**ENCLOSURE 2 TO NL-17-002**

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

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

**REV. 0 (JAN. 4, 2017)**

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New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: _____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

**TABLE OF CONTENTS**

## 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.

## 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).

**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 |
| 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 |

[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)

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% |
| 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% |

[2] Table 2E in IP-RPT-16-00077 (Reference 4)
[3] Table 3E in IP-RPT-16-00077 (Reference 4)

**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 |
|---|---|---|---|---|---|---|---|
| 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% |

The revised baseline with escalation of VALWNF and VNFRM resulted in one additional potentially cost-beneficial SAMA as shown below.

| Phase II SAMA | Description | Revised Baseline Benefit | Revised Baseline Benefit With Uncertainty | Estimated Cost (NL-14-143) |
|---|---|---|---|---|
| IP2-021 | 021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 2,216,549 | **4,666,419** | **4,632,227** |

**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% |

Increasing the TIMDEC and CDNFRM values to the maximum MACCS2 allowed values as stipulated in the RAI, with the revised baseline, resulted in one additional potentially cost-beneficial SAMA as shown below.

| Phase II SAMA | Description | Sensitivity Benefit | Estimated Cost (IP-RPT-09-00044) |
|---|---|---|---|
| IP3-057 | 057 - Provide backup cooling water source for the CCW heat exchangers. | **118,434** | **109,000** |

[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% |

The alternative baseline with the change to VDEPOS along with escalation of VALWNF and VNFRM did not result in additional 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 2009 analysis (Reference 3) shows that the OECR increases approximately 82-91%. The PDR increase is much smaller, approximately 7-10%.

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

**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% |

Increasing the TIMDEC and CDNFRM values to the maximum MACCS2 allowed values as stipulated in the RAI, with the alternative revised baseline, did not result in additional 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

## 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 95$^{th}$ 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 95$^{th}$ 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 Conclusions

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

The revised baseline with escalation of VALWNF and VNFRM resulted in one additional potentially cost-beneficial SAMA; IP2-021, "*Install additional pressure or leak monitoring instrumentation for ISLOCAs.*"

Table 10 provides the Sensitivity Case 4 SAMA results.

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

Increasing TIMDEC and CDNFRM (with escalated VALWNF and VNFRM) resulted in one additional potentially cost-beneficial SAMA; SAMA IP3-057, "*Provide backup cooling water source for the CCW heat exchangers.*"

Table 11 provides the Sensitivity Case 5 SAMA results.

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

Sensitivity Case 7 shows that the change to VDEPOS along with escalation of VALWNF and VNFRM did not result in additional potentially cost-beneficial SAMAs.

[In Case 0, SAMA IP2-062 was cost beneficial without the TI-SGTR evaluation. However, in Case 7, SAMA IP2-062 was not cost beneficial until after the TI-SGTR evaluation. This has no bearing on the results of this analysis since SAMA IP2-062 was retained in Case 0.]

Table 12 provides the Sensitivity Case 7 SAMA results.

### 6.4 Sensitivity Case 8 – 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 13 provides the Sensitivity Case 8 SAMA results.

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 374,757 | 788,963 | 374,757 | 788,963 | 1,137,000 | n/a | Not Beneficial |
| IP2-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 350,396 | 737,676 | 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. | 48,723 | 102,574 | 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. | 105,892 | 222,931 | n/a | n/a | 565,000 | n/a | Not Beneficial |
| IP2-006 | 006 - Add a diesel building high temperature alarm. | 24,361 | 51,287 | 32,541 | 68,508 | 274,000 | n/a | Not Beneficial |
| IP2-007 | 007 - Install a filtered containment vent to provide fission product scrubbing. | 1,766,838 | 3,719,658 | 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. | 6,592,922 | 13,879,837 | n/a | n/a | 108,000,000 | n/a | Not Beneficial |
| IP2-009 | 009 - Create a reactor cavity flooding system. | 6,592,922 | 13,879,837 | n/a | n/a | 4,100,000 | 1,741,724 | Retained |
| IP2-010 | 010 - Create a core melt source reduction system. | 6,592,922 | 13,879,837 | n/a | n/a | 90,000,000 | n/a | Not Beneficial |
| IP2-011 | 011 - Provide a means to inert containment. | 3,296,461 | 6,939,918 | n/a | n/a | 10,900,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 1,194,251 | 2,514,214 | 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. | 6,208,472 | 13,070,466 | 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. | 1,864,995 | 3,926,306 | 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. | 73,618 | 154,986 | 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. | 5,962,632 | 12,552,910 | n/a | n/a | 100,000,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 646,205 | 1,360,431 | n/a | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-021 | 021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 2,216,549 | 4,666,419 | n/a | n/a | 3,200,000 | 4,632,227 | Retained |
| IP2-022 | 022 - Add redundant and diverse limit switches to each containment isolation valve. | 1,112,364 | 2,341,820 | n/a | n/a | 2,200,000 | 7,692,784 | Not Beneficial |
| IP2-023 | 023 - Increase leak testing of valves in ISLOCA paths. | 1,112,364 | 2,341,820 | n/a | n/a | 7,964,000 | n/a | Not Beneficial |
| IP2-024 | 024 - Ensure all ISLOCA releases are scrubbed. | 2,216,549 | 4,666,419 | n/a | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-025 | 025 - Improve MSIV design. | 122,697 | 258,310 | 188,136 | 396,075 | 476,000 | n/a | Not Beneficial |
| IP2-026 | 026 - Provide additional DC battery capacity. | 48,723 | 102,574 | n/a | n/a | 1,875,000 | n/a | Not Beneficial |
| IP2-027 | 027 - Use fuel cells instead of lead-acid batteries. | 48,723 | 102,574 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-028 | 028 - Provide a portable diesel-driven battery charger. | 1,397,945 | 2,943,043 | n/a | n/a | 938,000 | 2,154,767 | Retained |
| IP2-029 | 029 - Increase/ improve DC bus load shedding. | 48,723 | 102,574 | 48,723 | 102,574 | 460,000 | n/a | Not Beneficial |
| IP2-030 | 030 - Create AC power cross-tie capability with other unit. | 56,813 | 119,607 | n/a | n/a | 1,156,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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). | 40,632 | 85,541 | 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. | 40,632 | 85,541 | 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. | 8,180 | 17,221 | n/a | n/a | 632,000 | n/a | Not Beneficial |
| IP2-035 | 035 - Provide an additional high pressure injection pump with independent diesel. | 73,529 | 154,798 | n/a | n/a | 5,000,000 | n/a | Not Beneficial |
| IP2-036 | 036 - Create automatic swap-over to recirculation cooling upon RWST depletion. | 138,344 | 291,251 | n/a | n/a | 1,000,000 | n/a | Not Beneficial |
| IP2-037 | 037 - Provide capability for alternate injection via diesel-driven fire pump. | 8,180 | 17,221 | 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. | 16,271 | 34,254 | 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. | 73,529 | 154,798 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 613,307 | 1,291,173 | 613,307 | 1,291,173 | 2,000,000 | n/a | Not Beneficial |
| IP2-041 | 041 - Install a digital feed water upgrade. | 179,154 | 377,167 | n/a | n/a | 900,000 | n/a | Not Beneficial |
| IP2-042 | 042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 16,360 | 34,441 | n/a | n/a | 214,000 | n/a | Not Beneficial |
| IP2-043 | 043 - Add a motor-driven feed water pump. | 179,154 | 377,167 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-044 | 044 - Use fire water system as backup for steam generator inventory. | 2,432,328 | 5,120,691 | 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. | 667,806 | 1,405,907 | 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. | 105,981 | 223,119 | n/a | n/a | 615,000 | n/a | Not Beneficial |
| IP2-049 | 049 - Install motor generator set trip breakers in control room. | 32,541 | 68,508 | n/a | n/a | 716,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 32,541 | 68,508 | 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. | 335,283 | 705,859 | 457,980 | 964,168 | 1,100,000 | n/a | Not Beneficial |
| IP2-053 | 053 - Keep both pressurizer PORV block valves open. | 659,715 | 1,388,873 | n/a | n/a | 800,000 | 1,471,234 | Not Beneficial |
| IP2-054 | 054 - Install flood alarm in the 480V switchgear room. | 5,796,276 | 12,202,686 | 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. | 48,723 | 102,574 | n/a | n/a | 82,000 | 1,704,938 | Not Beneficial |
| IP2-057 | 057 - Provide DC power backup for the PORVs. | 89,800 | 189,052 | 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. | 24,450 | 51,474 | n/a | n/a | 318,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 1,316,236 | 2,771,024 | 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. | 2,877,688 | 6,058,291 | 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. | 891,064 | 1,875,925 | n/a | n/a | 1,500,000 | 1,662,692 | Retained |
| IP2-063 | 063 - Provide a water-tight door for additional protection of the RHR pumps against flooding. | 32,452 | 68,320 | n/a | n/a | 324,000 | n/a | Not Beneficial |
| IP2-064 | 064 - Provide backup cooling water source for the CCW heat exchangers. | 40,632 | 85,541 | 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. | 5,796,276 | 12,202,686 | 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. | 2,546,745 | 5,361,568 | 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. | 8,091 | 17,033 | n/a | n/a | 576,000 | n/a | Not Beneficial |
| IP2-068 | 068 - Provide independent source of cooling for the recirculation pump motors. | 8,091 | 17,033 | n/a | n/a | 710,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 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. | 236,610 | 342,913 | 296,021 | 429,016 | 1,137,000 | n/a | Not Beneficial |
| IP3-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 213,104 | 308,847 | 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. | 130,575 | 189,240 | n/a | n/a | 565,000 | n/a | Not Beneficial |
| IP3-005 | 005 - Install a filtered containment vent to provide fission product scrubbing. | 1,556,574 | 2,255,904 | 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. | 5,275,716 | 7,645,965 | n/a | n/a | 108,000,000 | n/a | Not Beneficial |
| IP3-007 | 007 - Create a reactor cavity flooding system. | 5,275,716 | 7,645,965 | n/a | n/a | 4,100,000 | 1,874,933 | Retained |
| IP3-008 | 008 - Create a core melt source reduction system. | 5,275,716 | 7,645,965 | n/a | n/a | 90,000,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 2,530,918 | 3,667,996 | 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. | 926,815 | 1,343,210 | 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. | 5,180,658 | 7,508,199 | 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. | 1,259,518 | 1,825,388 | 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. | 1,520,539 | 2,203,680 | 1,532,421 | 2,220,900 | 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. | 14,364,337 | 20,817,880 | 23,347,312 | 33,836,685 | 100,000,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 3,517,144 | 5,097,310 | 10,587,078 | 15,343,591 | 12,000,000 | 35,691,159 | Not Beneficial |
| IP3-019 | 019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 2,316,779 | 3,357,650 | 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. | 1,128,684 | 1,635,773 | n/a | n/a | 4,000,000 | n/a | Not Beneficial |
| IP3-021 | 021 - Increase leak testing of valves in ISLOCA paths. | 1,128,684 | 1,635,773 | n/a | n/a | 10,604,000 | n/a | Not Beneficial |
| IP3-022 | 022 - Ensure all ISLOCA releases are scrubbed. | 2,316,779 | 3,357,650 | 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. | 47,141 | 68,320 | n/a | n/a | 1,875,000 | n/a | Not Beneficial |
| IP3-025 | 025 - Use fuel cells instead of lead-acid batteries. | 47,141 | 68,320 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-026 | 026 - Increase/ improve DC bus load shedding. | 47,141 | 68,320 | n/a | n/a | 460,000 | n/a | Not Beneficial |
| IP3-027 | 027 - Create AC power cross-tie capability with other unit. | 70,647 | 102,387 | 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). | 11,753 | 17,033 | n/a | n/a | 1,700,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 11,753 | 17,033 | n/a | n/a | 497,000 | n/a | Not Beneficial |
| IP3-030 | 030 - Provide a portable diesel-driven battery charger. | 284,656 | 412,546 | 296,539 | 429,766 | 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. | 118,822 | 172,206 | n/a | n/a | 1,254,000 | n/a | Not Beneficial |
| IP3-032 | 032 - Provide capability for diesel-driven, low pressure vessel makeup. | 23,764 | 34,441 | n/a | n/a | 632,000 | n/a | Not Beneficial |
| IP3-033 | 033 - Provide an additional high pressure injection pump with independent diesel. | 118,693 | 172,019 | n/a | n/a | 5,000,000 | n/a | Not Beneficial |
| IP3-034 | 034 - Create automatic swap-over to recirculation upon RWST depletion. | 591,137 | 856,721 | n/a | n/a | 1,000,000 | n/a | Not Beneficial |
| IP3-035 | 035 - Provide capability for alternate injection via diesel-driven fire pump. | 23,764 | 34,441 | 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. | 11,753 | 17,033 | 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. | 118,693 | 172,019 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-038 | 038 - Create/enhance a reactor coolant depressurization system. | 308,809 | 447,549 | n/a | n/a | 4,600,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 330,892 | 479,554 | n/a | n/a | 900,000 | n/a | Not Beneficial |
| IP3-040 | 040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 237,516 | 344,225 | 296,927 | 430,329 | 950,000 | n/a | Not Beneficial |
| IP3-041 | 041 - Add a motor-driven feedwater pump. | 330,892 | 479,554 | 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. | 47,141 | 68,320 | n/a | n/a | 1,072,000 | n/a | Not Beneficial |
| IP3-043 | 043 - Use fire water system as backup for steam generator inventory. | 450,490 | 652,885 | 509,902 | 738,988 | 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. | 1,365,811 | 1,979,436 | 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. | 283,622 | 411,046 | n/a | n/a | 615,000 | n/a | Not Beneficial |
| IP3-047 | 047 - Install motor generator set trip breakers in control room. | 35,388 | 51,287 | 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. | 35,388 | 51,287 | n/a | n/a | 90,000 | n/a | Not Beneficial |

**Table 10 – Case 4 Sensitivity SAMA Results[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. | 2,565,918 | 3,718,721 | n/a | n/a | 9,671,000 | n/a | Not Beneficial |
| IP3-051 | 051 - Operator action: Align main feedwater for secondary heat removal. | 23,635 | 34,254 | n/a | n/a | 55,000 | n/a | Not Beneficial |
| IP3-052 | 052 - Open city water supply valve for alternative AFW pump suction. | 308,809 | 447,549 | 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. | 486,913 | 705,671 | 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). | 4,263,267 | 6,178,648 | 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. | 47,141 | 68,320 | n/a | n/a | 982,000 | n/a | Not Beneficial |
| IP3-057 | 057 - Provide backup cooling water source for the CCW heat exchangers. | 59,023 | 85,541 | n/a | n/a | 109,000 | n/a | Not Beneficial |
| IP3-058 | 058 - Provide automatic DC power backup. | 94,282 | 136,640 | 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 4 Sensitivity SAMA Results[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. | 4,536,430 | 6,574,536 | n/a | n/a | 560,000 | 2,282,668 | Retained |
| IP3-062 | 062 - Install flood alarm in the 480 VAC switchgear room. | 4,536,430 | 6,574,536 | 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. | 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.
lavender highlight = SAMAs evaluated for TI-SGTR.
yellow highlight = SAMA newly retained in Case 4, revised baseline case
red text = SAMAs with NL-14-143 estimated costs.

**Table 11 – Case 5 Sensitivity SAMA Results[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. | 456,555 | 497,454 | 1,137,000 | n/a | Not Beneficial |
| IP2-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 440,374 | 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. | 48,723 | 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. | 105,892 | n/a | 565,000 | n/a | Not Beneficial |
| IP2-006 | 006 - Add a diesel building high temperature alarm. | 24,361 | 24,361 | 274,000 | n/a | Not Beneficial |
| IP2-007 | 007 - Install a filtered containment vent to provide fission product scrubbing. | 2,110,390 | 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. | 9,414,955 | n/a | 108,000,000 | n/a | Not Beneficial |
| IP2-009 | 009 - Create a reactor cavity flooding system. | 9,414,955 | n/a | 4,100,000 | 1,741,724 | Retained |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-010 | 010 - Create a core melt source reduction system. | 9,414,955 | n/a | 90,000,000 | n/a | Not Beneficial |
| IP2-011 | 011 - Provide a means to inert containment. | 5,259,614 | 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. | 1,456,005 | 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. | 9,349,516 | 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. | 3,296,461 | 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. | 114,517 | n/a | 7,400,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-019 | 019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift. | 10,911,414 | n/a | 100,000,000 | n/a | Not Beneficial |
| 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. | 1,300,589 | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-021 | 021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 4,106,084 | n/a | 3,200,000 | 4,632,227 | Not Beneficial |
| IP2-022 | 022 - Add redundant and diverse limit switches to each containment isolation valve. | 2,053,042 | n/a | 2,200,000 | 7,692,784 | Not Beneficial |
| IP2-023 | 023 - Increase leak testing of valves in ISLOCA paths. | 2,053,042 | n/a | 7,964,000 | n/a | Not Beneficial |
| IP2-024 | 024 - Ensure all ISLOCA releases are scrubbed. | 4,106,084 | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-025 | 025 - Improve MSIV design. | 212,675 | 319,012 | 476,000 | n/a | Not Beneficial |
| IP2-026 | 026 - Provide additional DC battery capacity. | 48,723 | n/a | 1,875,000 | n/a | Not Beneficial |
| IP2-027 | 027 - Use fuel cells instead of lead-acid batteries. | 48,723 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-028 | 028 - Provide a portable diesel-driven battery charger. | 1,921,453 | n/a | 938,000 | 2,154,767 | Not Beneficial |
| IP2-029 | 029 - Increase/ improve DC bus load shedding. | 48,723 | 48,723 | 460,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-030 | 030 - Create AC power cross-tie capability with other unit. | 56,813 | n/a | 1,156,000 | n/a | Not Beneficial |
| IP2-031 | 031 - Create a backup source for diesel cooling (not from existing system). | 32,452 | n/a | 1,700,000 | n/a | Not Beneficial |
| IP2-032 | 032 - Use fire protection system as a backup source for diesel cooling. | 32,452 | 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. | 73,529 | n/a | 5,000,000 | n/a | Not Beneficial |
| IP2-036 | 036 - Create automatic swap-over to recirculation cooling upon RWST depletion. | 138,344 | 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. | 8,091 | n/a | 82,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-039 | 039 - Replace two of three motor-driven SI pumps with diesel-powered pumps. | 73,529 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-040 | 040 - Create/enhance a reactor coolant depressurization system. | 956,859 | 956,859 | 2,000,000 | n/a | Not Beneficial |
| IP2-041 | 041 - Install a digital feed water upgrade. | 220,053 | n/a | 900,000 | n/a | Not Beneficial |
| IP2-042 | 042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 57,259 | n/a | 214,000 | n/a | Not Beneficial |
| IP2-043 | 043 - Add a motor-driven feed water pump. | 220,053 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-044 | 044 - Use fire water system as backup for steam generator inventory. | 3,201,230 | 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. | 798,683 | 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. | 105,981 | n/a | 615,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-049 | 049 - Install motor generator set trip breakers in control room. | 32,541 | n/a | 716,000 | n/a | Not Beneficial |
| IP2-050 | 050 - Provide capability to remove power from the bus powering the control rods. | 32,541 | 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. | 556,138 | 817,891 | 1,100,000 | n/a | Not Beneficial |
| IP2-053 | 053 - Keep both pressurizer PORV block valves open. | 823,311 | n/a | 800,000 | 1,471,234 | Not Beneficial |
| IP2-054 | 054 - Install flood alarm in the 480V switchgear room. | 8,045,722 | 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. | 48,723 | n/a | 82,000 | 1,704,938 | Not Beneficial |
| IP2-057 | 057 - Provide DC power backup for the PORVs. | 89,800 | 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 |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-059 | 059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path. | 24,450 | n/a | 318,000 | n/a | Not Beneficial |
| IP2-060 | 060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room. | 1,790,665 | 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. | 3,965,602 | n/a | 192,000 | 943,792 | Retained |
| IP2-062 | 062 - Provide a hard-wired connection to an SI pump from ASSS power supply. | 1,234,616 | 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. | 32,452 | n/a | 324,000 | n/a | Not Beneficial |
| IP2-064 | 064 - Provide backup cooling water source for the CCW heat exchangers. | 40,632 | n/a | 710,000 | n/a | Not Beneficial |
| IP2-065 | 065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling. | 8,045,722 | 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. | 3,070,252 | 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. | 8,091 | n/a | 576,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP2-068 | 068 - Provide independent source of cooling for the recirculation pump motors. | 8,091 | n/a | 710,000 | n/a | Not Beneficial |
| 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. | 307,904 | 307,904 | 1,137,000 | n/a | Not Beneficial |
| IP3-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 272,516 | 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. | 189,987 | n/a | 565,000 | n/a | Not Beneficial |
| IP3-005 | 005 - Install a filtered containment vent to provide fission product scrubbing. | 1,924,923 | 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. | 7,521,459 | n/a | 108,000,000 | n/a | Not Beneficial |
| IP3-007 | 007 - Create a reactor cavity flooding system. | 7,521,459 | n/a | 4,100,000 | 1,874,933 | Retained |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP3-008 | 008 - Create a core melt source reduction system. | 7,521,459 | n/a | 90,000,000 | n/a | Not Beneficial |
| IP3-009 | 009 - Provide means to inert containment. | 4,028,080 | 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. | 1,116,931 | 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. | 7,675,928 | 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. | 2,269,508 | 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. | 2,162,180 | 2,090,887 | 7,400,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP3-017 | 017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift. | 27,708,095 | 45,044,287 | 100,000,000 | n/a | Not Beneficial |
| 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. | 5,905,474 | 20,710,748 | 12,000,000 | 35,691,159 | Not Beneficial |
| IP3-019 | 019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 4,526,876 | n/a | 2,800,000 | 6,369,223 | Not Beneficial |
| IP3-020 | 020 - Add redundant and diverse limit switches to each containment isolation valve. | 2,269,379 | n/a | 4,000,000 | n/a | Not Beneficial |
| IP3-021 | 021 - Increase leak testing of valves in ISLOCA paths. | 2,269,379 | n/a | 10,604,000 | n/a | Not Beneficial |
| IP3-022 | 022 - Ensure all ISLOCA releases are scrubbed. | 4,526,876 | 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. | 47,141 | n/a | 1,875,000 | n/a | Not Beneficial |
| IP3-025 | 025 - Use fuel cells instead of lead-acid batteries. | 47,141 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-026 | 026 - Increase/ improve DC bus load shedding. | 47,141 | n/a | 460,000 | n/a | Not Beneficial |
| IP3-027 | 027 - Create AC power cross-tie capability with other unit. | 82,529 | n/a | 1,156,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[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). | 23,635 | n/a | 1,700,000 | n/a | Not Beneficial |
| IP3-029 | 029 - Use fire protection system as a backup source for diesel cooling. | 23,635 | n/a | 497,000 | n/a | Not Beneficial |
| IP3-030 | 030 - Provide a portable diesel-driven battery charger. | 344,068 | 415,361 | 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. | 178,234 | n/a | 1,254,000 | n/a | Not Beneficial |
| IP3-032 | 032 - Provide capability for diesel-driven, low pressure vessel makeup. | 83,176 | n/a | 632,000 | n/a | Not Beneficial |
| IP3-033 | 033 - Provide an additional high pressure injection pump with independent diesel. | 189,987 | n/a | 5,000,000 | n/a | Not Beneficial |
| IP3-034 | 034 - Create automatic swap-over to recirculation upon RWST depletion. | 721,842 | n/a | 1,000,000 | n/a | Not Beneficial |
| IP3-035 | 035 - Provide capability for alternate injection via diesel-driven fire pump. | 83,176 | 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. | 23,635 | n/a | 82,000 | n/a | Not Beneficial |
| IP3-037 | 037 - Replace two of three motor-driven SI pumps with diesel-powered pumps. | 189,987 | n/a | 2,000,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP3-038 | 038 - Create/enhance a reactor coolant depressurization system. | 427,631 | n/a | 4,600,000 | n/a | Not Beneficial |
| IP3-039 | 039 - Install a digital feed water upgrade. | 390,303 | n/a | 900,000 | n/a | Not Beneficial |
| IP3-040 | 040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 356,338 | 356,338 | 950,000 | n/a | Not Beneficial |
| IP3-041 | 041 - Add a motor-driven feedwater pump. | 390,303 | 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. | 47,141 | n/a | 1,072,000 | n/a | Not Beneficial |
| IP3-043 | 043 - Use fire water system as backup for steam generator inventory. | 640,606 | 640,606 | 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. | 1,876,748 | n/a | 2,700,000 | n/a | Not Beneficial |
| IP3-045 | 045 - Add an independent boron injection system. | 11,882 | 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. | 283,622 | n/a | 615,000 | n/a | Not Beneficial |
| IP3-047 | 047 - Install motor generator set trip breakers in control room. | 35,388 | n/a | 716,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP3-048 | 048 - Provide capability to remove power from the bus powering the control rods. | 35,388 | 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. | 3,647,202 | n/a | 9,671,000 | n/a | Not Beneficial |
| IP3-051 | 051 - Operator action: Align main feedwater for secondary heat removal. | 23,635 | n/a | 55,000 | n/a | Not Beneficial |
| IP3-052 | 052 - Open city water supply valve for alternative AFW pump suction. | 439,514 | n/a | 50,000 | 138,378 | Retained |
| IP3-053 | 053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions. | 677,029 | n/a | 228,000 | 344,599 | Retained |
| IP3-054 | 054 - Provide DC power backup for the PORVs. | 11,882 | 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). | 5,938,664 | n/a | 1,288,000 | 1,601,888 | Retained |
| IP3-056 | 056 - Install pneumatic controls and indication for the turbine-driven AFW pump. | 47,141 | n/a | 982,000 | n/a | Not Beneficial |
| IP3-057 | 057 - Provide backup cooling water source for the CCW heat exchangers. | 118,434 | n/a | 109,000 | n/a | Retained |
| IP3-058 | 058 - Provide automatic DC power backup. | 165,575 | n/a | 1,868,000 | n/a | Not Beneficial |

**Table 11 – Case 5 Sensitivity SAMA Results[1]**

| Phase II SAMA | Description | Baseline Benefit | TI-SGTR Benefit Without Uncertainty | Estimated Cost (IP-RPT-09-00044) | Estimated Cost (NL-14-143) | Conclusion |
|---|---|---|---|---|---|---|
| IP3-059 | 059 - Provide hardware connections to allow the primary water system to cool the charging pumps. | 11,882 | n/a | 576,000 | n/a | Not Beneficial |
| IP3-060 | 060 - Provide independent source of cooling for the recirculation pump motors. | 11,882 | n/a | 710,000 | n/a | Not Beneficial |
| IP3-061 | 061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling. | 6,342,530 | n/a | 560,000 | 2,282,668 | Retained |
| IP3-062 | 062 - Install flood alarm in the 480 VAC switchgear room. | 6,342,530 | 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.
lavender highlight = SAMAs evaluated for TI-SGTR.
yellow highlight = SAMA newly retained in Case 4, revised baseline case
red text = SAMAs with NL-14-143 estimated costs.

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 317,499 | 668,418 | 325,679 | 685,639 | 1,137,000 | n/a | Not Beneficial |
| IP2-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 301,317 | 634,352 | 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. | 40,543 | 85,353 | 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. | 56,813 | 119,607 | n/a | n/a | 565,000 | n/a | Not Beneficial |
| IP2-006 | 006 - Add a diesel building high temperature alarm. | 16,182 | 34,066 | 24,361 | 51,287 | 274,000 | n/a | Not Beneficial |
| IP2-007 | 007 - Install a filtered containment vent to provide fission product scrubbing. | 1,488,724 | 3,134,157 | 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. | 5,635,885 | 11,865,022 | n/a | n/a | 108,000,000 | n/a | Not Beneficial |
| IP2-009 | 009 - Create a reactor cavity flooding system. | 5,635,885 | 11,865,022 | n/a | n/a | 4,100,000 | 1,741,724 | Retained |
| IP2-010 | 010 - Create a core melt source reduction system. | 5,635,885 | 11,865,022 | n/a | n/a | 90,000,000 | n/a | Not Beneficial |
| IP2-011 | 011 - Provide a means to inert containment. | 2,805,673 | 5,906,680 | n/a | n/a | 10,900,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 1,022,476 | 2,152,580 | 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. | 5,333,232 | 11,227,858 | 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. | 1,668,680 | 3,513,011 | 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. | 65,438 | 137,765 | 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. | 5,496,383 | 11,571,333 | n/a | n/a | 100,000,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 556,227 | 1,171,004 | n/a | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-021 | 021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 2,052,953 | 4,322,006 | 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. | 1,038,746 | 2,186,834 | n/a | n/a | 2,200,000 | 7,692,784 | Not Beneficial |
| IP2-023 | 023 - Increase leak testing of valves in ISLOCA paths. | 1,038,746 | 2,186,834 | n/a | n/a | 7,964,000 | n/a | Not Beneficial |
| IP2-024 | 024 - Ensure all ISLOCA releases are scrubbed. | 2,052,953 | 4,322,006 | n/a | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-025 | 025 - Improve MSIV design. | 81,798 | 172,206 | 147,236 | 309,972 | 476,000 | n/a | Not Beneficial |
| IP2-026 | 026 - Provide additional DC battery capacity. | 40,543 | 85,353 | n/a | n/a | 1,875,000 | n/a | Not Beneficial |
| IP2-027 | 027 - Use fuel cells instead of lead-acid batteries. | 40,543 | 85,353 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-028 | 028 - Provide a portable diesel-driven battery charger. | 1,168,911 | 2,460,865 | n/a | n/a | 938,000 | 2,154,767 | Retained |
| IP2-029 | 029 - Increase/ improve DC bus load shedding. | 40,543 | 85,353 | 48,723 | 102,574 | 460,000 | n/a | Not Beneficial |
| IP2-030 | 030 - Create AC power cross-tie capability with other unit. | 48,634 | 102,387 | n/a | n/a | 1,156,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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). | 32,452 | 68,320 | 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. | 32,452 | 68,320 | 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. | 24,450 | 51,474 | n/a | n/a | 5,000,000 | n/a | Not Beneficial |
| IP2-036 | 036 - Create automatic swap-over to recirculation cooling upon RWST depletion. | 89,266 | 187,927 | 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. | 8,091 | 17,033 | 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. | 24,450 | 51,474 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 482,430 | 1,015,643 | 482,430 | 1,015,643 | 2,000,000 | n/a | Not Beneficial |
| IP2-041 | 041 - Install a digital feed water upgrade. | 162,795 | 342,726 | n/a | n/a | 900,000 | n/a | Not Beneficial |
| IP2-042 | 042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 8,180 | 17,221 | n/a | n/a | 214,000 | n/a | Not Beneficial |
| IP2-043 | 043 - Add a motor-driven feed water pump. | 162,795 | 342,726 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-044 | 044 - Use fire water system as backup for steam generator inventory. | 2,121,496 | 4,466,307 | 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. | 594,187 | 1,250,921 | 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. | 56,902 | 119,795 | n/a | n/a | 615,000 | n/a | Not Beneficial |
| IP2-049 | 049 - Install motor generator set trip breakers in control room. | 24,361 | 51,287 | n/a | n/a | 716,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 24,361 | 51,287 | 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. | 286,204 | 602,535 | 384,362 | 809,183 | 1,100,000 | n/a | Not Beneficial |
| IP2-053 | 053 - Keep both pressurizer PORV block valves open. | 586,097 | 1,233,888 | n/a | n/a | 800,000 | 1,471,234 | Not Beneficial |
| IP2-054 | 054 - Install flood alarm in the 480V switchgear room. | 4,970,116 | 10,463,401 | 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. | 40,543 | 85,353 | n/a | n/a | 82,000 | 1,704,938 | Not Beneficial |
| IP2-057 | 057 - Provide DC power backup for the PORVs. | 40,721 | 85,728 | 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. | 16,271 | 34,254 | n/a | n/a | 318,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 1,128,101 | 2,374,949 | 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. | 2,468,698 | 5,197,259 | 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. | 768,367 | 1,617,616 | 841,986 | 1,772,601 | 1,500,000 | 1,662,692 | Retained |
| IP2-063 | 063 - Provide a water-tight door for additional protection of the RHR pumps against flooding. | 32,452 | 68,320 | n/a | n/a | 324,000 | n/a | Not Beneficial |
| IP2-064 | 064 - Provide backup cooling water source for the CCW heat exchangers. | 32,452 | 68,320 | 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. | 4,970,116 | 10,463,401 | 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. | 2,350,429 | 4,948,273 | 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. | 8,091 | 17,033 | n/a | n/a | 576,000 | n/a | Not Beneficial |
| IP2-068 | 068 - Provide independent source of cooling for the recirculation pump motors. | 8,091 | 17,033 | n/a | n/a | 710,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 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. | 224,728 | 325,693 | 236,610 | 342,913 | 1,137,000 | n/a | Not Beneficial |
| IP3-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 129,929 | 188,302 | 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. | 118,693 | 172,019 | n/a | n/a | 565,000 | n/a | Not Beneficial |
| IP3-005 | 005 - Install a filtered containment vent to provide fission product scrubbing. | 1,318,929 | 1,911,491 | 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. | 4,491,488 | 6,509,402 | n/a | n/a | 108,000,000 | n/a | Not Beneficial |
| IP3-007 | 007 - Create a reactor cavity flooding system. | 4,491,488 | 6,509,402 | n/a | n/a | 4,100,000 | 1,874,933 | Retained |
| IP3-008 | 008 - Create a core melt source reduction system. | 4,491,488 | 6,509,402 | n/a | n/a | 90,000,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 2,115,039 | 3,065,274 | 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. | 772,346 | 1,119,342 | 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. | 4,372,665 | 6,337,196 | 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. | 1,093,166 | 1,584,299 | 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. | 1,235,365 | 1,790,384 | 1,294,776 | 1,876,487 | 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. | 12,641,412 | 18,320,887 | n/a | n/a | 100,000,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 2,839,856 | 4,115,733 | 9,612,734 | 13,931,498 | 12,000,000 | 35,691,159 | Not Beneficial |
| IP3-019 | 019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 2,007,840 | 2,909,913 | 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. | 974,215 | 1,411,905 | n/a | n/a | 4,000,000 | n/a | Not Beneficial |
| IP3-021 | 021 - Increase leak testing of valves in ISLOCA paths. | 974,215 | 1,411,905 | n/a | n/a | 10,604,000 | n/a | Not Beneficial |
| IP3-022 | 022 - Ensure all ISLOCA releases are scrubbed. | 2,007,840 | 2,909,913 | 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. | 35,259 | 51,100 | n/a | n/a | 1,875,000 | n/a | Not Beneficial |
| IP3-025 | 025 - Use fuel cells instead of lead-acid batteries. | 35,259 | 51,100 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-026 | 026 - Increase/ improve DC bus load shedding. | 35,259 | 51,100 | n/a | n/a | 460,000 | n/a | Not Beneficial |
| IP3-027 | 027 - Create AC power cross-tie capability with other unit. | 70,647 | 102,387 | 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). | 11,753 | 17,033 | n/a | n/a | 1,700,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 11,753 | 17,033 | n/a | n/a | 497,000 | n/a | Not Beneficial |
| IP3-030 | 030 - Provide a portable diesel-driven battery charger. | 201,481 | 292,001 | 284,656 | 412,546 | 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. | 106,940 | 154,986 | n/a | n/a | 1,254,000 | n/a | Not Beneficial |
| IP3-032 | 032 - Provide capability for diesel-driven, low pressure vessel makeup. | 11,882 | 17,221 | n/a | n/a | 632,000 | n/a | Not Beneficial |
| IP3-033 | 033 - Provide an additional high pressure injection pump with independent diesel. | 59,282 | 85,916 | n/a | n/a | 5,000,000 | n/a | Not Beneficial |
| IP3-034 | 034 - Create automatic swap-over to recirculation upon RWST depletion. | 519,844 | 753,397 | n/a | n/a | 1,000,000 | n/a | Not Beneficial |
| IP3-035 | 035 - Provide capability for alternate injection via diesel-driven fire pump. | 11,882 | 17,221 | 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. | 11,753 | 17,033 | 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. | 59,282 | 85,916 | n/a | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-038 | 038 - Create/enhance a reactor coolant depressurization system. | 237,516 | 344,225 | n/a | n/a | 4,600,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 247,716 | 359,009 | n/a | n/a | 900,000 | n/a | Not Beneficial |
| IP3-040 | 040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 166,222 | 240,902 | 237,516 | 344,225 | 950,000 | n/a | Not Beneficial |
| IP3-041 | 041 - Add a motor-driven feedwater pump. | 247,716 | 359,009 | 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. | 35,259 | 51,100 | n/a | n/a | 1,072,000 | n/a | Not Beneficial |
| IP3-043 | 043 - Use fire water system as backup for steam generator inventory. | 379,197 | 549,561 | 438,608 | 635,664 | 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. | 1,128,166 | 1,635,024 | 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. | 200,446 | 290,501 | n/a | n/a | 615,000 | n/a | Not Beneficial |
| IP3-047 | 047 - Install motor generator set trip breakers in control room. | 35,388 | 51,287 | 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. | 35,388 | 51,287 | n/a | n/a | 90,000 | n/a | Not Beneficial |

**Table 12 – Case 7 Sensitivity SAMA Results[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. | 2,161,921 | 3,133,219 | n/a | n/a | 9,671,000 | n/a | Not Beneficial |
| IP3-051 | 051 - Operator action: Align main feedwater for secondary heat removal. | 11,753 | 17,033 | n/a | n/a | 55,000 | n/a | Not Beneficial |
| IP3-052 | 052 - Open city water supply valve for alternative AFW pump suction. | 249,398 | 361,446 | 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. | 415,620 | 602,348 | 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). | 3,657,273 | 5,300,396 | 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. | 35,259 | 51,100 | n/a | n/a | 982,000 | n/a | Not Beneficial |
| IP3-057 | 057 - Provide backup cooling water source for the CCW heat exchangers. | 47,141 | 68,320 | n/a | n/a | 109,000 | n/a | Not Beneficial |
| IP3-058 | 058 - Provide automatic DC power backup. | 94,282 | 136,640 | 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 12 – Case 7 Sensitivity SAMA Results[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. | 3,859,142 | 5,592,959 | n/a | n/a | 560,000 | 2,282,668 | Retained |
| IP3-062 | 062 - Install flood alarm in the 480 VAC switchgear room. | 3,859,142 | 5,592,959 | 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. | 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.
lavender highlight = SAMAs evaluated for TI-SGTR.
red text = SAMAs with NL-14-143 estimated costs.

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 407,477 | 407,477 | 1,137,000 | n/a | Not Beneficial |
| IP2-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 342,216 | 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. | 40,543 | 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. | 105,892 | n/a | 565,000 | n/a | Not Beneficial |
| IP2-006 | 006 - Add a diesel building high temperature alarm. | 24,361 | 65,260 | 274,000 | n/a | Not Beneficial |
| IP2-007 | 007 - Install a filtered containment vent to provide fission product scrubbing. | 1,750,478 | 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. | 8,098,006 | n/a | 108,000,000 | n/a | Not Beneficial |
| IP2-009 | 009 - Create a reactor cavity flooding system. | 8,098,006 | n/a | 4,100,000 | 1,741,724 | Retained |
| IP2-010 | 010 - Create a core melt source reduction system. | 8,098,006 | n/a | 90,000,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 4,629,769 | 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. | 1,194,251 | 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. | 8,114,366 | 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. | 2,993,808 | 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. | 106,337 | 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. | 10,011,635 | n/a | 100,000,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 981,577 | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-021 | 021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 3,778,892 | n/a | 3,200,000 | 4,632,227 | Not Beneficial |
| IP2-022 | 022 - Add redundant and diverse limit switches to each containment isolation valve. | 1,889,446 | n/a | 2,200,000 | 7,692,784 | Not Beneficial |
| IP2-023 | 023 - Increase leak testing of valves in ISLOCA paths. | 1,889,446 | n/a | 7,964,000 | n/a | Not Beneficial |
| IP2-024 | 024 - Ensure all ISLOCA releases are scrubbed. | 3,778,892 | n/a | 9,700,000 | n/a | Not Beneficial |
| IP2-025 | 025 - Improve MSIV design. | 171,776 | 319,012 | 476,000 | n/a | Not Beneficial |
| IP2-026 | 026 - Provide additional DC battery capacity. | 40,543 | n/a | 1,875,000 | n/a | Not Beneficial |
| IP2-027 | 027 - Use fuel cells instead of lead-acid batteries. | 40,543 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-028 | 028 - Provide a portable diesel-driven battery charger. | 1,643,339 | n/a | 938,000 | 2,154,767 | Not Beneficial |
| IP2-029 | 029 - Increase/ improve DC bus load shedding. | 40,543 | 81,442 | 460,000 | n/a | Not Beneficial |
| IP2-030 | 030 - Create AC power cross-tie capability with other unit. | 56,813 | n/a | 1,156,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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). | 32,452 | n/a | 1,700,000 | n/a | Not Beneficial |
| IP2-032 | 032 - Use fire protection system as a backup source for diesel cooling. | 32,452 | 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. | 73,529 | n/a | 5,000,000 | n/a | Not Beneficial |
| IP2-036 | 036 - Create automatic swap-over to recirculation cooling upon RWST depletion. | 130,165 | 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. | 8,091 | n/a | 82,000 | n/a | Not Beneficial |
| IP2-039 | 039 - Replace two of three motor-driven SI pumps with diesel-powered pumps. | 73,529 | n/a | 2,000,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 695,105 | 736,004 | 2,000,000 | n/a | Not Beneficial |
| IP2-041 | 041 - Install a digital feed water upgrade. | 170,975 | n/a | 900,000 | n/a | Not Beneficial |
| IP2-042 | 042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 8,180 | n/a | 214,000 | n/a | Not Beneficial |
| IP2-043 | 043 - Add a motor-driven feed water pump. | 170,975 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP2-044 | 044 - Use fire water system as backup for steam generator inventory. | 2,767,700 | 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. | 725,064 | 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. | 97,801 | n/a | 615,000 | n/a | Not Beneficial |
| IP2-049 | 049 - Install motor generator set trip breakers in control room. | 24,361 | n/a | 716,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 24,361 | 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. | 515,239 | 727,914 | 1,100,000 | n/a | Not Beneficial |
| IP2-053 | 053 - Keep both pressurizer PORV block valves open. | 716,974 | n/a | 800,000 | 1,471,234 | Not Beneficial |
| IP2-054 | 054 - Install flood alarm in the 480V switchgear room. | 6,957,808 | 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. | 40,543 | n/a | 82,000 | 1,704,938 | Not Beneficial |
| IP2-057 | 057 - Provide DC power backup for the PORVs. | 89,800 | 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. | 16,271 | n/a | 318,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 1,561,630 | 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. | 3,417,556 | n/a | 192,000 | 943,792 | Retained |
| IP2-062 | 062 - Provide a hard-wired connection to an SI pump from ASSS power supply. | 1,071,020 | **1,226,436** | 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. | 32,452 | n/a | 324,000 | n/a | Not Beneficial |
| IP2-064 | 064 - Provide backup cooling water source for the CCW heat exchangers. | 32,452 | n/a | 710,000 | n/a | Not Beneficial |
| IP2-065 | 065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling. | 6,957,808 | 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. | 2,824,858 | 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. | 8,091 | n/a | 576,000 | n/a | Not Beneficial |
| IP2-068 | 068 - Provide independent source of cooling for the recirculation pump motors. | 8,091 | n/a | 710,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 296,021 | 296,021 | 1,137,000 | n/a | Not Beneficial |
| IP3-002 | 002 - Create an independent RCP seal injection system without a dedicated diesel. | 201,222 | 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. | 130,575 | n/a | 565,000 | n/a | Not Beneficial |
| IP3-005 | 005 - Install a filtered containment vent to provide fission product scrubbing. | 1,568,456 | 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. | 6,357,000 | n/a | 108,000,000 | n/a | Not Beneficial |
| IP3-007 | 007 - Create a reactor cavity flooding system. | 6,357,000 | n/a | 4,100,000 | 1,874,933 | Retained |
| IP3-008 | 008 - Create a core melt source reduction system. | 6,357,000 | n/a | 90,000,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 3,422,086 | 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. | 903,050 | 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. | 6,428,293 | 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. | 1,913,041 | 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. | 1,675,008 | 1,734,419 | 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. | 23,323,548 | n/a | 100,000,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 5,145,011 | 18,037,244 | 12,000,000 | 35,691,159 | Not Beneficial |
| IP3-019 | 019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs. | 3,790,177 | n/a | 2,800,000 | 6,369,223 | Not Beneficial |
| IP3-020 | 020 - Add redundant and diverse limit switches to each containment isolation valve. | 1,924,794 | n/a | 4,000,000 | n/a | Not Beneficial |
| IP3-021 | 021 - Increase leak testing of valves in ISLOCA paths. | 1,924,794 | n/a | 10,604,000 | n/a | Not Beneficial |
| IP3-022 | 022 - Ensure all ISLOCA releases are scrubbed. | 3,790,177 | 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. | 47,141 | n/a | 1,875,000 | n/a | Not Beneficial |
| IP3-025 | 025 - Use fuel cells instead of lead-acid batteries. | 47,141 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-026 | 026 - Increase/ improve DC bus load shedding. | 47,141 | n/a | 460,000 | n/a | Not Beneficial |
| IP3-027 | 027 - Create AC power cross-tie capability with other unit. | 70,647 | n/a | 1,156,000 | n/a | Not Beneficial |
| IP3-028 | 028 - Create a backup source for diesel cooling (not from existing system). | 11,753 | n/a | 1,700,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 11,753 | n/a | 497,000 | n/a | Not Beneficial |
| IP3-030 | 030 - Provide a portable diesel-driven battery charger. | 272,774 | 403,479 | 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. | 118,822 | n/a | 1,254,000 | n/a | Not Beneficial |
| IP3-032 | 032 - Provide capability for diesel-driven, low pressure vessel makeup. | 23,764 | n/a | 632,000 | n/a | Not Beneficial |
| IP3-033 | 033 - Provide an additional high pressure injection pump with independent diesel. | 118,693 | n/a | 5,000,000 | n/a | Not Beneficial |
| IP3-034 | 034 - Create automatic swap-over to recirculation upon RWST depletion. | 591,137 | n/a | 1,000,000 | n/a | Not Beneficial |
| IP3-035 | 035 - Provide capability for alternate injection via diesel-driven fire pump. | 23,764 | 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. | 11,753 | n/a | 82,000 | n/a | Not Beneficial |
| IP3-037 | 037 - Replace two of three motor-driven SI pumps with diesel-powered pumps. | 118,693 | n/a | 2,000,000 | n/a | Not Beneficial |
| IP3-038 | 038 - Create/enhance a reactor coolant depressurization system. | 308,809 | n/a | 4,600,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 319,010 | n/a | 900,000 | n/a | Not Beneficial |
| IP3-040 | 040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves. | 296,927 | 296,927 | 950,000 | n/a | Not Beneficial |
| IP3-041 | 041 - Add a motor-driven feedwater pump. | 319,010 | 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. | 47,141 | n/a | 1,072,000 | n/a | Not Beneficial |
| IP3-043 | 043 - Use fire water system as backup for steam generator inventory. | 509,902 | 569,313 | 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. | 1,508,398 | 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. | 271,739 | n/a | 615,000 | n/a | Not Beneficial |
| IP3-047 | 047 - Install motor generator set trip breakers in control room. | 35,388 | n/a | 716,000 | n/a | Not Beneficial |
| IP3-048 | 048 - Provide capability to remove power from the bus powering the control rods. | 35,388 | n/a | 90,000 | n/a | Not Beneficial |

**Table 13 – Case 8 Sensitivity SAMA Results[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. | 2,922,385 | n/a | 9,671,000 | n/a | Not Beneficial |
| IP3-051 | 051 - Operator action: Align main feedwater for secondary heat removal. | 23,635 | n/a | 55,000 | n/a | Not Beneficial |
| IP3-052 | 052 - Open city water supply valve for alternative AFW pump suction. | 320,691 | n/a | 50,000 | 138,378 | Retained |
| IP3-053 | 053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions. | 593,853 | 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). | 5,083,142 | n/a | 1,288,000 | 1,601,888 | Retained |
| IP3-056 | 056 - Install pneumatic controls and indication for the turbine-driven AFW pump. | 47,141 | n/a | 982,000 | n/a | Not Beneficial |
| IP3-057 | 057 - Provide backup cooling water source for the CCW heat exchangers. | 59,023 | n/a | 109,000 | n/a | Not Beneficial |
| IP3-058 | 058 - Provide automatic DC power backup. | 94,282 | 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 13 – Case 8 Sensitivity SAMA Results[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. | 5,415,716 | n/a | 560,000 | 2,282,668 | Retained |
| IP3-062 | 062 - Install flood alarm in the 480 VAC switchgear room. | 5,415,716 | 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.
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.xlsx | IP2 and IP3 | 11/26/16 | 3:41PM | Case 0 spreadsheet to confirm that the benefit results of IP-RPT-09-00044 can be reproduced. |
| Case 4 IPEC SAMA Sensitivities.xlsx | IP2 and IP3 | 12/3/16 | 9:18AM | Case 4 spreadsheet to evaluate escalated VALWNF and VNFRM and support response to RAI #1. |
| Case 5 IPEC SAMA Sensitivities.xlsx | IP2 and IP3 | 12/23/16 | 11:25AM | Case 5 spreadsheet to evaluate increased TIMDEC and CDNFRM and support response to RAI #2.a. |
| Case 7 IPEC SAMA Sensitivities.xlsx | IP2 and IP3 | 12/3/16 | 10:32AM | Case 7 spreadsheet to evaluate escalated VALWNF and VNFRM and revised VDEPOS. |
| Case 8 IPEC SAMA Sensitivities.xlsx | IP2 and IP3 | 12/23/16 | 11:33AM | Case 8 spreadsheet to evaluate increased TIMDEC and CDNFRM with revised VDEPOS. |

| Entergy | Engineering Report<br>Technical Review Comments and Resolutions Form | | |
|---|---|---|---|
| Engineering Report Number | IP-RPT-16-00078 | Rev. 0 | Indian Point RAI CLI-16-07 SAMA Cost-Benefit Sensitivities |
| **Quality Related:** ☐ Yes ☒ No | | **Special Notes or Instructions:** | |

| Comment Number | Section/ Page No. | Review Comment | Response/Resolution | Preparer's Accept Initials |
|---|---|---|---|---|
| 1 | 2.a, page 4 | It states $100k is the maximum CDNFRM value. However, the range for Indian Point is $71,255 to $112,856 (CLI-12-07 page 37). How is it the maximum if it is middle of the site range? Is it the maximum the MACCS code permits? I believe this is correct treatment and it may be more a comment on the CLI-12-07 report or RAI itself. | $100k is the maximum the MACCS2 code permits. The range in the order is merely a range of values proposed by the intervener in the license renewal legal proceeding for Indian Point. | AJS 12/12/16 |
| 2 | 3. page 4 | Consider defining Population Dose Risk (PDR) and an Offsite Economic Cost Risk (OECR) acronyms. They are spelled out in the RAI text and used later but never formally defined. | Yes, I did this just before Table 2, which is the first place I used the acronyms that wasn't in the text directly from the NRC RAI. | AJS 12/12/16 |
| 3 | Table 1 | Does table need units ($)? Most other tables list units (p-rem, p-rem/yr, $/yr) but this table does not denote that it is dollars ($) for the listed values.4 | Units added. | AJS 12/12/16 |
| 4 | Page 6 – below table 1 | It states the OECR increase of 9-10%. This information is in Reference 4 tables A-1A/1B but it is not clear how to get these numbers from the content of this report as stated "as shown in Table 2 and Table 3" | Reworded all similar sentences. | AJS 12/12/16 |
| 5 | Table 6 | It states and shows the SAMAs that appear potentially cost beneficial. Is it worth showing the details on the ones that are not? | In Section 6 of the report, I inserted the full results (all SAMAs) for each of the sensitivity cases. In Table 6 and Table 11, I left just the new potentially cost-beneficial SAMAs since I believe that is all we want to tell the NRC. I reworded the intros to Tables 6 and 11 accordingly. | AJS 12/12/16 |

| Entergy | Engineering Report<br>Technical Review Comments and Resolutions Form | | |
|---|---|---|---|
| Engineering Report Number | IP-RPT-16-00078 | Rev. 0 | Indian Point RAI CLI-16-07 SAMA Cost-Benefit Sensitivities |
| **Quality Related:** ☐ Yes ☒ No | | **Special Notes or Instructions:** | |

| Comment Number | Section/ Page No. | Review Comment | Response/Resolution | Preparer's Accept Initials |
|---|---|---|---|---|
| 6 | Page 15 and table 11 | Basically same as last comment. The wording states that *As shown in Table 11, when the TIMDEC and CDNFRM values are increased to the maximum MACCS2 allowed values as stipulated in the RAI, with the alternative revised baseline, none of the SAMA benefits are higher than the existing implementation cost estimate.*<br><br>The table only shows 4 SAMAs – only the ones relevant to the next paragraph. Is it worth showing the details of the ones that are not cost beneficial? If not consider rewording the text. | See response to comment 5. | AJS 12/12/16 |
| | | | | |

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|---|---|---|---|---|---|---|
| Verified/Reviewed By: | Andrew Spotts | | Date | 12/07/16 | Resolved By: | Lori Ann Potts |
| Site/Department: | Entergy/PSA | Ph. 281.788.0583 | | | Date: 12/11/2016 | |