n/a	n/a	497,000	n/a	Not Beneficial
IP2-033	033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0	0	n/a	n/a	1,254,000	n/a	Not Beneficial
IP2-034	034 - Provide capability for diesel-driven, low pressure vessel makeup.	5,830	12,274	n/a	n/a	632,000	n/a	Not Beneficial
IP2-035	035 - Provide an additional high pressure injection pump with independent diesel.	50,803	106,954	n/a	n/a	5,000,000	n/a	Not Beneficial
IP2-036	036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	85,768	180,565	n/a	n/a	1,000,000	n/a	Not Beneficial
IP2-037	037 - Provide capability for alternate injection via diesel-driven fire pump.	5,830	12,274	n/a	n/a	750,000	n/a	Not Beneficial
IP2-038	038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	9,992	21,036	n/a	n/a	82,000	n/a	Not Beneficial
IP2-039	039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	50,803	106,954	n/a	n/a	2,000,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-040	040 - Create/enhance a reactor coolant depressurization system.	433,925	913,526	433,925	913,526	2,000,000	n/a	Not Beneficial
IP2-041	041 - Install a digital feed water upgrade.	113,251	238,423	n/a	n/a	900,000	n/a	Not Beneficial
IP2-042	042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	11,660	24,548	n/a	n/a	214,000	n/a	Not Beneficial
IP2-043	043 - Add a motor-driven feed water pump.	113,251	238,423	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-044	044 - Use fire water system as backup for steam generator inventory.	1,638,970	3,450,463	n/a	n/a	1,656,000	3,073,130	Retained
IP2-045	045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	423,027	890,584	n/a	n/a	2,700,000	n/a	Not Beneficial
IP2-046	046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0	0	n/a	n/a	82,000	n/a	Not Beneficial
IP2-047	047 - Add an independent boron injection system.	0	0	n/a	n/a	300,000	n/a	Not Beneficial
IP2-048	048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	69,120	145,515	n/a	n/a	615,000	n/a	Not Beneficial
IP2-049	049 - Install motor generator set trip breakers in control room.	19,985	42,073	n/a	n/a	716,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-050	050 - Provide capability to remove power from the bus powering the control rods.	19,985	42,073	n/a	n/a	90,000	n/a	Not Beneficial
IP2-051	051- Provide digital large break LOCA protection.	0	0	n/a	n/a	2,036,000	n/a	Not Beneficial
IP2-052	052 - Install secondary side guard pipes up to the MSIVs.	237,368	499,722	324,820	683,832	1,100,000	n/a	Not Beneficial
IP2-053	053 - Keep both pressurizer PORV block valves open.	418,865	881,821	n/a	n/a	800,000	1,471,234	Not Beneficial
IP2-054	054 - Install flood alarm in the 480V switchgear room.	4,073,523	8,575,839	n/a	n/a	200,000	458,843	Retained
IP2-055	055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0	0	n/a	n/a	1,330,000	n/a	Not Beneficial
IP2-056	056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	28,309	59,597	n/a	n/a	82,000	1,704,938	Not Beneficial
IP2-057	057 - Provide DC power backup for the PORVs.	60,796	127,991	n/a	n/a	376,000	n/a	Not Beneficial
IP2-058	058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0	0	n/a	n/a	82,000	n/a	Not Beneficial
IP2-059	059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	15,822	33,310	n/a	n/a	318,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-060	060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	925,309	1,948,019	n/a	n/a	216,000	721,303	Retained
IP2-061	061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	2,022,186	4,257,234	n/a	n/a	192,000	943,792	Retained
IP2-062	062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	625,478	1,316,795	n/a	n/a	1,500,000	1,662,692	Not Beneficial
IP2-063	063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	18,317	38,561	n/a	n/a	324,000	n/a	Not Beneficial
IP2-064	064 - Provide backup cooling water source for the CCW heat exchangers.	24,147	50,835	n/a	n/a	710,000	n/a	Not Beneficial
IP2-065	065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	4,073,523	8,575,839	n/a	n/a	560,000	1,859,587	Retained
IP2-066	066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	1,571,296	3,307,992	n/a	n/a	33,500,000	n/a	Not Beneficial
IP2-067	067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	4,162	8,762	n/a	n/a	576,000	n/a	Not Beneficial
IP2-068	068 - Provide independent source of cooling for the recirculation pump motors.	4,162	8,762	n/a	n/a	710,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	13,000,000	n/a	n/a	50,000	453,745	Retained
IP3-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	138,872	201,264	178,570	258,797	1,137,000	n/a	Not Beneficial
IP3-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	127,973	185,468	n/a	n/a	1,000,000	n/a	Not Beneficial
IP3-003	003 - Install an additional CCW pump.	0	0	n/a	n/a	1,500,000	n/a	Not Beneficial
IP3-004	004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	84,845	122,964	n/a	n/a	565,000	n/a	Not Beneficial
IP3-005	005 - Install a filtered containment vent to provide fission product scrubbing.	1,040,084	1,507,367	n/a	n/a	5,700,000	n/a	Not Beneficial
IP3-006	006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	3,525,169	5,108,940	n/a	n/a	108,000,000	n/a	Not Beneficial
IP3-007	007 - Create a reactor cavity flooding system.	3,525,169	5,108,940	n/a	n/a	4,100,000	1,874,933	Retained
IP3-008	008 - Create a core melt source reduction system.	3,525,169	5,108,940	n/a	n/a	90,000,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-009	009 - Provide means to inert containment.	1,691,128	2,450,910	n/a	n/a	10,900,000	n/a	Not Beneficial
IP3-010	010 - Use the fire protection system as a backup source for the containment spray system.	0	0	n/a	n/a	565,000	n/a	Not Beneficial
IP3-011	011 - Install a passive containment spray system.	0	0	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-012	012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	619,286	897,516	n/a	n/a	5,000,000	n/a	Not Beneficial
IP3-013	013 - Construct a building connected to primary containment that is maintained at a vacuum.	3,461,652	5,016,887	n/a	n/a	61,000,000	n/a	Not Beneficial
IP3-014	014 - Install a redundant containment spray system.	0	0	n/a	n/a	5,800,000	n/a	Not Beneficial
IP3-015	015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	841,594	1,219,702	n/a	n/a	5,500,000	n/a	Not Beneficial
IP3-016	016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	1,008,795	1,462,022	1,016,735	1,473,528	7,400,000	n/a	Not Beneficial
IP3-017	017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	9,574,040	13,875,420	15,576,354	22,574,426	100,000,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-018	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.	2,350,112	3,405,960	7,074,156	10,252,400	12,000,000	35,691,159	Not Beneficial
IP3-019	019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	1,543,236	2,236,574	n/a	n/a	2,800,000	6,369,223	Not Beneficial
IP3-020	020 - Add redundant and diverse limit switches to each containment isolation valve.	751,769	1,089,520	n/a	n/a	4,000,000	n/a	Not Beneficial
IP3-021	021 - Increase leak testing of valves in ISLOCA paths.	751,769	1,089,520	n/a	n/a	10,604,000	n/a	Not Beneficial
IP3-022	022 - Ensure all ISLOCA releases are scrubbed.	1,543,236	2,236,574	n/a	n/a	9,700,000	n/a	Not Beneficial
IP3-023	023 - Improve MSIV design.	0	0	n/a	n/a	476,000	n/a	Not Beneficial
IP3-024	024 - Provide additional DC battery capacity.	24,289	35,201	n/a	n/a	1,875,000	n/a	Not Beneficial
IP3-025	025 - Use fuel cells instead of lead-acid batteries.	24,289	35,201	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-026	026 - Increase/ improve DC bus load shedding.	24,289	35,201	n/a	n/a	460,000	n/a	Not Beneficial
IP3-027	027 - Create AC power cross-tie capability with other unit.	35,188	50,997	n/a	n/a	1,156,000	n/a	Not Beneficial
IP3-028	028 - Create a backup source for diesel cooling (not from existing system).	5,450	7,898	n/a	n/a	1,700,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-029	029 - Use fire protection system as a backup source for diesel cooling.	5,450	7,898	n/a	n/a	497,000	n/a	Not Beneficial
IP3-030	030 - Provide a portable diesel-driven battery charger.	180,590	261,725	188,530	273,231	938,000	n/a	Not Beneficial
IP3-031	031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	79,396	115,066	n/a	n/a	1,254,000	n/a	Not Beneficial
IP3-032	032 - Provide capability for diesel-driven, low pressure vessel makeup.	15,879	23,013	n/a	n/a	632,000	n/a	Not Beneficial
IP3-033	033 - Provide an additional high pressure injection pump with independent diesel.	76,906	111,458	n/a	n/a	5,000,000	n/a	Not Beneficial
IP3-034	034 - Create automatic swap-over to recirculation upon RWST depletion.	339,710	492,334	n/a	n/a	1,000,000	n/a	Not Beneficial
IP3-035	035 - Provide capability for alternate injection via diesel-driven fire pump.	15,879	23,013	n/a	n/a	750,000	n/a	Not Beneficial
IP3-036	036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	5,450	7,898	n/a	n/a	82,000	n/a	Not Beneficial
IP3-037	037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	76,906	111,458	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-038	038 - Create/enhance a reactor coolant depressurization system.	203,939	295,564	n/a	n/a	4,600,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-039	039 - Install a digital feed water upgrade.	187,449	271,665	n/a	n/a	900,000	n/a	Not Beneficial
IP3-040	040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	156,301	226,524	195,999	284,057	950,000	n/a	Not Beneficial
IP3-041	041 - Add a motor-driven feedwater pump.	187,449	271,665	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-042	042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	24,289	35,201	n/a	n/a	1,072,000	n/a	Not Beneficial
IP3-043	043 - Use fire water system as backup for steam generator inventory.	281,784	408,383	321,482	465,916	1,656,000	n/a	Not Beneficial
IP3-044	044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	900,601	1,305,219	n/a	n/a	2,700,000	n/a	Not Beneficial
IP3-045	045 - Add an independent boron injection system.	0	0	n/a	n/a	300,000	n/a	Not Beneficial
IP3-046	046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	160,671	232,856	n/a	n/a	615,000	n/a	Not Beneficial
IP3-047	047 - Install motor generator set trip breakers in control room.	18,839	27,303	n/a	n/a	716,000	n/a	Not Beneficial
IP3-048	048 - Provide capability to remove power from the bus powering the control rods.	18,839	27,303	n/a	n/a	90,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-049	049 - Provide digital large break LOCA protection.	0	0	n/a	n/a	2,036,000	n/a	Not Beneficial
IP3-050	050 - Install secondary side guard pipes up to the MSIVs.	1,702,497	2,467,387	n/a	n/a	9,671,000	n/a	Not Beneficial
IP3-051	051 - Operator action: Align main feedwater for secondary heat removal.	13,389	19,405	n/a	n/a	55,000	n/a	Not Beneficial
IP3-052	052 - Open city water supply valve for alternative AFW pump suction.	203,939	295,564	n/a	n/a	50,000	138,378	Retained
IP3-053	053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	320,542	464,554	n/a	n/a	228,000	344,599	Retained
IP3-054	054 - Provide DC power backup for the PORVs.	0	0	n/a	n/a	376,000	n/a	Not Beneficial
IP3-055	055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	2,802,997	4,062,314	n/a	n/a	1,288,000	1,601,888	Retained
IP3-056	056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	24,289	35,201	n/a	n/a	982,000	n/a	Not Beneficial
IP3-057	057 - Provide backup cooling water source for the CCW heat exchangers.	32,228	46,707	n/a	n/a	109,000	n/a	Not Beneficial
IP3-058	058 - Provide automatic DC power backup.	48,577	70,402	n/a	n/a	1,868,000	n/a	Not Beneficial
IP3-059	059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0	0	n/a	n/a	576,000	n/a	Not Beneficial

Table 11 – Case 4 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-060	060 - Provide independent source of cooling for the recirculation pump motors.	0	0	n/a	n/a	710,000	n/a	Not Beneficial
IP3-061	061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	2,983,117	4,323,358	n/a	n/a	560,000	2,282,668	Retained
IP3-062	062 - Install flood alarm in the 480 VAC switchgear room.	2,983,117	4,323,358	n/a	n/a	196,800	496,071	Retained
IP3-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	19,000,000	n/a	n/a	50,000	453,745	Retained

(1) Legend: green highlight = SAMAs retained in Case 0, baseline case using 20 year license renewal period.
lavender highlight = SAMAs evaluated for TI-SGTR.
red text = SAMAs with NL-14-143 estimated costs.

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	298,132	327,282	1,137,000	n/a	Not Beneficial
IP2-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	289,807	n/a	1,000,000	n/a	Not Beneficial
IP2-003	003 - Install an additional CCW pump.	0	n/a	1,500,000	n/a	Not Beneficial
IP2-004	004 - Enhance procedural guidance for use of service water pumps.	28,309	n/a	1,750,000	n/a	Not Beneficial
IP2-005	005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	67,452	n/a	565,000	n/a	Not Beneficial
IP2-006	006 - Add a diesel building high temperature alarm.	14,154	14,154	274,000	n/a	Not Beneficial
IP2-007	007 - Install a filtered containment vent to provide fission product scrubbing.	1,504,177	n/a	5,700,000	n/a	Not Beneficial
IP2-008	008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	6,710,496	n/a	108,000,000	n/a	Not Beneficial
IP2-009	009 - Create a reactor cavity flooding system.	6,710,496	n/a	4,100,000	1,741,724	Retained
IP2-010	010 - Create a core melt source reduction system.	6,710,496	n/a	90,000,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-011	011 - Provide a means to inert containment.	3,748,782	n/a	10,900,000	n/a	Not Beneficial
IP2-012	012 - Use the fire protection system as a backup source for the containment spray system.	0	n/a	565,000	n/a	Not Beneficial
IP2-013	013 - Install a passive containment spray system.	0	n/a	2,000,000	n/a	Not Beneficial
IP2-014	014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	1,037,766	n/a	5,000,000	n/a	Not Beneficial
IP2-015	015 - Construct a building connected to primary containment that is maintained at a vacuum.	6,663,854	n/a	61,000,000	n/a	Not Beneficial
IP2-016	016 - Install a redundant containment spray system.	0	n/a	5,800,000	n/a	Not Beneficial
IP2-017	017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	2,349,548	n/a	5,500,000	n/a	Not Beneficial
IP2-018	018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	81,622	n/a	7,400,000	n/a	Not Beneficial
IP2-019	019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	7,769,072	n/a	100,000,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-020	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.	926,993	n/a	9,700,000	n/a	Not Beneficial
IP2-021	021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	2,923,396	n/a	3,200,000	4,632,227	Not Beneficial
IP2-022	022 - Add redundant and diverse limit switches to each containment isolation valve.	1,461,698	n/a	2,200,000	7,692,784	Not Beneficial
IP2-023	023 - Increase leak testing of valves in ISLOCA paths.	1,461,698	n/a	7,964,000	n/a	Not Beneficial
IP2-024	024 - Ensure all ISLOCA releases are scrubbed.	2,923,396	n/a	9,700,000	n/a	Not Beneficial
IP2-025	025 - Improve MSIV design.	151,584	227,376	476,000	n/a	Not Beneficial
IP2-026	026 - Provide additional DC battery capacity.	28,309	n/a	1,875,000	n/a	Not Beneficial
IP2-027	027 - Use fuel cells instead of lead-acid batteries.	28,309	n/a	2,000,000	n/a	Not Beneficial
IP2-028	028 - Provide a portable diesel-driven battery charger.	1,355,072	n/a	938,000	2,154,767	Not Beneficial
IP2-029	029 - Increase/ improve DC bus load shedding.	28,309	28,309	460,000	n/a	Not Beneficial
IP2-030	030 - Create AC power cross-tie capability with other unit.	32,471	n/a	1,156,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-031	031 - Create a backup source for diesel cooling (not from existing system).	18,317	n/a	1,700,000	n/a	Not Beneficial
IP2-032	032 - Use fire protection system as a backup source for diesel cooling.	18,317	n/a	497,000	n/a	Not Beneficial
IP2-033	033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0	n/a	1,254,000	n/a	Not Beneficial
IP2-034	034 - Provide capability for diesel-driven, low pressure vessel makeup.	0	n/a	632,000	n/a	Not Beneficial
IP2-035	035 - Provide an additional high pressure injection pump with independent diesel.	50,803	n/a	5,000,000	n/a	Not Beneficial
IP2-036	036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	85,768	n/a	1,000,000	n/a	Not Beneficial
IP2-037	037 - Provide capability for alternate injection via diesel-driven fire pump.	0	n/a	750,000	n/a	Not Beneficial
IP2-038	038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	4,162	n/a	82,000	n/a	Not Beneficial
IP2-039	039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	50,803	n/a	2,000,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-040	040 - Create/enhance a reactor coolant depressurization system.	678,791	678,791	2,000,000	n/a	Not Beneficial
IP2-041	041 - Install a digital feed water upgrade.	142,402	n/a	900,000	n/a	Not Beneficial
IP2-042	042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	40,811	n/a	214,000	n/a	Not Beneficial
IP2-043	043 - Add a motor-driven feed water pump.	142,402	n/a	2,000,000	n/a	Not Beneficial
IP2-044	044 - Use fire water system as backup for steam generator inventory.	2,187,003	n/a	1,656,000	3,073,130	Not Beneficial
IP2-045	045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	516,309	n/a	2,700,000	n/a	Not Beneficial
IP2-046	046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0	n/a	82,000	n/a	Not Beneficial
IP2-047	047 - Add an independent boron injection system.	0	n/a	300,000	n/a	Not Beneficial
IP2-048	048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	69,120	n/a	615,000	n/a	Not Beneficial
IP2-049	049 - Install motor generator set trip breakers in control room.	19,985	n/a	716,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-050	050 - Provide capability to remove power from the bus powering the control rods.	19,985	n/a	90,000	n/a	Not Beneficial
IP2-051	051- Provide digital large break LOCA protection.	0	n/a	2,036,000	n/a	Not Beneficial
IP2-052	052 - Install secondary side guard pipes up to the MSIVs.	394,782	581,346	1,100,000	n/a	Not Beneficial
IP2-053	053 - Keep both pressurizer PORV block valves open.	535,468	n/a	800,000	1,471,234	Not Beneficial
IP2-054	054 - Install flood alarm in the 480V switchgear room.	5,676,813	n/a	200,000	458,843	Retained
IP2-055	055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0	n/a	1,330,000	n/a	Not Beneficial
IP2-056	056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	28,309	n/a	82,000	1,704,938	Not Beneficial
IP2-057	057 - Provide DC power backup for the PORVs.	60,796	n/a	376,000	n/a	Not Beneficial
IP2-058	058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0	n/a	82,000	n/a	Not Beneficial
IP2-059	059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	15,822	n/a	318,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-060	060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	1,263,457	n/a	216,000	721,303	Retained
IP2-061	061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	2,797,595	n/a	192,000	943,792	Retained
IP2-062	062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	870,344	n/a	1,500,000	1,662,692	Not Beneficial
IP2-063	063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	18,317	n/a	324,000	n/a	Not Beneficial
IP2-064	064 - Provide backup cooling water source for the CCW heat exchangers.	24,147	n/a	710,000	n/a	Not Beneficial
IP2-065	065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	5,676,813	n/a	560,000	1,859,587	Retained
IP2-066	066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	1,944,425	n/a	33,500,000	n/a	Not Beneficial
IP2-067	067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	4,162	n/a	576,000	n/a	Not Beneficial
IP2-068	068 - Provide independent source of cooling for the recirculation pump motors.	4,162	n/a	710,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	n/a	50,000	453,745	Retained
IP3-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	186,509	186,509	1,137,000	n/a	Not Beneficial
IP3-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	167,671	n/a	1,000,000	n/a	Not Beneficial
IP3-003	003 - Install an additional CCW pump.	0	n/a	1,500,000	n/a	Not Beneficial
IP3-004	004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	124,543	n/a	565,000	n/a	Not Beneficial
IP3-005	005 - Install a filtered containment vent to provide fission product scrubbing.	1,286,210	n/a	5,700,000	n/a	Not Beneficial
IP3-006	006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	5,025,747	n/a	108,000,000	n/a	Not Beneficial
IP3-007	007 - Create a reactor cavity flooding system.	5,025,747	n/a	4,100,000	1,874,933	Retained
IP3-008	008 - Create a core melt source reduction system.	5,025,747	n/a	90,000,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-009	009 - Provide means to inert containment.	2,691,514	n/a	10,900,000	n/a	Not Beneficial
IP3-010	010 - Use the fire protection system as a backup source for the containment spray system.	0	n/a	565,000	n/a	Not Beneficial
IP3-011	011 - Install a passive containment spray system.	0	n/a	2,000,000	n/a	Not Beneficial
IP3-012	012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	746,319	n/a	5,000,000	n/a	Not Beneficial
IP3-013	013 - Construct a building connected to primary containment that is maintained at a vacuum.	5,128,962	n/a	61,000,000	n/a	Not Beneficial
IP3-014	014 - Install a redundant containment spray system.	0	n/a	5,800,000	n/a	Not Beneficial
IP3-015	015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	1,516,458	n/a	5,500,000	n/a	Not Beneficial
IP3-016	016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	1,437,532	1,389,894	7,400,000	n/a	Not Beneficial
IP3-017	017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	18,490,176	30,074,007	100,000,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-018	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.	3,945,966	13,838,669	12,000,000	35,691,159	Not Beneficial
IP3-019	019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	3,019,996	n/a	2,800,000	6,369,223	Not Beneficial
IP3-020	020 - Add redundant and diverse limit switches to each containment isolation valve.	1,513,968	n/a	4,000,000	n/a	Not Beneficial
IP3-021	021 - Increase leak testing of valves in ISLOCA paths.	1,513,968	n/a	10,604,000	n/a	Not Beneficial
IP3-022	022 - Ensure all ISLOCA releases are scrubbed.	3,019,996	n/a	9,700,000	n/a	Not Beneficial
IP3-023	023 - Improve MSIV design.	0	n/a	476,000	n/a	Not Beneficial
IP3-024	024 - Provide additional DC battery capacity.	24,289	n/a	1,875,000	n/a	Not Beneficial
IP3-025	025 - Use fuel cells instead of lead-acid batteries.	24,289	n/a	2,000,000	n/a	Not Beneficial
IP3-026	026 - Increase/ improve DC bus load shedding.	24,289	n/a	460,000	n/a	Not Beneficial
IP3-027	027 - Create AC power cross-tie capability with other unit.	43,127	n/a	1,156,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-028	028 - Create a backup source for diesel cooling (not from existing system).	13,389	n/a	1,700,000	n/a	Not Beneficial
IP3-029	029 - Use fire protection system as a backup source for diesel cooling.	13,389	n/a	497,000	n/a	Not Beneficial
IP3-030	030 - Provide a portable diesel-driven battery charger.	220,288	267,925	938,000	n/a	Not Beneficial
IP3-031	031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	119,094	n/a	1,254,000	n/a	Not Beneficial
IP3-032	032 - Provide capability for diesel-driven, low pressure vessel makeup.	55,577	n/a	632,000	n/a	Not Beneficial
IP3-033	033 - Provide an additional high pressure injection pump with independent diesel.	124,543	n/a	5,000,000	n/a	Not Beneficial
IP3-034	034 - Create automatic swap-over to recirculation upon RWST depletion.	427,046	n/a	1,000,000	n/a	Not Beneficial
IP3-035	035 - Provide capability for alternate injection via diesel-driven fire pump.	55,577	n/a	750,000	n/a	Not Beneficial
IP3-036	036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	13,389	n/a	82,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-037	037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	124,543	n/a	2,000,000	n/a	Not Beneficial
IP3-038	038 - Create/enhance a reactor coolant depressurization system.	283,335	n/a	4,600,000	n/a	Not Beneficial
IP3-039	039 - Install a digital feed water upgrade.	227,147	n/a	900,000	n/a	Not Beneficial
IP3-040	040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	235,697	235,697	950,000	n/a	Not Beneficial
IP3-041	041 - Add a motor-driven feedwater pump.	227,147	n/a	2,000,000	n/a	Not Beneficial
IP3-042	042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	24,289	n/a	1,072,000	n/a	Not Beneficial
IP3-043	043 - Use fire water system as backup for steam generator inventory.	408,817	408,817	1,656,000	n/a	Not Beneficial
IP3-044	044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	1,242,002	n/a	2,700,000	n/a	Not Beneficial
IP3-045	045 - Add an independent boron injection system.	7,940	n/a	300,000	n/a	Not Beneficial

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-046	046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	160,671	n/a	615,000	n/a	Not Beneficial
IP3-047	047 - Install motor generator set trip breakers in control room.	18,839	n/a	716,000	n/a	Not Beneficial
IP3-048	048 - Provide capability to remove power from the bus powering the control rods.	18,839	n/a	90,000	n/a	Not Beneficial
IP3-049	049 - Provide digital large break LOCA protection.	0	n/a	2,036,000	n/a	Not Beneficial
IP3-050	050 - Install secondary side guard pipes up to the MSIVs.	2,424,998	n/a	9,671,000	n/a	Not Beneficial
IP3-051	051 - Operator action: Align main feedwater for secondary heat removal.	13,389	n/a	55,000	n/a	Not Beneficial
IP3-052	052 - Open city water supply valve for alternative AFW pump suction.	291,274	n/a	50,000	138,378	Retained
IP3-053	053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	447,576	n/a	228,000	344,599	Retained
IP3-054	054 - Provide DC power backup for the PORVs.	7,940	n/a	376,000	n/a	Not Beneficial
IP3-055	055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	3,922,476	n/a	1,288,000	1,601,888	Retained

Table 12 – Case 5 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-056	056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	24,289	n/a	982,000	n/a	Not Beneficial
IP3-057	057 - Provide backup cooling water source for the CCW heat exchangers.	71,926	n/a	109,000	n/a	Not Beneficial
IP3-058	058 - Provide automatic DC power backup.	96,214	n/a	1,868,000	n/a	Not Beneficial
IP3-059	059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	7,940	n/a	576,000	n/a	Not Beneficial
IP3-060	060 - Provide independent source of cooling for the recirculation pump motors.	7,940	n/a	710,000	n/a	Not Beneficial
IP3-061	061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	4,189,932	n/a	560,000	2,282,668	Retained
IP3-062	062 - Install flood alarm in the 480 VAC switchgear room.	4,189,932	n/a	196,800	496,071	Retained
IP3-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	n/a	50,000	453,745	Retained

(1) Legend: green highlight = SAMAs retained in Case 0, baseline case using 20 year license renewal period.
lavender highlight = SAMAs evaluated for TI-SGTR.
red text = SAMAs with NL-14-143 estimated costs.

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	199,019	418,988	204,849	431,262	1,137,000	n/a	Not Beneficial
IP2-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	190,695	401,463	n/a	n/a	1,000,000	n/a	Not Beneficial
IP2-003	003 - Install an additional CCW pump.	0	0	n/a	n/a	1,500,000	n/a	Not Beneficial
IP2-004	004 - Enhance procedural guidance for use of service water pumps.	22,479	47,323	n/a	n/a	1,750,000	n/a	Not Beneficial
IP2-005	005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	32,471	68,360	n/a	n/a	565,000	n/a	Not Beneficial
IP2-006	006 - Add a diesel building high temperature alarm.	8,324	17,525	14,154	29,799	274,000	n/a	Not Beneficial
IP2-007	007 - Install a filtered containment vent to provide fission product scrubbing.	1,061,086	2,233,866	n/a	n/a	5,700,000	n/a	Not Beneficial
IP2-008	008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	4,016,969	8,456,777	n/a	n/a	108,000,000	n/a	Not Beneficial
IP2-009	009 - Create a reactor cavity flooding system.	4,016,969	8,456,777	n/a	n/a	4,100,000	1,741,724	Retained
IP2-010	010 - Create a core melt source reduction system.	4,016,969	8,456,777	n/a	n/a	90,000,000	n/a	Not Beneficial
IP2-011	011 - Provide a means to inert containment.	1,999,739	4,209,978	n/a	n/a	10,900,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-012	012 - Use the fire protection system as a backup source for the containment spray system.	0	0	n/a	n/a	565,000	n/a	Not Beneficial
IP2-013	013 - Install a passive containment spray system.	0	0	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-014	014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	728,768	1,534,248	n/a	n/a	5,000,000	n/a	Not Beneficial
IP2-015	015 - Construct a building connected to primary containment that is maintained at a vacuum.	3,801,254	8,002,640	n/a	n/a	61,000,000	n/a	Not Beneficial
IP2-016	016 - Install a redundant containment spray system.	0	0	n/a	n/a	5,800,000	n/a	Not Beneficial
IP2-017	017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	1,189,349	2,503,893	n/a	n/a	5,500,000	n/a	Not Beneficial
IP2-018	018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	46,641	98,192	n/a	n/a	7,400,000	n/a	Not Beneficial
IP2-019	019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	3,909,517	8,230,561	n/a	n/a	100,000,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-020	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.	396,450	834,631	n/a	n/a	9,700,000	n/a	Not Beneficial
IP2-021	021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	1,460,030	3,073,748	n/a	n/a	3,200,000	4,632,227	Not Beneficial
IP2-022	022 - Add redundant and diverse limit switches to each containment isolation valve.	738,760	1,555,285	n/a	n/a	2,200,000	7,692,784	Not Beneficial
IP2-023	023 - Increase leak testing of valves in ISLOCA paths.	738,760	1,555,285	n/a	n/a	7,964,000	n/a	Not Beneficial
IP2-024	024 - Ensure all ISLOCA releases are scrubbed.	1,460,030	3,073,748	n/a	n/a	9,700,000	n/a	Not Beneficial
IP2-025	025 - Improve MSIV design.	58,301	122,740	104,943	220,932	476,000	n/a	Not Beneficial
IP2-026	026 - Provide additional DC battery capacity.	22,479	47,323	n/a	n/a	1,875,000	n/a	Not Beneficial
IP2-027	027 - Use fuel cells instead of lead-acid batteries.	22,479	47,323	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-028	028 - Provide a portable diesel-driven battery charger.	818,698	1,723,576	n/a	n/a	938,000	2,154,767	Not Beneficial
IP2-029	029 - Increase/ improve DC bus load shedding.	22,479	47,323	28,309	59,597	460,000	n/a	Not Beneficial
IP2-030	030 - Create AC power cross-tie capability with other unit.	26,641	56,086	n/a	n/a	1,156,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-031	031 - Create a backup source for diesel cooling (not from existing system).	18,317	38,561	n/a	n/a	1,700,000	n/a	Not Beneficial
IP2-032	032 - Use fire protection system as a backup source for diesel cooling.	18,317	38,561	n/a	n/a	497,000	n/a	Not Beneficial
IP2-033	033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0	0	n/a	n/a	1,254,000	n/a	Not Beneficial
IP2-034	034 - Provide capability for diesel-driven, low pressure vessel makeup.	0	0	n/a	n/a	632,000	n/a	Not Beneficial
IP2-035	035 - Provide an additional high pressure injection pump with independent diesel.	15,822	33,310	n/a	n/a	5,000,000	n/a	Not Beneficial
IP2-036	036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	50,787	106,921	n/a	n/a	1,000,000	n/a	Not Beneficial
IP2-037	037 - Provide capability for alternate injection via diesel-driven fire pump.	0	0	n/a	n/a	750,000	n/a	Not Beneficial
IP2-038	038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	4,162	8,762	n/a	n/a	82,000	n/a	Not Beneficial
IP2-039	039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	15,822	33,310	n/a	n/a	2,000,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-040	040 - Create/enhance a reactor coolant depressurization system.	340,642	717,142	340,642	717,142	2,000,000	n/a	Not Beneficial
IP2-041	041 - Install a digital feed water upgrade.	101,591	213,875	n/a	n/a	900,000	n/a	Not Beneficial
IP2-042	042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	5,830	12,274	n/a	n/a	214,000	n/a	Not Beneficial
IP2-043	043 - Add a motor-driven feed water pump.	101,591	213,875	n/a	n/a	2,000,000	n/a	Not Beneficial
IP2-044	044 - Use fire water system as backup for steam generator inventory.	1,417,424	2,984,051	n/a	n/a	1,656,000	3,073,130	Not Beneficial
IP2-045	045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	370,556	780,118	n/a	n/a	2,700,000	n/a	Not Beneficial
IP2-046	046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0	0	n/a	n/a	82,000	n/a	Not Beneficial
IP2-047	047 - Add an independent boron injection system.	0	0	n/a	n/a	300,000	n/a	Not Beneficial
IP2-048	048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	34,139	71,871	n/a	n/a	615,000	n/a	Not Beneficial
IP2-049	049 - Install motor generator set trip breakers in control room.	14,154	29,799	n/a	n/a	716,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-050	050 - Provide capability to remove power from the bus powering the control rods.	14,154	29,799	n/a	n/a	90,000	n/a	Not Beneficial
IP2-051	051- Provide digital large break LOCA protection.	0	0	n/a	n/a	2,036,000	n/a	Not Beneficial
IP2-052	052 - Install secondary side guard pipes up to the MSIVs.	202,387	426,078	272,349	573,366	1,100,000	n/a	Not Beneficial
IP2-053	053 - Keep both pressurizer PORV block valves open.	366,394	771,355	n/a	n/a	800,000	1,471,234	Not Beneficial
IP2-054	054 - Install flood alarm in the 480V switchgear room.	3,484,679	7,336,166	n/a	n/a	200,000	458,843	Retained
IP2-055	055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0	0	n/a	n/a	1,330,000	n/a	Not Beneficial
IP2-056	056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	22,479	47,323	n/a	n/a	82,000	1,704,938	Not Beneficial
IP2-057	057 - Provide DC power backup for the PORVs.	25,815	54,347	n/a	n/a	376,000	n/a	Not Beneficial
IP2-058	058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0	0	n/a	n/a	82,000	n/a	Not Beneficial
IP2-059	059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	9,992	21,036	n/a	n/a	318,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-060	060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	791,216	1,665,717	n/a	n/a	216,000	721,303	Retained
IP2-061	061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	1,730,679	3,643,535	n/a	n/a	192,000	943,792	Retained
IP2-062	062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	538,025	1,132,685	590,497	1,243,151	1,500,000	1,662,692	Not Beneficial
IP2-063	063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	18,317	38,561	n/a	n/a	324,000	n/a	Not Beneficial
IP2-064	064 - Provide backup cooling water source for the CCW heat exchangers.	18,317	38,561	n/a	n/a	710,000	n/a	Not Beneficial
IP2-065	065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	3,484,679	7,336,166	n/a	n/a	560,000	1,859,587	Retained
IP2-066	066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	1,431,373	3,013,416	n/a	n/a	33,500,000	n/a	Not Beneficial
IP2-067	067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	4,162	8,762	n/a	n/a	576,000	n/a	Not Beneficial
IP2-068	068 - Provide independent source of cooling for the recirculation pump motors.	4,162	8,762	n/a	n/a	710,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	13,000,000	n/a	n/a	50,000	453,745	Retained
IP3-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	130,932	189,757	138,872	201,264	1,137,000	n/a	Not Beneficial
IP3-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	72,396	104,921	n/a	n/a	1,000,000	n/a	Not Beneficial
IP3-003	003 - Install an additional CCW pump.	0	0	n/a	n/a	1,500,000	n/a	Not Beneficial
IP3-004	004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	76,906	111,458	n/a	n/a	565,000	n/a	Not Beneficial
IP3-005	005 - Install a filtered containment vent to provide fission product scrubbing.	881,292	1,277,235	n/a	n/a	5,700,000	n/a	Not Beneficial
IP3-006	006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	3,001,157	4,349,503	n/a	n/a	108,000,000	n/a	Not Beneficial
IP3-007	007 - Create a reactor cavity flooding system.	3,001,157	4,349,503	n/a	n/a	4,100,000	1,874,933	Retained
IP3-008	008 - Create a core melt source reduction system.	3,001,157	4,349,503	n/a	n/a	90,000,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-009	009 - Provide means to inert containment.	1,413,243	2,048,179	n/a	n/a	10,900,000	n/a	Not Beneficial
IP3-010	010 - Use the fire protection system as a backup source for the containment spray system.	0	0	n/a	n/a	565,000	n/a	Not Beneficial
IP3-011	011 - Install a passive containment spray system.	0	0	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-012	012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	516,072	747,930	n/a	n/a	5,000,000	n/a	Not Beneficial
IP3-013	013 - Construct a building connected to primary containment that is maintained at a vacuum.	2,921,761	4,234,437	n/a	n/a	61,000,000	n/a	Not Beneficial
IP3-014	014 - Install a redundant containment spray system.	0	0	n/a	n/a	5,800,000	n/a	Not Beneficial
IP3-015	015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	730,440	1,058,609	n/a	n/a	5,500,000	n/a	Not Beneficial
IP3-016	016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	818,245	1,185,863	857,943	1,243,396	7,400,000	n/a	Not Beneficial
IP3-017	017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	8,422,802	12,206,960	n/a	n/a	100,000,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-018	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.	1,897,557	2,750,083	6,423,111	9,308,857	12,000,000	35,691,159	Not Beneficial
IP3-019	019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	1,336,807	1,937,402	n/a	n/a	2,800,000	6,369,223	Not Beneficial
IP3-020	020 - Add redundant and diverse limit switches to each containment isolation valve.	648,555	939,934	n/a	n/a	4,000,000	n/a	Not Beneficial
IP3-021	021 - Increase leak testing of valves in ISLOCA paths.	648,555	939,934	n/a	n/a	10,604,000	n/a	Not Beneficial
IP3-022	022 - Ensure all ISLOCA releases are scrubbed.	1,336,807	1,937,402	n/a	n/a	9,700,000	n/a	Not Beneficial
IP3-023	023 - Improve MSIV design.	0	0	n/a	n/a	476,000	n/a	Not Beneficial
IP3-024	024 - Provide additional DC battery capacity.	16,349	23,694	n/a	n/a	1,875,000	n/a	Not Beneficial
IP3-025	025 - Use fuel cells instead of lead-acid batteries.	16,349	23,694	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-026	026 - Increase/ improve DC bus load shedding.	16,349	23,694	n/a	n/a	460,000	n/a	Not Beneficial
IP3-027	027 - Create AC power cross-tie capability with other unit.	35,188	50,997	n/a	n/a	1,156,000	n/a	Not Beneficial
IP3-028	028 - Create a backup source for diesel cooling (not from existing system).	5,450	7,898	n/a	n/a	1,700,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-029	029 - Use fire protection system as a backup source for diesel cooling.	5,450	7,898	n/a	n/a	497,000	n/a	Not Beneficial
IP3-030	030 - Provide a portable diesel-driven battery charger.	125,013	181,178	180,590	261,725	938,000	n/a	Not Beneficial
IP3-031	031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	71,456	103,560	n/a	n/a	1,254,000	n/a	Not Beneficial
IP3-032	032 - Provide capability for diesel-driven, low pressure vessel makeup.	7,940	11,507	n/a	n/a	632,000	n/a	Not Beneficial
IP3-033	033 - Provide an additional high pressure injection pump with independent diesel.	37,208	53,925	n/a	n/a	5,000,000	n/a	Not Beneficial
IP3-034	034 - Create automatic swap-over to recirculation upon RWST depletion.	292,073	423,294	n/a	n/a	1,000,000	n/a	Not Beneficial
IP3-035	035 - Provide capability for alternate injection via diesel-driven fire pump.	7,940	11,507	n/a	n/a	750,000	n/a	Not Beneficial
IP3-036	036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	5,450	7,898	n/a	n/a	82,000	n/a	Not Beneficial
IP3-037	037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	37,208	53,925	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-038	038 - Create/enhance a reactor coolant depressurization system.	156,301	226,524	n/a	n/a	4,600,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-039	039 - Install a digital feed water upgrade.	131,872	191,119	n/a	n/a	900,000	n/a	Not Beneficial
IP3-040	040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	108,664	157,484	156,301	226,524	950,000	n/a	Not Beneficial
IP3-041	041 - Add a motor-driven feedwater pump.	131,872	191,119	n/a	n/a	2,000,000	n/a	Not Beneficial
IP3-042	042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	16,349	23,694	n/a	n/a	1,072,000	n/a	Not Beneficial
IP3-043	043 - Use fire water system as backup for steam generator inventory.	234,147	339,343	273,845	396,876	1,656,000	n/a	Not Beneficial
IP3-044	044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	741,809	1,075,086	n/a	n/a	2,700,000	n/a	Not Beneficial
IP3-045	045 - Add an independent boron injection system.	0	0	n/a	n/a	300,000	n/a	Not Beneficial
IP3-046	046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	105,094	152,310	n/a	n/a	615,000	n/a	Not Beneficial
IP3-047	047 - Install motor generator set trip breakers in control room.	18,839	27,303	n/a	n/a	716,000	n/a	Not Beneficial
IP3-048	048 - Provide capability to remove power from the bus powering the control rods.	18,839	27,303	n/a	n/a	90,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-049	049 - Provide digital large break LOCA protection.	0	0	n/a	n/a	2,036,000	n/a	Not Beneficial
IP3-050	050 - Install secondary side guard pipes up to the MSIVs.	1,432,552	2,076,162	n/a	n/a	9,671,000	n/a	Not Beneficial
IP3-051	051 - Operator action: Align main feedwater for secondary heat removal.	5,450	7,898	n/a	n/a	55,000	n/a	Not Beneficial
IP3-052	052 - Open city water supply valve for alternative AFW pump suction.	164,241	238,030	n/a	n/a	50,000	138,378	Retained
IP3-053	053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	272,905	395,515	n/a	n/a	228,000	344,599	Retained
IP3-054	054 - Provide DC power backup for the PORVs.	0	0	n/a	n/a	376,000	n/a	Not Beneficial
IP3-055	055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	2,398,079	3,475,477	n/a	n/a	1,288,000	1,601,888	Retained
IP3-056	056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	16,349	23,694	n/a	n/a	982,000	n/a	Not Beneficial
IP3-057	057 - Provide backup cooling water source for the CCW heat exchangers.	24,289	35,201	n/a	n/a	109,000	n/a	Not Beneficial
IP3-058	058 - Provide automatic DC power backup.	48,577	70,402	n/a	n/a	1,868,000	n/a	Not Beneficial
IP3-059	059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0	0	n/a	n/a	576,000	n/a	Not Beneficial

Table 13 – Case 7 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	Benefit With Uncertainty	TI-SGTR Benefit Without Uncertainty	TI-SGTR Benefit With Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-060	060 - Provide independent source of cooling for the recirculation pump motors.	0	0	n/a	n/a	710,000	n/a	Not Beneficial
IP3-061	061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	2,530,562	3,667,481	n/a	n/a	560,000	2,282,668	Retained
IP3-062	062 - Install flood alarm in the 480 VAC switchgear room.	2,530,562	3,667,481	n/a	n/a	196,800	496,071	Retained
IP3-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	19,000,000	n/a	n/a	50,000	453,745	Retained

(1) Legend: green highlight = SAMAs retained in Case 0, baseline case using 20 year license renewal period.
lavender highlight = SAMAs evaluated for TI-SGTR.
red text = SAMAs with NL-14-143 estimated costs.

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	263,151	263,151	1,137,000	n/a	Not Beneficial
IP2-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	219,846	n/a	1,000,000	n/a	Not Beneficial
IP2-003	003 - Install an additional CCW pump.	0	n/a	1,500,000	n/a	Not Beneficial
IP2-004	004 - Enhance procedural guidance for use of service water pumps.	22,479	n/a	1,750,000	n/a	Not Beneficial
IP2-005	005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	67,452	n/a	565,000	n/a	Not Beneficial
IP2-006	006 - Add a diesel building high temperature alarm.	14,154	43,305	274,000	n/a	Not Beneficial
IP2-007	007 - Install a filtered containment vent to provide fission product scrubbing.	1,247,651	n/a	5,700,000	n/a	Not Beneficial
IP2-008	008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	5,771,842	n/a	108,000,000	n/a	Not Beneficial
IP2-009	009 - Create a reactor cavity flooding system.	5,771,842	n/a	4,100,000	1,741,724	Retained
IP2-010	010 - Create a core melt source reduction system.	5,771,842	n/a	90,000,000	n/a	Not Beneficial
IP2-011	011 - Provide a means to inert containment.	3,299,861	n/a	10,900,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-012	012 - Use the fire protection system as a backup source for the containment spray system.	0	n/a	565,000	n/a	Not Beneficial
IP2-013	013 - Install a passive containment spray system.	0	n/a	2,000,000	n/a	Not Beneficial
IP2-014	014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	851,201	n/a	5,000,000	n/a	Not Beneficial
IP2-015	015 - Construct a building connected to primary containment that is maintained at a vacuum.	5,783,503	n/a	61,000,000	n/a	Not Beneficial
IP2-016	016 - Install a redundant containment spray system.	0	n/a	5,800,000	n/a	Not Beneficial
IP2-017	017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	2,133,833	n/a	5,500,000	n/a	Not Beneficial
IP2-018	018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	75,792	n/a	7,400,000	n/a	Not Beneficial
IP2-019	019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	7,127,756	n/a	100,000,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-020	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.	699,617	n/a	9,700,000	n/a	Not Beneficial
IP2-021	021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	2,690,190	n/a	3,200,000	4,632,227	Not Beneficial
IP2-022	022 - Add redundant and diverse limit switches to each containment isolation valve.	1,345,095	n/a	2,200,000	7,692,784	Not Beneficial
IP2-023	023 - Increase leak testing of valves in ISLOCA paths.	1,345,095	n/a	7,964,000	n/a	Not Beneficial
IP2-024	024 - Ensure all ISLOCA releases are scrubbed.	2,690,190	n/a	9,700,000	n/a	Not Beneficial
IP2-025	025 - Improve MSIV design.	122,433	227,376	476,000	n/a	Not Beneficial
IP2-026	026 - Provide additional DC battery capacity.	22,479	n/a	1,875,000	n/a	Not Beneficial
IP2-027	027 - Use fuel cells instead of lead-acid batteries.	22,479	n/a	2,000,000	n/a	Not Beneficial
IP2-028	028 - Provide a portable diesel-driven battery charger.	1,156,847	n/a	938,000	2,154,767	Not Beneficial
IP2-029	029 - Increase/ improve DC bus load shedding.	22,479	51,629	460,000	n/a	Not Beneficial
IP2-030	030 - Create AC power cross-tie capability with other unit.	32,471	n/a	1,156,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-031	031 - Create a backup source for diesel cooling (not from existing system).	18,317	n/a	1,700,000	n/a	Not Beneficial
IP2-032	032 - Use fire protection system as a backup source for diesel cooling.	18,317	n/a	497,000	n/a	Not Beneficial
IP2-033	033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0	n/a	1,254,000	n/a	Not Beneficial
IP2-034	034 - Provide capability for diesel-driven, low pressure vessel makeup.	0	n/a	632,000	n/a	Not Beneficial
IP2-035	035 - Provide an additional high pressure injection pump with independent diesel.	50,803	n/a	5,000,000	n/a	Not Beneficial
IP2-036	036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	79,938	n/a	1,000,000	n/a	Not Beneficial
IP2-037	037 - Provide capability for alternate injection via diesel-driven fire pump.	0	n/a	750,000	n/a	Not Beneficial
IP2-038	038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	4,162	n/a	82,000	n/a	Not Beneficial
IP2-039	039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	50,803	n/a	2,000,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-040	040 - Create/enhance a reactor coolant depressurization system.	492,226	521,377	2,000,000	n/a	Not Beneficial
IP2-041	041 - Install a digital feed water upgrade.	107,421	n/a	900,000	n/a	Not Beneficial
IP2-042	042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	5,830	n/a	214,000	n/a	Not Beneficial
IP2-043	043 - Add a motor-driven feed water pump.	107,421	n/a	2,000,000	n/a	Not Beneficial
IP2-044	044 - Use fire water system as backup for steam generator inventory.	1,878,006	n/a	1,656,000	3,073,130	Not Beneficial
IP2-045	045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	463,838	n/a	2,700,000	n/a	Not Beneficial
IP2-046	046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0	n/a	82,000	n/a	Not Beneficial
IP2-047	047 - Add an independent boron injection system.	0	n/a	300,000	n/a	Not Beneficial
IP2-048	048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	63,290	n/a	615,000	n/a	Not Beneficial
IP2-049	049 - Install motor generator set trip breakers in control room.	14,154	n/a	716,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-050	050 - Provide capability to remove power from the bus powering the control rods.	14,154	n/a	90,000	n/a	Not Beneficial
IP2-051	051- Provide digital large break LOCA protection.	0	n/a	2,036,000	n/a	Not Beneficial
IP2-052	052 - Install secondary side guard pipes up to the MSIVs.	365,631	517,215	1,100,000	n/a	Not Beneficial
IP2-053	053 - Keep both pressurizer PORV block valves open.	459,676	n/a	800,000	1,471,234	Not Beneficial
IP2-054	054 - Install flood alarm in the 480V switchgear room.	4,901,404	n/a	200,000	458,843	Retained
IP2-055	055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0	n/a	1,330,000	n/a	Not Beneficial
IP2-056	056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	22,479	n/a	82,000	1,704,938	Not Beneficial
IP2-057	057 - Provide DC power backup for the PORVs.	60,796	n/a	376,000	n/a	Not Beneficial
IP2-058	058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0	n/a	82,000	n/a	Not Beneficial
IP2-059	059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	9,992	n/a	318,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-060	060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	1,100,213	n/a	216,000	721,303	Retained
IP2-061	061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	2,406,976	n/a	192,000	943,792	Retained
IP2-062	062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	753,741	864,513	1,500,000	1,662,692	Not Beneficial
IP2-063	063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	18,317	n/a	324,000	n/a	Not Beneficial
IP2-064	064 - Provide backup cooling water source for the CCW heat exchangers.	18,317	n/a	710,000	n/a	Not Beneficial
IP2-065	065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	4,901,404	n/a	560,000	1,859,587	Retained
IP2-066	066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	1,769,521	n/a	33,500,000	n/a	Not Beneficial
IP2-067	067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	4,162	n/a	576,000	n/a	Not Beneficial
IP2-068	068 - Provide independent source of cooling for the recirculation pump motors.	4,162	n/a	710,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP2-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	n/a	50,000	453,745	Retained
IP3-001	001 - Create an independent RCP seal injection system with a dedicated diesel.	178,570	178,570	1,137,000	n/a	Not Beneficial
IP3-002	002 - Create an independent RCP seal injection system without a dedicated diesel.	120,033	n/a	1,000,000	n/a	Not Beneficial
IP3-003	003 - Install an additional CCW pump.	0	n/a	1,500,000	n/a	Not Beneficial
IP3-004	004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	84,845	n/a	565,000	n/a	Not Beneficial
IP3-005	005 - Install a filtered containment vent to provide fission product scrubbing.	1,048,023	n/a	5,700,000	n/a	Not Beneficial
IP3-006	006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	4,247,669	n/a	108,000,000	n/a	Not Beneficial
IP3-007	007 - Create a reactor cavity flooding system.	4,247,669	n/a	4,100,000	1,874,933	Retained
IP3-008	008 - Create a core melt source reduction system.	4,247,669	n/a	90,000,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-009	009 - Provide means to inert containment.	2,286,596	n/a	10,900,000	n/a	Not Beneficial
IP3-010	010 - Use the fire protection system as a backup source for the containment spray system.	0	n/a	565,000	n/a	Not Beneficial
IP3-011	011 - Install a passive containment spray system.	0	n/a	2,000,000	n/a	Not Beneficial
IP3-012	012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	603,407	n/a	5,000,000	n/a	Not Beneficial
IP3-013	013 - Construct a building connected to primary containment that is maintained at a vacuum.	4,295,307	n/a	61,000,000	n/a	Not Beneficial
IP3-014	014 - Install a redundant containment spray system.	0	n/a	5,800,000	n/a	Not Beneficial
IP3-015	015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	1,278,271	n/a	5,500,000	n/a	Not Beneficial
IP3-016	016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	1,112,009	1,151,707	7,400,000	n/a	Not Beneficial
IP3-017	017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	15,560,475	n/a	100,000,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-018	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.	3,437,833	12,052,266	12,000,000	35,691,159	Not Beneficial
IP3-019	019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	2,527,743	n/a	2,800,000	6,369,223	Not Beneficial
IP3-020	020 - Add redundant and diverse limit switches to each containment isolation valve.	1,283,720	n/a	4,000,000	n/a	Not Beneficial
IP3-021	021 - Increase leak testing of valves in ISLOCA paths.	1,283,720	n/a	10,604,000	n/a	Not Beneficial
IP3-022	022 - Ensure all ISLOCA releases are scrubbed.	2,527,743	n/a	9,700,000	n/a	Not Beneficial
IP3-023	023 - Improve MSIV design.	0	n/a	476,000	n/a	Not Beneficial
IP3-024	024 - Provide additional DC battery capacity.	24,289	n/a	1,875,000	n/a	Not Beneficial
IP3-025	025 - Use fuel cells instead of lead-acid batteries.	24,289	n/a	2,000,000	n/a	Not Beneficial
IP3-026	026 - Increase/ improve DC bus load shedding.	24,289	n/a	460,000	n/a	Not Beneficial
IP3-027	027 - Create AC power cross-tie capability with other unit.	35,188	n/a	1,156,000	n/a	Not Beneficial
IP3-028	028 - Create a backup source for diesel cooling (not from existing system).	5,450	n/a	1,700,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-029	029 - Use fire protection system as a backup source for diesel cooling.	5,450	n/a	497,000	n/a	Not Beneficial
IP3-030	030 - Provide a portable diesel-driven battery charger.	172,650	259,986	938,000	n/a	Not Beneficial
IP3-031	031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	79,396	n/a	1,254,000	n/a	Not Beneficial
IP3-032	032 - Provide capability for diesel-driven, low pressure vessel makeup.	15,879	n/a	632,000	n/a	Not Beneficial
IP3-033	033 - Provide an additional high pressure injection pump with independent diesel.	76,906	n/a	5,000,000	n/a	Not Beneficial
IP3-034	034 - Create automatic swap-over to recirculation upon RWST depletion.	339,710	n/a	1,000,000	n/a	Not Beneficial
IP3-035	035 - Provide capability for alternate injection via diesel-driven fire pump.	15,879	n/a	750,000	n/a	Not Beneficial
IP3-036	036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	5,450	n/a	82,000	n/a	Not Beneficial
IP3-037	037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	76,906	n/a	2,000,000	n/a	Not Beneficial
IP3-038	038 - Create/enhance a reactor coolant depressurization system.	203,939	n/a	4,600,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-039	039 - Install a digital feed water upgrade.	179,510	n/a	900,000	n/a	Not Beneficial
IP3-040	040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	195,999	195,999	950,000	n/a	Not Beneficial
IP3-041	041 - Add a motor-driven feedwater pump.	179,510	n/a	2,000,000	n/a	Not Beneficial
IP3-042	042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	24,289	n/a	1,072,000	n/a	Not Beneficial
IP3-043	043 - Use fire water system as backup for steam generator inventory.	321,482	361,180	1,656,000	n/a	Not Beneficial
IP3-044	044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	995,876	n/a	2,700,000	n/a	Not Beneficial
IP3-045	045 - Add an independent boron injection system.	0	n/a	300,000	n/a	Not Beneficial
IP3-046	046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	152,731	n/a	615,000	n/a	Not Beneficial
IP3-047	047 - Install motor generator set trip breakers in control room.	18,839	n/a	716,000	n/a	Not Beneficial
IP3-048	048 - Provide capability to remove power from the bus powering the control rods.	18,839	n/a	90,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-049	049 - Provide digital large break LOCA protection.	0	n/a	2,036,000	n/a	Not Beneficial
IP3-050	050 - Install secondary side guard pipes up to the MSIVs.	1,940,684	n/a	9,671,000	n/a	Not Beneficial
IP3-051	051 - Operator action: Align main feedwater for secondary heat removal.	13,389	n/a	55,000	n/a	Not Beneficial
IP3-052	052 - Open city water supply valve for alternative AFW pump suction.	211,878	n/a	50,000	138,378	Retained
IP3-053	053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	391,999	n/a	228,000	344,599	Retained
IP3-054	054 - Provide DC power backup for the PORVs.	0	n/a	376,000	n/a	Not Beneficial
IP3-055	055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	3,350,827	n/a	1,288,000	1,601,888	Retained
IP3-056	056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	24,289	n/a	982,000	n/a	Not Beneficial
IP3-057	057 - Provide backup cooling water source for the CCW heat exchangers.	32,228	n/a	109,000	n/a	Not Beneficial
IP3-058	058 - Provide automatic DC power backup.	48,577	n/a	1,868,000	n/a	Not Beneficial
IP3-059	059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0	n/a	576,000	n/a	Not Beneficial

Table 14 – Case 8 Sensitivity SAMA Results Using Shortened License Renewal Period[1]

Phase II SAMA	Description	Baseline Benefit	TI-SGTR Benefit Without Uncertainty	Estimated Cost (IP-RPT-09-00044)	Estimated Cost (NL-14-143)	Conclusion
IP3-060	060 - Provide independent source of cooling for the recirculation pump motors.	0	n/a	710,000	n/a	Not Beneficial
IP3-061	061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	3,570,645	n/a	560,000	2,282,668	Retained
IP3-062	062 - Install flood alarm in the 480 VAC switchgear room.	3,570,645	n/a	196,800	496,071	Retained
IP3-GAG	Not numbered - Use a gagging device to close a stuck open main steam safety valve following a steam generator tube rupture. (See Round 2 RAI 6 in Reference 2.)	n/a	n/a	50,000	453,745	Retained

(1) Legend: green highlight = SAMAs retained in Case 0, baseline case using 20 year license renewal period.
lavender highlight = SAMAs evaluated for TI-SGTR.
red text = SAMAs with NL-14-143 estimated costs.

Attachment 1 – List of Electronic Files

Input spreadsheets from IP-RPT-09-00044 (Reference 3):

File Name	Unit	Date	Time	Description
sumi2NS-noE-R-NmetEC.xls	IP2	11/19/2009	10:17AM	PDR and OECR for SAMA analysis cases – baseline
Cost-20-7-IP2-NS-noE-R-NmetEC.xls	IP2	11/19/2009	10:14AM	Benefit calculations for SAMA analysis cases – baseline
IP2 Radionuclide Release Results-Base-RAI#5.xls	IP2	04/30/2008	11:03AM	Source term for IP2 TI-SGTR sensitivity
sumi2NS-noE-R-NmetEC-RAI5.xls	IP2	11/18/2009	09:44AM	PDR and OECR for SAMA analysis cases – TI-SGTR sensitivity
Cost-20-7-IP2-NS-noE-R-NmetEC-RAI5.xls	IP2	11/18/2009	10:10AM	Benefit calculations for SAMA analysis cases – TI-SGTR sensitivity
sumi3NS-noE-NmetEC-R-level130a.xls	IP3	11/19/2009	10:29AM	PDR and OECR for SAMA analysis cases – baseline
ER-Cost-20-7-IP3-NS-noE-NmetEC-R-nm8-level1-30a.xls	IP3	11/19/2009	10:33AM	Benefit calculations for SAMA analysis cases – baseline
IP3 Radionuclide Release Results-Base-RAI#5.xls	IP3	04/30/2008	11:53AM	Source term for IP3 TI-SGTR sensitivity
sumi3NS-noE-NmetEC-R-level130a-RAI5.xls	IP3	11/18/2009	10:10AM	PDR and OECR for SAMA analysis cases – TI-SGTR sensitivity
ER-Cost-20-7-IP3-NS-noE-NmetEC-R-nm8-level1-30a-RAI5.xls	IP3	11/18/2009	10:08AM	Benefit calculations for SAMA analysis cases – TI-SGTR sensitivity

Input spreadsheet from IP-RPT-07-00007 (Reference 6):

File Name	Unit	Date	Time	Description
IP2 SAMA Radionuclide Release Results-Level1-20.xls	IP2	01/29/2007	12:55PM	Source Term for Analysis Case 16 – Phase II SAMA IP2-020.

Input spreadsheet from IP-RPT-07-00008 (Reference 7):

File Name	Unit	Date	Time	Description
IP3 SAMA Radionuclide Release Results-Level2-18.xls	IP3	01/23/2007	06:36AM	Source Term for Analysis Case 14 – Phase II SAMA IP3-018.

Input spreadsheet from IP-RPT-16-00077 (Reference 4):

File Name	Unit	Date	Time	Description
2016 IPEC MACCS2 Sens – RevD.xlsx	IP2 and IP3	11/24/16	1:08PM	MACCS2 results for RAI CLI-16-07 sensitivity cases

Attachment 1 – List of Electronic Files (cont.)

Output spreadsheets for IP-RPT-16-00078 (this report):

File Name	Unit	Date	Time	Description
Case 0 IPEC SAMA Sensitivities_R1.xlsx	IP2 and IP3	3/15/17	10:42AM	Case 0 spreadsheet with shortened license renewal period.
Case 4 IPEC SAMA Sensitivities_R1.xlsx	IP2 and IP3	3/15/17	10:56AM	Case 4 spreadsheet to evaluate escalated VALWNF and VNFRM with shortened license renewal period.
Case 5 IPEC SAMA Sensitivities_R1.xlsx	IP2 and IP3	3/15/17	11:02AM	Case 5 spreadsheet to evaluate increased TIMDEC and CDNFRM with shortened license renewal period.
Case 7 IPEC SAMA Sensitivities_R1.xlsx	IP2 and IP3	3/15/17	11:06AM	Case 7 spreadsheet to evaluate escalated VALWNF and VNFRM and revised VDEPOS with shortened license renewal period.
Case 8 IPEC SAMA Sensitivities_R1.xlsx	IP2 and IP3	3/15/17	11:11AM	Case 8 spreadsheet to evaluate increased TIMDEC and CDNFRM with revised VDEPOS and with shortened license renewal period.