Regulatory Analysis and Backfitting for the Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

Division of Policy and Rulemaking

ABSTRACT

The SECY paper titled, “Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containment Designs,” addresses the concerns with containment venting systems for boiling water reactors with either Mark I or Mark II containment designs.

This report presents the regulatory analysis for the SECY paper. It includes (1) a summary of the issue, (2) a summary of the technical findings, (3) the proposed technical solution, (4) alternative resolutions considered by the Nuclear Regulatory Commission (NRC), (5) an assessment of the benefits and costs of the alternatives considered, and (6) the decision rationale.

Based on this evaluation, the NRC staff concludes that boiling water reactors with Mark I and Mark II containment designs should install filtered Severe Accident Capable Vents .

The backfit analysis provided in Appendix B, “Backfitting”, shows that filtered vents are a cost-justified substantial safety enhancement under 10 CFR 50.109(a)(3).

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ABWR	Advanced Boiling Water Reactor
BWR	Boiling Water Reactor
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CPI	Containment Performance Improvements
CPI-U	Consumer-Price Index for all Urban Consumers
EPA	U.S. Environmental Protection Agency
FTE	Full-Time Equivalent
ICRP	International Commission on Radiation Protection
ISAP	Integrated Safety Assessment Program
MACCS2	MELCOR Accident Consequence Code System
NRC	Nuclear Regulatory Commission
NTTF	Near-Term Task Force
OMB	Office of Management and Budget
PPA	Purchase Power Agreement
PRA	Probabilistic Risk Assessment
PWR	Pressurized Water Reactor
RA	Regulatory Analyses
SPAR	Standardized Plant Analysis Risk
SRM	Staff Requirements Memorandum
TMI-2	Three Mile Island Unit 2
VSL	Value of Statistical Life
WENRA	Western European Nuclear Regulators' Association

EXECUTIVE SUMMARY

The accident at the Fukushima Dai-ichi nuclear facility in Japan highlighted the need for safety improvements for nuclear power plants related to beyond-design-basis natural hazards and resultant effects on plant systems and barriers from an extended loss of electrical power and access to heat removal systems. One of the actions taken by the U.S. Nuclear Regulatory Commission (NRC) staff was the issuance of Orders on March 12, 2012 requiring hardened containment vents to those licensees of boiling water reactor (BWR) facilities with Mark I and II containment designs. The hardened containment vents would address problems encountered during the Fukushima accident by providing plant operators with improved methods to vent containment during accident conditions and thereby prevent containment overpressurization. Additionally, the NRC staff identified in SECY-11-0137 an additional issue related to possible upgrading of the containment vents, including the addition of engineered to improve reliability and limit the release of radioactive materials should the venting systems be used after significant core damage had occurred.

This regulatory analysis addresses the possible upgrading of the containment vents by considering four alternatives.

The first alternative is the “no action” alternative. The staff would continue with the implementation of Order EA 12-050 for reliable hardened vents to reduce the likelihood of core damage and failure of BWR Mark I and Mark II containments and take no additional action to improve their ability to operate under severe accident conditions or to require the installation of an engineered filtered vent system. This alternative is equivalent to the status quo and serves as a baseline to measure against the other alternatives and is assumed to have a certain level of risk and consequence that is above zero.

The second alternative would require installing severe accident capable vents without filters through orders. This would entail upgrading or replacing the reliable hardened vents required by EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions. This alternative has two sub-alternatives. The first sub-alternative requires all Mark I containments to install severe accident capable vents in the wetwell to control hydrogen and pressure under severe accident conditions and maintain a vent path that includes suppression pool scrubbing of releases to reduce the amount of radioactive material released to the environment during venting. The second sub-alternative would require installing severe accident capable vents and a corium shield for vulnerable containment sumps and downcomers in Mark II containments. These design features would address the postulated consequences that would result should the molten core breach the reactor vessel in a Mark II containment during a severe accident, as the molten core could potentially fail drain lines and downcomer pipes, opening holes between the drywell and suppression chamber atmosphere. Without the pool scrubbing effects to reduce the airborne radioactive material, the benefits of severe accident capable vents would not be achieved.

The third alternative would require installing severe accident capable vents with engineered filters for Mark I and Mark II reactors through orders. This would entail designing and installing an engineered filtered containment venting system to prevent the release of significant amounts of radioactive material following the dominant severe accident sequences at BWRs with Mark I and Mark II containments. These filtered severe accident vents are capable of filtering the vent flow stream from either the drywell or the wetwell.

The fourth alternative involves the establishment of a severe accident confinement

strategy. This would entail pursuing development of requirements, technical acceptance criteria and methods for demonstrating compliance. Licensees would be required to justify the effectiveness and reliability of operator actions and systems, (such as suppression pools, containment sprays, and separate filters) relied upon to accomplish the intended function and meet the requirements. As an interim measure, the NRC may require licensees for Mark I and Mark II containments to install severe accident capable vents to achieve some near-term benefits. For the regulatory analysis of the severe accident confinement strategy, as there is so little hard information on the specifics of this approach , the NRC staff assumed an approach that in the final determination may not achieve the required performance The NRC staff assumes that for this alternative, Mark I and Mark II containments nuclear power plant licensees would install severe accident capable vents and perform Level 2 probabilistic risk assessments (PRA) . The NRC staff also assumed if the licensees pursued this approach that the benefits achieved by this severe accident confinement strategy would be equivalent to the filtered vent alternative, although incurred in a later year.

As a result, it is important to note that the certain assumptions in the provided regulatory analysis for the severe accident confinement strategy are highly speculative. There are significant unknowns in relation to costs and benefits. The costs are sensitive to the amount of plant analysis and site-specific work that would be required as well as development and demonstration of costs for an as yet unspecified approach. Similarly, the benefits are sensitive to both the effectiveness of the strategy, as well as the timing of implementation. A separate regulatory analysis for the severe accident confinement strategy would be performed in the event that new requirements developed under this alternative result in rulemaking.

This regulatory analysis follows the methodology outlined within NUREG/BR-0058, Revision 4, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” dated September 2004, and NUREG/BR-0184, “Regulatory Analysis Technical Evaluation Handbook,” dated January 1997. The regulatory analysis identifies all attributes related to the regulatory action and analyzes them either quantitatively or qualitatively.

For the quantified regulatory analysis, the staff develops expected values for each cost and benefit taking into account the probabilities and consequences for each cost and benefit, including the year the cost or benefit is incurred. The NRC staff discounts the consequences in future years to the current year of the regulatory action. Finally, the staff sums the costs and the benefits for each alternative and compares them.

After performing a quantitative regulatory analysis, the staff will assess attributes that could only be qualified. Based on the qualification of each attribute, uncertainties, sensitivities, and the quantified costs and benefits, the staff will determine whether the alternative is cost-beneficial for each alternative. If the benefits, both quantified and qualified, are judged to be less than the quantified and qualified costs, then the NRC staff will recommend the alternative should not be implemented. If multiple alternatives are cost-beneficial, then the alternative with the greatest net benefit is recommended.

Sensitivity analysis was used to evaluate the impact of key assumptions on the results. Sensitivities analyzed include: the core damage frequency based on the Standardized Plant Analysis Risk models, the dollar per person-rem conversion value based on NUREG-1530 published values, and occupational worker radiation dose and onsite property costs based on NUREG/BR-0184 published values. The mean value for the averted public health dose and the offsite property damage calculated using the MELCOR Accident Consequence Code System (MACCS2) were assigned as best estimates and the 5^{th} and 95^{th} percentile results were used as

the low and high estimate, respectively.

Based on these analyses, the NRC determined that the quantitative analysis results are very sensitive to the assumptions made, the best estimate input values used, and the many uncertainties contained within those inputs. Therefore, based on the uncertainties related to the quantitative analysis, the appropriate level of consideration was given to the qualitative analysis.

Summary of the estimates for each of the analyzed alternatives is provided in the table below.

Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe accident capable vents for Mark I Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$72 to $95	$72 to $95	$72 to $95
Benefits	$0.093 to $0.11 + B_Q	$18 to $22 + B_Q	$66 to $83 + B_Q
Net benefits (benefits – costs)	($95) to ($72) + B_Q	($77) to ($50) + B_Q	($29) to $11 + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

As the table above shows, the qualitative benefits are included into the total benefits for the severe accident capable vents for Mark I containments. For the best estimate, if the qualified benefits, B_Q are conceptually valued at or greater than $77 million, then the alternative would be cost-beneficial. Similarly this methodology to determine whether an alternative is cost-beneficial can be used for other estimates presented.

The qualitative benefits for the severe accident capable vents for Mark I containments come from regulatory efficiency, defense-in-depth, reduction of uncertainties, and improved hydrogen control.[1] The regulatory efficiency benefit is from resolving the deficiencies of the Mark I containments relative to other containment designs. The defense-in-depth and uncertainties benefit relate to the core damage frequency, the decontamination factor achieved through scrubbing within the wetwell, the reduction of radionuclide releases to the public and the environment, and the effectiveness of emergency planning in the event of a severe accident. The NRC staff has reviewed the quantified and qualified costs and benefits of severe accident capable vents for Mark I containments and has deemed them to be cost-beneficial.

[1] There are minor differences in the labeling and discussion of the qualitative benefits and costs for each option between those contained within the regulatory analysis and the other sections of the SECY paper. These differences are nonsubstantive and do not result in any changes that are of substance in the SECY paper or its attachments.

Summary of Estimates of Present Value Benefits, Costs, and Net Benefits of Severe Accident Capable Vents for Mark II Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$52 to $110	$52 to $110	$52 to $110
Benefits	$0.032 to $0.040 + B_Q	$6.2 to $7.5 + B_Q	$24 to $29 + B_Q
Net benefits (benefits – costs)	($110) to ($52) + B_Q	($100) to ($45) + B_Q	($86) to ($23) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.
b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

As the table above shows for the best estimate, the highest cost and the lowest quantified benefit at 3 percent net present value provides a net value of negative $100 million; therefore, if the qualified benefits are conceptually valued at or greater than $100 million, then the alternative would be cost-beneficial. The same analysis is true at 7 percent net present value.

The qualitative benefits for the severe accident capable vents for Mark II containments come from regulatory efficiency, defense-in-depth, uncertainties, and hydrogen control. The regulatory efficiency deals with resolving the deficiencies of the Mark II containments relative to other containment designs. The defense-in-depth and uncertainties benefits are the same as for the Mark I containments. The NRC staff has reviewed the quantified and qualified costs and benefits of severe accident capable vents for Mark II containments and has deemed them to be cost-beneficial.

Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Filtered Vents at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$520 to $670	$520 to $670	$520 to $670
Benefits	$0.68 to $36 + B_Q	$42 to $87 + B_Q	$160 to $230 + B_Q
Net benefits (benefits – costs)	($670) to ($480) + B_Q	($630) to ($430) + B_Q	($510) to ($290) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.
b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

As the table above shows for the filtered vents best estimate, the highest cost and the lowest quantified benefit at 3 percent net present value provides a net value of negative $630 million; and, if the qualified benefits are conceptually valued at $630 million or greater, then the alternative would still be cost-beneficial. The same analysis is true at 7 percent net present value.

There are more qualitative benefits for filtered vents than for unfiltered severe accident capable vents. The qualitative benefits for the filtered vents are environmental considerations, regulatory efficiency, and other considerations, related to uncertainties, defense-in-depth, prevention, independence of barriers, emergency planning, and severe accident management system. Although the benefit may be greater, the justification for the regulatory efficiency,

uncertainty and defense-in-depth benefits are the same as for the severe accident capable vents. The environmental considerations relate to the radionuclide source term release that would occur while venting even though evacuation of the populace near the damaged reactor facility has already occurred. A more detailed discussion of the qualitative benefits of filtered vents are provided within the regulatory analysis contained within the body of this paper. The NRC staff has reviewed the quantified and qualified costs and benefits of filtered vents for Mark I and Mark II containments and has deemed them to be cost-beneficial.

Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of the Severe Accident Confinement Strategy at 3 percent net present value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	\$180 to \$260 + C_Q	\$180 to \$260 + C_Q	\$180 to \$260 + C_Q
Benefits	\$0.52 to \$25 + B_Q	\$45 to \$71 + B_Q	\$140 to \$200 + B_Q
Net benefits (benefits – costs)	(\$260) to (\$160) + B_Q – C_Q	(\$220) to (\$110) + B_Q – C_Q	(\$120) to \$20 + B_Q – C_Q

a Benefits are composed primarily of averted onsite and offsite property costs.
b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.
c Not all possible costs are quantified and monetized for this analysis. C_Q is the sum of all unquantified costs. Unquantified costs were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values. C_Q may be either positive or negative..

As the table above shows for the severe accident confinement strategy, the qualitative benefits are included in the total costs and benefits for the alternative. For the best estimate, the highest cost and the lowest quantified benefit at 3 percent net present value provides a net value of negative \$220 million. If the unqualified costs are at least \$410 million, then the total costs would be the same as the filtered vents alternative. However, if the unquantified benefits is at least \$220 million greater than the unquantified costs, then the alternative would be cost-beneficial. The same analysis is true at 7 percent net present value. Because of the large uncertainty in potential development, demonstration and implementation costs of an as yet unspecified approach, as well as the uncertainty in achievable benefits, the staff is not able to draw a cost/benefit conclusion regarding the severe accident confinement option.

As the severe accident capable vents and the filtered vents are both cost-beneficial, they then should be compared to each other. The filtered vents alternative provides a higher per unit cost, but also a higher per unit benefit, both quantitatively and qualitatively. As the filtered vents are a severe accident capable vent design and considering the qualitative analysis results and its uncertainties related to the inputs for the quantitative analysis, the NRC staff recommends implementing the cost-beneficial alternative, filtered vents based on the assignment of a high value to each of the qualitative benefits identified. A backfit analysis performed on these alternatives (located in Appendix B, “Backfitting” of this report) concluded that severe accident capable vents from Mark I and Mark II containments and filtered vents were both cost-justified substantial safety enhancements under 10 CFR 50.109(a)(3). However, for the same reasons given for the regulatory analysis, the NRC staff recommends backfitting Mark I and Mark II containments with severe accident capable vents with an engineered filter.

As there are many attributes and considerations that cannot be quantified, the attributes and considerations can only be compared to each of the alternatives relative to the status quo alternative. The alternatives are provided a rank of highest, middle, or lowest, for each

qualitative attribute or consideration. For those attributes or considerations that provide a disbenefit, they are ranked negatively from highest to lowest; therefore, within the regulatory efficiency attribute, the severe accident capable vents and the filtered vents provide the highest disbenefit and the severe accident confinement strategy provides the next highest disbenefit.

Summary Evaluation of Estimated Unquantified Attributes and Considerations

Attribute/Consideration	Severe Accident Capable Vents	Filtered Vents	Severe Accident Confinement Strategy
Environmental Considerations	Lowest	Highest	Middle
Regulatory Efficiency	(Highest)	(Highest)	(Middle)
Uncertainties	Lowest	Highest	Middle
Hydrogen Control	Middle	Middle	Middle
Defense in Depth	Lowest	Highest	Middle
Severe Accident Management	Lowest	Middle	Middle
Emergency Planning	Lowest	Highest	Middle
Independence of Barriers	Lowest	Highest	Middle
Severe Accident Policy Statement	(Highest)	(Highest)	(Highest)
External Events	Lowest	Middle	Middle
Multi-Unit Events	Lowest	Middle	Middle

The total relative unqualified benefit depends on the alternative. The highest relative unquantified benefit arises from the filtered vents alternative, the second highest alternative from the Severe Accident Confinement Strategy, and the smallest benefit from the severe accident capable vent.

The staff concludes that installation of engineered filtered venting systems for Mark I and Mark II containments is the alternative that would provide the most regulatory certainty and the timeliest implementation. The vast majority of Mark I and Mark II severe accident sequences would benefit from a containment vent, (whether the vent includes an engineered filter or not) and the addition of an engineered filter reduces the release of radioactive materials should a severe accident occur. A comparison of only the quantifiable costs and benefits of the proposed modifications, would not, by themselves, demonstrate that the benefits exceed the associated costs. However, when qualitative factors such as the importance of containment systems within the NRC's defense-in-depth philosophy are considered, a decision to require the installation of engineered filtered vent systems is justified.

REGULATORY ANALYSIS

1. Statement of the Problem and Objective

The accident at the Fukushima Dai-ichi nuclear facility in Japan highlighted the need for safety improvements for nuclear power plants related to beyond-design-basis natural hazards and resultant effects on plant systems and barriers from an extended loss of electrical power and access to heat removal systems. In SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011, the NRC staff described its proposals for the regulatory actions to be taken to address the recommendations of the Fukushima Near-Term Task Force (NTTF). One of the (Tier 1) actions taken by the NRC staff was the issuance of Orders requiring hardened containment vents to those licensees of boiling water reactor (BWR) facilities with Mark I and II containment designs. The hardened containment vents would address problems encountered during the Fukushima accident by providing plant operators with improved methods to vent containment during accident conditions and thereby prevent containment overpressurization. Orders requiring reliable hardened vents for BWR facilities with Mark I and II containment designs were issued on March 12, 2012. Additionally, the NRC staff identified in SECY-11-0137 an additional issue related to requiring filters on the containment vents in order to limit the release of radioactive materials should the venting systems be used after significant core damage had occurred.

In the staff requirements memorandum (SRM) for SECY-11-0137, dated December 15, 2011, the Commission directed the NRC staff as follows:

> The staff should quickly shift the issue of "Filtration of Containment Vents" from the "additional issues" category and merge it with the Tier 1 issue of hardened vents for Mark I and Mark II containments such that the analysis and interaction with stakeholders needed to inform a decision on whether filtered vents should be required can be performed concurrently with the development of the technical bases, acceptance criteria, and design expectations for reliable hardened vents.

In response to the SRM, the staff included plans to address the filtered venting issue for Mark I and II containments in SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami", dated February 17, 2012. The staff explained the proposed evaluations and need for timely consideration as follows:

> The staff has determined that some of the additional issues should be included in existing Tier 1 activities. In accordance with the direction in SRM-SECY-11-0137, the additional issue of filtration of containment vents was merged with the Tier 1 issue of hardened vents for Mark I and Mark II containments such that further analysis and interaction with stakeholders will inform whether filtered vents should be required. The staff has determined that consideration of severe accident conditions in the design and operation of the vent, the addition of filters to hardened reliable vents, and consideration of vents in areas other than primary containment, will be the topic of a policy paper to the Commission in July 2011.[2]

[2] The schedule for this paper was subsequently extended to November 30, 2012, in a memorandum dated August 6, 2012, "Staff Requirements – COMSECY-12-0014 – Revised Schedule and Plans for Japan Lessons- Learned."

> The staff believes that the requirements for hardened reliable vents in the proposed order (Enclosure 5) are important to ensure core and containment cooling, and that these requirements should be imposed before the staff completes its evaluation of the technical and policy issues associated with imposing additional requirements, as described above. In public meetings, the staff has encouraged licensees to consider the potential for the later addition of filters. However, the industry has stated that the addition of filters to hardened containment vents may require modifications to the vent design. In light of this, a consideration in the staff's proposal to issue the proposed order now is that the proposed order requires submission of integrated plans for implementing the requirements of the order by February 28, 2013, eight months after the staff plans to send the July 2012 policy paper to the Commission for consideration. As a result, licensees should have time to revise draft plans in response to any new Commission direction before the integrated implementation plans are due.

In SECY-12-0095, "Tier 3 Program Plans and 6-Month Status Update in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Subsequent Tsunami," dated July 13, 2012, the staff described the current course of action as follows:

> One of the six additional recommendations identified in SECY-11-0137, and further developed in SECY-12-0025, was consideration of additional performance requirements, including filters, for hardened containment vent systems for boiling-water reactor Mark I and Mark II containment designs. In SECY-12-0025, the staff explained that it needed to resolve technical and policy issues before regulatory action could be proposed that would require licensees to install filters, or change any other performance requirement, for hardened containment vent systems. The staff's recommendation on additional performance requirements for containment vents will be provided in a separate paper.

2. Identification and Preliminary Analysis of Alternative Approaches

The NRC has identified four alternatives for consideration.

2.1 Alternative 1 – Taking No Action

This alternative entails continuing with the implementation of Order EA 12-050 for reliable hardened vents to reduce the likelihood of core damage and failure of BWR Mark I and Mark II containments and take no additional action to improve their ability to operate under severe accident conditions or to require the installation of an engineered filtered vent system. This alternative is equivalent to the status quo and serves as a baseline to measure against the other alternatives and is assumed to have a certain level of risk and consequence that is above zero. This alternative assumes that there is the capability to provide water on the drywell floor based on 10 CFR 50.54(hh)(2) and EA-12-049, assisting in the prevention of liner melt-through. However, for the basis of this regulatory analysis, the status quo is set as the baseline and any change in risk or consequence as a result of the other alternatives is dispositioned within the alternatives.

2.2 Alternative 2 – Severe Accident Capable Vents

The second alternative would require installation of severe accident capable vents without filters through orders. This would entail upgrading or replacing the reliable hardened

vents required by EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions. The alternative has two sub-alternatives based on the containment designs. The sub-alternatives are not mutually exclusive and, thus, can both be implemented, if chosen.

2.2.1 Alternative 2a – Mark I Containments

The first sub-alternative would require all Mark I licensees to install severe accident capable vents to reduce the amount of radioactive material released to the environment.

2.2.2 Alternative 2b – Mark II Containments

The second sub-alternative would require all Mark II licensees to install severe accident capable vents and a corium shield for vulnerable containment sumps and downcomers. These design features would address the postulated consequences that would result should the molten core breach the reactor vessel in a Mark II containment during a severe accident, as the molten core would potentially fail drain lines and downcomer pipes, opening holes between the drywell and suppression chamber atmosphere. Without the pool scrubbing effects to reduce the airborne radioactive material, the benefits of severe accident capable vents would not be achieved. The benefits for the Mark II containments per unit would be the same as the Mark I containments; however, the costs would be higher per unit.

2.3 Alternative 3 – Filtered Vents

The third alternative would require installing severe accident capable vents with engineered filters for Mark I and Mark II reactors through orders. This would entail designing and installing an engineered filtered containment venting system that is intended to prevent the release of significant amounts of radioactive material following the dominant severe accident sequences at BWRs with Mark I and Mark II containments. These filtered severe accident vents are capable of filtering releases from either the drywell or the wetwell, and would trap radionuclides in the vent flow stream before being released to the environment. The filtering system and connections to the containment wetwell and drywell would need to be capable of operation during conditions associated with significant core damage, including breaching of the reactor vessel.

2.4 Alternative 4 – Severe Accident Confinement Strategy

The fourth alternative involves the establishment of a severe accident confinement strategy (e.g., defined decontamination factor or site-specific cost/benefit analysis). This would entail pursuing development of requirements and technical acceptance criteria for confinement strategies and requiring licensees to select and justify systems or combinations of systems such as suppression pools, containment sprays, or separate filters to accomplish the function and meet the performance criteria. In keeping with previous experience in developing performance-based requirements, the staff envisions that this option would be pursued through rulemaking. The rulemaking process will likely involve extensive interactions with stakeholders and require the development of detailed industry and regulatory guidance documents. As an interim measure, the NRC may require licensees for Mark I and Mark II containments to install severe accident capable vents to achieve some near-term benefits.

For the regulatory analysis of the severe accident confinement strategy, as there is so little hard information on the specifics of this approach , the NRC staff assumed an approach

that in the final determination may not achieve the required performance The NRC staff assumes that for this alternative, Mark I and Mark II containments nuclear power plant licensees would install severe accident capable vents and perform Level 2 probabilistic risk assessments (PRA) . The NRC staff also assumed if the licensees pursued this approach that the benefits achieved by this severe accident confinement strategy would be equivalent to the filtered vent alternative, although incurred in a later year.

As a result, it is important to note that the certain assumptions in the provided regulatory analysis for the severe accident confinement strategy are highly speculative. There are significant unknowns in relation to costs and benefits. The costs are sensitive to the amount of plant analysis and site-specific work that would be required as well as development and demonstration of costs for an as yet unspecified approach. Similarly, the benefits are sensitive to both the effectiveness of the strategy, as well as the timing of implementation. A separate regulatory analysis for the severe accident confinement strategy would be performed in the event that new requirements developed under this alternative result in rulemaking.

3. Estimation and Evaluation of Values and Impacts/Presentation of Results

For the following sections, summary tables are labeled and provided within the structure of the regulatory analysis. Other tables that provide more detail are numbered and are provided within Appendix C.

3.1 Methodology

The methodology for a regulatory analysis is specified by various guidance documents. The two documents that govern the NRC's voluntary regulatory analysis process are NUREG/BR-0058, Revision 4, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," dated September 2004 (RA Guidelines), and NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," dated January 1997 (RA Handbook). The regulatory analysis identifies all attributes related to the regulatory action and analyzes them either quantitatively or qualitatively. Therefore, there are minor differences in the labeling and discussion of the qualitative benefits and costs between those contained within the regulatory analysis and the other sections of the SECY paper. These differences are nonsubstantive and do not result in any changes that are of substance in the SECY paper or its attachments.

For the quantified regulatory analysis, the NRC staff develops expected values for each cost and benefit. The expected value is the product of the probability of the cost or benefit occurring and the consequences which would occur assuming the event actually happens. First for each alternative, the staff determines the probabilities and consequences for each cost and benefit, including the year the consequence is incurred. The NRC staff then discounts the consequences in future years to the current year of the regulatory action. Finally, the NRC staff sums the costs and the benefits for each alternative and compares them.

After performing a quantitative regulatory analysis, the NRC staff will add attributes that could only be qualified. Based on the qualification of each attribute, uncertainties, sensitivities, and the quantified costs and benefits, the staff will make a recommendation for each alternative. If the benefits, both quantified and qualified, are judged to be greater than the quantified and qualified costs, then the staff will recommend the alternative should be implemented. If the benefits, both quantified and qualified, are judged to be less than the quantified and qualified costs, then the staff will recommend the alternative should not be implemented.

For this regulatory analysis, the NRC staff is providing various sensitivities, known as frameworks. The current framework (CF), also known as the "base case", follows the guidance provided within the RA Guidelines and RA Handbook. Deviations from the current framework are labeled as such. For example, following all of the assumptions in the current framework except using $4,000 per person-rem instead of $2,000 per person-rem, the table may state, "CF ($4,000)" or "$4000 per person-rem".

3.2 Assumptions

3.2.1 Labor Costs

A year's worth of labor effort is known as a full-time equivalent (FTE). The NRC assumes that one FTE for Industry is worth $416,000 and the hourly wage for Industry is $200. The NRC assumes than one FTE for the NRC is $172,000 and the hourly wage is $119.

3.2.2 Present-worth Calculations

The present-worth calculations determine how much society would need to invest today to ensure that the designated dollar amount is available in a given year in the future. By using discount factors for the costs and benefits, it allows for future costs and benefits to be valued equally. Based on Office of Management and Budget (OMB) guidance Circular No. A-4, dated September 17, 2003, present-worth calculations are presented using both 3 percent and 7 percent real discount rates. Although the NRC is not bound to follow OMB guidance, the NRC has historically voluntarily complied with the present-worth calculations developed in OMB Circular No. A-4 and have stated such in RA Guidelines and RA Handbook.

3.2.3 Cost/Benefit Inflators

The consequences for occupational health (accident) and onsite property are estimated based on the values published in the RA Handbook. Within the RA Handbook, the information in relation to severe reactor accident consequences is provided in previous year dollars. Therefore, to evaluate the costs and benefits consistently, the consequences are inflated. The most common inflator is the Consumer-Price Index for all urban consumers (CPI-U), developed by the U.S. Department of Labor, Bureau of Labor Statistics. Using the CPI-U, the previous year dollars was converted to the year of expected implementation, 2012. The formula to determine the amount in 2012 dollars is $\frac{\mathrm{CPIU}_{2012}}{\mathrm{CPIU}_{\mathrm{Base\ Year}}} * \mathrm{Consequence}_{\mathrm{Base\ Year}} = \mathrm{Consequence}_{2012}$.

3.2.4 Core Damage Frequency

Based on the information provided in Enclosure 5 of this SECY paper, the NRC assumes that the "best estimate" core damage frequency (CDF) is 2×10^{-5} per reactor-year. A low and high estimate were provided using the 5th and 95th percentile, respectively.

3.2.5 Dollar per Person-Rem

Using the dollar value of the health detriment and a risk factor that establishes the nominal probability for stochastic health effects attributable to radiological exposure (fatal and non-fatal cancers and hereditary effects) provides a dollar per person-rem of $2,000, rounded to the nearest thousand, according to NUREG-1530, "Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy," dated December 1995.

The NRC currently assumes that the value of statistical life (VSL) is $3 million based on NUREG-1530, and a cancer risk factor of 7.0×10^{-4}, which is a reduction to the closest significant digit of a recommendation by the International Commission on Radiation Protection (ICRP) in Publication No. 60. Therefore, the dollar per person-rem is equal to $3 million times 7.0×10^{-4} rounded to the nearest thousand (due to uncertainties) or $2,000.

3.2.6 Replacement Energy Costs

Replacement energy costs are the costs for replacing the energy from the nuclear power plant due to a plant shutdown to install required equipment or due to an accident.[3] The NRC assumes that replacement energy costs would be averted only in a situation where there is successful venting without overpressurization and/or liner melt-through. Therefore, the probability of averting replacement energy costs is determined by multiplying the CDF by the probability of successful venting without resulting in either containment overpressurization and/or liner melt-through. The NRC assumes that for passive venting, both severe accident capable and filtered, that the probability of successful venting without resulting in either containment overpressurization and/or liner melt-through is 66.9 percent, which would be multiplied by the CDF.

The NRC assumes that licensees engage in Purchase Power Agreements (PPA) to economically purchase replacement power. A PPA is a legal contract between an electricity generator (licensee) and a power purchaser. The NRC assumes that a licensee will not be able to replace the power through other generation for 10 years and would, thus, have to buy power from the market. Although all licensees may not have PPAs, the licensee will still replace the lost energy any time that the nuclear power plant is not operating to meet its electrical power supply obligations. The NRC assumes that after 10 years other power sources will be developed, or the PPA will have expired, and, thus, other permanent sources will replace the lost energy.

For this regulatory analysis, the replacement energy costs are associated with multi-unit sites. The NRC assumes that a single Mark I or Mark II unit has the postulated accident unit, and the replacement energy cost benefit results from the other unit(s) at the site. Currently, there are 9 sites with 1 other unit and 1 site with 2 other units. Therefore, the NRC assumes that there are 11 potential boiling water reactor units that could be affected in relation to replacement energy costs modeling assumption due to an accident.

3.2.7 Occupational Worker Dose (Accident)

The NRC assumes in the “take no action” alternative (alternative 1) that the total occupational dose will be 14,000 person-rem, which is the high estimate on occupational dose following a severe reactor accident from the RA Handbook, which is based on the estimated number of occupational workers that would be used to mitigate and respond to the accident sequence analyzed. For the severe accident capable vents alternative (alternative 2), the NRC assumes that the middle range of occupational exposure within the RA Handbook applies, resulting in a total occupational worker dose of 3,300 person-rem. For the filtered vent alternative (alternative 3), the NRC assumes that the radiological exposure level would be similar to the occupational work exposure experienced following the Three Mile Island, Unit 2

[3] The replacement energy cost is only the cost to buy the energy for production on the market. Therefore, the cost would be the cost of buying the cheapest energy. The costs do not include transmission or distribution.

(TMI-2) accident, as shown in the RA Handbook, of 1,000 person-rem total.

To estimate long-term occupational worker dose following a severe reactor accident, the NRC assumes that occupational workers will be required to cleanup and refurbish or decommission the onsite property. The NRC assumes that the process will begin five years after the accident and will take seven years to complete. During those seven years, the NRC assumes that each occupational worker at the damaged reactor site will be exposed to 140 rem each year. During that time, the NRC assumes in the "no action" alternative (alternative 1) that the total occupational dose will be 30,000 person-rem, which is the high estimate of occupational dose from the RA Handbook, which is based on the number of occupational workers that would be required to cleanup, refurbish, or decommission the onsite property while maintaining post-accident radiation exposures as low as reasonably achievable. For the severe accident capable vents alternative (alternative 2), the NRC assumes that the middle range of occupational exposure within the RA Handbook applies, resulting in a total occupational worker dose of 20,000 person-rem. For the filtered vent alternative (alternative 3), the NRC estimates that the radiological exposure level would be similar to the occupational work exposure experienced following the TMI-2 accident and listed in the RA Handbook as 10,000 person-rem total.

3.2.8 Onsite Property

The attribute measures the expected monetary effects on onsite property, including replacement energy costs, decontamination, and refurbishment costs, from the proposed action. The NRC assumes that, based on the current regulatory framework, with insights from the Fukushima Dai-ichi accident, that onsite property would be affected radiologically in the following way. Using the RA Handbook, the NRC assumes that that the high estimate for onsite property costs of $2 billion (1993 dollars), or $3.2 billion (2012 dollars), is equivalent for the no action alternative (alternative 1). The NRC assumes the severe accident capable vent alternative (alternative 2) onsite property costs are $1.5 billion (1993 dollars), or $2.4 billion (2012 dollars), which is equivalent to the middle range in the RA Handbook. Finally, the NRC estimated the filtered vent alternative (alternative 3) onsite property costs are equivalent to the TMI-2 accident onsite property of $750 million (1981 dollars) listed in the RA Handbook, or $1.9 billion (2012 dollars).

3.3 Sensitivity Analysis

3.3.1 Present Value Calculations

Current trends in the marketplace have provided returns on investments well below the 3 percent and 7 percent discount rates, which OMB Circular No. A-4 is based. The NRC is providing a zero discount rate (e.g., undiscounted values) as a further sensitivity analyses. Historically, regulatory analyses have provided the undiscounted values for the costs and benefits for information purposes, but have not provided them as a sensitivity analysis. However, the NRC is reporting the undiscounted costs and benefits as part of the sensitivity analysis based on current market trends and future predictions.

3.3.2 Dollar per Person-Rem

The NRC is currently revising the dollar per person-rem averted conversion factor based on recent information regarding VSL. However, until the NRC completes the update and publishes the appropriate guidance documents, the NRC will perform sensitivity analysis to

estimate the impact on the calculated results when more current VSL and cancer risk factor are used. The NRC assumes the U.S. Environmental Protection Agency's (EPA) VSL as an interim value in the sensitivity analysis. The EPA's VSL was developed through a rigorous process, reviewing many published academic papers, and includes review from the Scientific Advisory Board, an independent review board.

The EPA's VSL in 2009 dollars is approximately $7.2 million.[4] The VSL is derived from "using a mixed effects model (random intercept with fixed effects for study characteristics), the authors regressed the VSL estimates on average income, probability of death, and several study design variables" (EPA, page 41). Therefore, using the CPI-U based inflator to adjust from 2009 dollars to 2012 dollars yields a VSL of approximately $7.7 million. As the ICRP has updated the mortality risk factor in ICRP Publication No. 103, the updated risk coefficient is 5×10^{-4}. Using the ICRP risk coefficient and escalated EPA-based VSL, the dollar per person-rem conversion, rounded to the nearest thousand, is $4,000 per person-rem.

Therefore, the NRC will provide the $2,000 per person-rem conversion value for the recommendation and the $4,000 per person-rem conversion value as a sensitivity analysis for this regulatory analysis.

3.3.3 Replacement Energy Costs

The NRC is currently updating its estimates for replacement energy costs based on a U.S. competitive electricity market area model. The updated model provides the replacement energy costs by day, week, and year, based on market area, in 2010 dollars. For each U.S. power market area, a lowest cost and highest cost replacement energy cost estimate was calculated, normalizing for reactor megawatt rating differences. The estimated replacement energy cost per reactor per year ranges from a high estimate of $54.4 million to a low estimate of $692,000 across all U.S. power markets. The average estimated cost per reactor per year across all U.S. power markets is $9.6 million and the median estimated cost is $6.4 million in 2010 dollars. The average CPI-U in 2010 was 218.1 and the December 2011 CPI-U was 225.7. Using the CPI-U inflator formula, the estimated replacement energy costs range from $56.3 million to $716,000 in 2012 dollars. The average estimated cost per reactor per year across all US power markets is $9.9 million and the median estimated cost is $6.6 million in 2012 dollars.

As an additional sensitivity analysis, there is evidence from other countries that a severe reactor accident with a significant release could lead to a decision by the federal government that other unaffected nuclear power plants could be shut down. This assumption has never been the case in the United States and, thus, this assumption is too speculative to be included within the best-estimate regulatory analysis. However, the staff has included this assumption in its sensitivity analysis to evaluate its effect. The NRC assumes in this sensitivity analysis that all BWR reactors with either a Mark I or a Mark II containment design will be shut down (31 reactors) if there is a severe-accident with a significant release that occurs at a BWR with either a Mark I or Mark II containment. For a severe-accident without a significant release at a Mark I or Mark II BWR, the regulatory analysis assumes that only the damaged reactor would be effected.

[4] Environmental Protection Agency, National Center for Environmental Economics, "Valuing Mortality Risk Reductions for Environmental Policy: A White Paper", dated December 2010.

3.4 Alternative 2 – Severe Accident Capable Vents

The sub-alternatives (i.e. Mark I and Mark II approaches) for the severe accident capable vents are discussed in the following sections, where applicable. While all of the attributes considered in the regulatory analysis would have different costs and benefits, the only change in per unit cost or benefit would occur within the Industry Implementation, Industry Operation, NRC Implementation, and NRC Operation attributes. The quantitative analysis for the costs and benefits are divided by sub-alternative, but the qualitative analysis, as it would be the same for both Mark I and Mark II containments, does not make a distinction between the containment sub-alternatives.

3.4.1 Public Health (Accident)

This attribute measures expected changes in radiation exposure to the public due to change in accident frequencies or accident consequences associated with the proposed action. The expected changes in radiation exposure are measured over a 50-mile radius from the plant site. The dose to the public is from reoccupation of the land and other activities following a severe accident. Also, the dose to the public includes the occupational dose to workers for cleanup and decontamination of the contaminated land not onsite. The calculation for each alternative is made by subtracting the alternative from the status quo. The difference (delta) is the benefit of the alternative in person-rem. The quantitative results for the alternatives are based on the MACCS2 and PRA analyses described in further detail in Enclosure 5 of the SECY paper.

3.4.1.1 Alternative 2a – Mark I Containments

Table 1 – Summary of Public Health (Accident) for Mark I Containments (Current Framework (CF) with $2,000 and $4,000 per person-rem)

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Discount	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF ($2,000)	14	2,500	10,000	$5.0	$0.020	$3.5	$14	$0.014	$2.4	$9.9
CF ($4,000)	14	2,500	10,000	$10	$0.039	$7.2	$30	$0.027	$4.9	$20

As table 2 located in Appendix C shows, the delta benefit for public health (accident) is 4.2 person-rem per reactor-year, approximately 110 person-rem averted per reactor, or 2,500 person-rem averted total. The estimated total benefit to the public health (accident) for severe accident capable vents for Mark I containments relative to the status quo, assuming $2,000 per person-rem averted, ranges from $3.5 million (3 percent net present value) to $2.4 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $7.2 million (3 percent net present value) to $4.9 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 3 and 4, respectively. The low estimate delta probability-weighted exposure to the public is 0.023 person-rem per reactor-year, approximately 0.60 person-rem averted per reactor, or

14 person-rem averted total. Therefore, the estimated total benefit to the public health (accident) for severe accident capable vents for Mark I containments relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.020 million (3 percent net present value) to $0.014 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.039 million (3 percent net present value) to $0.027 million (7 percent net present value).

The high estimate delta probability-weighted exposure to the public is 17 person-rem per reactor-year, approximately 440 person-rem averted per reactor, or 10,000 person-rem averted total. The estimated total benefit to the public health (accident) for severe accident capable vents for Mark I containments relative to the status quo, assuming $2,000 per person-rem averted, ranges from $14 million (3 percent net present value) to $9.9 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $30 million (3 percent net present value) to $20 million (7 percent net present value) for the high estimate.

3.4.1.2 Alternative 2b – Mark II Containments

Table 5 – Summary of Public Health (Accident) for Mark II Containments (Current Framework (CF) with $2,000 and $4,000 per person-rem)

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Discount	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF ($2,000)	4.8	880	3,500	$1.7	$0.0068	$1.2	$5.0	$0.0047	$0.85	$3.4
CF ($4,000)	4.8	880	3,500	$3.4	$0.014	$2.4	$10	$0.0094	$1.6	$6.8

The per unit public health (accident) benefits for the Mark II containments are the same as the Mark I containments. However, there are only 8 Mark II containments, relative to the 23 Mark I containments and, thus, would produce a lower total benefit overall.

As table 6 located in Appendix C shows, the delta benefit for public health (accident) is 4.2 person-rem per reactor-year, approximately 110 person-rem averted per reactor, or 880 person-rem averted total. The estimated total benefit to the public health (accident) for severe accident capable vents for Mark I containments relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1.2 million (3 percent net present value) to $0.85 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $2.4 million (3 percent net present value) to $1.6 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 7 and 8, respectively. The low estimate delta probability-weighted exposure to the public is 0.023 person-rem per reactor-year, approximately 0.60 person-rem averted per reactor, or 4.8 person-rem averted total. Therefore, the estimated total benefit to the public health (accident) for severe accident capable vents for Mark I containments relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.0068 million (3 percent net present value) to $0.0047 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.014 million (3 percent net present value) to $0.0094 million (7 percent net

present value).

The high estimate delta probability-weighted exposure to the public is 17 person-rem per reactor-year, approximately 440 person-rem averted per reactor, or 3,500 person-rem averted total. The estimated total benefit to the public health (accident) for severe accident capable vents for Mark I containments relative to the status quo, assuming $2,000 per person-rem averted, ranges from $5.0 million (3 percent net present value) to $3.4 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $10 million (3 percent net present value) to $6.8 million (7 percent net present value) for the high estimate.

3.4.2 Occupational Health (Accident)

Occupational health measures health effects, both immediate and long-term, associated with site workers as a result of changes in accident frequency or accident mitigation. Within the status quo, the short-term occupational exposure related to the accident occurs at the time of the accident and during the immediate management of the emergency and during decontamination and decommissioning of the onsite property. The radiological occupational exposure resulting from cleanup and refurbishment or decommissioning activities of the damaged facility to occupational workers are found within the long-term occupational exposure. The assumptions for each of the alternatives in relation to the exposures for occupational health (accident) are found in the assumptions section of this regulatory analysis. From those assumptions, the PRA calculations provided in Enclosure 5 of the SECY quantify the results.

3.4.2.1 Mark I Containments

Table 9 – Summary of Occupational Health (Accident) for Mark I Containments (Current Framework (CF) with $2,000 and $4,000 per person-rem)

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Disc.	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Short-Term ($2,000)	0.67	120	530	$0.24	$0.00094	$0.17	$0.76	$0.00065	$0.12	$0.52
Long-Term ($2,000)	0.58	110	440	$0.23	$0.00066	$0.13	$0.48	$0.00033	$0.065	$0.25
Total ($2,000)	1.3	230	970	$0.47	$0.0016	$0.30	$1.2	$0.00098	$0.19	$0.77
Short-Term ($4,000)	0.67	120	530	$0.47	$0.0018	$0.33	$1.5	$0.0013	$0.23	$1.0
Long-term ($4,000)	0.58	110	440	$0.44	$0.0013	$0.25	$0.96	$0.00066	$0.13	$0.49
Total ($4,000)	1.3	230	970	$0.91	$0.0031	$0.58	$2.5	$0.0020	$0.36	$1.5

As table 10 located in Appendix C shows, based on these calculations, the delta benefit for short-term occupational health (accident) is 0.20 person-rem per reactor-year, approximately 5.2 person-rem averted per reactor, or 120 person-rem averted total. The estimated total benefit to the short-term occupational health (accident) for severe accident capable vents

relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.17 million (3 percent net present value) to $0.12 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.33 million (3 percent net present value) to $0.23 million (7 percent net present value).

As table 11 shows, the delta benefit long-term occupational health (accident) is 0.19 person-rem per reactor-year, approximately 4.9 person-rem averted per reactor, or 110 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.13 million (3 percent net present value) to $0.065 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.25 million (3 percent net present value) to $0.13 million (7 percent net present value).

Thus, the estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.30 million (3 percent net present value) to $0.19 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.58 million (3 percent net present value) to $0.36 million (7 percent net present value).

The 5th percentile for short-term and long-term occupational health were provided as a low estimate and are shown in tables 12 and 13, respectively, and the 95th percentile for short-term and long-term occupational health were provided as a high estimate and are shown in tables 14 and 15, respectively. The low estimate delta probability-weighted exposure to the short-term occupational health is 0.0011 person-rem per reactor-year, approximately 0.029 person-rem averted per reactor, or 0.67 person-rem averted total. Therefore, the estimated total benefit to the short-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.00094 million (3 percent net present value) to $0.00065 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.0018 million (3 percent net present value) to $0.0013 million (7 percent net present value).

The low estimate delta benefit long-term occupational health (accident) is 0.0010 person-rem per reactor-year, approximately 0.025 person-rem averted per reactor, or 0.58 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.00066 million (3 percent net present value) to $0.00033 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.0013 million (3 percent net present value) to $0.00066 million (7 percent net present value).

Thus, the low estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.0016 million (3 percent net present value) to $0.00098 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.0031 million (3 percent net present value) to $0.0017 million (7 percent net present value).

The high estimate delta probability-weighted exposure to the short-term occupational

workers is 0.89 person-rem per reactor-year, approximately 23 person-rem averted per reactor, or 530 person-rem averted total. The estimated total benefit to the short-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.76 million (3 percent net present value) to $0.52 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $1.5 million (3 percent net present value) to $1.0 million (7 percent net present value).

The high estimate delta benefit long-term occupational health (accident) is 0.72 person-rem per reactor-year, approximately 19 person-rem averted per reactor, or 440 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.48 million (3 percent net present value) to $0.25 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.96 million (3 percent net present value) to $0.49 million (7 percent net present value).

Thus, the high estimate total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1.2 million (3 percent net present value) to $0.77 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $2.5 million (3 percent net present value) to $1.5 million (7 percent net present value).

3.4.2.2 Mark II Containments

Table 16 – Summary of Occupational Health (Accident) for Mark II Containments (Current Framework (CF) with $2,000 and $4,000 per person-rem)

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Disc.	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Short-Term ($2,000)	0.23	42	180	$0.083	$0.00033	$0.059	$0.26	$0.00023	$0.040	$0.18
Long-Term ($2,000)	0.20	39	150	$0.078	$0.00023	$0.044	$0.17	$0.00012	$0.022	$0.089
Total ($2,000)	0.43	81	330	$0.16	$0.0056	$0.10	$0.43	$0.00035	$0.062	$0.27
Short-Term ($4,000)	0.23	42	180	$0.17	$0.00064	$0.12	$0.52	$0.00045	$0.081	$0.35
Long-term ($4,000)	0.20	39	150	$0.16	$0.00045	$0.089	$0.34	$0.00023	$0.045	$0.17
Total ($4,000)	0.43	81	330	$0.33	$0.0011	$0.21	$0.86	$0.00068	$0.13	$0.52

As table 17 located in Appendix C shows, based on these calculations, the delta benefit for short-term occupational health (accident) is 0.20 person-rem per reactor-year, approximately 5.2 person-rem averted per reactor, or 42 person-rem averted total. The estimated total benefit to the short-term occupational health (accident) for severe accident capable vents relative to the

status quo, assuming $2,000 per person-rem averted, ranges from $0.059 million (3 percent net present value) to $0.040 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.12 million (3 percent net present value) to $0.081 million (7 percent net present value).

As table 18 shows, the delta benefit long-term occupational health (accident) is 0.19 person-rem per reactor-year, approximately 4.9 person-rem averted per reactor, or 39 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.044 million (3 percent net present value) to $0.022 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.089 million (3 percent net present value) to $0.045 million (7 percent net present value).

Thus, the estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.10 million (3 percent net present value) to $0.062 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.21 million (3 percent net present value) to $0.13 million (7 percent net present value).

The 5th percentile for short-term and long-term occupational health were provided as a low estimate and are shown in tables 19 and 20, respectively, and the 95th percentile for short-term and long-term occupational health were provided as a high estimate and are shown in tables 21and 22, respectively. The low estimate delta probability-weighted exposure to the short-term occupational health is 0.0011 person-rem per reactor-year, approximately 0.029 person-rem averted per reactor, or 0.23 person-rem averted total. Therefore, the estimated total benefit to the short-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $330 (3 percent net present value) to $230 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $640 (3 percent net present value) to $450 (7 percent net present value).

The low estimate delta benefit long-term occupational health (accident) is 0.0010 person-rem per reactor-year, approximately 0.025 person-rem averted per reactor, or 0.20 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $230 (3 percent net present value) to $120 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $450 (3 percent net present value) to $230 (7 percent net present value).

Thus, the low estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $560 (3 percent net present value) to $350 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $1,100 (3 percent net present value) to $680 (7 percent net present value).

The high estimate delta probability-weighted exposure to the short-term occupational workers is 0.89 person-rem per reactor-year, approximately 23 person-rem averted per reactor, or 180 person-rem averted total. The estimated total benefit to the short-term occupational

health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.26 million (3 percent net present value) to $0.18 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.52 million (3 percent net present value) to $0.35 million (7 percent net present value).

The high estimate delta benefit long-term occupational health (accident) is 0.72 person-rem per reactor-year, approximately 19 person-rem averted per reactor, or 150 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.17 million (3 percent net present value) to $0.089 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.34 million (3 percent net present value) to $0.17 million (7 percent net present value).

Thus, the high estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for severe accident capable vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.43 million (3 percent net present value) to $0.27 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.86 million (3 percent net present value) to $0.52 million (7 percent net present value).

3.4.3 Offsite Property

Offsite property measures the expected total monetary effects on offsite property resulting from the proposed action. Changes to offsite property can take various forms, both direct, (e.g. land, food, and water) and indirect (e.g. tourism). This attribute is typically the product of the change in accident frequency and the property consequences from the occurrence of an accident.

In the status quo, the offsite property costs are any property consequences resulting from any radiological release from the occurrence of an accident. Normal operational releases and those releases before severe accident are outside the scope of this regulatory analysis. The status quo assumes that the accident would overpressurize the containment leading to an uncontrolled radiological plume release.

The cost offsets for severe accident capable vents are quantified relative to the status quo based on the MACCS2 and PRA calculations provided in Enclosure 5 of the SECY paper. The results for each of the alternatives are compared to the status quo. The calculation for each alternative is made by subtracting the alternative from the status quo.

3.4.3.1 Mark I Containments

Table 23 – Summary of Offsite Property Cost Offsets for Mark I Containments (Current Framework (CF))

Case	Offsite Property Cost Offsets per reactor-year (2012 dollars in millions)			Offsite Property Cost Offsets (2012 dollars in millions)						
				No Disc.	3% Net Present Value			7% Net Present Value		
	Low Est.	Best Est.	High Est.	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF	$0.00099	$0.020	$0.075	$12	$0.042	$8.5	$31	$0.029	$5.8	$22

As table 24 located in Appendix C shows, based on these calculations, the delta cost offset for probability weighted offsite property is $20,000 per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $8.5 million (3 percent net present value) to $5.8 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 25 and 26, respectively. The low estimate delta probability-weighted offsite property cost is $99 per reactor-year. Therefore, the estimated total cost offset for severe accident capable vents relative to the status quo ranges from $0.042 million (3 percent net present value) to $0.029 million (7 percent net present value).

The high estimate delta probability-weighted offsite property cost is $75,000 per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $31 million (3 percent net present value) to $22 million (7 percent net present value).

3.4.3.2 Mark II Containments

Table 27 – Summary of Offsite Property Cost Offsets for Mark II Containments (Current Framework (CF))

Case	Offsite Property Cost Offsets per reactor-year (2012 dollars in millions)			Offsite Property Cost Offsets (2012 dollars in millions)						
				No Disc.	3% Net Present Value			7% Net Present Value		
	Low Est.	Best Est.	High Est.	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF	$0.00099	$0.020	$0.075	$4.2	$0.015	$3.0	$11	$0.010	$2.0	$7.6

As table 28 shows, based on these calculations, the delta cost offset for probability weighted offsite property is $20,000 per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $3.0 million (3 percent net present value) to $2.0 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 29 and 30, respectively. The low estimate delta probability-weighted offsite property cost is $99 per reactor-year. Therefore, the estimated total cost offset for severe accident capable vents relative to the status quo ranges from $0.015 million (3 percent net present value) to $0.010 million (7 percent net present value).

The high estimate delta probability-weighted offsite property cost is $75,000 per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $11 million (3 percent net present value) to $7.6 million (7 percent net present value).

3.4.4 Onsite Property

This attribute measures the expected monetary effects on onsite property, including replacement power costs, decontamination, and refurbishment costs, from the proposed action. There are two forms of onsite property costs that each alternative must disposition. The first

type of onsite property costs are the cleanup and decontamination costs for the unit. The second type of onsite property costs are the cost to replace the energy from the damaged or shutdown unit(s). The cost offsets for severe accident capable vents are quantified relative to the status quo based on the RA Handbook and PRA calculations provided in Enclosure 5 of the SECY paper.

Also stated within the assumptions, there are 11 units that are co-located on a site with another Mark I or Mark II reactor. Therefore, those units may not operate (e.g., due to significant site damage or contamination resulting in high occupational exposure to the undamaged unit) due to the severe accident occurring at the adjacent Mark I or Mark II boiling-water reactor. In modeling the replacement energy costs based on these scenarios, it is assumed that the cost offsets would only occur in those alternatives with filtered vents (alternative 3) when there was no combination of overpressurization and/or liner melt-through. Those alternatives without filtered venting would experience no cost offset (alternatives 1 and 2) for replacement energy costs and, thus, are not included within this section.

3.4.4.1 Mark I Containments

Table 31 – Summary of Offsite Property Cost Offsets for Mark I Containments (Current Framework (CF))

Case	Onsite Property Cost Offsets per reactor-year (2012 dollars in millions)						
CF	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$0.015	$0.000068	$0.013	$0.048	$0.000056	$0.011	$0.040
	Onsite Property Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$9.1	$0.029	$5.5	$20	$0.016	$3.2	$12

As table 32 shows, based on these calculations, the delta cost offset for probability weighted onsite property ranges from $13,000 (3 percent net present value) to $11,000 (7 percent net present value) per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $5.5 million (3 percent net present value) to $3.2 million (7 percent net present value).

The 5th and 95th percentile were provided to provide as a low and high estimate and are shown in tables 33 and 34, respectively. The low estimate delta probability-weighted onsite property cost ranges from $68 (3 percent net present value) to $56 (7 percent net present value) per reactor-year. Therefore, the estimated total cost offset for severe accident capable vents relative to the status quo ranges from $0.029 million (3 percent net present value) to $0.016 million (7 percent net present value).

The high estimate delta probability-weighted onsite property cost ranges from $48,000 (3 percent net present value) to $40,000 (7 percent net present value) per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $20 million (3 percent net present value) to $12 million (7 percent net present value).

3.4.4.2 Mark II Containments

Table 35 – Summary of Offsite Property Cost Offsets for Mark II Containments (Current Framework (CF))

Case	Onsite Property Cost Offsets per reactor-year (2012 dollars in millions)						
CF	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$0.015	$0.000068	$0.013	$0.048	$0.000056	$0.011	$0.040
	Onsite Property Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$3.1	$0.010	$1.9	$7.1	$0.0057	$1.1	$4.0

As table 36 shows, based on these calculations, the delta cost offset for probability weighted onsite property ranges from $13,000 (3 percent net present value) to $11,000 (7 percent net present value) per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $1.9 million (3 percent net present value) to $1.1 million (7 percent net present value).

The 5th and 95th percentile were provided to provide as a low and high estimate and are shown in tables 37 and 38, respectively. The low estimate delta probability-weighted onsite property cost ranges from $68 (3 percent net present value) to $56 (7 percent net present value) per reactor-year. Therefore, the estimated total cost offset for severe accident capable vents relative to the status quo ranges from $0.010 million (3 percent net present value) to $0.0057 million (7 percent net present value).

The high estimate delta probability-weighted onsite property cost ranges from $48,000 (3 percent net present value) to $40,000 (7 percent net present value) per reactor-year. The estimated total cost offset for severe accident capable vents relative to the status quo ranges from $7.1 million (3 percent net present value) to $4.0 million (7 percent net present value).

3.4.4.3 All Mark I and Mark II Shutdown Sensitivity Analysis

3.4.4.3.1 Mark I Containments

For a sensitivity analysis, the NRC has modeled that all Mark I and Mark II reactors would be shut down due to an unmitigated release (alternative 1) and that in all other alternatives, the replacement energy costs would not be required.

Following the assumptions for replacement energy costs within the RA Handbook, as table 39 shows, the estimated probability-weighted cost offsets for severe accident capable vents relative to the status quo would range from $21 million (3 percent net present value) to $13 million (7 percent net present value).

As a sensitivity analysis, the NRC has provided a low and high replacement energy cost estimates, as shown in tables 40 and 41, respectively. Based on low replacement energy cost, the estimated probability-weighted cost offset for severe accident capable vents relative to the status quo ranges from $0.95 million (3 percent net present value) to $0.58 million (7 percent

net present value). Based on the high replacement energy cost, the estimated probability-weighted cost offset for severe accident capable vents relative to the status quo ranges from $75 million (3 percent net present value) to $47 million (7 percent net present value).

3.4.4.3.2 Mark II Containments

For a sensitivity analysis, the NRC modeled that all Mark I and Mark II reactors would be shut down due to an unmitigated release (alternative 1) and that in all other alternatives, the replacement energy costs would not be required.

Following the assumptions for replacement energy costs within the RA Handbook, as table 42 shows, the estimated probability-weighted cost offsets for severe accident capable vents relative to the status quo would range from $7.3 million (3 percent net present value) to $4.5 million (7 percent net present value).

As a sensitivity analysis, the NRC has provided a low and high replacement energy cost estimates, as shown in tables 43 and 44, respectively. Based on low replacement energy cost, the estimated probability-weighted cost offset for severe accident capable vents relative to the status quo ranges from $0.33 million (3 percent net present value) to $0.20 million (7 percent net present value). Based on the high replacement energy cost, the estimated probability-weighted cost offset for severe accident capable vents relative to the status quo ranges from $26 million (3 percent net present value) to $16 million (7 percent net present value).

3.4.5 Industry Implementation

This attribute measures the projected net economic effect on the affected licensees to install or implement mandated changes. Costs will include procedural and administrative activities, equipment, labor, materials, and shutdown costs, including the cost of replacement power.

Industry implementation costs would be from the engineering, purchasing, installing, testing, and recordkeeping of the severe-accident capable vent equipment and the costs to change in licensing documents and operation, maintenance, test, and training procedures for the new equipment. The type of unit (Mark I or Mark II) and the level of implementation of the hardened vents, based on previous voluntary action, will determine the cost of implementing severe accident capable vents relative to the status quo. Specifically, the costs would come from installation of: floor/wall core bore and penetration, new primary containment penetration, pipe, pipe elbows/tees/flanges, valve and actuators, dedicated electrical and pneumatic supply for valve operation and indication, rupture disk and holder, supports suitable for seismic loads, and pipe shielding.

3.4.5.1 Mark I Containments

For all Mark I reactor designs, the cost for engineering, purchasing, installing, and testing the severe-accident capable vents is estimated to be between $2 million and $3 million per unit. The majority of these costs are required to engineer, purchase, and install the required piping, pipe fittings, supports, valves, rupture disk, shielding, wall/floor core bores, and primary containment penetration. Therefore, as shown in table 45, the estimated total implementation costs for severe accident capable vents relative to the status quo range from $46 million to $69 million.

3.4.5.2 Mark II Containments

The Mark II containments would require the same equipment as the Mark I containments and, thus the same costs, but would also require a device similar to the Advanced Boiler Water Reactor (ABWR) Sump Corium Shield. Since this device would be required to be retrofitted onto all Mark II containments and there could be significant complexity in its design and installation, the NRC assumes that the cost of engineering, purchasing, installing, and testing the ABWR Sump Corium Shield would range from $3 million to $10 million. Therefore, as shown in table 46, the estimated total implementation costs for severe accident capable vents relative to the status quo range from $40 million to $100 million and between $5 million and $13 million per unit.

3.4.6 Industry Operation

This attribute measures the projected net economic effect due to routine and recurring activities required by the proposed action on all affected licensees.

3.4.6.1 Mark I Containments

As shown in table 47, the estimated industry operation costs for severe accident capable vents is 0.10 FTE per year for each unit and 2.3 FTE total per year, or $0.92 million per year. The estimated cost ranges from $17 million (3 percent net present value) to $12 million (7 percent net present value).

3.4.6.2 Mark II Containments

As shown in table 48, the estimated industry operation costs for severe accident capable vents is 0.15 FTE per year for each unit and 1.2 FTE total per year, or $0.48 million per year. The estimated cost ranges from $8.9 million (3 percent net present value) to $6.1 million (7 percent net present value).

3.4.7 NRC Implementation

This attribute measures the projected net economic effect on the NRC to place the proposed action into operation. Costs already incurred, including all pre-decisional activities performed by the NRC, are viewed as “sunk” costs and are not to be included. There are NRC implementation costs for the Mark I and Mark II containments, which are different between the two different containments.

3.4.7.1 Mark I Containments

The severe accident capable vents would require an NRC initial review and plant inspection. The estimated FTE for the initial review is 80 hours per unit and 1,840 hours overall. The plant inspection is estimated to require an additional 80 hours per unit and 1,840 hours overall. Therefore, as shown in table 49, the estimated NRC implementation costs for severe accident capable vents is $19,000 per unit and $440,000 overall.

3.4.7.2 Mark II Containments

The severe accident capable vents would require an NRC initial review and plant inspection. The estimated FTE for the initial review is 160 hours per unit and 1,280 hours overall. The plant inspection is estimated to require an additional 160 hours per unit and 1,280 hours overall. Therefore, as shown in table 50, the estimated NRC implementation costs for severe accident capable vents is $38,000 per unit and $300,000 overall.

3.4.8 NRC Operation

This attribute measures the projected net economic effect on the NRC after the proposed action is implemented. Additional inspections, evaluation, or enforcement activities would be examples of such costs.

3.4.8.1 Mark I Containments

As shown in table 51, the total estimated NRC operation costs for severe accident capable vents would be 0.050 FTE per unit per year for the licensed operating term of the unit or 1.2 FTE total per year. The estimated total NRC operation costs range from $8.5 million (3 percent net present value) to $5.8 million (7 percent net present value).

3.4.8.2 Mark II Containments

As shown in table 52, the total estimated NRC operation costs for severe accident capable vents would be 0.050 FTE per unit per year for the licensed operating term of the unit or 0.40 FTE total per year. The estimated total NRC operation costs range from $3.0 million (3 percent net present value) to $2.0 million (7 percent net present value).

3.4.9 Regulatory Efficiency

This attribute attempts to measure regulatory and compliance improvements resulting from the proposed action. These may include changes in industry reporting requirements and the NRC's inspection and review effects. Achieving consistency with international standards groups may also improve regulatory efficiency for both the NRC and the groups.

The regulatory efficiency attribute is a net negative for the severe accident capable vents. By installing severe accident capable vents in Mark I and/or Mark II containments it would decrease the regulatory efficiency between regulatory technologies.

A comparison between a Mark I containment and a pressurized water reactor (PWR) containment of the conditional containment failure probability given various core damage events was provided in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants." The figure below from NUREG-1150 shows that the conditional failure probability for Mark I containments is relatively high (approximately 0.75 for the plant evaluated in that study).

Table 53 (Figure 1) – Relative Probability of Containment Failure Modes

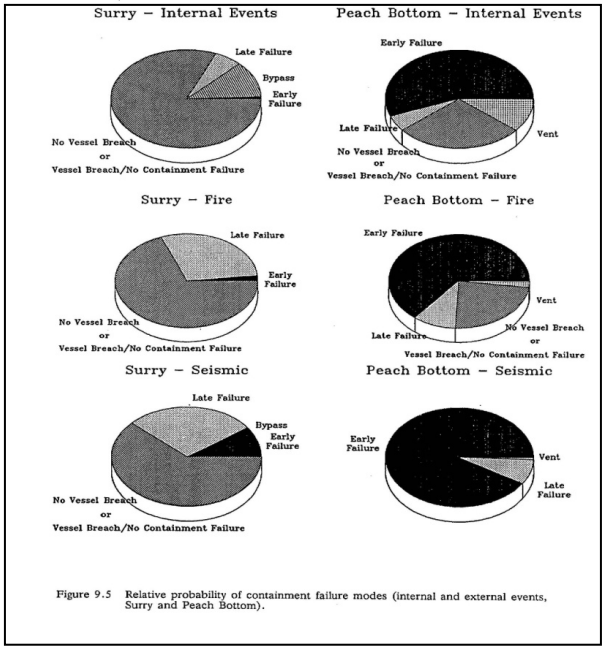


Figure 9.5 Relative probability of containment failure modes (internal and external events, Surry and Peach Bottom).

However, as pointed out in NUREG-1150 and NUREG-1560 and shown in Table 54, when combined with estimated frequencies of core damage events, the risk of large releases from BWRs with Mark I and Mark II containments is comparable to other plant designs. A low core damage frequency is estimated due to a more diverse set of plant equipment able to add water to the reactor core under most plant conditions. The weighting of the defense in depth approaches to emphasize minimizing core damage can result in similar overall risk profiles for large releases. However, many of these core-cooling systems would be rendered unavailable for events such as an extended station blackout as occurred at Fukushima Dai-ichi. Thus given a core damage event, the higher conditional failure probability of containment failure means that a release is more likely.

Table 54 (Figure 2) – NUREG-1560, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance"

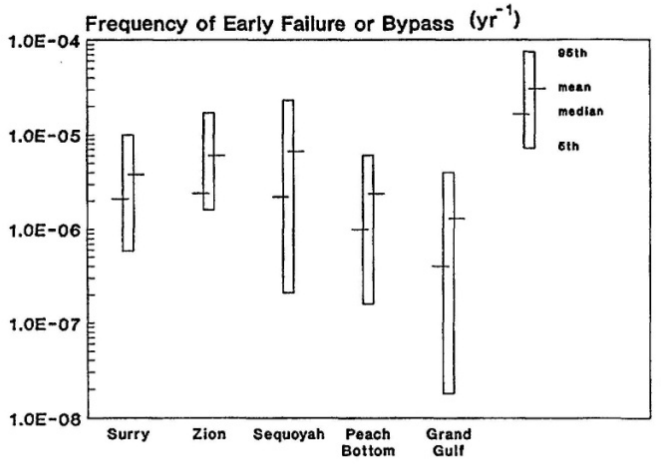


Figure 9.3 Frequency of early containment failure or bypass (all plants).

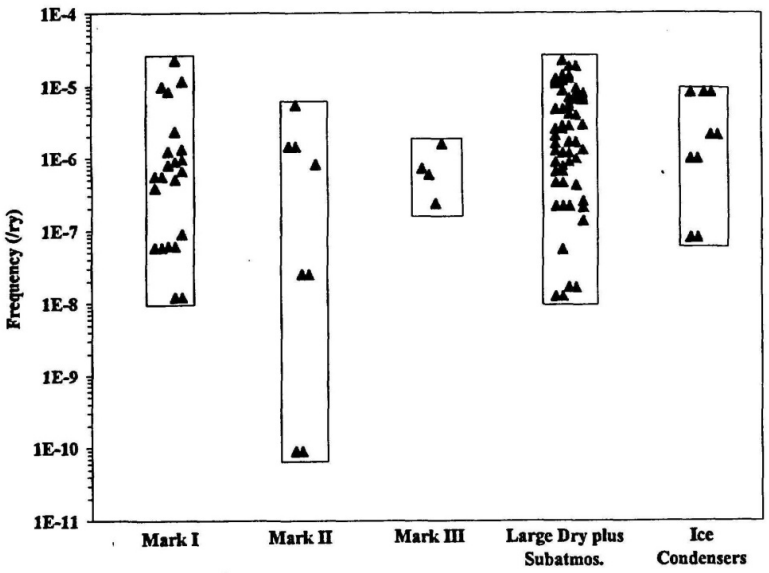


Figure E.3 **Frequencies of significant early release (by containment type) as reported in the IPEs.**

3.4.10 Other Considerations

Other than the uncertainties and hydrogen control issues that are either resolved or assisted by including severe accident capable vents, the other considerations are the same as the other alternatives, but do not provide the same benefit. As the benefit is less than the filtered vent alternative or the severe accident confinement strategy

alternative for those other considerations, they will be discussed within those sections.

3.4.10.1 Uncertainties

There remains significant uncertainties in estimating the frequency of events for which a severe accident capable or filtered venting system would be a useful severe accident design feature. There are also significant uncertainties in the calculation of event consequences in terms of the dispersion of radioactive material into the site environs. This is due in part to significant uncertainties regarding the degree to which radioactive materials would be retained within the plant as a result of systems such as sprays and suppression pools. Estimating economic consequences given a large release also includes large uncertainties as it is difficult to model the many different aspects of local economies and their impact on the larger economy. An example of this is the supply chain disruptions that followed the tsunami in Japan or the flooding in Thailand. Just as an increase in event frequency by approximately an order of magnitude was sufficient to change the results of the cost/benefit analyses, an increase in consequences by an order of magnitude would similarly change the balance to cost beneficial.

3.4.10.2 Hydrogen Control

In addition to providing a means of pressure control, severe accident capable or filtered venting systems could also remove hydrogen from the containment spaces and lessen the likelihood of hydrogen detonations in the containment structures or the reactor building. The primary consideration of improving the control of hydrogen during a severe accident is associated with the Tier 3 item related to NTTF Recommendation 6, “Hydrogen Control and Mitigation Inside Containment or in Other Buildings“. However, the successful venting of containments during severe accidents could help address the potential problems of the buildup of hydrogen in primary and secondary containment systems. Selection of any of the venting options proposed in this paper will therefore influence and potentially help resolve hydrogen control issues for Mark I and II containments.

The potential benefits of venting hydrogen for BWRs with Mark I or II containments were evident during the accident at Fukushima. Hydrogen generated by various mechanisms associated with severe accidents made its way to the reactor buildings and resulted in explosions. Those explosions in turn increased the amount of radioactive materials escaping from the facility, complicated operators efforts to respond to the event, and increased concerns about the integrity of spent fuel pools. The location of the spent fuel pools within the BWR reactor buildings is another feature that makes the venting function and control of hydrogen especially important for these reactor designs. Proper venting of hydrogen would alleviate concerns associated with hydrogen ignition within the reactor building impacting the integrity of the spent fuel pool.

3.4.11 Attributes Not Affected

Attributes that are not affected by this action are as followed: (1) public health (routine); (2) occupational safety (routine); (3) other government; (4) general public; (5) improvements in knowledge; (6) antitrust considerations; (7) safeguards considerations; and (8) environmental considerations.

3.5 Alternative 3 – Filtered Vents

3.5.1 Public Health (Accident)

Table 55 – Summary of Public Health (Accident) for Filtered Vents (Current Framework (CF) with $2,000 and $4,000 per person-rem)

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Discount	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF ($2,000)	34	6,500	25,000	$13	$0.050	$9.2	$35	$0.034	$6.3	$24
CF ($4,000)	34	6,500	25,000	$26	$0.10	$18	$70	$0.069	$13	$48

This attribute measures expected changes in radiation exposure to the public due to change in accident frequencies or accident consequences associated with the proposed action. The expected changes in radiation exposure are measured over a 50-mile radius from the plant site. The dose to the public is from reoccupation of the land and other activities following a severe accident. Also, the dose to the public includes the occupational dose to workers for cleanup and decontamination of the contaminated land not onsite. The calculation for each alternative is made by subtracting the alternative from the status quo. The difference (delta) is the benefit of the alternative in person-rem. The quantitative results for the alternatives are based on the MACCS2 and PRA analyses described in further detail in Enclosure 5 of the SECY paper.

There are multiple ways that the public health can be affected by an accident. The quantitative results for the alternatives are based on the MACCS2 and PRA code runs provided in further detail in Enclosure 5. The majority of the dose to the public is from reoccupation of the land and other activities following a severe accident. Thus, modifications to the assumptions for the allowed dose for return would change the public health dose. Also, the dose to the public includes the occupational dose to workers for cleanup and decontamination of the contaminated land not onsite. The calculation for each alternative is made by subtracting the alternative from the status quo. The difference (delta) is the benefit of the alternative in person-rem.

As table 56 shows, the delta benefit for public health (accident) is 8.1 person-rem per reactor-year, approximately 210 person-rem averted per reactor, or 6,500 person-rem averted total. The estimated total benefit to the public health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $9.2 million (3 percent net present value) to $6.3 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $18 million (3 percent net present value) to $13 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 57 and 58, respectively. The low estimate delta probability-weighted exposure to the public is 0.044 person-rem per reactor-year, approximately 1.1 person-rem averted per reactor, or 34 person-rem averted total. Therefore, the estimated total benefit to the public health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted,

ranges from $0.050 million (3 percent net present value) to $0.034 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.10 million (3 percent net present value) to $0.069 million (7 percent net present value).

The high estimate delta probability-weighted exposure to the public is 31 person-rem per reactor-year, approximately 810 person-rem averted per reactor, or 25,000 person-rem averted total. The estimated total benefit to the public health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $35 million (3 percent net present value) to $24 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $70 million (3 percent net present value) to $48 million (7 percent net present value) for the high estimate.

3.5.2 Occupational Health (Accident)

Table 59 – Summary of Occupational Health (Accident) for Filtered Vents (Current Framework (CF) with $2,000 and $4,000 per person-rem)

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Disc.	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Short-Term ($2,000)	1.1	200	900	$0.42	$0.0016	$0.30	$1.3	$0.0011	$0.20	$0.86
Long-Term ($2,000)	1.5	310	1,100	$0.62	$0.0017	$0.35	$1.3	$0.00089	$0.18	$0.65
Total ($2,000)	2.6	510	2,000	$1.0	$0.0033	$0.65	$2.6	$0.0020	$0.38	$1.5
Short-Term ($4,000)	1.1	200	900	$0.81	$0.0031	$0.57	$2.6	$0.0022	$0.39	$1.8
Long-term ($4,000)	1.5	310	1,100	$1.2	$0.0035	$0.68	$2.5	$0.0018	$0.35	$1.3
Total ($4,000)	2.6	510	2,000	$2.0	$0.0066	$1.3	$5.1	$0.0040	$0.74	$3.1

Occupational health measures health effects, both immediate and long-term, associated with site workers as a result of changes in accident frequency or accident mitigation. Within the status quo, the short-term occupational exposure related to the accident occurs at the time of the accident and during the immediate management of the emergency and during decontamination and decommissioning of the onsite property. The radiological occupational exposure resulting from cleanup and refurbishment or decommissioning activities of the damaged facility to occupational workers are found within the long-term occupational exposure. The assumptions for each of the alternatives in relation to the exposures for occupational health (accident) are found in the assumptions section of this regulatory analysis. From those assumptions, the PRA calculations provided in Enclosure 5 of the SECY quantify the results.

Within the status quo, the short-term occupational exposure related to the accident occurs at the time of the accident and during the immediate management of the emergency and during decontamination and decommissioning of the onsite property. The radiological occupational exposure resulting from cleanup and refurbishment or decommissioning activities of the damaged facility to occupational workers are found within the long-term occupational

exposure. The assumptions for each of the alternatives in relation to the exposures for occupational health (accident) are found in the assumptions section of this regulatory analysis.

The benefits for filtered vents are quantified relative to the status quo based on the MACCS2 and PRA calculations provided in Enclosure 5. As table 60 shows, based on these calculations, the incremental benefit for short-term occupational health (accident) is 0.25 person-rem per reactor-year, approximately 6.5 person-rem averted per reactor, or 200 person-rem averted total. The estimated total benefit to the short-term occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.30 million (3 percent net present value) to $0.20 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.57 million (3 percent net present value) to $0.39 million (7 percent net present value).

As table 61 shows, the delta benefit long-term occupational health (accident) is 0.38 person-rem per reactor-year, approximately 9.9 person-rem averted per reactor, or 310 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.35 million (3 percent net present value) to $0.18 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.68 million (3 percent net present value) to $0.35 million (7 percent net present value).

Thus, the estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.65 million (3 percent net present value) to $0.38 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $1.3 million (3 percent net present value) to $0.74 million (7 percent net present value).

The 5th percentile for short-term and long-term occupational health were provided as a low estimate and are shown in tables 62 and 63, respectively, and the 95th percentile for short-term and long-term occupational health were provided as a high estimate and are shown in tables 64 and 65, respectively. The low estimate delta probability-weighted exposure to the short-term occupational health is 0.0014 person-rem per reactor-year, approximately 0.036 person-rem averted per reactor, or 1.1 person-rem averted total. Therefore, the estimated total benefit to the short-term occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1,600 (3 percent net present value) to $1,100 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $3,100 (3 percent net present value) to $2,200 (7 percent net present value).

The low estimate delta benefit long-term occupational health (accident) is 0.0019 person-rem per reactor-year, approximately 0.049 person-rem averted per reactor, or 1.5 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1,700 (3 percent net present value) to $890 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $3,500 (3 percent net present value) to $1,800 (7 percent net present value).

Thus, the low estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for filtered vents

relative to the status quo, assuming $2,000 per person-rem averted, ranges from $3,300 (3 percent net present value) to $2,000 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $6,600 (3 percent net present value) to $4,000 (7 percent net present value).

The high estimate delta probability-weighted exposure to the short-term occupational workers is 1.1 person-rem per reactor-year, approximately 29 person-rem averted per reactor, or 900 person-rem averted total. The estimated total benefit to the short-term occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1.3 million (3 percent net present value) to $0.86 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $2.6 million (3 percent net present value) to $1.8 million (7 percent net present value).

The high estimate delta benefit long-term occupational health (accident) is 1.4 person-rem per reactor-year, approximately 36 person-rem averted per reactor, or 1,100 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1.3 million (3 percent net present value) to $0.65 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $2.5 million (3 percent net present value) to $1.3 million (7 percent net present value).

Thus, the high estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for filtered vents relative to the status quo, assuming $2,000 per person-rem averted, ranges from $2.6 million (3 percent net present value) to $1.5 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $5.1 million (3 percent net present value) to $3.1 million (7 percent net present value).

3.5.3 Offsite Property

Table 66 – Summary of Offsite Property Cost Offsets for Filtered Vents (Current Framework (CF))

Case	Offsite Property Cost Offsets per reactor-year (2012 dollars in millions)			Offsite Property Cost Offsets (2012 dollars in millions)						
				No Disc.	3% Net Present Value			7% Net Present Value		
	Low Est.	Best Est.	High Est.	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF	$0.00020	$0.034	$0.13	$29	$0.11	$20	$74	$0.078	$14	$51

Offsite property measures the expected total monetary effects on offsite property resulting from the proposed action. Changes to offsite property can take various forms, both direct, (e.g. land, food, and water) and indirect (e.g. tourism). This attribute is typically the product of the change in accident frequency and the property consequences from the occurrence of an accident.

In the status quo, the offsite property costs are any property consequences resulting from any radiological release from the occurrence of an accident. Normal operational releases and those releases before severe accident are outside the scope of this regulatory analysis.

The status quo assumes that the accident would overpressurize containment leading to an uncontrolled radiological plume release.

The cost offsets for filtered vents are quantified relative to the status quo based on the MACCS2 and PRA calculations provided in Enclosure 5. The results for each of the alternatives are compared to the status quo. The calculation for each alternative is made by subtracting the alternative from the status quo.

As table 67 shows, based on these calculations, the delta cost offset for probability weighted offsite property is $34,000 per reactor-year. The estimated total cost offset for filtered vents relative to the status quo ranges from $20 million (3 percent net present value) to $14 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 68 and 69, respectively. The low estimate delta probability-weighted offsite property cost is $200 per reactor-year. Therefore, the estimated total cost offset for filtered vents relative to the status quo ranges from $0.11 million (3 percent net present value) to $0.078 million (7 percent net present value).

The high estimate delta probability-weighted offsite property cost is $130,000 per reactor-year. The estimated total cost offset for filtered vents relative to the status quo ranges from $74 million (3 percent net present value) to $51 million (7 percent net present value).

3.5.4 Onsite Property

Table 70 – Summary of Onsite Property Cost Offsets for Filtered Vents (Current Framework (CF))

Case	Onsite Property Cost Offsets per reactor-year (2012 dollars in millions)						
CF	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$0.025	$0.00011	$0.021	$0.078	$0.000091	$0.018	$0.065
	Onsite Property Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$20	$0.063	$12	$45	$0.036	$7.1	$25

This attribute measures the expected monetary effects on onsite property, including replacement power costs, decontamination, and refurbishment costs, from the proposed action. There are two forms of onsite property costs that each alternative must disposition. The first type of onsite property costs are the cleanup and decontamination costs for the unit. The second type of onsite property costs are the cost to replace the energy from the damaged or shutdown unit(s). The cost offsets for severe accident capable vents are quantified relative to the status quo based on the RA Handbook and PRA calculations provided in Enclosure 5 of the SECY paper.

There are two forms of onsite property costs that each alternative must disposition. The first type of onsite property costs are the cleanup and decontamination costs for the unit. The

second type of onsite property costs are the cost to replace the energy from the damaged or shutdown unit(s). The onsite property cost assumptions are stated in the assumptions section and are also used in the PRA, which can be found in Enclosure 5, to develop probability-weighted costs.

Also stated within the assumptions, there are 11 units that are co-located on the same site as a Mark I or Mark II reactor. Therefore, those units may be ordered to shutdown due to the severe accident occurring at the adjacent Mark I or Mark II boiling-water reactor. In modeling the replacement energy costs based on these scenarios, it is assumed that the cost offsets would only occur in those alternatives with filtered vents (alternative 3) when there was no combination of containment overpressurization, liner melt-through, or both events occurring.

As table 71 shows, based on these calculations, the delta cost offset for probability weighted onsite property range from $21,000 (3 percent net present value) to $18,000 (7 percent net present value) per reactor-year. The estimated total cost offset for filtered vents relative to the status quo ranges from $12 million (3 percent net present value) to $7.1 million (7 percent net present value).

The 5th and 95th percentile were provided to provide as a low and high estimate and are shown in tables 72 and 73, respectively. The low estimate delta probability-weighted onsite property cost ranges from $110 (3 percent net present value) to $91 (7 percent net present value) per reactor-year. Therefore, the estimated total cost offset for filtered vents relative to the status quo ranges from $0.063 million (3 percent net present value) to $0.036 million (7 percent net present value).

The high estimate delta probability-weighted onsite property cost ranges from $78,000 (3 percent net present value) to $65,000 (7 percent net present value) per reactor-year. The estimated total cost offset for filtered vents relative to the status quo ranges from $45 million (3 percent net present value) to $25 million (7 percent net present value).

3.5.4.1 Replacement Energy Costs

Table 74 – Summary of Replacement Energy Cost Offsets for Filtered Vents (Current Framework (CF))

Case	Replacement Energy Cost Offsets (2012 dollars in millions)						
CF	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$15	$0.45	$10	$36	$0.28	$6.2	$23

As stated previously within this section, for the current framework, there would be a cost offset for replacement energy costs, if reactors located at other sites would be ordered to shut down, as this filtered vent scenario is modeled similar to the what occurred following the TMI-2 accident where the co-located TMI-1 unit was not allowed to operate for six years. Therefore, the averted replacement energy costs would provide a cost offset for filtered vents. Assuming the replacement energy costs provided in the RA Handbook, as shown in table 75, the estimated probability-weighted cost offset for filtered vents relative to the status quo ranges from $10 million (3 percent net present value) to $6.2 million (7 percent net present value).

The NRC has provided a low and high replacement energy cost estimates based on the

assumptions within the sensitivity analysis section previously, as shown in tables 76 and 77, respectively. Based on low replacement energy cost, the estimated probability-weighted cost offset for filtered vents relative to the status quo ranges from $0.45 million (3 percent net present value) to $0.28 million (7 percent net present value). Based on the high replacement energy cost, the estimated probability-weighted cost offset for filtered vents relative to the status quo ranges from $36 million (3 percent net present value) to $23 million (7 percent net present value).

3.5.4.2 All Mark I and Mark II Shutdown Sensitivity Analysis

For a sensitivity analysis, the NRC modeled that all Mark I and Mark II reactors would be shut down due to an unmitigated release (alternative 1) and that in all other alternatives, the replacement energy costs would not be required.

Following the assumptions for replacement energy costs within the RA Handbook, as table 78 shows, the estimated probability-weighted cost offsets for filtered vents relative to the status quo would range from $28 million (3 percent net present value) to $18 million (7 percent net present value).

As a sensitivity analysis, the NRC has provided a low and high replacement energy cost estimates, as shown in tables 79 and 80, respectively. Based on low replacement energy cost, the estimated probability-weighted cost offset for filtered vents relative to the status quo ranges from $1.3 million (3 percent net present value) to $0.78 million (7 percent net present value). Based on the high replacement energy cost, the estimated probability-weighted cost offset for filtered vents relative to the status quo ranges from $100 million (3 percent net present value) to $63 million (7 percent net present value).

3.5.5 Industry Implementation

This attribute measures the projected net economic effect on the affected licensees to install or implement mandated changes. Costs will include procedural and administrative activities, equipment, labor, materials, and shutdown costs, including the cost of replacement power.

The industry implementation costs for the filters would be for the equipment, the plant procedures and plant review. Specifically, the costs would come from installation of: floor/wall core bore and penetration, new primary containment penetration, pipe, pipe elbows/tees/flanges, valve and actuators, dedicated electrical and pneumatic supply for valve operation and indication, rupture disk and holder, supports suitable for seismic loads, pipe shielding, engineered filter and filter shielding. The filter equipment including installation is estimated to cost between $15 million and $20 million per filter. Examples of other types of filtration systems are provided in enclosure 3 of the SECY paper. Therefore, as shown in table 81, the estimated total implementation costs for filtered vents relative to the status quo ranges from $465 million to $620 million.

3.5.6 Industry Operation

This attribute measures the projected net economic effect due to routine and recurring activities required by the proposed action on all affected licensees.

As show in table 82, the estimated industry operation costs for filtered vents is 0.15 FTE per plant per year and 4.7 FTE total per year, or $1.9 million per year. The estimated total cost ranges from $35 million (3 percent net present value) to $24 million (7 percent net present value).

3.5.7 NRC Implementation

This attribute measures the projected net economic effect on the NRC to place the proposed action into operation. Costs already incurred, including all pre-decisional activities performed by the NRC, are viewed as “sunk” costs and are not to be included.

The NRC would incur implementation costs for filtered vents which include the preparation and maintenance of inspection procedures, supporting and reviewing a licensee’s change to licensing and operation procedures and technical specifications, and performing plant inspections.

The filtered vents would require an NRC initial review and plant inspection. The estimated FTE for the initial review per unit is 145 hours and 4,495 hours overall. The plant inspection is estimated to require an additional 80 hours per unit and 2,480 hours overall. Therefore, as shown in table 83, the estimated NRC implementation costs for filtered vents is $27,000 per unit and $840,000 overall.

3.5.8 NRC Operation

This attribute measures the projected net economic effect on the NRC after the proposed action is implemented. Additional inspections, evaluation, or enforcement activities would be examples of such costs.

As shown in table 84, the total estimated NRC operation costs for filtered vents would be 0.050 FTE per unit per year for average life of the units or 1.6 FTE total per year. The estimated total NRC operation costs range from $11 million (3 percent net present value) to $7.8 million (7 percent net present value).

3.5.9 Environmental Considerations

This attributes measures the effect to the environment and is similar to the requirements for an environmental impact statement or environmental assessment.

Installation of filtered vents would provide protection of the environment, including protecting land, species, and historic or cultural sites from radiological contamination resulting from inadvertent or severe accident radiological releases. The quality of the environs has direct significance to people’s enjoyment of daily activities and their overall sense of well being. Individuals value and expect environmental stewardship both in the places they live and work, the places they travel to for recreational purposes, and at sites of unique public value, such as historic and cultural sites. This section discusses the qualitative benefits that are achieved by averting radiological releases through installation of containment filtered vents.

Qualitative economic benefits are believed to consist of use values and nonuse values. Use values include the aesthetic benefits of the availability of pristine land, unfettered residential activities, and enhanced recreation activities such as hunting, recreational fishing, bird watching,

hiking, or boating. Nonuse values are based on people's beliefs that the environment ought to exist free of human-induced contamination or pollution in order to maintain a resource's aesthetic qualities. Nonuse value is especially important for recreational areas such as national parks and monuments.

While the NRC expects that these averted radiological releases will prevent adverse environmental impacts that are considered unacceptable or undesirable, the quantification of those averted disbenefits cannot be quantified at this time in a defensible way. This is not to imply that there are no benefits, rather it is a reflection of the modeling difficulties for these environmental impacts and presents a formidable challenge for several reasons. First, natural systems are inherently complex and the many services they provide and how they provide them may be poorly understood. Second, ecological risk varies widely in terms of persistence (e.g., eutrophication versus species extinction), geographic extent, and the degree to which the overall threat can be predicted (e.g., effects on wildlife populations). Third, many of the less tangible benefits are not readily amenable to monetary valuation.

3.5.10 Regulatory Efficiency

This attribute attempts to measure regulatory and compliance improvements resulting from the proposed action. These may include changes in industry reporting requirements and the NRC's inspection and review effects. Achieving consistency with international standards groups may also improve regulatory efficiency for both the NRC and the groups.

A description of the staff's collection and assessment of information from various countries related to decisions on filtered venting systems is provided in Enclosure 3 of the SECY paper. As discussed in that enclosure, the majority of countries with BWRs using Mark I and Mark II containment designs have or are planning to modify the designs to include filtered containment venting systems. In addition, some countries are requiring filtered venting systems on other reactor containment designs. As previously mentioned, in the discussions on determining whether a proposed change meets the standard of a substantial increase in safety, the Commission stated:

> …The approach is also flexible enough to allow for arguments that consistency with national and international standards, or the incorporation of widespread industry practices, contributes either directly or indirectly to a substantial increase in safety. Such arguments concerning consistency with other standards, or incorporation of industry practices, would have to rest on the particulars of a given proposed rule…

Although there is not a particular international standard that calls specifically for filtered vents for Mark I and Mark II containments, the requirement is consistent with general standards and guides that call for improving the ability of containments to contain radioactive materials during severe accident conditions. Such a requirement would also place the U.S. among the majority of countries that have required filtered venting systems, and maintain stature as a leader in nuclear safety. Another significant benefit from the international experience is that various filtering systems have been developed and installed. This lessens concerns that requiring filtered vents would necessitate research and development programs to design and test a new technology.

However, it should be noted that many countries that have decided to pursue filtered venting systems have done so in conjunction with the development of the defense in depth

system described in guidance from IAEA and Western European Nuclear Regulators' Association (WENRA). This defense in depth logic includes a specific level for dealing with severe accidents and minimizing the need to displace populations near nuclear power plants. The logic is shown below along with the corresponding regulatory structure in the United States.

Table 85 – Corresponding Regulatory Structure in the United States

International System of Defense in Depth		Corresponding US Considerations	
1	Normal Operations	Normal Operations	Risk Informed Licensing Reactor Oversight Process
2	Anticipated Operational Occurrences	Anticipated Operational Occurrences	
3	Design Basis Accidents	Design Basis Accidents	
	Design Extension Events	Beyond Design Basis Events (Design Extension considered under Recommendation 1)	
4	Severe Accident	Safety Goal Policy Statement **Severe Accident Policy Statement** - **Operating Plants** - New Reactors	
5	Emergency Planning	Emergency Planning	

As shown above, the regulatory systems are similar in most areas but do differ in the treatment of beyond design basis and severe accidents. The Severe Accident Policy Statement is discussed as a separate qualitative factor in the following section.

The regulatory efficiency would be decreased by installing filtered vents within only Mark I and Mark II reactor containments and would provide the same disbenefits as explained in the previous section and the severe accident capable vent alternative.

3.5.12 Other Considerations

3.5.12.1 Uncertainties

As discussed above, there remains significant uncertainties in estimating the frequency of events for which a severe accident capable or filtered venting system would be a useful severe accident design feature. The results of the regulatory analyses are sensitive to the event frequency and as shown above, a frequency assumption of 3×10^{-4} per year is sufficient to make the filtered vent marginally cost effective. There are also significant uncertainties in the calculation of event consequences in terms of the dispersion of radioactive material into the site environs. This is due in part to significant uncertainties regarding the degree to which radioactive materials would be retained within the plant as a result of systems such as sprays and suppression pools. Estimating economic consequences given a large release also includes large uncertainties as it is difficult to model the many different aspects of local economies and their impact on the larger economy. An example of this is the supply chain disruptions that followed the tsunami in Japan or the flooding in Thailand. Just as an increase in event

frequency by approximately an order of magnitude was sufficient to change the results of the cost/benefit analyses, so would an increase in consequences by an order of magnitude similarly change the balance between costs and benefits.

3.5.12.2 Hydrogen Control

The filtered vent alternative would provide the same benefit as the severe accident capable vent alternative and would provide no additional delta benefit.

3.5.12.3 Defense in Depth

A key principal of NRC's regulation and oversight of nuclear power plants has historically been and continues to be "defense in depth." An aspect of defense in depth has traditionally been to have multiple barriers to the release of radioactive materials and equipment and personnel to (1) prevent accidents from occurring or progressing, (2) containing radioactive materials if released from the fuel, and (3) mitigating the possible release through protective actions such as evacuation. The containment systems at nuclear power plants play a key role in confining fission products within the plant if an accident progresses to a point where significant core damage has occurred. Containment designs also help to control accidents by absorbing the energy released from the reactor coolant system, holding water for long term core cooling, and protecting systems from external hazards. Given the key role of containment performance as an essential element of defense in depth, concerns regarding the performance of Mark I and II containments during severe accident conditions have been a topic of discussion for many years.

The logic underlying this set of basic goals is that each level of defense represents a threshold where failure to accomplish the prior goal introduces a significantly greater potential for consequences as well as a greater uncertainty in the phenomenology, in accident progression, and therefore, the ability to control the outcome of an event.

3.5.12.4 Severe Accident Management

The experiences at Fukushima demonstrated that responding to, and arresting the accident were more complicated by the problems associated with venting containment, and by the subsequent failure of containment. The failure of containments by overpressure conditions will create harsh environments in the reactor building and other plant locations. The elevated temperatures and radiation levels can in turn impede operators in their attempts to restore installed equipment or put into service temporary equipment such as that required by NRC Order EA-12-049. Severe accident capable vents would not only include equipment that could remain functional and support venting operations during severe accident conditions but would also address shielding and equipment operation to ensure personnel could execute needed tasks during a severe accident. Some severe accident capable venting designs include the use of passive features such as rupture disks to provide additional confidence that the system would operate and prevent failure of containment structures due to overpressure conditions.

The filtered vent designs would provide the same improvements to the plant to prevent containment failures and thereby help control conditions within the reactor building and other site areas. The filtered system could provide an additional advantage in that decision-makers could be more confident (or at least less stressed) about ordering the venting operation knowing that the filter would contain the vast majority of radioactive materials. From an accident management perspective, this increased confidence in the venting operation would enable

measures to restore installed equipment, connect temporary equipment, or otherwise take measures to arrest the accident.

3.5.12.5 Emergency Planning

The installation of severe accident capable or filtered venting systems can add to existing emergency planning margins (e.g., effective evacuation periods) by controlling the releases of radioactive materials as compared to containment failure by overpressurization. The filtered vent system provides additional advantages by dramatically reducing the amount of radioactive materials released via containment venting during severe accident conditions. This could in turn allow different protective action recommendations that would reduce the number of evacuees and thereby reduce the stress and risks associated with such emergency measures. In addition to the effects on immediate protective measures to protect public health and safety, the filtered vent option reduces or eliminates concerns regarding the return of populations following a possible release of radioactive materials and the long term exposures associated with contamination of the countryside by the failure of containment or the release from an unfiltered venting operation. The issue of long-lasting effects from a release also relates to other qualitative factors such as societal considerations and uncertainties in estimating economic consequences.

3.5.12.6 Independence of Barriers

The events at Fukushima highlighted the interdependence between the performance of core cooling functions and the pressure suppression containment designs used for BWRs with Mark I or Mark II containment designs. This dependent relationship between what is generally thought of as individual barriers to the release of radioactive materials has been noted in various severe accident studies and during the operating history of BWRs with Mark I or Mark II containments (see Enclosure 2). Although the primary fission product barriers are usually discussed as being largely independent from each other, the NRC has previously recognized and accepted some dependencies such as for the crediting of containment accident pressure for supplying net positive suction head for pumps in the emergency core cooling system. In its SRM for SECY-11-0014, “Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents,” the Commission directed the NRC staff to continue to use existing guidance in the standard review plan which states:

> Defense in depth is preserved (for example, system redundancy, diversity, and independence are maintained commensurate with the expected frequency and consequence of challenges to the system; defenses against potential common cause failures are maintained and the introduction of new common cause failure mechanisms is assessed; and defenses against human errors are maintained).

Although the above discussion related to design basis functions, previous (pre-Fukushima) evaluations performed by the NRC also found that the expected frequency and consequences of severe accidents involving potential releases through established vent pathways for BWRs did not warrant additional severe accident design features (see SECY-89-017 and related SRM). The Commission could, however, find that the Fukushima accident has changed our understanding of severe accident frequencies and consequences such that measures are needed to address this issue and compensate for the lack of independence between the core cooling and containment functions. The installation of a filtered vent would be a plausible approach to improving the defense in depth attributes for BWRs with Mark I or Mark

II containments. In their efforts to address lessons learned from Fukushima, the industry to date has emphasized additional measures for preventing core damage (e.g., making available portable pumps for injection into the core or drywell) versus the installation of an additional barrier (filters) on a dedicated vent pathway from containment.

A focus on preventing or arresting the progression of core damage is also consistent with the NRC Order EA-12-050 which requires modifications to ensure BWRs with Mark I and II containments have a reliable hardened vent to control containment pressure. EA-12-050 was issued with a finding that the action was needed for adequate protection and the following explanation was included in the order:

> The events at Fukushima Dai-ichi highlight the possibility that extreme natural phenomena could challenge the prevention, mitigation, and emergency preparedness defense-in-depth layers. At Fukushima, limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure. In particular, the operators were unable to successfully operate the containment venting system. The inability to reduce containment pressure inhibited efforts to cool the reactor core. If additional backup or alternate sources of power had been available to operate the containment venting system remotely, or if certain valves had been more accessible for manual operation, the operators at Fukushima may have been able to depressurize the containment earlier. This, in turn, could have allowed operators to implement strategies using low-pressure water sources that may have limited or prevented damage to the reactor core. Thus, the events at Fukushima demonstrate that reliable hardened vents at BWR facilities with Mark I and Mark II containment designs are important to maintain core and containment cooling.

3.5.12.7 Severe Accident Policy Statement

Following the 1979 accident at TMI-2, the U.S. and international nuclear safety community recognized that severe accidents needed further attention. The NRC evaluated, generically, the capability of existing plants to tolerate a severe accident. The NRC found that the design-basis approach contained significant safety margins for the analyzed events. These margins permitted operating plants to accommodate a large spectrum of severe accidents. Based on this information, the Commission, in the Severe Accident Policy Statement, “Policy Statement on Severe Accidents Regarding Future Designs and Existing Plants,” (50 FR 32138, August 8, 1985), concluded that existing plants posed no undue risk to public health and safety, and that no basis existed for immediate action on generic rulemaking or other regulatory changes affecting these plants because of the risk posed by a severe accident. To address this issue for operating plants in the long term, the NRC issued SECY-88-147, “Integration Plan for Closure of Severe Accident Issues,” in May 1988. This document identified the following necessary elements for closure of severe accidents:

- Performance of an individual plant examination
- Assessment of generic containment performance improvements (CPIs)
- Improved plant operations
- A severe accident research program

- An external events program
- An accident management program

Each of these programs and the conclusions reached has been discussed elsewhere in this paper. That portion of the Policy Statement that deals with operating plants states:

> *In light of the above principles and conclusions, the Commission's policy for operating reactors includes the following guidance:*
>
> - *Operating nuclear power plants require no further regulatory action to deal with severe accident issues unless significant new safety information arises to question whether there is adequate assurance of no undue risk to public health and safety.*
> - *In the latter event, a careful assessment shall be made of the severe accident vulnerability posed by the issue and whether this vulnerability is plant or site specific or of generic importance.*
> - *The most cost-effective options for reducing this vulnerability shall be identified and a decision shall be reached consistent with the cost-effectiveness criteria of the Commission's backfit policy as to which option or set of options (if any) are justifiable and required to be implemented.*
> - *In those instances where the technical issue goes beyond current regulatory requirements, generic rulemaking will be the preferred solution. In other cases, the issue should be disposed of through the conventional practice of issuing Bulletings and Orders or Generic Letters where modifications are justified through backfit policy, or through plant-specific decision making along the lines of the Integrated Safety Assessment Program (ISAP) conception.*
> - *Recognizing that plant-specific PRAs have yielded valuable insight to unique plant vulnerabilities to severe accidents leading to low-cost modifications, licensees of each operating reactor will be expected to perform a limited-scope, accident safety analysis designed to discover instances (i.e., outliers) of particular vulnerability to core melt or to unusually poor containment performance, given core-melt accidents. These plant-specific studies will serve to verify that conclusions developed from intensive severe accident safety analyses of reference or surrogate plants can be applied to each of the individual operating plants. During the next two years, the Commission will formulate a systematic approach, including the development of guidelines and procedural criteria, with an expectation that such an approach will be implemented by licensees of the remaining operating reactors not yet systematically analyzed in an equivalent or superior manner.*

For advanced nuclear power plants, including both the evolutionary and passive designs, the NRC concluded that vendors should address severe accidents during the design stage. Designers can take full advantage of the insights gained from such input as probabilistic

safety assessments, operating experience, severe accident research, and accident analysis by designing features to reduce the likelihood that severe accidents will occur and, in the unlikely occurrence of a severe accident, to mitigate the consequences of such an accident. Incorporating insights and design features during the design phase is much more cost effective than modifying existing plants

3.5.12.8 External Events

The estimated core damage frequencies for BWRs from internal events are lower than that for pressurized water reactors (PWR) in part because of the multiple systems available to add water to the reactor core. However, events such as an extended loss of electrical power renders some of these systems unavailable and potentially reduces the BWR advantage for such events, which are likely caused by a major external event (e.g., a beyond-design-basis seismic or flooding event). Provided the filtered vent is able to survive the external event and remain available for use if the accident progresses to involve significant core damage, then the system could be a major part of the accident response. As mentioned previously, the availability of a reliable venting system during severe accident conditions could help prevent conditions degrading further and enable responders to continue efforts to cool the molten core. The filtered vent thereby compliments the ability of the portable equipment to help arrest an event even if previous efforts had failed to prevent core damage.

3.5.12.9 Multi-Unit Events

The quantitative evaluations did not consider potential scenarios involving accidents at more than one unit at a multiple unit site. The tsunami that flooded the Fukushima site initiated a series of events that resulted in core damage accidents at three of the six units sharing the site. The most likely cause of multi-unit accidents is a major external event such as that which occurred at Fukushima and discussed above. Although the frequencies of such events might be estimated for particular sites, the uncertainties are relatively large given the limited recorded histories and limited knowledge of hazards such as large seismic or flooding events. In addition, the possibility of core damage events at multiple units has the potential for larger releases and increased economic damage. By improving severe accident management functions and reducing the releases from each unit, the filtered vent alternative could help address concerns about concurrent core damage events at multiple units greater than the severe accident capable vent.

3.5.13 Attributes Not Affected

Attributes that are not affected by this action are as followed: (1) public health (routine); (2) occupational safety (routine); (3) other government; (4) general public; (5) improvements in knowledge; (6) safeguards considerations and (7) antitrust considerations.

3.6 Alternative 4 – Severe Accident Confinement Strategy

As previously stated, the regulatory analysis for the severe accident containment strategy is highly speculative based on the uncertainty regarding the approach, the level of analysis required, the specifics regarding required plant modifications, and possible regulatory changes. Therefore, a regulatory analysis was developed to the full extent possible for this alternative given the numerous unknowns in relation to implementation of the severe accident confinement strategy. The costs associated with this alternative could significantly increase due to the amount of site-specific effort that would be required as well as development and

demonstration costs for an as yet unspecified approach. For example, if Level 2 PRAs are not required for each Mark I and Mark II containment, the costs would decrease significantly. However, the estimated costs for plant modification (e.g., any engineering design, procurement, installation or testing); therefore, if it is determined that after significant analysis and effort that filtered vents would be required to achieve the required performance standard, the costs for this alternative would be greater than the costs for the filtered vent alternative. The benefits for this alternative could also change due to both the timing of implementation of the alternative as well as the effectiveness of the alternative.

As an assumption for this alternative, the NRC staff expects that the implementation of this alternative would take 5 years longer than the filtered vent alternative (alternative 3). Therefore, the benefits of the severe accident confinement strategy for the first five years (2012-2016) would be the same as the severe accident capable vent alternative and then, after implementation of the performance based alternative in year 5, would have the same benefit as the filtered vent alternative (2017-2037).

3.6.1 Public Health (Accident)

**Table 86 – Summary of Public Health (Accident)
for the Severe Accident Confinement Strategy
(Current Framework (CF) with $2,000 and $4,000 per person-rem)**

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Discount	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF ($2,000)	31	5,900	23,000	$12	$0.044	$8.1	$31	$0.028	$5.3	$21
CF ($4,000)	31	5,900	23,000	$24	$0.089	$16	$62	$0.058	$11	$41

This attribute measures expected changes in radiation exposure to the public due to change in accident frequencies or accident consequences associated with the proposed action. The expected changes in radiation exposure are measured over a 50-mile radius from the plant site. The dose to the public is from reoccupation of the land and other activities following a severe accident. Also, the dose to the public includes the occupational dose to workers for cleanup and decontamination of the contaminated land not onsite. The calculation for each alternative is made by subtracting the alternative from the status quo. The difference (delta) is the benefit of the alternative in person-rem. The quantitative results for the alternatives are based on the MACCS2 and PRA analyses described in further detail in Enclosure 5 of the SECY paper.

There are multiple ways that the public health can be affected by an accident. The quantitative results for the alternatives are based on the MACCS2 and PRA code runs provided in further detail in Enclosure 5. The dose to the public is from reoccupation of the land and other activities following a severe accident. Thus, modifications to the assumptions for the allowed dose for return would change the public health dose. Also, the dose to the public includes the occupational dose to workers for cleanup and decontamination of the contaminated land not onsite. The calculation for each alternative is made by subtracting the alternative from

the status quo. The difference (delta) is the benefit of the alternative in person-rem.

As table 87 shows, the delta benefit for public health (accident) varies based on the year. For the first five years the delta benefit is the same as the severe accident capable vent alternative of 4.2, but then after implementation of the performance-based approach increased to the same level as the filtered vent alternative of 8.1 person-rem per reactor-year, which provides an overall estimated person-rem averted per reactor of 190 or a total estimated person-rem averted of 5,900. The estimated total benefit to the public health (accident) for the severe accident confinement strategy alternative relative to the status quo, assuming $2,000 per person-rem averted, ranges from $8.1 million (3 percent net present value) to $5.3 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $16 million (3 percent net present value) to $11 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 88 and 89, respectively. The low estimate delta probability-weighted exposure to the public is approximately 1.0 person-rem averted per reactor, or 31 person-rem averted total. Therefore, the estimated total benefit to the public health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.044 million (3 percent net present value) to $0.028 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.089 million (3 percent net present value) to $0.058 million (7 percent net present value).

The high estimate delta probability-weighted exposure to the public is approximately 740 person-rem averted per reactor, or 23,000 person-rem averted total. The estimated total benefit to the public health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $31 million (3 percent net present value) to $21 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $62 million (3 percent net present value) to $41 million (7 percent net present value) for the high estimate.

3.6.2 Occupational Health (Accident)

**Table 90 – Summary of Occupational Health (Accident)
for the Severe Accident Confinement Strategy
(Current Framework (CF) with $2,000 and $4,000 per person-rem)**

Case	Dose (averted person-rem)			Benefits (2012 dollars in millions)						
	Low Est.	Best Est.	High Est.	No Disc.	3% Net Present Value			7% Net Present Value		
				Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Short-Term ($2,000)	1.1	200	870	$0.40	$0.0015	$0.28	$1.2	$0.0010	$0.18	$0.80
Long-Term ($2,000)	1.4	280	1,000	$0.56	$0.0015	$0.30	$1.1	$0.00074	$0.15	$0.54
Total ($2,000)	2.5	480	1,900	$0.96	$0.0030	$0.58	$2.3	$0.0017	$0.33	$1.3
Short-Term ($4,000)	1.1	200	870	$0.78	$0.0030	$0.54	$2.4	$0.0020	$0.37	$1.6
Long-term ($4,000)	1.4	280	1,000	$1.1	$0.0030	$0.60	$2.2	$0.0015	$0.29	$1.1
Total ($4,000)	2.5	480	1,900	$1.9	$0.0060	$1.1	$4.6	$0.0035	$0.66	$2.7

Occupational health measures health effects, both immediate and long-term, associated with site workers as a result of changes in accident frequency or accident mitigation. Within the status quo, the short-term occupational exposure related to the accident occurs at the time of the accident and during the immediate management of the emergency and during decontamination and decommissioning of the onsite property. The radiological occupational exposure resulting from cleanup and refurbishment or decommissioning activities of the damaged facility to occupational workers are found within the long-term occupational exposure. The assumptions for each of the alternatives in relation to the exposures for occupational health (accident) are found in the assumptions section of this regulatory analysis. From those assumptions, the PRA calculations provided in Enclosure 5 of the SECY quantify the results.

Similar to the public health (accident) attribute, the occupational health (accident) for the severe accident confinement strategy relative to the status quo would realize a combination of the benefits from the severe accident capable vent alternative and the filtered vent alternative.

Within the status quo, the short-term occupational exposure related to the accident occurs at the time of the accident and during the immediate management of the emergency and during decontamination and decommissioning of the onsite property. The radiological occupational exposure resulting from cleanup and refurbishment or decommissioning activities of the damaged facility to occupational workers are found within the long-term occupational exposure. The assumptions for each of the alternatives in relation to the exposures for occupational health (accident) are found in the assumptions section of this regulatory analysis.

As table 91 shows, based on these calculations, the incremental benefit for short-term occupational health (accident) is approximately 6.3 person-rem averted per reactor, or 200 person-rem averted total. The estimated total benefit to the short-term occupational health

(accident) for the Severe Accident Confinement Strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.28 million (3 percent net present value) to $0.18 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.54 million (3 percent net present value) to $0.37 million (7 percent net present value).

As table 92 shows, the delta benefit long-term occupational health (accident) is approximately 8.9 person-rem averted per reactor, or 280 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for the Severe Accident Confinement Strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.30 million (3 percent net present value) to $0.15 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.60 million (3 percent net present value) to $0.29 million (7 percent net present value).

Thus, the estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.58 million (3 percent net present value) to $0.33 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $1.1 million (3 percent net present value) to $0.66 million (7 percent net present value).

The 5^{th} percentile for short-term and long-term occupational health were provided as a low estimate and are shown in tables 93 and 94, respectively, and the 95^{th} percentile for short-term and long-term occupational health were provided as a high estimate and are shown in tables 95 and 96, respectively. The low estimate delta probability-weighted exposure to the short-term occupational health is approximately 0.035 person-rem averted per reactor, or 1.1 person-rem averted total. Therefore, the estimated total benefit to the short-term occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $0.0015 million (3 percent net present value) to $0.0010 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $0.0030 million (3 percent net present value) to $0.0020 million (7 percent net present value).

The low estimate delta benefit long-term occupational health (accident) is approximately 0.045 person-rem averted per reactor, or 1.4 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1,500 (3 percent net present value) to $740 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $3,000 (3 percent net present value) to $1,500 (7 percent net present value).

Thus, the low estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $3,000 (3 percent net present value) to $1,700 (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $6,000 (3 percent net present value) to $3,500 (7 percent net present value).

The high estimate delta probability-weighted exposure to the short-term occupational workers is approximately 28 person-rem averted per reactor, or 870 person-rem averted total.

The estimated total benefit to the short-term occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1.2 million (3 percent net present value) to $0.80 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $2.4 million (3 percent net present value) to $1.6 million (7 percent net present value).

The high estimate delta benefit long-term occupational health (accident) is approximately 33 person-rem averted per reactor, or 1,000 person-rem averted total. The estimated total benefit to the long-term occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $1.1 million (3 percent net present value) to $0.54 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $2.2 million (3 percent net present value) to $1.1 million (7 percent net present value).

Thus, the high estimate estimated total benefit for occupational health (accident) is calculated by adding together the short-term and long-term averted dose to the occupational workers. The estimated total benefit to the occupational health (accident) for the severe accident confinement strategy relative to the status quo, assuming $2,000 per person-rem averted, ranges from $2.3 million (3 percent net present value) to $1.3 million (7 percent net present value) and, assuming $4,000 per person-rem averted, ranges from $4.6 million (3 percent net present value) to $2.7 million (7 percent net present value).

3.6.3 Offsite Property

Table 97 – Summary of Offsite Property Cost Offsets for the Severe Accident Confinement Strategy (Current Framework (CF))

Case	Offsite Property Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
CF	$26	$0.099	$18	$66	$0.065	$12	$43

Offsite property measures the expected total monetary effects on offsite property resulting from the proposed action. Changes to offsite property can take various forms, both direct, (e.g. land, food, and water) and indirect (e.g. tourism). This attribute is typically the product of the change in accident frequency and the property consequences from the occurrence of an accident.

Similar to the previous sections, the cost offsets due to offsite property from the severe accident confinement strategy relative to the status quo is the same as the severe accident capable vent alternative for the first five years and then has the same cost offset as the filtered vent alternative for the rest of the average life.

In the status quo, the offsite property costs are any property consequences resulting from any radiological release from the occurrence of an accident. Normal operational releases and those releases before severe accident are outside the scope of this regulatory analysis. The status quo assumes that the accident would overpressurize containment leading to an uncontrolled radiological plume release.

The cost offsets for the severe accident confinement strategy are quantified relative to the status quo based on the MACCS2 and PRA calculations provided in Enclosure 5. The results for each of the alternatives are compared to the status quo. The calculation for each alternative is made by subtracting the alternative from the status quo.

As table 98 shows, based on these calculations, the estimated total cost offset for the severe accident confinement strategy relative to the status quo ranges from $18 million (3 percent net present value) to $12 million (7 percent net present value).

The 5th and 95th percentile were provided as a low and high estimate and are shown in tables 99 and 100, respectively. The low estimate delta probability-weighted offsite property total cost offset for the severe accident confinement strategy relative to the status quo ranges from $0.099 million (3 percent net present value) to $0.065 million (7 percent net present value).

The high estimate delta probability-weighted offsite property cost total cost offset for the severe accident confinement strategy relative to the status quo ranges from $66 million (3 percent net present value) to $43 million (7 percent net present value).

3.6.4 Onsite Property

Table 101 – Summary of Onsite Property Cost Offsets for the Severe Accident Confinement Strategy (Current Framework (CF))

Case	Onsite Property Cost Offsets (2012 dollars in millions)						
CF	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$19	$0.057	$11	$45	$0.031	$6.1	$25

This attribute measures the expected monetary effects on onsite property, including replacement power costs, decontamination, and refurbishment costs, from the proposed action. There are two forms of onsite property costs that each alternative must disposition. The first type of onsite property costs are the cleanup and decontamination costs for the unit. The second type of onsite property costs are the cost to replace the energy from the damaged or shutdown unit(s). The cost offsets for severe accident capable vents are quantified relative to the status quo based on the RA Handbook and PRA calculations provided in Enclosure 5 of the SECY paper.

There are two forms of onsite property costs that each alternative must disposition. The first type of onsite property costs are the cleanup and decontamination costs for the unit. The second type of onsite property costs are the cost to replace the energy from the damaged or shutdown unit(s).

Also stated within the assumptions, there are 11 units that are co-located on the same site as a Mark I or Mark II reactor. Therefore, those units may be ordered to shutdown due to the severe accident occurring at the adjacent Mark I or Mark II boiling-water reactor. In modeling the replacement energy costs based on these scenarios, it is assumed that the cost offsets would only occur once the performance based alternative is implemented. Therefore, the cost offsets from the onsite property would not begin until after five years.

As table 102 shows, based on these calculations, the estimated total cost offset for the severe accident confinement strategy relative to the status quo ranges from $11 million (3 percent net present value) to $6.1 million (7 percent net present value).

The 5th and 95th percentile were provided to provide as a low and high estimate and are shown in tables 103 and 104, respectively. The low estimated total cost offset for the severe accident confinement strategy relative to the status quo ranges from $0.057 million (3 percent net present value) to $0.031 million (7 percent net present value).

The high estimated total cost offset for the severe accident confinement strategy relative to the status quo ranges from $45 million (3 percent net present value) to $25 million (7 percent net present value).

3.6.4.1 Replacement Energy Costs

Table 105 – Summary of Replacement Energy Cost Offsets for the Severe Accident Confinement Strategy (Current Framework (CF))

Case	Replacement Energy Cost Offsets (2012 dollars in millions)						
CF	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
	$12	$0.32	$7.1	$25	$0.18	$3.9	$14

As stated previously within this section, there would be a cost offset for replacement energy costs, assuming reactors located at other sites would be ordered to shut down, as this severe accident confinement strategy is modeled similar to the what occurred following the TMI-2 accident where the co-located TMI-1 unit was not allowed to operate. Therefore, the averted replacement energy costs would provide a cost offset once the severe accident confinement strategy alternative is implemented after five years. Assuming the replacement energy costs provided in the RA Handbook, as shown in table 106, the estimated probability-weighted cost offset for the severe accident confinement strategy relative to the status quo ranges from $7.1 million (3 percent net present value) to $3.9 million (7 percent net present value).

The NRC has provided a low and high replacement energy cost estimates based on the assumptions within the sensitivity analysis section previously, as shown in tables 107 and 108, respectively. Based on low replacement energy cost, the estimated probability-weighted cost offset for the severe accident confinement strategy relative to the status quo ranges from $0.32 million (3 percent net present value) to $0.18 million (7 percent net present value). Based on the high replacement energy cost, the estimated probability-weighted cost offset for the severe accident confinement strategy relative to the status quo ranges from $25 million (3 percent net present value) to $14 million (7 percent net present value).

3.6.4.2 All Mark I and Mark II Shutdown Sensitivity Analysis

For a sensitivity analysis, the NRC assumes that all Mark I and Mark II reactors would be shut down due to an unmitigated release (alternative 1) and that in all other alternatives, the replacement energy costs would not be required.

Following the assumptions for replacement energy costs within the RA Handbook, as table 109 shows, the estimated probability-weighted cost offsets for the severe accident confinement strategy relative to the status quo would range from $28 million (3 percent net present value) to $18 million (7 percent net present value).

As a sensitivity analysis, the NRC has provided a low and high replacement energy cost estimates, as shown in tables 110 and 111, respectively. Based on low replacement energy cost, the estimated probability-weighted cost offset for the severe accident confinement strategy relative to the status quo ranges from $1.3 million (3 percent net present value) to $0.78 million (7 percent net present value). Based on the high replacement energy cost, the estimated probability-weighted cost offset for the severe accident confinement strategy relative to the status quo ranges from $100 million (3 percent net present value) to $63 million (7 percent net present value).

3.6.5 Industry Implementation

Table 112 – Summary of Industry Implementation Costs for the Severe Accident Confinement Strategy Alternative

Action	Implementation Date	Costs (2012 dollars in millions)	
		3% Net Present Value	7% Net Present Value
Install Severe Accident Capable Vents	2012	$86 to $170	$86 to $170
Level 2 PRA and Review	2017	$19	$17
Generic Severe Accident Confinement Strategy	2017	$CI_{i1}/1.03^t$; t= 5	$CI_{i1}/1.07^t$; t= 5
Installation of Equipment	2017	$CI_{i2}/1.03^t$; t= 5	$CI_{i2}/1.07^t$; t= 5
Total	-	$110 to $190 + $(CI_{i1} + CI_{i2})/1.03^t$; t= 5	$100 to $190 + $(CI_{i1} + CI_{i2})/1.07^t$; t= 5

This attribute measures the projected net economic effect on the affected licensees to install or implement mandated changes. Costs will include procedural and administrative activities, equipment, labor, materials, and shutdown costs, including the cost of replacement power.

The industry implementation costs would require a four-step process. The first step would be to install severe accident capable vents before or during the development of the generic severe accident confinement strategy. Therefore, the qualitative industry implementation costs would be equivalent to the severe accident capable alternative (alternative 2) and, as shown in table 113, would have an estimated range from $86 million to $170 million.

The second step of the process would likely require Level 2 PRAs for the 16 sites. As each licensee is developing the Level 2 PRAs, a generic severe accident confinement strategy would likely be developed by industry concurrently. It is assumed that every Mark I and Mark II unit would be required to develop and have peer reviewed a Level 2 PRA for the severe accident confinement strategy alternative. The NRC assumes that the upgrade of the plant-specific Level 2 PRAs would take 3,120 per unit and would be required for all units and the peer review of the PRA would require 624 hours per unit. Therefore, as shown in table 114, the estimated industry implementation costs for the Level 2 PRAs ranges from $19 million (3 percent net present value) to $17 million (7 percent net present value).

The third step would require the industry to apply the generic severe accident confinement strategy to each site-specific PRA and then submit that information to the NRC for review for both the new design and any procedural changes that would be required. The generic severe accident confinement strategy may be based on an NRC guidance document that would likely be developed with industry input.

Finally, after receiving the NRC approval for the design modifications, each unit would be required to install the equipment to meet the severe accident confinement strategy. This would require both installing the equipment to the required levels and an initial inspection of that equipment. Depending on the complexity of the design and modifications, as well as the site-specific nature of the modifications, could lead to large costs. The estimated unquantified industry implementation costs range from $(CI_{i1} + CI_{i2})/1.03^t$; t=5 (3 percent net present value) to $(CI_{i1} + CI_{i2})/1.07^t$; t=5 (7 percent net present value).

3.6.6 Industry Operation

Table 115 – Summary of Industry Operation Costs for the Severe Accident Confinement Strategy Alternative

Action	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Inspection of Severe accident capable vents	$31	$22
Maintenance/Upgrading of Level 2 PRAs	$24	$14
Monitoring and Testing of Equipment, Guidance, and Procedures	$CI_O/1.03^t$	$CI_O/1.07^t$
Total	$\$55 + CI_O/1.03^t$	$\$36 + CI_O/1.07^t$

This attribute measures the projected net economic effect due to routine and recurring activities required by the proposed action on all affected licensees.

The industry operation costs would be based on the new inspections and maintenance of the materials and guidance from the site-specific severe accident confinement strategy. There would be required inspections and maintenance for the severe accident capable vents and then an additional cost for any other implementations. As shown in table in table 116, the estimated cost for the severe accident capable vents ranges from $31 million (3 percent net present value) to $22 million (7 percent net present value).

The industry would also incur operational costs from maintaining and upgrading the site-specific Level 2 PRAs. The NRC assumes that it would require 200 hours for PRA maintenance each reactor year and every four years would require 480 hours for upgrading each unit's PRA. As shown in table 117, the estimated cost for the maintenance and upgrading the Level 2 PRAs ranges from $24 million (3 percent net present value) to $14 million (7 percent net present value).

Additionally, any operational costs that would be required in relation to testing of the newly installed equipment outside of the severe accident capable vents and any operational costs to modifications of guidance or testing of procedures would also be included within the industry operation costs. The estimated unquantified industry operation costs range from $(CI_{i1} + CI_{i2})/1.03^t$ (3 percent net present value) to $(CI_{i1} + CI_{i2})/1.07^t$ (7 percent net present value).

3.6.7 NRC Implementation

Table 118 - Summary of NRC Implementation Costs for the Severe Accident Confinement Strategy Alternative

Action	Implementation Date	Costs (2012 dollars in millions)	
		3% Net Present Value	7% Net Present Value
Review of Severe accident capable vents	2012	$0.74	$0.74
Level 2 PRA Review	2018	$2.3	$1.8
Development of Regulatory Framework	2012 – 2018	$CN_{i1}/1.03^t$; t= 1 to 6	$CN_{i1}/1.07^t$; t = 1 to 6
Inspection of Equipment	2018	$CN_{i2}/1.03^t$; t= 6	$CN_{i2}/1.07^t$; t= 6
Total	-	$3.0 + $(CN_{i1} + CN_{i2})/1.03^t$	$2.5 + $(CN_{i1} + CN_{i2})/1.07^t$

This attribute measures the projected net economic effect on the NRC to place the proposed action into operation. Costs already incurred, including all pre-decisional activities performed by the NRC, are viewed as “sunk” costs and are not to be included.

Like the industry implementation, the NRC implementation costs would occur from the multi-step process, which are not necessarily sequential in order. The first step would be from the inspection of the severe accident capable vents. These costs are the summation of the NRC implementation costs for the Mark I and Mark II containments for the severe accident capable vents. As shown in table 119, the estimated NRC implementation costs is $0.74 million for the severe accident confinement strategy alternative.

The second step would require the NRC to inspect both the documents submitted by industry, as well as any plant design modifications, including Level 2 PRAs. The NRC assumes that review and submittal of a Level 2 PRA and issuance of a safety evaluation report (SER) would take 740 hours per unit in year 2018. Therefore, as shown in table 120, the estimated NRC implementation costs to review Level 2 PRAs ranges from $2.3 million (3 percent net present value) to $1.8 million (7 percent net present value).

The third step of the process, which may come before the second step, would developing the regulatory framework. If the NRC determines that a safety equivalent goal needs to be developed, significant effort would be required to develop that goal and follow the normal NRC process. If the NRC does not determine that a goal needs to be established, the NRC would still be required to go through the regulatory framework process, including relevant guidance documents.

The fourth step would come from inspection of any installed equipment other than the severe accident capable vents for each unit. Therefore, the NRC assumes that there would be costs from inspections. The estimated unquantified NRC implementation costs range from $(CN_{i1} + CN_{i2})/1.03^t$ (3 percent net present value) to $(CN_{i1} + CN_{i2})/1.07^t$ (7 percent net present value).

3.6.8 NRC Operation

Table 121 – Summary of Industry Operation Costs for the Severe Accident Confinement Strategy Alternative

Action	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Inspection of Severe accident capable vents	$14	$9.9
Inspection of Equipment	$CN_O/1.03^t$	$CN_O/1.07^t$
Total	$\$14 + CN_O/1.03^t$	$\$9.9 + CN_O/1.07^t$

This attribute measures the projected net economic effect on the NRC after the proposed action is implemented. Additional inspections, evaluation, or enforcement activities would be examples of such costs.

As shown in table 122, the estimated NRC operation costs from reviewing and inspecting the severe accident capable vents would range from $14 million (3 percent net present value) to $9.9 million (7 percent net present value

The NRC would also incur operation costs from any inspections of equipment that is installed for the severe accident confinement strategy alternative that is not the severe accident capable vent. The estimated unquantified NRC operation costs range from $CN_O/1.03^t$ (3 percent net present value) to $CN_O/1.07^t$ (7 percent net present value).

3.6.9 Environmental Considerations

The environmental considerations would be almost as large for the severe accident confinement strategy alternative as for the filtered vent alternative. The fully implemented severe accident confinement strategy alternative would be as effective as the filtered vent alternative; however, because of the implementation times, the severe accident confinement strategy alternative would not be as effective in relation to environmental considerations as the filtered vent alternative.

3.6.10 Regulatory Efficiency

This attribute attempts to measure regulatory and compliance improvements resulting from the proposed action. These may include changes in industry reporting requirements and the NRC's inspection and review effects. Achieving consistency with international standards groups may also improve regulatory efficiency for both the NRC and the groups.

The severe accident confinement strategy would increase regulatory efficiency relative to the filtered vent alternative as it would performance based. This would be similar to how the NRC has treated other recent regulations and orders and would be consistent with treatment of other reactor containments.

3.6.11 Other Considerations

As the other considerations are the same as the filtered vent alternative, they are provided in relation to the filtered vent alternative.

3.6.12.1 Uncertainties

The uncertainties that exist within the filtered vent alternative can be applied to the severe accident confinement strategy alternative. However, as there may not be an engineered filter that would alleviate many of the uncertainties, the severe accident confinement strategy alternative would not resolve the uncertainties surrounding mitigation as well as the filtered vent alternative.

3.6.12.1 Hydrogen Control

The severe accident confinement strategy alternative provides the same benefit as the severe accident capable vent alternative and provides no delta benefit.

3.6.12.2 Defense in Depth

The severe accident confinement strategy alternative may lead to units not including an engineered filter; therefore, there would not be as much defense in depth as there would be if an engineered filter was put on the severe accident capable vents. Thus, the severe accident confinement strategy alternative would not provide as much defense in depth as the filtered vent alternative.

3.6.12.3 Severe Accident Management

The severe accident management benefits would be the same for the severe accident confinement strategy alternative as the filtered vent alternative.

3.6.12.4 Emergency Planning

The emergency planning benefit should be essentially equivalent to the filtered vent alterative.

3.6.12.5 Independence of Barriers

While the severe accident confinement strategy alternative may lead to some units having independent engineered filters, for those units that would not have an engineered independent filter, the independence of the systems would not be as robust as the filtered vent. Therefore, the independence of barriers would be less for the severe accident confinement strategy alternative relative to the filtered vent alternative.

3.6.12.6 Severe Accident Policy Statement

The severe accident confinement strategy alternative has the same disbenefits as the filtered vent alternative and the severe accident capable vent alternative.

3.6.12.7 External Events

The severe accident confinement strategy alternative has the same benefits as the filtered vent alternative.

3.6.12.8 Multi-Unit Events

The severe accident confinement strategy alternative has the same benefits as the filtered vent alternative.

3.6.12 Attributes Not Affected

Attributes that are not affected by this action are as followed: (1) public health (routine); (2) occupational safety (routine); (3) other government; (4) general public; (5) improvements in knowledge; (6) safeguards considerations; and (7) antitrust considerations.

3.7 Totals

3.7.1 Summary Tables

The following summary table provides the quantified and qualified costs and benefits for the alternatives. For the quantitative analysis, the "best estimate" values are used a range of estimates is provided based on the sensitivity assumptions of dollar per person-rem and cost of replacement energy (not including shutting down all Mark I and Mark II reactors).

Table 123 – Summary of Totals for Alternatives

Net Monetary Savings (or Costs) – Total Present Value	Non-Monetary Benefits/Costs
Alternative 1: No Action $0	**Qualitative Benefits and Costs:** None.
Alternative 2 – Severe accident capable vents *Alternative 2a – Mark I Containments* **Industry:** ($63 million) – ($86 million) using a 3% discount rate ($58 million) – ($81 million) using a 7% discount rate **NRC:** ($8.9 million) using a 3% discount rate ($6.2 million) using a 7% discount rate **Benefits:** $0.93 million – $160 million using a 3% discount rate $0.60 million – $100 million using a 7% discount rate *Alternative 2b – Mark II Containments* **Industry:** ($49 million) – ($110 million) using a 3% discount rate ($46 million) – ($110 million) using a 7% discount rate **NRC:** ($3.3 million) using a 3% discount rate ($2.3 million) using a 7% discount rate **Benefits:** $0.32 million – $55 million using a 3% discount rate $0.21 million – $35 million using a 7% discount rate	**Qualitative Costs:** None. **Qualitative Benefits:** Uncertainties. Defense-in-Depth. Hydrogen Control. **Qualitative Costs:** None. **Qualitative Benefits:** Uncertainties. Defense-in-Depth. Hydrogen Control.
Alternative 3 – Filtered Vents	**Qualitative Costs:** None.

Net Monetary Savings (or Costs) – Total Present Value	Non-Monetary Benefits/Costs
Industry: ($510 million) – ($660 million) using a 3% discount rate ($490 million) – ($640 million) using a 7% discount rate **NRC:** ($12 million) using a 3% discount rate ($8.6 million) using a 7% discount rate **Benefits:** $0.68 million – $290 million using a 3% discount rate $0.43 million – $190 million using a 7% discount rate	**Qualitative Benefits:** Uncertainties. Defense-in-Depth. Hydrogen Control. Severe Accident Management. Emergency Planning. Safety Culture. Independence of Barriers. International Practices.
Alternative 4 – Severe Accident Confinement Strategy **Industry:** ($160 million) – ($250 million) using a 3% discount rate ($140 million) – ($230 million) using a 7% discount rate **NRC:** ($17 million) using a 3% discount rate ($12 million) using a 7% discount rate **Benefits:** $0.52 million – $270 million using a 3% discount rate $0.31 million – $170 million using a 7% discount rate	**Qualitative Costs:** The unquantified costs come from the unknowns about the equipment that would be needed to be installed as well as the uncertainties in relation to the implementation and inspection costs. These costs are highly speculative and sensitive to potential changes and subject to regulatory risk. **Qualitative Benefits:** The overall benefits for the severe accident confinement strategy would be similar to the benefits for the filtered vent alternative (alternative 3). These benefits are highly speculative and sensitive to potential changes.

The following table provides a summary evaluation of the unquantified attributes and considerations. As there are many attributes and considerations that cannot be quantified, the attributes and considerations can only be compared to each of the alternatives. The alternatives are provided a rank of highest, middle, or lowest, for each qualitative attribute or consideration. For those attributes or considerations that provide a disbenefit, they are ranked negatively from highest to lowest; therefore, within the regulatory efficiency attribute, the severe accident capable vents and the filtered vents provide the highest disbenefit and the severe accident confinement strategy provides the next highest disbenefit.

Table 124 – Summary Evaluation of Estimated Unquantified Attributes and Considerations

Attribute/Consideration	Severe Accident Capable Vents	Filtered Vents	Severe Accident Confinement Strategy
Environmental Considerations	Lowest	Highest	Middle
Regulatory Efficiency	(Highest)	(Highest)	(Middle)
Uncertainties	Lowest	Highest	Middle
Hydrogen Control	Middle	Middle	Middle
Defense in Depth	Lowest	Highest	Middle
Severe Accident Management	Lowest	Middle	Middle
Emergency Planning	Lowest	Highest	Middle
Independence of Barriers	Lowest	Highest	Middle
Severe Accident Policy Statement	(Highest)	(Highest)	(Highest)
External Events	Lowest	Middle	Middle

Multi-Unit Events	Lowest	Middle	Middle

All of the attributes and considerations other than the severe accident policy statement and the consistency with other technologies, provide positive benefits for the alternative. In general, the filtered vents alternative provides the highest relative positive benefits, the Severe Accident Confinement Strategy provides the second highest relative positive benefits, and the severe accident capable vents the lowest relative positive benefits, relative to the status quo.

3.7.2 Implementation and Operation Costs

3.7.2.1 Alternative 2 – Severe Accident Capable Vents

3.7.2.1.1 Mark I Containments

Table 125 – Summary of Total Implementation and Operation Costs – Severe Accident Capable Vents – Mark I Containments

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Industry Implementation	$46 to $69	$46 to $69
Industry Operation	$17	$12
NRC Implementation	$0.44	$0.44
NRC Operation	$8.5	$5.8
Total	$72 to $95	$64 to $87

The severe accident capable vents alternative for Mark I containments total cost is the summation of the industry implementation and operation costs and the NRC implementation and operation costs. Therefore, as shown in table 126, the total estimated costs for severe accident capable vents relative to the status quo ranges on the low range from $72 million (3 percent net present value) to $64 million (7 percent net present value) and on the high range from $95 million (3 percent net present value) to $87 million (7 percent net present value).

The cost per unit for the severe accident capable vent is the totals provided in the paragraph above divided by the number of Mark I units. Therefore, as shown in table 127, the total estimated costs per unit for severe accident capable vents relative to the status quo ranges on the low range from $3.1 million (3 percent net present value) to $2.8 million (7 percent net present value) and on the high range from $4.1 million (3 percent net present value) to $3.8 million (7 percent net present value).

3.7.2.1.2 Mark II Containments

Table 128 – Summary of Total Implementation and Operation Costs – Severe Accident Capable Vents – Mark II Containments

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Industry Implementation	$40 to $100	$40 to $100
Industry Operation	$8.9	$6.1
NRC Implementation	$0.30	$0.30
NRC Operation	$3.0	$2.0
Total	$52 to $110	$48 to $110

The severe accident capable vents alternative for Mark II containments total cost is the summation of the industry implementation and operation costs and the NRC implementation and operation costs. Therefore, as shown in table 129, the total estimated costs for severe accident capable vents relative to the status quo ranges on the low range from $52 million (3 percent net present value) to $48 million (7 percent net present value) and on the high range from $110 million (3 percent net present value) to $110 million (7 percent net present value).

The cost per unit for the severe accident capable vent is the totals provided in the paragraph above divided by the number of Mark II units. Therefore, as shown in table 130, the total estimated costs per unit for severe accident capable vents relative to the status quo ranges on the low range from $6.5 million (3 percent net present value) to $6.0 million (7 percent net present value) and on the high range from $14 million (3 percent net present value) to $14 million (7 percent net present value).

3.7.2.2 Alternative 3 – Filtered Vents

Table 131 – Summary of Total Implementation and Operation Costs – Filtered Vents

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Industry Implementation	$470 to $620	$470 to $620
Industry Operation	$35	$24
NRC Implementation	$0.84	$0.84
NRC Operation	$11	$7.8
Total	$520 to $670	$500 to $650

The filtered vents alternative total cost is the summation of the industry implementation and operation costs and the NRC implementation and operation costs. Therefore, as shown in table 132, the total estimated costs for filtered vents relative to the status quo ranges on the low range from $520 million (3 percent net present value) to $500 million (7 percent net present value) and on the high range from $670 million (3 percent net present value) to $650 million (7 percent net present value).

The cost per unit for the filtered vent is the totals provided in the paragraph above divided by the number of Mark I and Mark II units. Therefore, as shown in table 133, the total estimated costs per unit for filtered vents relative to the status quo ranges on the low range from $17 million (3 percent net present value) to $16 million (7 percent net present value) and on the high range from $22 million (3 percent net present value) to $21 million (7 percent net present value).

3.7.2.3 Alternative 4 – Severe Accident Confinement Strategy

Table 134 – Total Implementation and Operation Costs – Severe Accident Confinement Strategy

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Industry Implementation	\$110 to \$190 + $(CI_{i1} + CI_{i2})/1.03^t$	\$100 to \$190 + $(CI_{i1} + CI_{i2})/1.07^t$
Industry Operation	\$55 + $CI_O/1.03^t$	\$36 + $CI_O/1.07^t$
NRC Implementation	\$3.0 + $(CN_{i1} + CN_{i2})/1.03^t$	\$2.5 + $(CN_{i1} + CN_{i2})/1.07^t$
NRC Operation	\$14 + $CN_O/1.03^t$	\$9.9 + $CN_O/1.07^t$
Total	\$180 to \$260 + $(CI_{i1} + CI_{i2} + CI_O + CN_{i1} + CN_{i2} + CN_O)/1.03^t$	\$150 to \$240 + $(CI_{i1} + CI_{i2} + CI_O + CN_{i1} + CN_{i2} + CN_O)/1.07^t$
Total per Unit	\$5.8 to \$8.4 + $\{(CI_{i1} + CI_{i2} + CI_O + CN_{i1} + CN_{i2} + CN_O)/1.03^t\}/31$	\$4.8 to \$7.7 + $\{(CI_{i1} + CI_{i2} + CI_O + CN_{i1} + CN_{i2} + CN_O)/1.07^t\}/31$

[1] The time,t, is not the same value for each unquantified cost.

The severe accident confinement strategy alternative total cost is the summation of the industry implementation and operation costs and the NRC implementation and operation costs. Therefore, as shown in the table above, the estimated quantified total costs range from \$180 million to \$260 million (3 percent net present value) and \$150 million to \$240 million (7 percent net present value). There are many unknowns in relation to the various costs. The estimated quantified total cost per unit ranges from \$5.8 million to \$8.4 million (3 percent net present value) and \$4.8 million to \$7.7 million (7 percent net present value).

As stated previously, these costs are based on one approach to implement the severe accident confinement strategy that may be unsuccessful or may adversely impact the alternative estimated cost or achieved benefits.

3.7.3 Total Benefits and Cost Offsets

3.7.3.1 Alternative 2 – Severe accident capable vents

3.7.3.1.1 Mark I Containments

Table 135 – Summary of Total Benefits and Cost Offsets – Severe Accident Capable Vents – Mark I Containments

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	\$4.9	\$3.5	\$2.4
Occupational Health (Accident)	\$0.47	\$0.30	\$0.19
Offsite Property	\$12	\$8.5	\$5.8
Onsite Property	\$9.1	\$5.5	\$3.2
Replacement Energy	\$0	\$0	\$0
Total	\$26	\$18	\$12

The total benefits, which include only the public health (accident) and occupational health (accident), for the severe accident capable vents, as shown in table 136, provide an estimated person-rem averted of 2,700 and provide a benefit ranging from, assuming \$2,000 per person-rem averted, \$3.8 million (3 percent net present value) to \$2.6 million (7 percent net

present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $7.8 million (3 percent net present value) to $5.3 million (7 percent net present value).

The severe accident capable vent total benefits and cost offsets is the summation of the those benefits and cost offsets for the public health (accident), occupational health (accident), offsite property, and onsite property, including replacement energy costs. Therefore, as shown in the table above, the total estimated benefits and cost offsets for severe accident capable vents relative to the status quo ranges from $18 million (3 percent net present value) to $12 million (7 percent net present value). The total estimated benefits and cost offsets per unit, as shown in table 137, ranges from $0.77 million (3 percent net present value) to $0.50 million (7 percent net present value).

The 5th and 95th percentile were provided to provide as a low and high estimate, the total benefits are shown in tables 138 and 139, respectively, and the total benefits and cost offsets for the 5th and 95th percentile are shown in tables 140 and 141, respectively. The low estimate total estimated benefits for severe accident capable vents relative to the status quo provide an estimated person-rem averted of 15 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $0.022 million (3 percent net present value) to $0.015 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $0.042 million (3 percent net present value) to $0.029 million (7 percent net present value). The high estimate total estimated benefits for severe accident capable vents relative to the status quo provide an estimated person-rem averted of 11,000 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $15 million (3 percent net present value) to $11 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $32 million (3 percent net present value) to $21 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets for severe accident capable vents relative to the status quo ranges from $0.092 million (3 percent net present value) to $0.060 million (7 percent net present value). The high estimate total estimated benefits and cost offsets for severe accident capable vents relative to the status quo ranges from $66 million (3 percent net present value) to $44 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets per unit, as shown in table 142, ranges from $4,000 (3 percent net present value) to $2,600 (7 percent net present value). The high estimate total estimated benefits and cost offsets per unit, as shown in table 143, ranges from $2.8 million (3 percent net present value) to $1.9 million (7 percent net present value).

3.7.3.1.2 Mark II Containments

Table 144 – Summary of Total Benefits and Cost Offsets – Severe Accident Capable Vents – Mark II Containments

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$1.7	$1.2	$0.85
Occupational Health (Accident)	$0.083	$0.059	$0.040
Offsite Property	$4.2	$3.0	$2.0
Onsite Property	$3.1	$1.9	$1.1
Replacement Energy	$0	$0	$0
Total	$9.1	$6.2	$4.0

The total benefits, which include only the public health (accident) and occupational health (accident), for the severe accident capable vents, as shown in table 145, provide an estimated person-rem averted of 960 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $1.3 million (3 percent net present value) to $0.91 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $2.6 million (3 percent net present value) to $1.7 million (7 percent net present value).

The severe accident capable vent total benefits and cost offsets is the summation of the those benefits and cost offsets for the public health (accident), occupational health (accident), offsite property, and onsite property, including replacement energy costs. Therefore, as shown in the table above, the total estimated benefits and cost offsets for severe accident capable vents relative to the status quo ranges from $6.2 million (3 percent net present value) to $4.0 million (7 percent net present value). The total estimated benefits and cost offsets per unit, as shown in table 146, ranges from $0.78 million (3 percent net present value) to $0.51 million (7 percent net present value).

The 5^{th} and 95^{th} percentile were provided to provide as a low and high estimate, the total benefits are shown in tables 147 and 148, respectively, and the total benefits and cost offsets for the 5^{th} and 95^{th} percentile are shown in tables 149 and 150, respectively. The low estimate total estimated benefits for severe accident capable vents relative to the status quo provide an estimated person-rem averted of 5.2 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $7,400 (3 percent net present value) to $5,100 (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $0.015 million (3 percent net present value) to $0.010 million (7 percent net present value).

The high estimate total estimated benefits for severe accident capable vents relative to the status quo provide an estimated person-rem averted of 3,800 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $5.4 million (3 percent net present value) to $3.7 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $11 million (3 percent net present value) to $7.3 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets for severe accident capable vents relative to the status quo ranges from $0.032 million (3 percent net present value) to $0.021 million (7 percent net present value). The high estimate total estimated benefits and cost offsets for severe accident capable vents relative to the status quo ranges from $23 million (3 percent net present value) to $15 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets per unit, as shown in table 151, ranges from $0.0041 million (3 percent net present value) to $0.0026 million (7 percent net present value). The high estimate total estimated benefits and cost offsets per unit, as shown in table 152, ranges from $3.0 million (3 percent net present value) to $1.9 million (7 percent net present value).

3.7.3.2 Alternative 3 – Filtered Vents

Table 153 – Summary of Total Benefits and Cost Offsets – Filtered Vents

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$13	$9.2	$6.3
Occupational Health (Accident)	$0.42	$0.30	$0.20
Offsite Property	$29	$20	$14
Onsite Property	$20	$12	$7.1
Replacement Energy	$15	$10	$6.2
Total	$77	$52	$34

The total benefits, which include only the public health (accident) and occupational health (accident), for the filtered vents, as shown in table 154, provide an estimated person-rem averted of 7,000 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $9.9 million (3 percent net present value) to $6.7 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $19 million (3 percent net present value) to $14 million (7 percent net present value).

The filtered vent total benefits and cost offsets is the summation of the those benefits and cost offsets for the public health (accident), occupational health (accident), offsite property, and onsite property, including replacement energy costs. Therefore, as shown in the table above, the total estimated benefits and cost offsets for filtered vents relative to the status quo ranges from $52 million (3 percent net present value) to $34 million (7 percent net present value). The total estimated benefits and cost offsets per unit, as shown in table 155, ranges from $1.7 million (3 percent net present value) to $1.1 million (7 percent net present value).

The 5^{th} and 95^{th} percentile were provided to provide as a low and high estimate, the total benefits are shown in tables 156 and 157, respectively, and the total benefits and cost offsets for the 5^{th} and 95^{th} percentile are shown in tables 158 and 159, respectively. The low estimate total estimated benefits for filtered vents relative to the status quo provide an estimated person-rem averted of 37 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $0.053 million (3 percent net present value) to $0.036 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $0.11 million (3 percent net present value) to $0.073 million (7 percent net present value).

The high estimate total estimated benefits for filtered vents relative to the status quo provide an estimated person-rem averted of 27,000 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $38 million (3 percent net present value) to $26 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $75 million (3 percent net present value) to $51 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets for filtered vents relative to the status quo ranges from $10 million (3 percent net present value) to $6.3 million (7 percent net present value). The high estimate total estimated benefits and cost offsets for filtered vents relative to the status quo ranges from $170 million (3 percent net present value) to $110 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets per unit, as shown in table 160, ranges from $0.33 million (3 percent net present value) to $0.20 million (7 percent net present value). The high estimate total estimated benefits and cost offsets per unit, as shown in table 161, ranges from $5.4 million (3 percent net present value) to $3.4 million (7 percent net present value).

3.7.3.3 Alternative 4 – Severe Accident Confinement Strategy

Table 162 – Summary of Total Benefits and Cost Offsets – Severe Accident Confinement Strategy

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$12	$8.1	$5.3
Occupational Health (Accident)	$0.40	$0.28	$0.18
Offsite Property	$26	$18	$12
Onsite Property	$19	$11	$6.1
Replacement Energy	$12	$7.1	$3.9
Total	$12	$44	$27

The total benefits, which include only the public health (accident) and occupational health (accident), for the severe accident confinement strategy alternative related to the status quo, as shown in table 163, provide an estimated person-rem averted of 6,400 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $8.7 million (3 percent net present value) to $5.6 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $17 million (3 percent net present value) to $12 million (7 percent net present value).

The severe accident confinement strategy alternative total benefits and cost offsets is the summation of the those benefits and cost offsets for the public health (accident), occupational health (accident), offsite property, and onsite property, including replacement energy costs. Therefore, as shown in the table above, the total estimated benefits and cost offsets for the severe accident confinement strategy relative to the status quo ranges from $44 million (3 percent net present value) to $27 million (7 percent net present value). The total estimated benefits and cost offsets per unit, as shown in table 164, ranges from $1.4 million (3 percent net present value) to $0.90 million (7 percent net present value).

The 5^{th} and 95^{th} percentile were provided to provide as a low and high estimate, the total benefits are shown in tables 165 and 166, respectively, and the total benefits and cost offsets for the 5^{th} and 95^{th} percentile are shown in tables 167 and 168, respectively. The low estimate total estimated benefits for the severe accident confinement strategy relative to the status quo provide an estimated person-rem averted of 34 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $0.047 million (3 percent net present value) to $0.030 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-

rem averted, $0.095 million (3 percent net present value) to $0.062 million (7 percent net present value).

The high estimate total estimated benefits for the severe accident confinement strategy relative to the status quo provide an estimated person-rem averted of 25,000 and provide a benefit ranging from, assuming $2,000 per person-rem averted, $33 million (3 percent net present value) to $22 million (7 percent net present value) and provide a benefit ranging from, assuming $4,000 per person-rem averted, $67 million (3 percent net present value) to $44 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets for the severe accident confinement strategy relative to the status quo ranges from $7.3 million (3 percent net present value) to $4.0 million (7 percent net present value). The high estimate total estimated benefits and cost offsets for the severe accident confinement strategy relative to the status quo ranges from $150 million (3 percent net present value) to $91 million (7 percent net present value).

The low estimate total estimated benefits and cost offsets per unit, as shown in table 169, ranges from $0.24 million (3 percent net present value) to $0.13 million (7 percent net present value). The high estimate total estimated benefits and cost offsets per unit, as shown in table 170, ranges from $4.7 million (3 percent net present value) to $2.9 million (7 percent net present value).

3.7.4 Sensitivity Analysis

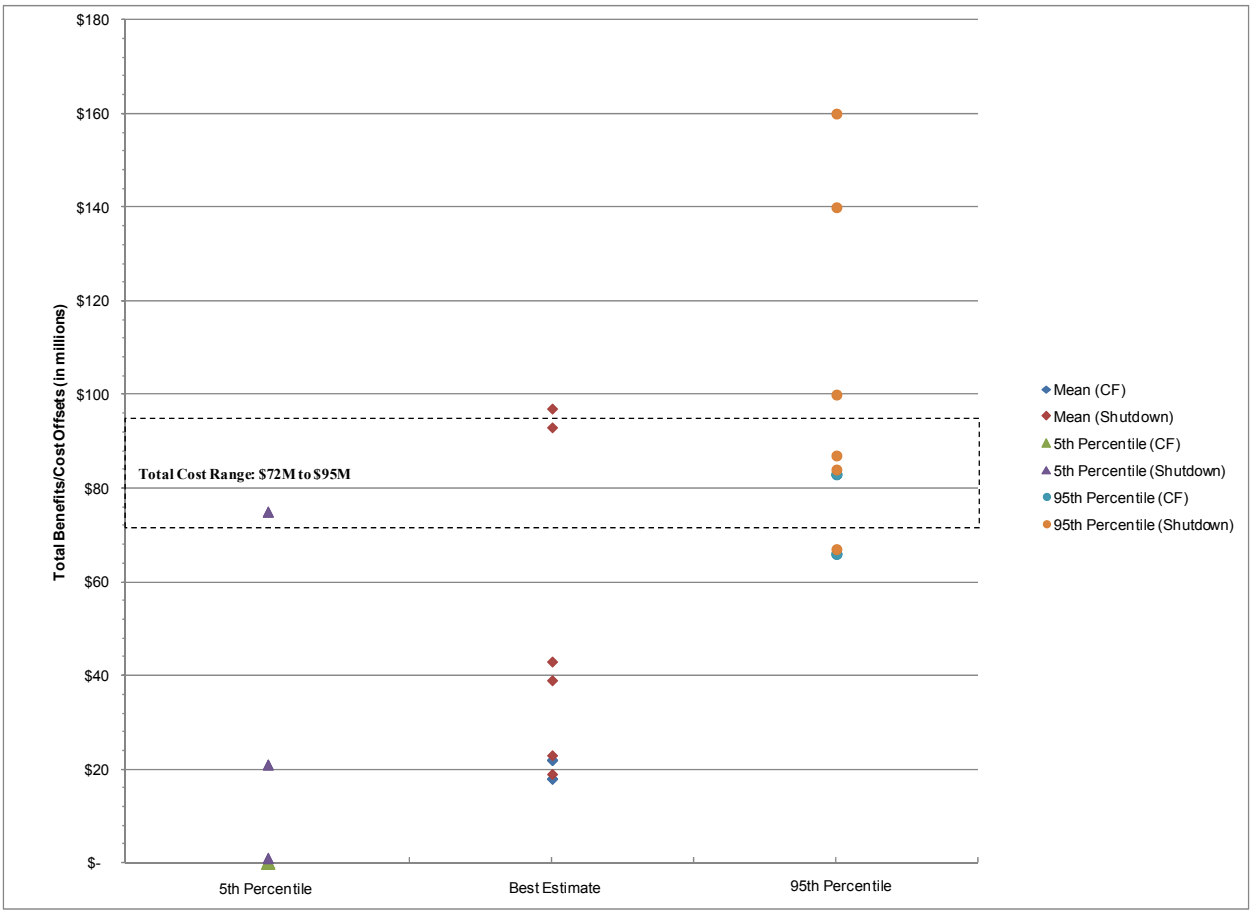
3.7.4.1 Alternative 2 – Severe accident capable vents

3.7.4.1.1 Mark I containments

As shown in table 171, the total benefits and offset costs range for severe accident capable vents relative to the status quo ranges from $0.093 million (3 percent net present value) and $0.060 million (7 percent net present value) to $160 million (3 percent net present value) and $100 million (7 percent net present value) and an undiscounted range from $0.14 million to $210 million.

The total estimated benefits and cost offsets per unit sensitivity analysis, as shown in table 172, ranges from $0.0040 million (3 percent net present value) and $0.0026 million (7 percent net present value) to $7.0 million (3 percent net present value) and $4.3 million (7 percent net present value) and an undiscounted range from $0.0061 million to $10 million.

Table 173 (Chart 1) – Sensitivity Analysis – Severe Accident Capable Vents – Mark I Containments – 3 Percent Net Present Value



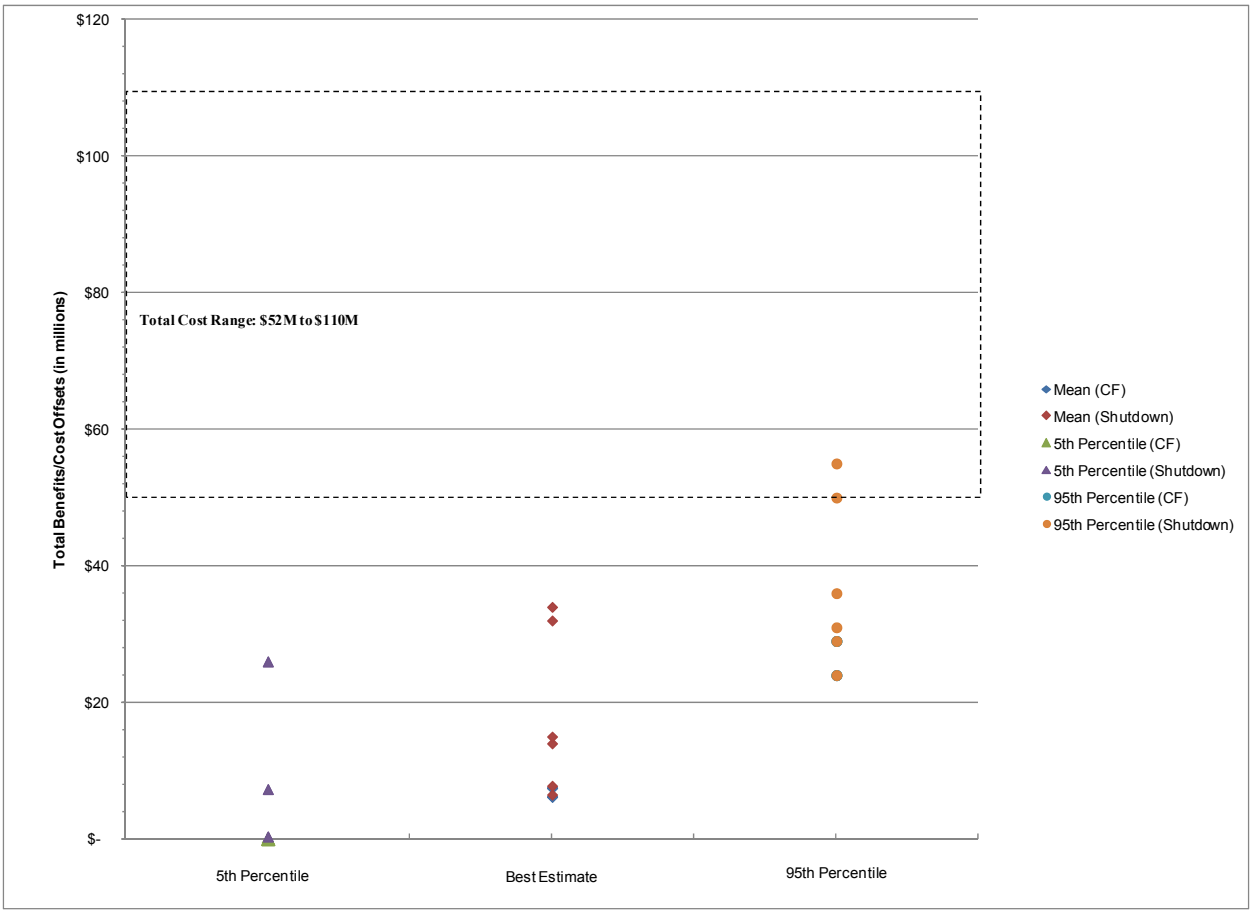
Tables 173, 174, and 175 (Charts 1, 2, and 3), show the sensitivities of the costs and benefits in 3 percent net present value, 7 percent net present value, and undiscounted, respectively. The charts provide the 5th percentile, best/point estimate, and the 95th percentile. The total benefits and cost offsets are the points in the chart and the Industry and NRC implementation and operation costs are the bar provided in the charts. Tables 176, 177, and 178 (Charts 4, 5, and 6) provide the sensitivities of the costs and benefits on a per unit basis in 3 percent net present value, 7 percent net present value, and undiscounted, respectively.

3.7.4.1.2 Mark II Containments

As shown in table 179, the total benefits and offset costs range for severe accident capable vents relative to the status quo ranges from $0.032 million (3 percent net present value) and $0.021 million (7 percent net present value) to $55 million (3 percent net present value) and $35 million (7 percent net present value) and an undiscounted range from $0.047 million to $82 million.

The total estimated benefits and cost offsets per unit sensitivity analysis, as shown in table 180, ranges from $4.0 thousand (3 percent net present value) and $2.6 thousand (7 percent net present value) to $6.9 million (3 percent net present value) and $4.4 million (7 percent net present value) and an undiscounted range from $6.6 thousand to $10 million.

Table 181 (Chart 7) – Sensitivity Analysis – Severe Accident Capable Vents – Mark II Containments – 3 Percent Net Present Value



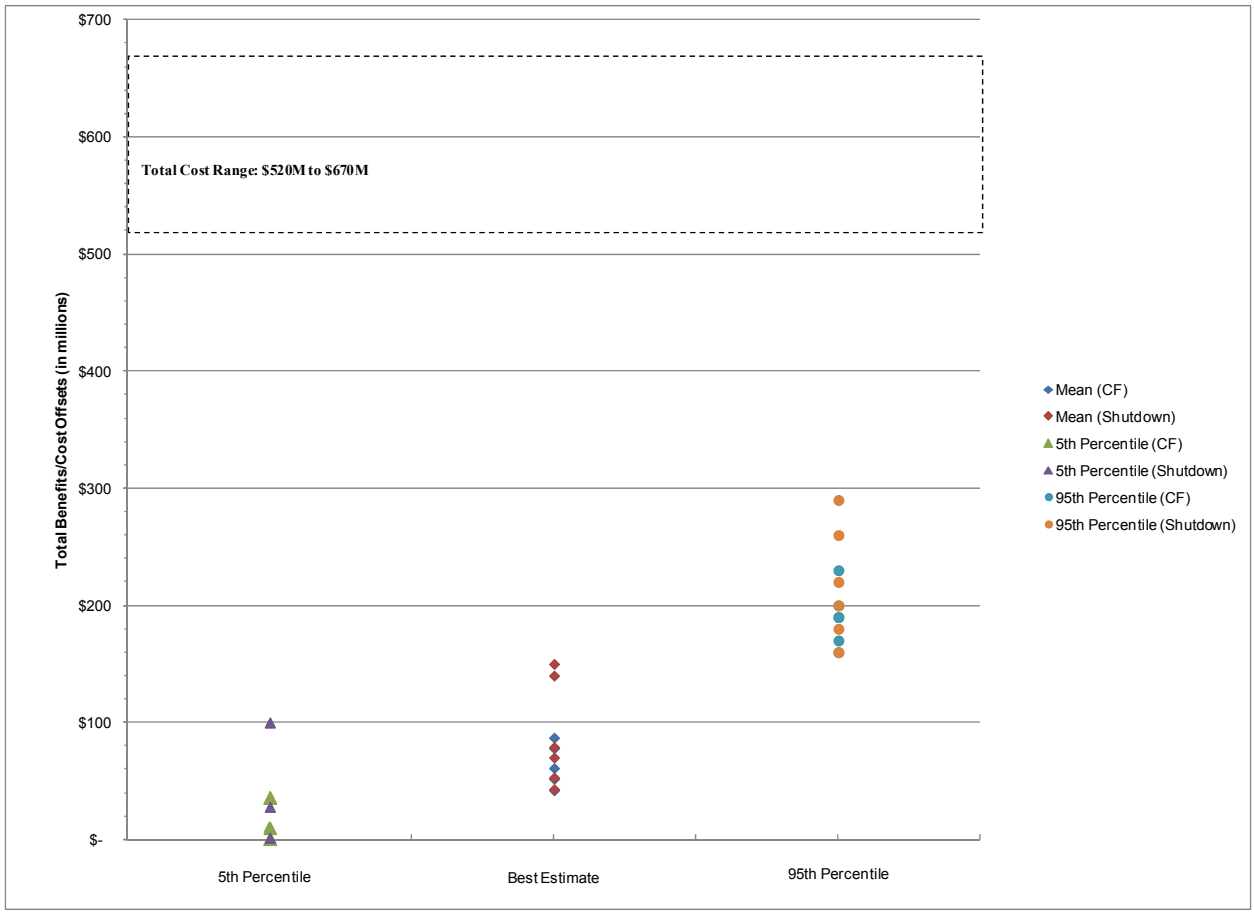
Tables 181, 182, and 183 (Charts 7, 8, and 9), show the sensitivities of the costs and benefits in 3 percent net present value, 7 percent net present value, and undiscounted, respectively. The charts provide the 5th percentile, point estimate, and the 95th percentile. The total benefits and cost offsets are the points in the chart and the Industry and NRC implementation and operation costs are the bar provided in the charts. Tables 184, 185, and 186 (Charts 10, 11, and 12) provide the sensitivities of the costs and benefits on a per unit basis in 3 percent net present value, 7 percent net present value, and undiscounted, respectively.

3.7.4.2 Alternative 3 – Filtered Vents

As shown in table 187, the total benefits and offset costs range for filtered vents relative to the status quo ranges from $0.68 million (3 percent net present value) and $0.43 million (7 percent net present value) to $290 million (3 percent net present value) and $190 million (7 percent net present value) and an undiscounted range from $1.0 million to $430 million.

The total estimated benefits and cost offsets per unit sensitivity analysis, as shown in table 188, ranges from $0.022 million (3 percent net present value) and $0.014 million (7 percent net present value) to $9.4 million (3 percent net present value) and $6.1 million (7 percent net present value) and an undiscounted range from $0.032 million to $14 million.

Table 189 (Chart 13) – Sensitivity Analysis – Filtered Vents – 3 Percent Net Present Value



Tables 189, 190, and 191 (Charts 13, 14, and 15), show the sensitivities of the costs and benefits in 3 percent net present value, 7 percent net present value, and undiscounted, respectively. The charts provide the 5th percentile, point estimate, and the 95th percentile. The total benefits and cost offsets are the points in the chart and the Industry and NRC implementation and operation costs are the bar provided in the charts. Tables 192, 193, and 194 (Charts 16, 17 and 18) provide the sensitivities of the costs and benefits on a per unit basis in 3 percent net present value, 7 percent net present value, and undiscounted, respectively.

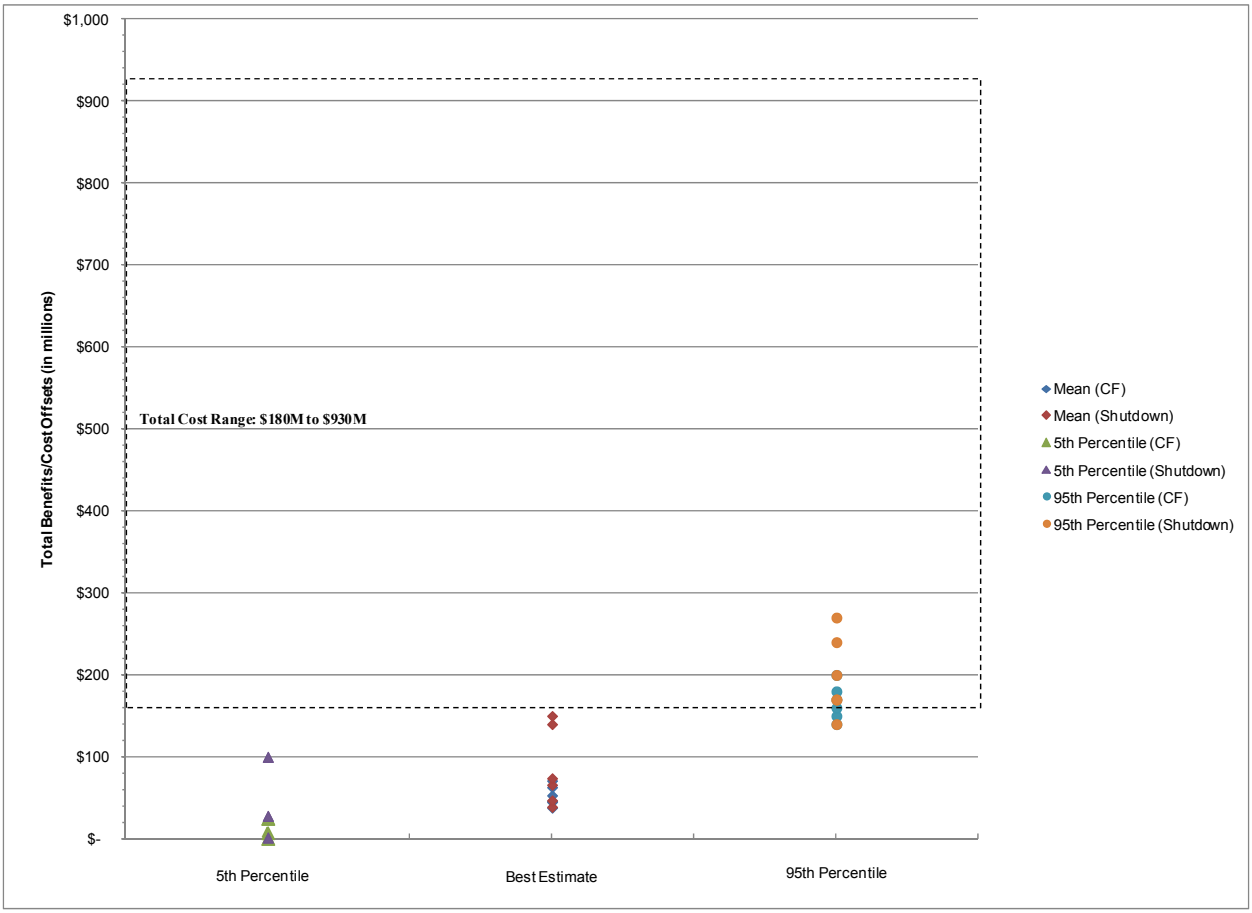
3.7.4.3 Alternative 4 – Severe Accident Confinement Strategy

As shown in table 195, the total benefits and offset costs range for the performance based alternative relative to the status quo ranges from $0.52 million (3 percent net present value) and $0.31 million (7 percent net present value) to $270 million (3 percent net present value) and $170 million (7 percent net present value) and an undiscounted range from $0.83 million to $410 million.

The total estimated benefits and cost offsets per unit sensitivity analysis, as shown in table 196, ranges from $0.017 million (3 percent net present value) and $0.010 million (7 percent net present value) to $8.7 million (3 percent net present value) and $5.5 million (7 percent net present value) and an undiscounted range from $0.027 million to $13 million.

The estimated severe accident confinement strategy alternative costs range from those outlined in the previous sections, including the Level 2 PRA costs for industry and the NRC, to as low as just the costs for the severe accident capable vents for industry and the NRC (no further action required). However, because the installation costs for the severe accident confinement strategy are unknown, the upper bound cost estimate for the severe accident confinement strategy would be the above stated costs plus the costs for installation of a filtered vent. Thus, the costs for the severe accident confinement strategy range from $180 million to $930 million (3 percent net present value).

Table 197 (Chart 19) – Sensitivity Analysis – Severe Accident Confinement Strategy – 3 Percent Net Present Value



Tables 197, 198, and 199 (Charts 19, 20, and 21), show the sensitivities of the costs and benefits in 3 percent net present value, 7 percent net present value, and undiscounted, respectively. The charts provide the 5th percentile, point estimate, and the 95th percentile. As there are no quantitative costs for the severe accident confinement strategy, the costs are not included within the charts. Tables 200, 201, and 202 (Charts 22, 23 and 24) provide the sensitivities of the costs and benefits on a per unit basis in 3 percent net present value, 7 percent net present value, and undiscounted, respectively.

3.8 Disaggregation

3.8.1 Filtered Vents Relative to Severe Accident Capable Vents

Table 203 – Summary of Quantified "Best Estimate" Costs and Benefits – Filtered Vents Relative to Severe Accident Capable Vents

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$6.4	$4.5	$3.1
Occupational Health (Accident)	$0.10	$0.071	$0.040
Offsite Property	$13	$8.5	$6.2
Onsite Property	$7.8	$4.6	$2.8
Replacement Energy	$15	$10	$6.2
Total Benefits	$42	$28	$18
Industry Operation	($13)	($9.1)	($5.9)
NRC Implementation	($0.10)	($0.10)	$0.10
NRC Operation	$0.20	$0.50	$0.0
Sub-Total	**$29**	**$19**	**$12**
High Industry Implementation	($450)	($450)	($450)
Total (High Cost)	**($420)**	**($380)**	**($380)**
Low Industry Implementation	($380)	($380)	($380)
Total (Low Cost)	**($350)**	**($360)**	**($370)**

The filtered vent alternative relative to the severe accident capable vent alternative removes all of the benefits and costs associated with the severe accident capable alternative and looks at just the benefits and costs from the filtered vent. Therefore, the overall benefits and cost offsets for the filtered vent alternative relative to the severe accident capable vent alternative ranges from $28 million (3 percent net present value) to $18 million (7 percent net present value). After considering all of the quantitative benefits and costs, the filtered vent alternative relative to the severe accident capable vent alternative ranges from negative $380 million (3 and 7 percent net present values) and negative $360 million (3 percent net present value) to negative $370 million (7 percent net present value). Therefore, the filtered vent alternative, after removing the severe accident capable vent alternative, would not be cost-beneficial quantitatively.

However, as shown in the previous sections, the qualitative benefits for the filtered vent alternative are much greater than the severe accident capable vent alternative. Including both the quantitative and qualitative benefits and costs, the filtered vent alternative would be cost-beneficial even without the benefits and costs from the severe accident capable vent alternative.

3.8.2 Severe Accident Confinement Strategy Relative to Severe Accident Capable Vents

Table 204 – Summary of Quantified "Best Estimate" Costs and Benefits – Severe Accident Confinement Strategy Relative to Severe Accident Capable Vents

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$5.4	$3.4	$2.1
Occupational Health (Accident)	$0.077	$0.051	$0.020
Offsite Property	$9.8	$6.5	$4.2
Onsite Property	$6.8	$3.6	$1.8
Replacement Energy	$12	$7.1	$3.9
Total Benefits	**$34**	**$21**	**$12**
Industry Operation	($45)	($29)	($18)
NRC Implementation	($2.7)	($2.3)	($1.8)
NRC Operation	($3.8)	($2.5)	($2.1)
Sub-Total	**($17)**	**($13)**	**($10)**
High Industry Implementation	($21)	($21)	($21)
Total (High Cost)	**($38)**	**($34)**	**($31)**
Low Industry Implementation	($14)	($14)	($14)
Total (Low Cost)	**($35)**	**($27)**	**($24)**

The severe accident confinement strategy alternative relative to the severe accident capable vent alternative removes all of the benefits and costs associated with the passive severe accident capable alternative and looks at just the benefits and costs from the severe accident confinement strategy. Therefore, the overall benefits and cost offsets for the severe accident confinement strategy alternative relative to the severe accident capable vent alternative ranges from $21 million (3 percent net present value) to $12 million (7 percent net present value). After considering all of the quantitative benefits and costs, the severe accident confinement strategy alternative relative to the severe accident capable vent alternative ranges from negative $34 million (3 percent net present value) to negative $31 million (7 percent net present value) and negative $27 million (3 percent net present value) to negative $24 million (7 percent net present value). Therefore, the severe accident confinement strategy alternative, after removing the severe accident capable vent alternative, would not be cost-beneficial quantitatively.

However, as discussed in the previous sections, the qualitative benefits for the severe accident confinement strategy alternative are assumed to be much greater than the severe accident capable vent alternative. Also, there are qualitative costs that were not quantified that might be realized in the severe accident confinement strategy alternative, which could make the alternative not cost-beneficial. Therefore, including both the quantitative and qualitative benefits and costs, the severe accident confinement strategy alternative would be cost-beneficial even without the benefits and costs from the severe accident capable vent alternative.

4. Decision Rationale for Selection of Proposed Action

As stated previously, the decision rationale for the selection of the proposed action is based on the current framework. In general, the quantitative costs and benefits are highly sensitive to the inputs of the models.

4.1 Alternative 2 – Severe Accident Capable Vents

4.1.1 Mark I Containments

Table 205 – Summary of Quantified "Best Estimate" Costs and Benefits – Severe Accident Capable Vents – Mark I Containments

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$4.9	$3.5	$2.4
Occupational Health (Accident)	$0.24	$0.17	$0.12
Offsite Property	$12	$8.5	$5.8
Onsite Property	$9.1	$5.5	$3.2
Replacement Energy	$0	$0	$0
Total Benefits	**$26**	**$18**	**$12**
Industry Operation	($24)	($17)	($12)
NRC Implementation	($0.44)	($0.44)	($0.44)
NRC Operation	($12)	($8.5)	($5.8)
Sub-Total	**($10)**	**($7.9)**	**($6.2)**
High Industry Implementation	($69)	($69)	($69)
Total (High Cost)	**($79)**	**($77)**	**($75)**
Low Industry Implementation	($46)	($46)	($46)
Total (Low Cost)	**($56)**	**($54)**	**($52)**

As shown in the table above, evaluating only the quantitative attributes under the "best estimate" current framework, the severe accident capable vents for Mark I containments would not be cost-beneficial. The estimated net value for severe accident capable vents for Mark I containments relative to the status quo ranges from negative $77 million (3 percent net present value) to negative $75 million (7 percent net present value) and negative $54 million (3 percent net present value) to negative $52 million (7 percent net present value).

As shown in table 206, the estimated net value per unit for severe accident capable vent relative to the status quo ranges from negative $3.3 million (3 percent net present value) to negative $3.3 million (7 percent net present value) and negative $2.3 million (3 percent net present value) to negative $2.3 million (7 percent net present value).

However, as shown in tables 207 through 210, if the NRC assumes the 5th and 95th percentile, the estimated net value for the severe accident capable vents for Mark I containments are negative for all "best estimates" from the 5th to the 95th percentile.

The following table shows the summary of estimates for the benefits, costs and net benefits for severe accident capable vents for Mark I containments. The range for the benefits includes the $4,000 per person-rem averted and the higher and lower replacement energy costs.

Table 211 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark I Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$72 to $95	$72 to $95	$72 to $95
Benefits	$0.093 to $0.11 + B_Q	$18 to $22 + B_Q	$66 to $83 + B_Q
Net benefits (benefits – costs)	($95) to ($72) + B_Q	($77) to ($50) + B_Q	($29) to $11 + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.
b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

As there are qualified benefits that relate to the severe accident capable vents for Mark I containments, along with the uncertainties and sensitivities surrounding the quantitative analysis, the NRC staff finds that severe accident capable vents for Mark I containments are cost-justified. The range of quantified net benefits for the severe accident capable vents for Mark I containments range from negative to positive from the low to high estimates and, along with the unquantified benefits, would provide a positive net benefit. Tables 212 and 213 provide the summary table for the 7 percent net present value and the undiscounted net present value, respectively.

4.1.2 Mark II Containments

Table 214 – Summary of Quantified "Best Estimate" Costs and Benefits – Severe Accident Capable Vents – Mark II Containments

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$1.7	$1.2	$0.85
Occupational Health (Accident)	$0.083	$0.059	$0.040
Offsite Property	$4.2	$3.0	$2.0
Onsite Property	$3.1	$1.9	$1.1
Replacement Energy	$0	$0	$0
Total Benefits	**$9.1**	**$6.2**	**$4.0**
Industry Operation	($12)	($8.9)	($6.1)
NRC Implementation	($0.30)	($0.30)	($0.30)
NRC Operation	($4.2)	($3.0)	($2.0)
Sub-Total	**($7.4)**	**($6.0)**	**($4.4)**
High Industry Implementation	($100)	($100)	($100)
Total (High Cost)	**($110)**	**($110)**	**($100)**
Low Industry Implementation	($40)	($40)	($40)
Total (Low Cost)	**($47)**	**($46)**	**($44)**

As the table above shows, evaluating only the quantitative attributes under the "best estimate" current framework, the severe accident capable vents for Mark II containments would not be cost-beneficial. The estimated net value for severe accident capable vents for Mark II containments relative to the status quo ranges from negative $110 million (3 percent net present value) to negative $100 million (7 percent net present value) and negative $46 million (3 percent net present value) to negative $44 million (7 percent net present value).

As shown in table 215, the estimated net value per unit for severe accident capable vent for Mark II containments relative to the status quo ranges from negative $14 million (3 percent net present value) to negative $14 million (7 percent net present value) and negative $5.7 million (3 percent net present value) to negative $5.5 million (7 percent net present value).

However, as shown in tables 216 through 219, if the NRC assumes the 5th and 95th percentile, the estimated net value for the severe accident capable vents for Mark II containments are negative in all instances.

The following table shows the summary of estimates for the benefits, costs and net benefits for severe accident capable vents for Mark II containments. The range for the benefits includes the $4,000 per person-rem averted and the higher and lower replacement energy costs.

Table 220 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark II Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5th Percentile)	Best Estimate (Point-Estimate)	High Estimate (95th Percentile)
Costs	$52 to $110	$52 to $110	$52 to $110
Benefits	$0.032 to $0.040 + B_Q	$6.2 to $7.5 + B_Q	$24 to $29 + B_Q
Net benefits (benefits – costs)	($110) to ($52) + B_Q	($100) to ($45) + B_Q	($86) to ($23) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

As there are qualified benefits that relate to the severe accident capable vents for Mark II containments, along with the uncertainties and sensitivities surrounding the quantitative analysis, the NRC staff finds that severe accident capable vents for Mark II containments are cost-justified. The range of quantified net benefits for the severe accident capable vents for Mark II containments range from negative to positive from the low to high estimates and, along with the unquantified benefits, would provide a positive net benefit. Tables 221 and 222 provide the summary table for the 7 percent net present value and the undiscounted net present value, respectively.

4.2 Alternative 3 – Filtered Vents

Table 223 – Summary of Quantified "Best Estimate" Costs and Benefits – Filtered Vents

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$13	$9.2	$6.3
Occupational Health (Accident)	$0.42	$0.30	$0.20
Offsite Property	$29	$20	$14
Onsite Property	$20	$12	$7.1
Replacement Energy	$15	$10	$6.2
Total Benefits	**$77**	**$52**	**$34**
Industry Operation	($49)	($35)	($24)
NRC Implementation	($0.84)	($0.84)	($0.84)
NRC Operation	($16)	($11)	($7.8)
Sub-Total	**$11**	**$5.2**	**$1.4**
High Industry Implementation	($620)	($620)	($620)
Total (High Cost)	**($610)**	**($610)**	**($620)**
Low Industry Implementation	($470)	($470)	($470)
Total (Low Cost)	**($460)**	**($460)**	**($470)**

As shown in the table above, evaluating only the quantitative attributes under the "best estimate" current framework, the filtered vents would not be cost-beneficial. The estimated net value for filtered vents relative to the status quo ranges from negative $610 million (3 percent net present value) to negative $620 million (7 percent net present value) and negative $460 million (3 percent net present value) to negative $470 million (7 percent net present value).

As shown in table 224, the estimated net value per unit for filtered vents relative to the status quo ranges from negative $27 million (3 and 7 percent net present value) to negative $20 million (3 and 7 percent net present value).

However, as shown in tables 225 through 228, if the NRC assumes the 5th and 95th percentile, the estimated net value for filtered vents are all negative.

The following table shows the summary of estimates for the benefits, costs and net benefits for filtered vents. The range for the benefits includes the $4,000 per person-rem averted and the higher and lower replacement energy costs.

Table 229 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Filtered Vents at 3 Percent Net Present Value (millions of 2012$)

Description	**Low Estimate (5th Percentile)**	**Best Estimate (Point-Estimate)**	**High Estimate (95th Percentile)**
Costs	$520 to $670	$520 to $670	$520 to $670
Benefits	$0.68 to $36 + B_Q	$42 to $87 + B_Q	$160 to $230 + B_Q
Net benefits (benefits – costs)	($670) to ($480) + B_Q	($630) to ($430) + B_Q	($510) to ($290) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

As there are qualified benefits that relate to filtered vents, along with the uncertainties and sensitivities surrounding the quantitative analysis, the NRC staff finds that filtered vents are cost-justified. The range of quantified net benefits for filtered vents are negative; however, combined with the unquantified benefits, would provide a positive net benefit. Tables 230 and 231 provide the summary table for the 7 percent net present value and the undiscounted net present value, respectively.

4.3 Alternative 4 – Severe Accident Confinement Strategy

Table 232 – Summary of Quantified "Best Estimate" Benefits – Severe Accident Confinement Strategy

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$12	$8.1	$5.3
Occupational Health (Accident)	$0.40	$0.28	$0.18
Offsite Property	$26	$18	$12
Onsite Property	$19	$11	$6.1
Replacement Energy	$12	$7.1	$3.9
Total Benefits	**$69**	**$44**	**$27**
Industry Operation	($81)	($55)	($36)
NRC Implementation	($3.4)	($3.0)	($2.5)
NRC Operation	($20)	($14)	($9.9)
Sub-Total	**($34)**	**($28)**	**($21)**
High Industry Implementation	($190)	($190)	($190)
Total (High Cost)	**($220)**	**($220)**	**($210)**
Low Industry Implementation	($100)	($100)	($100)
Total (Low Cost)	**($130)**	**($130)**	**($120)**

As shown in the table above, evaluating only the quantitative attributes under the "best estimate" current framework, the severe accident confinement strategy would provide an estimated net value relative to the status quo ranging from negative $200 million (3 percent net present value) to negative $190 million (7 percent net present value) and negative $110 million (3 percent net present value) to negative $110 million (7 percent net present value).

As shown in table 233, the estimated net value per unit for the severe accident confinement strategy relative to the status quo ranges from negative $7.0 million (3 percent net present value) to negative $6.8 million (7 percent net present value) and negative $4.1 million (3 percent net present value) to negative $3.9 million (7 percent net present value).

However, as shown in tables 234 through 237, if the NRC assumes the 5th and 95th percentile, the estimated net value for the severe accident confinement strategy are all negative.

The following table shows the summary of estimates for the benefits, costs and net benefits for the severe accident confinement strategy alternative. The range for the benefits includes the $4,000 per person-rem averted and the higher and lower replacement energy costs.

Table 238 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of the Severe Accident Confinement Strategy at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	\$180 to \$260 + C_Q	\$180 to \$260 + C_Q	\$180 to \$260 + C_Q
Benefits	\$0.52 to \$25 + B_Q	\$45 to \$71 + B_Q	\$140 to \$200 + B_Q
Net benefits (benefits – costs)	(\$260) to (\$160) + B_Q – C_Q	(\$220) to (\$110) + B_Q – C_Q	(\$120) to \$20 + B_Q – C_Q

a Benefits are composed primarily of averted onsite and offsite property costs.
b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.
c Not all possible costs are quantified and monetized for this analysis. C_Q is the sum of all unquantified costs. Unquantified costs were given appropriate consideration in weighting to the quantified attributes due to the large uncertainty ranges in monetized values. C_Q may be either negative or positive.

There are qualified benefits and costs that relate to the severe accident confinement strategy, along with the uncertainties and sensitivities surrounding the quantitative analysis. However, because of the large uncertainty in potential development, demonstration and implementation costs of an as yet unspecified approach, as well as the uncertainty in achievable benefits, the staff is not able to draw a cost/benefit conclusion regarding the severe accident confinement option.

4.4 Summary

As multiple alternatives are cost-beneficial, the alternatives would then need to be compared to each other to determine which is the best alternative. In relation to benefits, the filtered vents alternative provides the most quantified and unquantified benefits, the performance based alternative provides the second highest benefits and the severe accident capable vents provides the third highest. In relation to costs, the filtered vents alternative provides the highest quantified costs; however, there are many potential unquantified costs for the severe accident confinement strategy alternative from the costs that could be equal to or larger than the costs for the filtered vent alternative.

As the filtered vent alternative and severe accident confinement strategy alternative subsume the severe accident capable vent alternative, including the uncertainties and other qualitative benefits with those alternatives, the severe accident capable vent alternative should not be implemented alone. Therefore, the next step is to compare the filtered vent alternative relative to the severe accident confinement strategy alternative.

4.4.1 Alternative 3 Compared to Alternative 4

Table 241 – Summary of Quantified "Best Estimate" Costs and Benefits – Filtered Vents Relative to Severe Accident Confinement Strategy

Attribute	Benefits/Costs (2012 dollars in millions)		
	Undiscounted	3% Net Present Value	7% Net Present Value
Public Health (Accident)	$1.0	$1.1	$1.0
Occupational Health (Accident)	$0.020	$0.020	$0.020
Offsite Property	$3.0	$2.0	$2.0
Onsite Property	$1.0	$1.0	$1.0
Replacement Energy	$3.0	$2.9	$2.3
Total Benefits	**$8.0**	**$7.0**	**$6.3**
Industry Operation	$32	$20	$12
NRC Implementation	$2.6	$2.2	$1.7
NRC Operation	$4.0	$3.0	$2.1
Sub-Total	**$47**	**$32**	**$22**
High Industry Implementation	($430)	($430)	($430)
Total (High Cost)	**($380)**	**($400)**	**($410)**
Low Industry Implementation	($370)	($370)	($370)
Total (Low Cost)	**($320)**	**($340)**	**($350)**

The filtered vent alternative relative to the severe accident confinement strategy alternative removes all of the benefits and costs associated with the passive severe accident capable alternative and looks at just the benefits and costs from the filtered vent. Therefore, the overall benefits and cost offsets for the filtered vent alternative relative to the severe accident confinement strategy alternative ranges from $7.0 million (3 percent net present value) to $6.3 million (7 percent net present value). After considering all of the quantitative benefits and costs, the filtered vent alternative relative to the severe accident confinement strategy alternative ranges from negative $400 million (3 percent net present value) to negative $410 million (7 percent net present value) and negative $340 million (3 percent net present value) to negative $350 million (7 percent net present value). Therefore, the filtered vent alternative relative to the severe accident confinement strategy alternative would not be cost-beneficial quantitatively.

However, as shown in the previous sections, the qualitative benefits for the filtered vent alternative are greater than the severe accident confinement strategy alternative. Also, there are unquantified costs associated with the severe accident confinement strategy that may be greater than or equal to the costs of the filtered vent alternative. Therefore, including both the quantitative and qualitative benefits and costs, the filtered vent alternative would be the most cost-effective alternative.

APPENDIX A – REFERENCES

NUREG-1150, “Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants,” dated December 1990.

NUREG-1530, “Reassessment of NRC’s Dollar per Person-REM Conversion Factor Policy”, dated December 1995.

NUREG/BR-0058, Revision 4, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission”, dated September 2004.

NUREG/BR-0184, “Regulatory Analysis Technical Evaluation Handbook,” dated January 1997.

U.S. Environmental Protection Agency, National Center for Environmental Economics, Office of Policy, “Guidelines for Preparing Economic Analyses,” dated December 17, 2010.

U.S. Bureau of Labor Statistics, “Consumer Price Index, urban consumers,” available at ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt.

APPENDIX B – BACKFITTING

Section 50.109 of Title 10 of the Code of Federal Regulations (10 CFR) requires that for,

> any modification of or addition to systems, structures, components, or design of a facility . . . any of which may result from a new or amended provision in the Commission's regulations or the imposition of a regulatory staff position interpreting the Commission's regulation that is either new or different from a previously applicable staff position . . . shall require a systematic and documented analysis . . . .

B.1 Adequate Protection

There are certain situations that an action must be taken regardless of the cost. These situations are exempt from a Backfitting Analysis under 10 CFR 50.109(a)(4). Specifically, the NRC is exempt if the regulatory action provides, defines, or redefines adequate protection to the public health and safety or common defense and security. According to the statement of considerations in the 1988 Backfitting rule,

> the regulations, though they do not define "adequate protection," are presumed to ensure it, and, in the absence of a redefinition of "adequate protection" that presumption can be overcome only by significant new information or some showing that the regulations do not address some significant safety issue. [53 FR 20638]

As stated within Enclosure 1 of the SECY, the NRC staff assessed the possible benefits associated with the options described in this paper for improving containment venting at BWRs with Mark I and II containments. The assessment and lessons learned from the Fukushima accident indicate that functions to delay core damage and containment failure in combination with protective actions taken to evacuate or shelter the public are able to minimize risks to the public health and safety. The NRC has traditionally reserved the use of the adequate protection standard for the protection of public health and safety and has invoked it for design-basis accidents, selected functions to prevent core damage (e.g., EA-12-050), and programs to ensure licensees have strategies or contingencies for severe accidents (e.g., emergency planning, EA-12-049 ("Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, dated March 12, 2012) and 10 CFR 50.54(hh)). The NRC has previously considered incorporating into its approach to defense in depth a balancing of prevention and mitigation measures. However, such an approach and the related criteria for achieving a balance between elements of defense in depth were not formally adopted nor included in the NRC's guidance documents. For the purpose of this analysis, the staff did not apply any of the exceptions to the Backfit Rule. The staff has proceeded with analyses of proposed venting modifications as possible cost-justified substantial safety improvements. The staff's decision to proceed with a cost-benefit analysis does not represent a staff recommendation regarding whether alternatives 2, 3, or 4 could be pursued under one of the exceptions to the Backfit Rule.

The NRC staff does not currently consider the potential economic consequences of an accident within its deliberations on adequate protection. A Commission decision to revise the agency's accounting of offsite land contamination (Option 3 in SECY-12-0110) could affect arguments related to finding whether the addition of a filtered vent system for BWRs with Mark I or II containments might be needed for a revised adequate protection standard or a separate equivalent standard for economic consequences. Even in the absence of Commission direction to revise the current focus on public health and safety in deliberations on adequate protection

(or equivalent standard for economic consequences), the current assessment process for a regulatory analysis or a backfit analysis includes consideration of offsite costs—a topic discussed within the additional qualitative factors in Section 5.

B.2 Cost-Justified Substantial Safety Enhancement

Because requiring the alternatives is not likely to be applicable to an exception under 10 CFR 50.109(a)(4), a two-part backfitting analysis must be applied to each requirement, as described in 10 CFR 50.109(a)(3). The first part of the test under paragraph (a)(3) is whether there is a "substantial increase in the overall protection of the public health and safety or the common defense and security derived from the backfit." To determine whether there is a substantial increase, the description of final rule for the Backfitting Rule in 1985 states,

> [s]ubstantial means "important or significant" in a large amount, extent or degree." Under such a standard, the Commission would not ordinarily expect that safety improvements would be required as backfits which result in an insignificant or small benefit to public health and safety or the common defense and security, regardless of the implementation costs.

In considering those benefits that apply to the substantial increase to public health and safety and common defense and security, NUREG-1409, "Backfitting Guidelines", dated July 1990, states that,

> averted onsite costs can arise when it is estimated that the backfit will save money for licensees, such as reducing forced outage rates. These savings are not treated as a benefit (safety enhancement). They are, however, considered a negative cost, that is, an offset against other licensee costs.

However, in response to the NRC staff's reevaluation of the 1989 Backfitting Rule, the Commission provided SRM-SECY-93-086, "Backfit Considerations," on June 30, 1993. Within the staff requirements memoranda, the Commission reiterated their interpretation of the "substantial increase" criterion to continue with the degree of flexibility originally intended within the 1985 rule. Also, the Commission stated that the substantial determination should:

> allow for qualitative arguments that a given proposed rule would substantially increase safety. The approach is also flexible enough to allow for arguments that consistency with national and international standards, or the incorporation of widespread industry practices, contributes either directly or indirectly to a substantial increase in safety. Such arguments concerning consistency with other standards, or incorporation of industry practices, would have to rest on the particulars of a given proposed rule.

Therefore, any attributes that contribute to the increase of safety, either directly, through person-rem averted, or indirectly, through consistency with national and international standards, can be considered in relation to a substantial increase to public health and safety.

The second step relates to applying information to the direct and indirect costs of the backfit. Section 50.109(c) states that "any . . . information relevant and material to the proposed backfit" may be considered in the analysis and, thus, taken into account in the safety decision. Chairman Palladino, when promulgating the original Backfitting Rule, stated that 10 CFR 50.109(c) provides

> ample room for Commission reliance on, among other things, the expertise of the staff to supplement other analytical tools in order to provide an adequate basis for a particular backfit decision. [50 FR 38104]

Also, the 1988 revision to the Backfitting rule states that,

> [n]ot only may there . . . be individual cases that require actions to go beyond what is necessary under the regulations to assure adequate protection, there will also be times when the NRC issues a rule which required something beyond adequate protection. This follows directly from the Commission's power under section 161 of the Atomic Energy Act, affirmed by the Court, to issue rules or orders to "minimize danger to life or property". [53 FR 20609]

Therefore, the staff will disposition all costs and benefits, direct or indirect, for the second step of the cost-beneficial substantial safety enhancement determination of these backfits within 10 CFR 50.109(a)(3) by evaluating the factors within 10 CFR 50.109(c).

B.2.1 Statement of the specific objectives that the proposed backfit is designed to achieve

The accident at the Fukushima Dai-ichi nuclear facility in Japan highlighted the need for safety improvements for nuclear power plants related to beyond-design-basis natural hazards and resultant effects on plant systems and barriers from an extended loss of electrical power and access to heat removal systems. In SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011, the NRC staff described its proposals for the regulatory actions to be taken to address the recommendations of the Fukushima Near-Term Task Force (NTTF). One of the (Tier 1) actions taken by the NRC staff was the issuance of Orders requiring hardened containment vents to those licensees of boiling water reactor (BWR) facilities with Mark I and II containment designs. The hardened containment vents would address problems encountered during the Fukushima accident by providing plant operators with improved methods to vent containment during accident conditions and thereby prevent containment overpressurization. Orders requiring reliable hardened vents for BWR facilities with Mark I and II containment designs were issued on March 12, 2012. Additionally, the NRC staff identified in SECY-11-0137 an additional issue related to requiring filters on the containment vents in order to limit the release of radioactive materials should the venting systems be used after significant core damage had occurred.

In the staff requirements memorandum (SRM) for SECY-11-0137, dated December 15, 2011, the Commission directed the NRC staff as follows:

> The staff should quickly shift the issue of "Filtration of Containment Vents" from the "additional issues" category and merge it with the Tier 1 issue of hardened vents for Mark I and Mark II containments such that the analysis and interaction with stakeholders needed to inform a decision on whether filtered vents should be required can be performed concurrently with the development of the technical bases, acceptance criteria, and design expectations for reliable hardened vents.

In response to the SRM, the staff included plans to address the filtered venting issue for Mark I and II containments in SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and

Tsunami, dated February 17, 2012. The staff explained the proposed evaluations and need for timely consideration as follows:

> The staff has determined that some of the additional issues should be included in existing Tier 1 activities. In accordance with the direction in SRM-SECY-11-0137, the additional issue of filtration of containment vents was merged with the Tier 1 issue of hardened vents for Mark I and Mark II containments such that further analysis and interaction with stakeholders will inform whether filtered vents should be required. The staff has determined that consideration of severe accident conditions in the design and operation of the vent, the addition of filters to hardened reliable vents, and consideration of vents in areas other than primary containment, will be the topic of a policy paper to the Commission in July 2012.[1]
>
> The staff believes that the requirements for hardened reliable vents in the proposed order (Enclosure 5) are important to ensure core and containment cooling, and that these requirements should be imposed before the staff completes its evaluation of the technical and policy issues associated with imposing additional requirements, as described above. In public meetings, the staff has encouraged licensees to consider the potential for the later addition of filters. However, the industry has stated that the addition of filters to hardened containment vents may require modifications to the vent design. In light of this, a consideration in the staff's proposal to issue the proposed order now is that the proposed order requires submission of integrated plans for implementing the requirements of the order by February 28, 2013, eight months after the staff plans to send the July 2012 policy paper to the Commission for consideration. As a result, licensees should have time to revise draft plans in response to any new Commission direction before the integrated implementation plans are due.

In SECY-12-0095, "Tier 3 Program Plans and 6-Month Status Update in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Subsequent Tsunami," dated July 13, 2012, the staff described the current course of action as follows:

> One of the six additional recommendations identified in SECY-11-0137, and further developed in SECY-12-0025, was consideration of additional performance requirements, including filters, for hardened containment vent systems for boiling-water reactor Mark I and Mark II containment designs. In SECY-12-0025, the staff explained that it needed to resolve technical and policy issues before regulatory action could be proposed that would require licensees to install filters, or change any other performance requirement, for hardened containment vent systems. The staff's recommendation on additional performance requirements for containment vents will be provided in a separate paper.

B.2.2 General description of the activity that would be required by the licensee or applicant in order to complete the backfit

B.2.2.1 Alternative 2 – Severe accident capable vents

[1] The schedule for this paper was subsequently extended to November 30, 2012, in a memorandum dated August 6, 2012, "Staff Requirements – COMSECY-12-0014 – Revised Schedule and Plans for Japan Lessons- Learned."

B.2.2.1.1 Mark I Containments

The alternative would require that licensees of Mark I reactors install severe accident capable vents. This would entail upgrading or replacing the reliable hardened vents required by EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions. Specifically, estimated costs include the installation of: floor/wall core bore and penetration, new primary containment penetration, pipe, pipe elbows/tees/and flanges, valve and actuators, dedicated electrical and pneumatic supply for valve operation and indication, rupture disk and holder, supports suitable for seismic ruggedness, and pipe shielding.

B.2.2.1.2 Mark II Containments

The alternative would require that licensees with Mark II containments install severe accident capable vents. This would entail upgrading or replacing the reliable hardened vents required by EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions. Specifically, the costs would be the same as for the Mark I containments, but would also require a device to be installed that is similar to the Advanced Boiling Water Reactor (ABWR) Sump Corium Shield to resolve the potential wetwell bypass issues in the Mark II containment designs.

B.2.2.2 Alternative 3 – Filtered Vents

The alternative would require that licensees of Mark I and Mark II containments would install severe accident capable vents with engineered filters for the drywell and wetwell. This would entail designing and installing an engineered filtered containment venting system that is intended to prevent the release of significant amounts of radioactive material following the dominant severe accident sequences at BWRs with Mark I and Mark II containments. Specifically, the costs would come from installation of: floor/wall core bore and penetration, new primary containment penetration, pipe, pipe elbows/tees/and flanges, valve and actuators, dedicated electrical and pneumatic supply for valve operation and indication, rupture disk and holder, supports suitable for seismic rugged, pipe shielding, engineered filter, and filter shielding.

B.2.2.3 Alternative 4 – Severe Accident Confinement Strategy

The fourth alternative involves the establishment of a severe accident confinement strategy (e.g., defined decontamination factor or site-specific cost/benefit analysis). This would entail pursuing development of requirements and technical acceptance criteria for confinement strategies and requiring licensees to select and justify systems or combinations of systems such as suppression pools, containment sprays, or separate filters to accomplish the function and meet the performance criteria. In keeping with previous experience in developing performance-based requirements, the staff envisions that this option would be pursued through rulemaking. The rulemaking process will likely involve extensive interactions with stakeholders and require the development of detailed industry and regulatory guidance documents. As an interim measure, the NRC may require licensees for Mark I and Mark II containments to install severe accident capable vents to achieve some near-term benefits.

For the regulatory analysis of the severe accident confinement strategy, as there is so little hard information on the specifics of this approach , the NRC staff assumed an approach that in the final determination may not achieve the required performance The NRC staff

assumes that for this alternative, Mark I and Mark II containments nuclear power plant licensees would install severe accident capable vents and perform Level 2 probabilistic risk assessments (PRA) . The NRC staff also assumed if the licensees pursued this approach that the benefits achieved by this severe accident confinement strategy would be equivalent to the filtered vent alternative, although incurred in a later year.

As a result, it is important to note that the certain assumptions in the provided regulatory analysis for the severe accident confinement strategy are highly speculative. There are significant unknowns in relation to costs and benefits. The costs are sensitive to the amount of plant analysis and site-specific work that would be required as well as development and demonstration of costs for an as yet unspecified approach. Similarly, the benefits are sensitive to both the effectiveness of the strategy, as well as the timing of implementation. A separate regulatory analysis for the severe accident confinement strategy would be performed in the event that new requirements developed under this alternative result in rulemaking.

B.2.3 Potential change in the risk to the public from the accidental off-site release of radioactive material

B.2.3.1 Alternative 2 – Severe Accident Capable Vents

B.2.3.1.1 Mark I Containments

Table B-1 – Public Health (Accident) Person-Rem Averted – Severe Accident Capable Vents – Mark I Containments

Framework	Person-Rem Averted	Benefits (2012 dollars in millions)	
		3% Net Present Value	7% Net Present Value
5th Percentile	14	$0.020	$0.014
Best Estimate	2,500	$3.5	$2.4
95th Percentile	10,000	$14	$9.9

Installation of severe accident capable vents for Mark I containments would decrease the radiation exposure to the public by between 14 and 10,000 person-rem. The dose to the public mostly comes from the reoccupation of land after decontamination and the exposure to the workers who are decontaminating the public land. It is also assumed that 0.5% of the public will not evacuate during the accident, whose resultant radiation dose is included within the public health exposure. As shown in the regulatory analysis, the estimated “best estimate” benefits ranges from $3.5 million (3 percent net present value) to $2.4 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $7.2 million (3 percent net present value) to $4.9 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the public health (accident) section within the regulatory analysis.

B.2.3.1.2 Mark II Containments

Table B-2 – Public Health (Accident) Person-Rem Averted – Severe Accident Capable Vents – Mark II Containments

Framework	Person-Rem Averted	Benefits (2012 dollars in millions)	
		3% Net Present Value	7% Net Present Value
5th Percentile	4.8	$0.0068	$0.0047
Best Estimate	880	$1.2	$0.85
95th Percentile	3,500	$5.0	$3.4

Installation of severe accident capable vents for Mark II containments would decrease the radiation exposure to the public by between 4.8 and 3,500 person-rem. The dose to the public mostly comes from the reoccupation of land after decontamination and the exposure to the workers who are decontaminating the public land. It is also assumed that 0.5% of the public will not evacuate during the accident, whose resultant radiation dose is included within the public health exposure. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $1.2 (3 percent net present value) to $0.85 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $2.4 million (3 percent net present value) to $1.6 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the public health (accident) section within the regulatory analysis.

B.2.3.2 Alternative 3 – Filtered Vents

Table B-3 – Public Health (Accident) Person-Rem Averted – Filtered Vents

Framework	Person-Rem Averted	Benefits (2012 dollars in millions)	
		3% Net Present Value	7% Net Present Value
5th Percentile	34	$0.050	$0.034
Best Estimate	6,500	$9.2	$6.3
95th Percentile	25,000	$35	$24

Installation of filtered vents would decrease the radiation exposure to the public by between 34 and 25,000 person-rem. The dose to the public mostly results from the reoccupation of land after decontamination and the exposure to the workers who are decontaminating the public land. It is also assumed that 0.5% of the public will not evacuate during the accident, whose resultant radiation dose is included within the public health exposure. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $9.2 (3 percent net present value) to $6.3 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $18 million (3 percent net present value) to $13 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the public health (accident) section within the regulatory analysis.

B.2.3.3 Alternative 4 – Severe Accident Confinement Strategy

Table B-4 – Public Health (accident) Person-Rem Averted – Severe Accident Confinement Strategy

Framework	Person-Rem Averted	Benefits (2012 dollars in millions)	
		3% Net Present Value	7% Net Present Value
5th Percentile	31	$0.044	$0.0028
Best Estimate	5,900	$8.1	$5.3
95th Percentile	23,000	$31	$21

Installation of the severe accident confinement strategy alternative would decrease the radiation exposure to the public by between 31 and 23,000 person-rem. The dose to the public mostly results from the reoccupation of land after decontamination and the exposure to the workers who are decontaminating the public land. It is also assumed that 0.5% of the public will not evacuate during the accident, whose resultant radiation dose is included within the public health exposure. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $8.1 (3 percent net present value) to $5.3 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $16 million (3 percent net present value) to $11 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the public health (accident) section within the regulatory analysis.

B.2.4 Potential impact on radiological exposure of facility employees

B.2.4.1 Alternative 2 – Severe Accident Capable Vents

B.2.4.1.1 Mark I Containments

Table B-5 – Facility Employee Exposure – Severe Accident Capable Vents – Mark I Containments

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Short-Term	Long-term	Total	3% Net Present Value	7% Net Present Value
5th Percentile	0.67	0.58	1.3	$0.016	$0.00098
Best Estimate	120	110	330	$0.30	$0.19
95th Percentile	530	440	970	$1.2	$0.77

Installation of severe accident capable vents would decrease the radiation exposure to the facility employees by between 1.3 and 970 person-rem. The exposure to the facility employees comes from a short-term dose, based on the exposure during the accident and a long-term dose based on the exposure from the onsite cleanup costs. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $0.30 million (3 percent net present value) to $0.19 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $0.58 million (3 percent net present value) to $0.36 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the occupational health (accident) section within the regulatory analysis.

B.2.4.1.2 Mark II Containments

Table B-6 – Facility Employee Exposure – Severe Accident Capable Vents – Mark II Containments

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Short-Term	Long-term	Total	3% Net Present Value	7% Net Present Value
5th Percentile	0.23	0.20	0.43	$0.00056	$0.00035
Best Estimate	42	39	81	$0.10	$0.062
95th Percentile	180	150	320	$0.43	$0.27

Installation of severe accident capable vents for Mark II Containments would decrease the radiation exposure to the facility employees by between 0.43 and 320 person-rem. The exposure to the facility employees comes from a short-term dose, based on the exposure during the accident and a long-term dose based on the exposure from the onsite cleanup costs. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $0.10 million (3 percent net present value) to $0.062 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $0.21 million (3 percent net present value) to $0.13 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the occupational health (accident) section within the regulatory analysis.

B.2.4.2 Alternative 3 – Filtered Vents

Table B-7 – Facility Employee Exposure – Filtered Vents

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Short-Term	Long-term	Total	3% Net Present Value	7% Net Present Value
5th Percentile	1.1	1.5	2.6	$0.0033	$0.0020
Best Estimate	200	310	510	$0.65	$0.38
95th Percentile	900	1,100	2,000	$2.6	$1.5

Installation of filtered vents would decrease the radiation exposure to the facility employees by between 2.6 and 2,000 person-rem. The exposure to the facility employees comes from a short-term dose, based on the exposure during the accident and a long-term dose based on the exposure from the onsite cleanup costs. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $0.65 million (3 percent net present value) to $0.38 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $1.3 million (3 percent net present value) to $0.74 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the occupational health (accident) section within the regulatory analysis.

B.2.4.3 Alternative 4 – Severe Accident Confinement Strategy

Table B-8 – Facility Employee Exposure – Severe Accident Confinement Strategy

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Short-Term	Long-term	Total	3% Net Present Value	7% Net Present Value
5th Percentile	1.1	1.4	2.5	$0.0030	$0.0017
Best Estimate	200	280	480	$0.58	$0.33
95th Percentile	870	1,000	1,900	$2.3	$1.3

Installation of the severe accident confinement strategy alternative would decrease the radiation exposure to the facility employees by between 2.5 and 1,900 person-rem. The exposure to the facility employees comes from a short-term dose, based on the exposure during the accident and a long-term dose based on the exposure from the onsite cleanup costs. As shown in the regulatory analysis, the estimated "best estimate" benefits ranges from $0.58 million (3 percent net present value) to $0.33 million (7 percent net present value); if the NRC assumes the higher dollar per person-rem amount, the estimated benefit ranges from $1.1 million (3 percent net present value) to $0.66 million (7 percent net present value). A more in-depth review of the person-rem exposure to the public can be found within the occupational health (accident) section within the regulatory analysis.

B.2.5 Installation and continuing costs associated with the backfit, including the cost of facility downtime or the cost of construction delay

As the backfit is assumed to be completed during normal operation outages, without having to extend the outage, there are no assumed replacement energy costs or construction delays for that period.

B.2.5.1 Alternative 2 – Severe Accident Capable Vents

B.2.5.1.1 Mark I Containments

Table B-9 – Industry Costs – Severe Accident Capable Vents – Mark I Containments

Range	Costs (2012 dollars in millions)				
	Implementation	Operation		Total	
		3% Net Present Value	7% Net Present Value	3% Net Present Value	7% Net Present Value
Low	$46	$17	$12	$63	$58
High	$69			$86	$81

The one-time implementation costs to the industry for severe accident capable vents for Mark I containments relative to the status quo ranges from $46 million to $69 million and total industry operation costs ranges from $17 million (3 percent net present value) to $12 million (7 percent net present value). The total estimated industry costs for severe accident capable vents for Mark I containments ranges from $63 million (3 percent net present value) to $58 million (7 percent net present value) and from $86 million (3 percent net present value) to $81 million (7 percent net present value). A more detailed analysis of the industry implementation and operation costs is provided within the regulatory analysis contained within the main body of this paper.

B.2.5.1.2 Mark II Containments

Table B-10 – Industry Costs – Severe Accident Capable Vents – Mark II Containments

Range	Costs (2012 dollars in millions)				
	Implementation	Operation		Total	
		3% Net Present Value	7% Net Present Value	3% Net Present Value	7% Net Present Value
Low	$40	$8.9	$6.1	$49	$46
High	$100			$110	$110

The one-time implementation costs to the industry for severe accident capable vents relative to the status quo ranges from $40 million to $100 million and total industry operation costs ranging from $8.9 million (3 percent net present value) to $6.1 million (7 percent net present value). The total estimated industry costs for severe accident capable vents for Mark II containments ranges from $49 million (3 percent net present value) to $46 million (7 percent net present value) and $110 million (3 and 7 percent net present values). A more detailed analysis of the industry implementation and operation costs is provided within the regulatory analysis contained within the main body of this paper.

B.2.5.2 Alternative 3 – Filtered Vents

Table B-11 – Industry Costs – Filtered Vents

Range	Costs (2012 dollars in millions)				
	Implementation	Operation		Total	
		3% Net Present Value	7% Net Present Value	3% Net Present Value	7% Net Present Value
Low	$470	$35	$24	$510	$490
High	$620			$660	$640

The one-time implementation costs to the industry for filtered vents relative to the status quo ranges from $470 million to $620 million and total industry operation costs from the analysis baseline range from $35 million (3 percent net present value) to $24 million (7 percent net present value). The estimated industry costs range from $510 million (3 percent net present value) and $490 million (7 percent net present value) to $660 million (3 percent net present value) and $640 million (7 percent net present value). A more detailed analysis of the industry implementation and operation costs is provided within the regulatory analysis contained within the main body of this paper.

B.2.5.3 Alternative 4 – Severe Accident Confinement Strategy

Table B-12 – Industry Costs – Severe Accident Confinement Strategy

Range	Costs (2012 dollars in millions)				
	Implementation	Operation		Total	
		3% Net Present Value	7% Net Present Value	3% Net Present Value	7% Net Present Value
Low	$100	$55	$36	$160	$140
High	$190			$250	$230

The one-time implementation costs to the industry for the severe accident confinement strategy relative to the status quo ranges from $100 million to $190 million and total industry operation costs from the analysis baseline range from $55 million (3 percent net present value) to $36 million (7 percent net present value). The estimated industry costs range from $160 million (3 percent net present value) to $140 million (7 percent net present value) and $250 million (3 percent net present value) to $230 million (7 percent net present value). However, as noted within the regulatory analysis, there are potential significant costs that have not been quantified within the analysis. These costs can be from installation and implementation of equipment to fulfill the performance based requirements of the alternative, as well as an documentation and operational costs that would be associated with those modifications. A more detailed analysis of the industry implementation and operation costs is provided within the regulatory analysis contained within the main body of this paper.

B.2.6 The potential safety impact of changes in plant or operational complexity, including the relationship to proposed and existing regulatory requirements

B.2.6.1 Alternative 2 – Severe Accident Capable Vents

B.2.6.1.1 Mark I Containments

Adding a severe accident capable vent onto a Mark I containments would not increase the complexity in plant design nor operations as the current severe accident mitigation guidelines involve venting during a severe accident.

B.2.6.1.2 Mark II Containments

For Mark II containments, while it is assumed that operations will not increase in complexity, the design modifications that would require Mark II reactors to have severe accident capable vents would increase plant complexity as well as the installation of a corium shield. These modifications and the resultant increase in plant complexity are not believed to have any potential adverse safety impact.

B.2.6.2 Alternative 3 – Filtered Vents

The addition of filtered vents may require a change to the severe accident mitigation guidelines. There is no assumed safety impact based on the potential increased complexity in operator procedures or in using the modified severe accident mitigation guidelines.

B.2.6.3 Alternative 4 – Severe Accident Confinement Strategy

A severe accident confinement strategy would create an increased overall complexity throughout the Mark I and Mark II containments. The severe accident confinement strategy may require either an overall economic consequences goal similar to the safety goal or would require significant rulemaking. Also, as each unit may be different, it could create unique designs for each unit and different requirements for each unit. However, within the unit, the severe accident confinement strategy may optimize the design of the unit.

B.2.7 The estimated resource burden on the NRC associated with the proposed backfit and the availability of such resources

B.2.7.1 Alternative 2 – Severe Accident Capable Vents

B.2.7.1.1 Mark I Containments

Table B-13 – NRC Costs – Severe Accident Capable Vents – Mark I Containments

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Implementation	$0.44	$0.44
Operation	$8.5	$5.8
Total	$8.9	$6.2

The one-time implementation costs to the NRC for severe accident capable vents for Mark I containments relative to the status quo is estimated to be $0.44 million and total NRC operation costs range from $8.5 million (3 percent net present value) to $5.8 million (7 percent net present value). The estimated total NRC costs range from $8.9 million (3 percent net present value) to $6.2 million (7 percent net present value). A more detailed analysis of the NRC implementation and operation costs can be found within the regulatory analysis.

B.2.7.1.2 Mark II Containments

Table B-14 – NRC Costs – Severe Accident Capable Vents – Mark II Containments

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Implementation	$0.30	$0.30
Operation	$3.0	$2.0
Total	$3.3	$2.3

The one-time implementation costs to the NRC for severe accident capable vents for Mark II containments relative to the status quo is estimated to be $0.30 million and total NRC operation costs ranging from $3.0 million (3 percent net present value) to $2.0 million (7 percent net present value). The estimated total NRC costs range from $3.3 million (3 percent net present value) to $2.3 million (7 percent net present value). A more detailed analysis of the NRC implementation and operation costs can be found within the regulatory analysis.

B.2.7.2 Alternative 3 – Filtered Vents

Table B-14 – NRC Costs – Filtered Vents

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Implementation	$0.84	$0.84
Operation	$11	$7.8
Total	$12	$8.6

The one-time implementation costs to the NRC for filtered vents relative to the status quo is estimated to be $0.84 million and total NRC operation costs ranging from $11 million (3 percent net present value) to $7.8 million (7 percent net present value). The estimated total NRC costs range from $12 million (3 percent net present value) to $8.6 million (7 percent net present value). A more detailed analysis of the NRC implementation and operation costs can be found within the regulatory analysis.

B.2.7.3 Alternative 4 – Severe Accident Confinement Strategy

Table B-15 – NRC Costs – Severe Accident Confinement Strategy

Attribute	Costs (2012 dollars in millions)	
	3% Net Present Value	7% Net Present Value
Implementation	$3.0	$2.5
Operation	$14	$9.9
Total	$17	$12

The one-time implementation costs to the NRC for the severe accident confinement strategy relative to the status quo is estimated to range from $3.0 million (3 percent net present value) to $2.5 million (7percent net present value) million and total NRC operation costs range from $14 million (3 percent net present value) to $9.9 million (7 percent net present value). The estimated total NRC costs range from $17 million (3 percent net present value) to $12 million (7 percent net present value). Similar to the industry costs, there are unquantified costs for any new installed equipment or procedures that would be required to fulfill the severe accident confinement strategy. A more detailed analysis of the NRC implementation and operation costs can be found within the regulatory analysis.

B.2.8 The potential impact of differences in facility type, design or age on the relevancy and practicality of the proposed backfit

B.2.8.1 Alternative 2 – Severe Accident Capable Vents

B.2.8.1.1 Mark I Containments

The Mark I containment designs would have the same severe accident capable vent requirement and there is no expected significant differentiation in how the final design will end up for the units.

B.2.8.1.2 Mark II Containments

Given the possibility of molten core breaching the reactor vessel in a Mark II containment, suppression pool bypass is thought to be likely shortly after the core debris reaches the floor as the corium fails drain lines or downcomer pipes, opening holes between the drywell and suppression chamber atmosphere. From that time on, the suppression pool provides decontamination only to the extent that some core debris eventually falls into the pool and is thus submerged. Without the pool scrub, the overall containment decontamination factor would be insufficient and an external filter would be the only option to ensure radiological release consequences are kept below an acceptable level should a severe accident occur. Therefore, a system similar to the ABWR Sump Corium Shield would be required to be installed in all of the Mark II containment designs.

B.2.8.2 Alternative 3 – Filtered Vents

There is no anticipated differences based on the different facility type, design, or age in relation to filtered vents for Mark I or Mark II reactor containments.

B.2.8.3 Alternative 4 – Severe Accident Confinement Strategy

As the severe accident confinement strategy would ideally have site-specific modifications for each unit, each unit would be different based on containment, age and specifications. Depending on how the licensee decides to implement their filtration strategy, the backfit may vary significantly.

B.2.9 Whether the proposed backfit is interim or final and, if interim, the justification for imposing the proposed backfit on an interim basis

B.2.9.1 Alternative 2 – Severe Accident Capable Vents

The proposed backfit is final.

B.2.9.2 Alternative 3 – Filtered Vents

The proposed backfit is final.

B.2.9.3 Alternative 4 – Severe Accident Confinement Strategy

The backfit would require orders and would, in the interim, require severe accident capable vents to be implemented via an order. The reason for this interim requirement is that the severe accident confinement strategy would require at least severe accident capable vents. Therefore, while developing a formal guidance for the severe accident confinement strategy, a minimum requirement can be established.

B.2.10 Other information relevant and material to the proposed backfit

Table B-16 – Summary of Total Cost Offsets for Onsite and Offsite Property

Alternative	Total Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Severe accident capable vents – Mark I Containments	$21	$0.071	$14	$51	$0.045	$9.0	$34
Severe accident capable vents – Mark II Containments	$7.3	$0.025	$4.9	$18	$0.016	$3.1	$12
Filtered Vents	$64	$0.62	$42	$155	$0.39	$27	$99
Severe Accident Confinement Strategy	$57	$0.48	$36	$130	$0.28	$22	$79

As the table above shows, the alternatives would incur onsite and offsite property cost offsets from an accident. The greatest cost offsets come from the filtered vent alternative, followed by the severe accident confinement strategy. The significantly higher cost offsets for the two alternatives include the benefit of replacement energy costs for multi-unit sites. Within

those alternatives, the capability to filter during post-accident containment venting would minimize the amount of radiological contamination of the other unit, which reduces contamination cleanup cost and allows the non=accident unit to remain in service. The regulatory analysis provides greater detail on the onsite and offsite property and replacement energy cost offsets.

Table B-17 – Summary Evaluation of Estimated Unquantified Attributes and Considerations

Attribute/Consideration	Severe accident capable vents	Filtered Vents	Severe Accident Confinement Strategy
Environmental Considerations	Lowest	Highest	Middle
Regulatory Efficiency	(Highest)	(Highest)	(Middle)
Uncertainties	Lowest	Highest	Middle
Hydrogen Control	Middle	Middle	Middle
Defense in Depth	Lowest	Highest	Middle
Severe Accident Management	Lowest	Middle	Middle
Emergency Planning	Lowest	Highest	Middle
Independence of Barriers	Lowest	Highest	Middle
Severe Accident Policy Statement	(Highest)	(Highest)	(Highest)
External Events	Lowest	Middle	Middle
Multi-Unit Events	Lowest	Middle	Middle

Also, all of the alternatives would have unquantified benefits and disbenefits. The total relative unqualified benefit depends on the alternative. The highest relative unquantified benefit arises from the filtered vents alternative, the second highest alternative from the severe accident confinement strategy, and the smallest benefit from the severe accident capable vent. The qualitative factors are discussed in greater detail within the regulatory analysis.

B.2.10.1 Alternative 2 – Severe Accident Capable Vents

B.2.10.1.1 Mark I Containments

Table B-18 – Cost Offsets for Onsite and Offsite Property – Severe Accident Capable Vents – Mark I Containments

Attribute	Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Offsite	$12	$0.042	$8.5	$31	$0.029	$5.8	$22
Onsite	$9.1	$0.029	$5.5	$20	$0.016	$3.2	$12
Total	$21	$0.071	$14	$51	$0.045	$9.0	$34

The severe accident capable vents for Mark I containments would realize cost offsets from both offsite and onsite property relative to the status quo. The estimated offsite property cost offsets ranges from $0.042 million to $31 million (3 percent net present value) and $0.029 million to $22 million (7 percent net present value). The estimated onsite property cost offsets ranges from $0.029 million to $20 million (3 percent net present value) and $0.016 million to $12 million (7 percent net present value). The total estimated cost offsets for the severe accident capable vents for Mark I containments relative to the status quo, using the “best estimate”, ranges from $14 million (3 percent net present value) to $9.0 million (7 percent net present

value).

B.2.10.1.2 Mark II Containments

Table B-19 – Cost Offsets for Onsite and Offsite Property – Severe Accident Capable Vents – Mark II Containments

Attribute	Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Offsite	$4.2	$0.015	$3.0	$11	$0.010	$2.0	$7.6
Onsite	$3.1	$0.010	$1.9	$7.1	$0.0057	$1.1	$4.0
Total	$7.3	$0.025	$4.9	$18	$0.016	$3.1	$12

The severe accident capable vents for Mark II containments would realize cost offsets from both offsite and onsite property relative to the status quo. The estimated offsite property cost offsets ranges from $0.015 million to $11 million (3 percent net present value) and $0.010 million to $7.6 million (7 percent net present value). The estimated onsite property cost offsets ranges from $0.010 million to $7.1 million (3 percent net present value) and $0.0057 million to $4.0 million (7 percent net present value). The total estimated cost offsets for the severe accident capable vents for Mark II containments relative to the status quo, using the "best estimate", ranges from $4.9 million (3 percent net present value) to $3.1 million (7 percent net present value).

B.2.10.2 Alternative 3 – Filtered Vents

Table B-20 – Cost Offsets for Onsite and Offsite Property – Filtered Vents

Attribute	Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Offsite	$29	$0.11	$20	$74	$0.078	$14	$51
Onsite	$20	$0.063	$12	$45	$0.036	$7.1	$25
Replacement Energy	$15	$0.45	$10	$36	$0.28	$6.2	$23
Total	$64	$0.62	$42	$155	$0.39	$27	$99

The filtered vents would realize cost offsets from both offsite and onsite property and replacement energy costs relative to the status quo. The estimated offsite property cost offsets ranges from $0.11 million to $74 million (3 percent net present value) and $0.078 million to $51 million (7 percent net present value). The estimated onsite property cost offsets ranges from $0.063 million to $45 million (3 percent net present value) and $0.036 million to $25 million (7 percent net present value). The estimated replacement energy cost offsets ranges from $0.45 million to $36 million (3 percent net present value) and $0.28 million to $23 million (7 percent net present value). The total estimated cost offsets for the filtered vents relative to the status quo, using the "best estimate", ranges from $42 million (3 percent net present value) to $27 million (7 percent net present value).

B.2.10.3 Alternative 4 – Severe Accident Confinement Strategy

Table B-21 – Cost Offsets from Onsite and Offsite Property – Severe Accident Confinement Strategy

Attribute	Cost Offsets (2012 dollars in millions)						
	No Disc.	3% Net Present Value			7% Net Present Value		
	Best Est.	Low Est.	Best Est.	High Est.	Low Est.	Best Est.	High Est.
Offsite	$26	$0.099	$18	$66	$0.065	$12	$43
Onsite	$19	$0.057	$11	$40	$0.031	$6.1	$22
Replacement Energy	$12	$0.32	$7.1	$25	$0.18	$3.9	$14
Total	$57	$0.48	$36	$130	$0.28	$22	$79

The severe accident confinement strategy would realize cost offsets from both offsite and onsite property and replacement energy costs relative to the status quo. The estimated offsite property cost offsets ranges from $0.099 million to $66 million (3 percent net present value) and $0.065 million to $43 million (7 percent net present value). The estimated onsite property cost offsets ranges from $0.057 million to $40 million (3 percent net present value) and $0.031 million to $22 million (7 percent net present value). The estimated replacement energy cost offsets ranges from $0.32 million to $25 million (3 percent net present value) and $0.18 million to $14 million (7 percent net present value). The total estimated cost offsets for the filtered vents relative to the status quo, using the "best estimate", ranges from $36 million (3 percent net present value) to $22 million (7 percent net present value).

B.3 Summary

The NRC staff recommends implementing the filtered vent alternative as a cost-justified substantial safety enhancement under 10 CFR 50.109(a)(3) based on the quantified and qualified benefits and costs.

B.3.1 Alternative 2 – Severe Accident Capable Vents

B.3.1.1 Mark I Containments

Table B-19 – Summary of Reduction in Radiation Dose of Severe Accident Capable Vents for Mark I Containments

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	14	1.3	15	$0.036	$0.015
Best Estimate	2,500	330	2,800	$3.8	$2.6
95th Percentile	10,000	970	20,000	$15	$11
Framework (per Unit)	Person-Rem Averted per Unit			Benefits per Unit (2012 dollars in millions)	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	0.61	0.057	0.65	$0.0016	$0.0070
Best Estimate	110	14	120	$0.17	$0.11
95th Percentile	430	42	470	$0.65	$0.48

In relation to the severe accident capable vents for Mark I containments being a substantial safety enhancement relative to the status quo, as stated previously, the radiation dose averted ranges from 15 to 20,000 person-rem and provides an estimated total benefit ranging from $0.036 million to $15 million (3 percent net present value) and $0.015 million to $11 million (7 percent net present value). As there are only 23 units that have Mark I containments, to compare the severe accident capable vents for Mark I containments to the other alternatives, the per unit radiation dose averted relative to the status quo ranges from 0.61 to 430 person-rem and provides an estimated total per unit benefit ranging from $0.0016 million to $0.65 million (3 percent net present value) and $0.0070 million to $0.48 million (7 percent net present value).

The Commission has not set an averted person-rem criteria and has previously stated that qualitative factors should be included when making a determination of a substantial safety enhancement. Due to the range in the quantitative analysis and the other additional qualitative benefits, as outlined within the regulatory analysis, the NRC staff recommends that the severe accident capable vents for Mark I containments provide a substantial increase to public health and safety.

Table B-20 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark I Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$72 to $95	$72 to $95	$72 to $95
Benefits	$0.093 to $0.11 + B_Q	$18 to $22 + B_Q	$66 to $83 + B_Q
Net benefits (benefits – costs)	($95) to ($72) + B_Q	($77) to ($50) + B_Q	($29) to $11 + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

In relation to the severe accident capable vents for Mark I containments being cost-justified, as provided in further detail within the regulatory analysis, the table above shows the sensitivities and uncertainties related to the quantitative analysis for the severe accident capable vents for Mark I containments. The quantitative analysis alone shows that the severe accident capable vents are not cost-justified using the “best estimate”, but are cost-justified using the “high estimate”. Based on the quantitative results, along with the qualified benefits provided in the regulatory analysis, the NRC staff recommends that the severe accident capable vents for Mark I containments are cost-justified.

Therefore, the severe accident capable vents for Mark I containments are cost-justified substantial safety enhancements and meet the criterion established within 10 CFR 50.109(a)(3).

B.3.1.2 Mark II Containments

Table B-21 – Summary of Reduction in Radiation Dose of Severe Accident Capable Vents for Mark II Containments

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	4.8	0.43	5.2	$0.0074	$0.0051
Best Estimate	880	81	960	$1.3	$0.91
95th Percentile	3,500	320	3,800	$5.4	$3.7
Framework (per Unit)	**Person-Rem Averted per Unit**			**Benefits per Unit (2012 dollars in millions)**	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	0.60	0.054	0.65	$0.00090	$0.00064
Best Estimate	110	10	120	$0.16	$0.11
95th Percentile	440	40	480	$0.68	$0.46

In relation to the severe accident capable vents for Mark II containments being a substantial safety enhancement relative to the status quo, as stated previously, the radiation dose averted ranges from 5.2 to 3,800 person-rem and provides an estimated total benefit ranging from $0.0074 million to $5.4 million (3 percent net present value) and $0.0051 million to $3.7 million (7 percent net present value). As there are only 8 units that have Mark II containments, to compare the severe accident capable vents for Mark II containments to the other alternatives, the per unit radiation dose averted relative to the status quo ranges from 0.60 to 440 person-rem and provides an estimated total per unit benefit ranging from $0.00090 million to $0.68 million (3 percent net present value) and $0.00064 million to $0.46 million (7 percent net present value). Comparing the per unit radiation dose averted and benefits of the two sub-alternatives of the severe accident capable vents, shows that each sub-alternative provides essentially the same per unit benefit as the other.

The Commission has not set an averted person-rem criteria and has previously stated that qualitative factors should be included when making a determination of a substantial safety enhancement. Due to the range in the quantitative analysis and the other additional qualitative benefits, as outlined within the regulatory analysis, the NRC staff recommends that the severe accident capable vents for Mark I containments provide a substantial increase to public health and safety.

Table B-22 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark II Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5th Percentile)	Best Estimate (Point-Estimate)	High Estimate (95th Percentile)
Costs	$52 to $110	$52 to $110	$52 to $110
Benefits	$0.032 to $0.040 + B_Q	$6.2 to $7.5 + B_Q	$24 to $29 + B_Q
Net benefits (benefits – costs)	($110) to ($52) + B_Q	($100) to ($45) + B_Q	($86) to ($23) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

In relation to the severe accident capable vents for Mark II containments being cost-justified, as provided in further detail within the regulatory analysis, the table above shows the sensitivities and uncertainties related to the quantitative analysis for the severe accident capable vents for Mark II containments. The quantitative analysis alone shows that the severe accident capable vents are not cost-justified using the "best estimate", but are cost-justified using the "high estimate". Based on the quantitative results, along with the qualified benefits provided in the regulatory analysis, the NRC staff recommends that the severe accident capable vents for Mark II containments are cost-justified.

Therefore, the severe accident capable vents for Mark II containments are cost-justified substantial safety enhancements and meet the criterion established within 10 CFR 50.109(a)(3).

B.3.2 Alternative 3 – Filtered Vents

Table B-23 – Summary of Reduction in Radiation Dose of Filtered Vents

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	34	2.6	37	$0.053	$0.036
Best Estimate	6,500	510	7,000	$9.9	$6.7
95th Percentile	25,000	2,000	27,000	$38	$26
Framework (per Unit)	Person-Rem Averted per Unit			Benefits per Unit (2012 dollars in millions)	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	1.1	0.084	1.2	$0.0017	$0.0012
Best Estimate	210	16	230	$0.32	$0.22
95th Percentile	810	65	870	$1.2	$0.84

In relation to the filtered vents alternative being a substantial safety enhancement, as stated previously, the radiation dose averted ranges from 37 to 27,000 person rem and provides an estimated total benefit ranging from $0.053 million to $38 million (3 percent net present value) and $0.036 million to $26 million (7 percent net present value). To compare the filtered vent alternative to the other alternatives, the per unit radiation dose averted relative to the status quo ranges from 1.2 to 810 person-rem and provides an estimated total per unit benefit ranging from $0.0017 million to $1.2 million (3 percent net present value) and $0.0012 million to $0.84 million (7 percent net present value). Compared to the severe accident capable vents, the filtered vents provide about two times the benefit as the severe accident capable vents.

Due to the range in the quantitative analysis and the other additional unquantified benefits as outlined within the regulatory analysis, the staff believes that the filtered vents provide a substantial increase to public health and safety. Some of the key benefits are the defense-in-depth issues and emergency planning uncertainties. These qualitative benefits, provided with the quantitative range, provide a substantial safety enhancement for the filtered vent alternative.

Table B-24 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Filtered Vents at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5th Percentile)	Best Estimate (Point-Estimate)	High Estimate (95th Percentile)
Costs	$520 to $670	$520 to $670	$520 to $670
Benefits	$0.68 to $36 + B_Q	$42 to $87 + B_Q	$160 to $230 + B_Q
Net benefits (benefits – costs)	($670) to ($480) + B_Q	($630) to ($430) + B_Q	($510) to ($290) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

In relation to the filtered vents being cost-justified, as provided in further detail within the regulatory analysis, there are numerous sensitivities and uncertainties related to the quantitative analysis for the filtered vents. In none of the quantitative sensitivities is the filtered vent option cost-justified. However, the filtered vent alternative provides significant qualitative benefits including benefits to the environment and related to defense-in-depth. Based on the quantitative results, along with the qualified benefits provided in the regulatory analysis, the NRC staff believes that the filtered vents are cost-justified.

Therefore, the filtered vents are cost-justified substantial safety enhancements and meet the criterion established within 10 CFR 50.109(a)(3). As the filtered vents would also include severe accident capable vents and they are both cost-justified substantial safety enhancements, the NRC staff recommends implementing filtered vents alternative (alternative 3), which subsumes the severe accident capable vents (alternative 2), and has the greatest net benefit.

B.3.3 Alternative 4 – Severe Accident Confinement Strategy

Table B-25 – Summary of Reduction in Radiation Dose of Severe Accident Confinement Strategy

Framework	Person-Rem Averted			Benefits (2012 dollars in millions)	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	31	2.5	34	$0.047	$0.0045
Best Estimate	5,900	480	6,400	$8.7	$5.6
95th Percentile	23,000	1,900	25,000	$33	$22
Framework (per Unit)	**Person-Rem Averted per Unit**			**Benefits per Unit (2012 dollars in millions)**	
	Public Health	Facility Employee	Total	3% Net Present Value	7% Net Present Value
5th Percentile	1.0	0.081	1.1	$0.0015	$0.00010
Best Estimate	190	15	210	$0.28	$0.18
95th Percentile	740	91	810	$1.1	$0.71

In relation to the severe accident confinement strategy alternative being a substantial safety enhancement, as stated previously, the radiation dose averted ranges from 34 to 25,000 person rem and provides an estimated total benefit ranging from $0.047 million to $33 million (3 percent net present value) and $0.0045 million to $22 million (7 percent net present value). To compare the severe accident confinement strategy alternative to the other alternatives, the per unit radiation dose averted relative to the status quo ranges from 1.1 to 740 person-rem and provides an estimated total per unit benefit ranging from $0.0015 million to $1.1 million (3

percent net present value) and $0.00010 million to $0.71 million (7 percent net present value). Compared to the severe accident capable vents, the severe accident confinement strategy alternative provide about two times the benefit as the severe accident capable vents. The severe accident confinement strategy alternative provides almost two times as much benefit as the severe accident capable vents, but slightly less benefit than the filtered vent alternative.

There are numerous uncertainties associated with the benefits and costs reported for the severe accident confinement strategy. It was assumed that the severe accident confinement strategy would be as beneficial as the filtered vent alternative if it met the specified performance criteria. However, the actual severe accident confinement strategy solution implemented could have benefits that are not as great. Also, the costs for the severe accident confinement strategy are necessarily conjectural since there is little hard information on how the performance criteria could be met. The cost estimate assumes that all Mark I and Mark II units would require Level 2 PRAs but does not include any costs for engineering design, equipment procurement, installation, or testing. As a result, this alternative's costs may be artificially low.

Table B-22 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of the Severe Accident Confinement Strategy at 3 percent net present value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	\$180 to \$260 + C_Q	\$180 to \$260 + C_Q	\$180 to \$260 + C_Q
Benefits	\$0.52 to \$25 + B_Q	\$45 to \$71 + B_Q	\$140 to \$200 + B_Q
Net benefits (benefits – costs)	(\$260) to (\$160) + B_Q – C_Q	(\$220) to (\$110) + B_Q – C_Q	(\$120) to \$20 + B_Q – C_Q

a Benefits are composed primarily of averted onsite and offsite property costs.
b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.
c Not all possible costs are quantified and monetized for this analysis. C_Q is the sum of all unquantified costs. Unquantified costs were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values. C_Q may be either positive or negative.

In relation to the severe accident confinement strategy alternative being cost-justified, as provided in further detail within the regulatory analysis, there are numerous sensitivities and uncertainties related to the quantitative analysis for the severe accident confinement strategy. While the "best estimate" is not quantitatively cost-justified, the "high estimate" does provide a scenario where severe accident confinement strategy is cost-justified quantitatively. However, the severe accident confinement strategy alternative provides qualitative benefits relative to the filtered vent alternative, although not as great. Also, the severe accident confinement strategy has potentially significant costs that have not been able to be quantified. Because of the large uncertainty in potential development, demonstration and implementation costs of an as yet unspecified approach, as well as the uncertainty in achievable benefits, the staff is not able to draw a cost/benefit conclusion regarding the severe accident confinement option.

Therefore, a determination that severe accident confinement strategy is a cost-justified substantial safety enhancement and meets the criterion established within 10 CFR 50.109(a)(3) cannot be made at this time. However, the NRC staff does not recommend implementing the severe accident confinement strategy alternative as the unquantified costs and benefits for the severe accident confinement strategy make the alternative less desirable than the filtered vent alternative.

APPENDIX C – TABLES

Table 2 – Public Health (Accident) – Severe Accident Capable Vents – Mark I Containments

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	4.2	$2,000	$4,000	$190,000	$190,000	$190,000	$390,000	$390,000	$390,000
2013	23	4.2	$2,000	$4,000	$190,000	$180,000	$180,000	$390,000	$380,000	$360,000
2014	23	4.2	$2,000	$4,000	$190,000	$180,000	$170,000	$390,000	$370,000	$340,000
2015	23	4.2	$2,000	$4,000	$190,000	$170,000	$160,000	$390,000	$360,000	$320,000
2016	23	4.2	$2,000	$4,000	$190,000	$170,000	$140,000	$390,000	$350,000	$300,000
2017	23	4.2	$2,000	$4,000	$190,000	$160,000	$140,000	$390,000	$340,000	$280,000
2018	23	4.2	$2,000	$4,000	$190,000	$160,000	$130,000	$390,000	$330,000	$260,000
2019	23	4.2	$2,000	$4,000	$190,000	$150,000	$120,000	$390,000	$320,000	$240,000
2020	23	4.2	$2,000	$4,000	$190,000	$150,000	$110,000	$390,000	$310,000	$230,000
2021	23	4.2	$2,000	$4,000	$190,000	$150,000	$100,000	$390,000	$300,000	$210,000
2022	23	4.2	$2,000	$4,000	$190,000	$140,000	$97,000	$390,000	$290,000	$200,000
2023	23	4.2	$2,000	$4,000	$190,000	$140,000	$90,000	$390,000	$280,000	$190,000
2024	23	4.2	$2,000	$4,000	$190,000	$130,000	$84,000	$390,000	$270,000	$170,000
2025	23	4.2	$2,000	$4,000	$190,000	$130,000	$79,000	$390,000	$270,000	$160,000
2026	23	4.2	$2,000	$4,000	$190,000	$130,000	$74,000	$390,000	$260,000	$150,000
2027	23	4.2	$2,000	$4,000	$190,000	$120,000	$69,000	$390,000	$250,000	$140,000
2028	23	4.2	$2,000	$4,000	$190,000	$120,000	$64,000	$390,000	$240,000	$130,000
2029	23	4.2	$2,000	$4,000	$190,000	$110,000	$60,000	$390,000	$240,000	$120,000
2030	23	4.2	$2,000	$4,000	$190,000	$110,000	$56,000	$390,000	$230,000	$120,000
2031	23	4.2	$2,000	$4,000	$190,000	$110,000	$53,000	$390,000	$220,000	$110,000
2032	23	4.2	$2,000	$4,000	$190,000	$110,000	$49,000	$390,000	$220,000	$100,000
2033	23	4.2	$2,000	$4,000	$190,000	$100,000	$46,000	$390,000	$210,000	$94,000
2034	23	4.2	$2,000	$4,000	$190,000	$99,000	$43,000	$390,000	$200,000	$88,000
2035	23	4.2	$2,000	$4,000	$190,000	$96,000	$40,000	$390,000	$200,000	$82,000
2036	23	4.2	$2,000	$4,000	$190,000	$93,000	$37,000	$390,000	$190,000	$77,000
2037	23	4.2	$2,000	$4,000	$190,000	$91,000	$35,000	$390,000	$190,000	$72,000
Total per unit:		**110**		**Total:**	**$4,900,000**	**$3,500,000**	**$2,400,000**	**$10,000,000**	**$7,200,000**	**$4,900,000**
Total:		**2,500**								

Table 3 – Public Health (Accident) – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.023	$2,000	$4,000	$1,100	$1,100	$1,100	$2,100	$2,100	$2,100
2013	23	0.023	$2,000	$4,000	$1,100	$1,100	$1,000	$2,100	$2,000	$2,000
2014	23	0.023	$2,000	$4,000	$1,100	$1,000	$960	$2,100	$2,000	$1,800
2015	23	0.023	$2,000	$4,000	$1,100	$1,000	$900	$2,100	$1,900	$1,700
2016	23	0.023	$2,000	$4,000	$1,100	$980	$840	$2,100	$1,900	$1,600
2017	23	0.023	$2,000	$4,000	$1,100	$950	$780	$2,100	$1,800	$1,500
2018	23	0.023	$2,000	$4,000	$1,100	$920	$730	$2,100	$1,800	$1,400
2019	23	0.023	$2,000	$4,000	$1,100	$890	$690	$2,100	$1,700	$1,300
2020	23	0.023	$2,000	$4,000	$1,100	$870	$640	$2,100	$1,700	$1,200
2021	23	0.023	$2,000	$4,000	$1,100	$840	$600	$2,100	$1,600	$1,100
2022	23	0.023	$2,000	$4,000	$1,100	$820	$560	$2,100	$1,600	$1,100
2023	23	0.023	$2,000	$4,000	$1,100	$790	$520	$2,100	$1,500	$1,000
2024	23	0.023	$2,000	$4,000	$1,100	$770	$490	$2,100	$1,500	$930
2025	23	0.023	$2,000	$4,000	$1,100	$750	$460	$2,100	$1,400	$870
2026	23	0.023	$2,000	$4,000	$1,100	$730	$430	$2,100	$1,400	$810
2027	23	0.023	$2,000	$4,000	$1,100	$710	$400	$2,100	$1,300	$760
2028	23	0.023	$2,000	$4,000	$1,100	$690	$370	$2,100	$1,300	$710
2029	23	0.023	$2,000	$4,000	$1,100	$670	$350	$2,100	$1,300	$660
2030	23	0.023	$2,000	$4,000	$1,100	$650	$330	$2,100	$1,200	$620
2031	23	0.023	$2,000	$4,000	$1,100	$630	$300	$2,100	$1,200	$580
2032	23	0.023	$2,000	$4,000	$1,100	$610	$280	$2,100	$1,200	$540
2033	23	0.023	$2,000	$4,000	$1,100	$590	$270	$2,100	$1,100	$510
2034	23	0.023	$2,000	$4,000	$1,100	$570	$250	$2,100	$1,100	$470
2035	23	0.023	$2,000	$4,000	$1,100	$560	$230	$2,100	$1,100	$440
2036	23	0.023	$2,000	$4,000	$1,100	$540	$220	$2,100	$1,000	$410
2037	23	0.023	$2,000	$4,000	$1,100	$530	$200	$2,100	$1,000	$390
Total per unit:		**0.60**		**Total:**	**$29,000**	**$20,000**	**$14,000**	**$55,000**	**$39,000**	**$27,000**
Total:		**14**								

Table 4 – Public Health (Accident) – Severe Accident Capable Vents – Mark I Containments– 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	17	$2,000	$4,000	$780,000	$780,000	$780,000	$1,600,000	$1,600,000	$1,600,000
2013	23	17	$2,000	$4,000	$780,000	$760,000	$730,000	$1,600,000	$1,600,000	$1,500,000
2014	23	17	$2,000	$4,000	$780,000	$740,000	$680,000	$1,600,000	$1,500,000	$1,400,000
2015	23	17	$2,000	$4,000	$780,000	$710,000	$640,000	$1,600,000	$1,500,000	$1,300,000
2016	23	17	$2,000	$4,000	$780,000	$690,000	$600,000	$1,600,000	$1,400,000	$1,200,000
2017	23	17	$2,000	$4,000	$780,000	$670,000	$560,000	$1,600,000	$1,400,000	$1,100,000
2018	23	17	$2,000	$4,000	$780,000	$650,000	$520,000	$1,600,000	$1,300,000	$1,100,000
2019	23	17	$2,000	$4,000	$780,000	$630,000	$490,000	$1,600,000	$1,300,000	$1,000,000
2020	23	17	$2,000	$4,000	$780,000	$620,000	$450,000	$1,600,000	$1,300,000	$930,000
2021	23	17	$2,000	$4,000	$780,000	$600,000	$420,000	$1,600,000	$1,200,000	$870,000
2022	23	17	$2,000	$4,000	$780,000	$580,000	$400,000	$1,600,000	$1,200,000	$810,000
2023	23	17	$2,000	$4,000	$780,000	$560,000	$370,000	$1,600,000	$1,200,000	$760,000
2024	23	17	$2,000	$4,000	$780,000	$550,000	$350,000	$1,600,000	$1,100,000	$710,000
2025	23	17	$2,000	$4,000	$780,000	$530,000	$320,000	$1,600,000	$1,100,000	$660,000
2026	23	17	$2,000	$4,000	$780,000	$520,000	$300,000	$1,600,000	$1,100,000	$620,000
2027	23	17	$2,000	$4,000	$780,000	$500,000	$280,000	$1,600,000	$1,000,000	$580,000
2028	23	17	$2,000	$4,000	$780,000	$490,000	$260,000	$1,600,000	$1,000,000	$540,000
2029	23	17	$2,000	$4,000	$780,000	$470,000	$250,000	$1,600,000	$970,000	$510,000
2030	23	17	$2,000	$4,000	$780,000	$460,000	$230,000	$1,600,000	$940,000	$470,000
2031	23	17	$2,000	$4,000	$780,000	$440,000	$220,000	$1,600,000	$910,000	$440,000
2032	23	17	$2,000	$4,000	$780,000	$430,000	$200,000	$1,600,000	$890,000	$410,000
2033	23	17	$2,000	$4,000	$780,000	$420,000	$190,000	$1,600,000	$860,000	$390,000
2034	23	17	$2,000	$4,000	$780,000	$410,000	$180,000	$1,600,000	$840,000	$360,000
2035	23	17	$2,000	$4,000	$780,000	$400,000	$160,000	$1,600,000	$810,000	$340,000
2036	23	17	$2,000	$4,000	$780,000	$380,000	$150,000	$1,600,000	$790,000	$320,000
2037	23	17	$2,000	$4,000	$780,000	$370,000	$140,000	$1,600,000	$760,000	$290,000
Total per unit:		**440**		**Total:**	**$20,000,000**	**$14,000,000**	**$9,900,000**	**$42,000,000**	**$30,000,000**	**$20,000,000**
Total:		**10,000**								

Table 6 – Public Health (Accident) – Severe Accident Capable Vents – Mark II Containments

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	4.2	$2,000	$4,000	$67,000	$67,000	$67,000	$130,000	$130,000	$130,000
2013	8	4.2	$2,000	$4,000	$67,000	$65,000	$63,000	$130,000	$130,000	$120,000
2014	8	4.2	$2,000	$4,000	$67,000	$63,000	$59,000	$130,000	$120,000	$110,000
2015	8	4.2	$2,000	$4,000	$67,000	$61,000	$55,000	$130,000	$120,000	$110,000
2016	8	4.2	$2,000	$4,000	$67,000	$60,000	$51,000	$130,000	$120,000	$99,000
2017	8	4.2	$2,000	$4,000	$67,000	$58,000	$48,000	$130,000	$110,000	$93,000
2018	8	4.2	$2,000	$4,000	$67,000	$56,000	$45,000	$130,000	$110,000	$87,000
2019	8	4.2	$2,000	$4,000	$67,000	$54,000	$42,000	$130,000	$110,000	$81,000
2020	8	4.2	$2,000	$4,000	$67,000	$53,000	$39,000	$130,000	$100,000	$76,000
2021	8	4.2	$2,000	$4,000	$67,000	$51,000	$36,000	$130,000	$100,000	$71,000
2022	8	4.2	$2,000	$4,000	$67,000	$50,000	$34,000	$130,000	$97,000	$66,000
2023	8	4.2	$2,000	$4,000	$67,000	$48,000	$32,000	$130,000	$94,000	$62,000
2024	8	4.2	$2,000	$4,000	$67,000	$47,000	$30,000	$130,000	$91,000	$58,000
2025	8	4.2	$2,000	$4,000	$67,000	$46,000	$28,000	$130,000	$89,000	$54,000
2026	8	4.2	$2,000	$4,000	$67,000	$44,000	$26,000	$130,000	$86,000	$50,000
2027	8	4.2	$2,000	$4,000	$67,000	$43,000	$24,000	$130,000	$83,000	$47,000
2028	8	4.2	$2,000	$4,000	$67,000	$42,000	$23,000	$130,000	$81,000	$44,000
2029	8	4.2	$2,000	$4,000	$67,000	$41,000	$21,000	$130,000	$79,000	$41,000
2030	8	4.2	$2,000	$4,000	$67,000	$39,000	$20,000	$130,000	$76,000	$38,000
2031	8	4.2	$2,000	$4,000	$67,000	$38,000	$19,000	$130,000	$74,000	$36,000
2032	8	4.2	$2,000	$4,000	$67,000	$37,000	$17,000	$130,000	$72,000	$34,000
2033	8	4.2	$2,000	$4,000	$67,000	$36,000	$16,000	$130,000	$70,000	$31,000
2034	8	4.2	$2,000	$4,000	$67,000	$35,000	$15,000	$130,000	$68,000	$29,000
2035	8	4.2	$2,000	$4,000	$67,000	$34,000	$14,000	$130,000	$66,000	$27,000
2036	8	4.2	$2,000	$4,000	$67,000	$33,000	$13,000	$130,000	$64,000	$26,000
2037	8	4.2	$2,000	$4,000	$67,000	$32,000	$12,000	$130,000	$62,000	$24,000
Total per unit:		**110**		**Total:**	**$1,700,000**	**$1,200,000**	**$850,000**	**$3,400,000**	**$2,400,000**	**$1,600,000**
Total:		**880**								

Table 7 – Public Health (Accident) – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.023	$2,000	$4,000	$370	$370	$370	$740	$740	$740
2013	8	0.023	$2,000	$4,000	$370	$360	$350	$740	$720	$690
2014	8	0.023	$2,000	$4,000	$370	$350	$320	$740	$700	$650
2015	8	0.023	$2,000	$4,000	$370	$340	$300	$740	$680	$600
2016	8	0.023	$2,000	$4,000	$370	$330	$280	$740	$660	$560
2017	8	0.023	$2,000	$4,000	$370	$320	$260	$740	$640	$530
2018	8	0.023	$2,000	$4,000	$370	$310	$250	$740	$620	$490
2019	8	0.023	$2,000	$4,000	$370	$300	$230	$740	$600	$460
2020	8	0.023	$2,000	$4,000	$370	$290	$220	$740	$580	$430
2021	8	0.023	$2,000	$4,000	$370	$280	$200	$740	$570	$400
2022	8	0.023	$2,000	$4,000	$370	$280	$190	$740	$550	$380
2023	8	0.023	$2,000	$4,000	$370	$270	$180	$740	$530	$350
2024	8	0.023	$2,000	$4,000	$370	$260	$160	$740	$520	$330
2025	8	0.023	$2,000	$4,000	$370	$250	$150	$740	$500	$310
2026	8	0.023	$2,000	$4,000	$370	$240	$140	$740	$490	$290
2027	8	0.023	$2,000	$4,000	$370	$240	$130	$740	$470	$270
2028	8	0.023	$2,000	$4,000	$370	$230	$130	$740	$460	$250
2029	8	0.023	$2,000	$4,000	$370	$220	$120	$740	$450	$230
2030	8	0.023	$2,000	$4,000	$370	$220	$110	$740	$430	$220
2031	8	0.023	$2,000	$4,000	$370	$210	$100	$740	$420	$200
2032	8	0.023	$2,000	$4,000	$370	$200	$96	$740	$410	$190
2033	8	0.023	$2,000	$4,000	$370	$200	$89	$740	$400	$180
2034	8	0.023	$2,000	$4,000	$370	$190	$84	$740	$390	$170
2035	8	0.023	$2,000	$4,000	$370	$190	$78	$740	$370	$160
2036	8	0.023	$2,000	$4,000	$370	$180	$73	$740	$360	$150
2037	8	0.023	$2,000	$4,000	$370	$180	$68	$740	$350	$140
Total per unit:		**0.60**		**Total:**	**$9,600**	**$6,800**	**$4,700**	**$19,000**	**$14,000**	**$9,400**
Total:		**4.8**								

Table 8 – Public Health (Accident) – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	17	$2,000	$4,000	$270,000	$270,000	$270,000	$540,000	$540,000	$540,000
2013	8	17	$2,000	$4,000	$270,000	$260,000	$250,000	$540,000	$520,000	$500,000
2014	8	17	$2,000	$4,000	$270,000	$250,000	$240,000	$540,000	$510,000	$470,000
2015	8	17	$2,000	$4,000	$270,000	$250,000	$220,000	$540,000	$490,000	$440,000
2016	8	17	$2,000	$4,000	$270,000	$240,000	$210,000	$540,000	$480,000	$410,000
2017	8	17	$2,000	$4,000	$270,000	$230,000	$190,000	$540,000	$470,000	$390,000
2018	8	17	$2,000	$4,000	$270,000	$230,000	$180,000	$540,000	$450,000	$360,000
2019	8	17	$2,000	$4,000	$270,000	$220,000	$170,000	$540,000	$440,000	$340,000
2020	8	17	$2,000	$4,000	$270,000	$210,000	$160,000	$540,000	$430,000	$310,000
2021	8	17	$2,000	$4,000	$270,000	$210,000	$150,000	$540,000	$410,000	$290,000
2022	8	17	$2,000	$4,000	$270,000	$200,000	$140,000	$540,000	$400,000	$270,000
2023	8	17	$2,000	$4,000	$270,000	$200,000	$130,000	$540,000	$390,000	$260,000
2024	8	17	$2,000	$4,000	$270,000	$190,000	$120,000	$540,000	$380,000	$240,000
2025	8	17	$2,000	$4,000	$270,000	$180,000	$110,000	$540,000	$370,000	$220,000
2026	8	17	$2,000	$4,000	$270,000	$180,000	$100,000	$540,000	$360,000	$210,000
2027	8	17	$2,000	$4,000	$270,000	$170,000	$98,000	$540,000	$350,000	$200,000
2028	8	17	$2,000	$4,000	$270,000	$170,000	$91,000	$540,000	$340,000	$180,000
2029	8	17	$2,000	$4,000	$270,000	$160,000	$85,000	$540,000	$330,000	$170,000
2030	8	17	$2,000	$4,000	$270,000	$160,000	$80,000	$540,000	$320,000	$160,000
2031	8	17	$2,000	$4,000	$270,000	$150,000	$75,000	$540,000	$310,000	$150,000
2032	8	17	$2,000	$4,000	$270,000	$150,000	$70,000	$540,000	$300,000	$140,000
2033	8	17	$2,000	$4,000	$270,000	$150,000	$65,000	$540,000	$290,000	$130,000
2034	8	17	$2,000	$4,000	$270,000	$140,000	$61,000	$540,000	$280,000	$120,000
2035	8	17	$2,000	$4,000	$270,000	$140,000	$57,000	$540,000	$270,000	$110,000
2036	8	17	$2,000	$4,000	$270,000	$130,000	$53,000	$540,000	$270,000	$110,000
2037	8	17	$2,000	$4,000	$270,000	$130,000	$50,000	$540,000	$260,000	$99,000
Total per unit:		**440**		**Total:**	**$7,000,000**	**$5,000,000**	**$3,400,000**	**$14,000,000**	**$10,000,000**	**$6,800,000**
Total:		**3,500**								

Table 10 – Occupational Health (Accident) Short-Term – Severe Accident Capable Vents – Mark I Containments

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.20	$2,000	$4,000	$9,200	$9,200	$9,200	$18,000	$18,000	$18,000
2013	23	0.20	$2,000	$4,000	$9,200	$8,900	$8,600	$18,000	$17,000	$17,000
2014	23	0.20	$2,000	$4,000	$9,200	$8,700	$8,000	$18,000	$17,000	$16,000
2015	23	0.20	$2,000	$4,000	$9,200	$8,400	$7,500	$18,000	$16,000	$15,000
2016	23	0.20	$2,000	$4,000	$9,200	$8,200	$7,000	$18,000	$16,000	$14,000
2017	23	0.20	$2,000	$4,000	$9,200	$7,900	$6,600	$18,000	$16,000	$13,000
2018	23	0.20	$2,000	$4,000	$9,200	$7,700	$6,100	$18,000	$15,000	$12,000
2019	23	0.20	$2,000	$4,000	$9,200	$7,500	$5,700	$18,000	$15,000	$11,000
2020	23	0.20	$2,000	$4,000	$9,200	$7,300	$5,400	$18,000	$14,000	$10,000
2021	23	0.20	$2,000	$4,000	$9,200	$7,100	$5,000	$18,000	$14,000	$9,800
2022	23	0.20	$2,000	$4,000	$9,200	$6,800	$4,700	$18,000	$13,000	$9,200
2023	23	0.20	$2,000	$4,000	$9,200	$6,600	$4,400	$18,000	$13,000	$8,600
2024	23	0.20	$2,000	$4,000	$9,200	$6,500	$4,100	$18,000	$13,000	$8,000
2025	23	0.20	$2,000	$4,000	$9,200	$6,300	$3,800	$18,000	$12,000	$7,500
2026	23	0.20	$2,000	$4,000	$9,200	$6,100	$3,600	$18,000	$12,000	$7,000
2027	23	0.20	$2,000	$4,000	$9,200	$5,900	$3,300	$18,000	$12,000	$6,500
2028	23	0.20	$2,000	$4,000	$9,200	$5,700	$3,100	$18,000	$11,000	$6,100
2029	23	0.20	$2,000	$4,000	$9,200	$5,600	$2,900	$18,000	$11,000	$5,700
2030	23	0.20	$2,000	$4,000	$9,200	$5,400	$2,700	$18,000	$11,000	$5,300
2031	23	0.20	$2,000	$4,000	$9,200	$5,200	$2,500	$18,000	$10,000	$5,000
2032	23	0.20	$2,000	$4,000	$9,200	$5,100	$2,400	$18,000	$10,000	$4,700
2033	23	0.20	$2,000	$4,000	$9,200	$4,900	$2,200	$18,000	$9,700	$4,300
2034	23	0.20	$2,000	$4,000	$9,200	$4,800	$2,100	$18,000	$9,400	$4,100
2035	23	0.20	$2,000	$4,000	$9,200	$4,700	$1,900	$18,000	$9,100	$3,800
2036	23	0.20	$2,000	$4,000	$9,200	$4,500	$1,800	$18,000	$8,900	$3,500
2037	23	0.20	$2,000	$4,000	$9,200	$4,400	$1,700	$18,000	$8,600	$3,300
Total per unit:		**5.2**		**Total:**	**$240,000**	**$170,000**	**$120,000**	**$470,000**	**$330,000**	**$230,000**
Total:		**120**								

Table 11 – Occupational Health (Accident) Long-Term – Severe Accident Capable Vents – Mark I Containments

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.19	$2,000	$4,000	$8,700	$6,900	$5,100	$17,000	$13,000	$10,000
2013	23	0.19	$2,000	$4,000	$8,700	$6,700	$4,800	$17,000	$13,000	$9,300
2014	23	0.19	$2,000	$4,000	$8,700	$6,500	$4,500	$17,000	$13,000	$8,700
2015	23	0.19	$2,000	$4,000	$8,700	$6,300	$4,200	$17,000	$12,000	$8,200
2016	23	0.19	$2,000	$4,000	$8,700	$6,100	$3,900	$17,000	$12,000	$7,600
2017	23	0.19	$2,000	$4,000	$8,700	$5,900	$3,600	$17,000	$12,000	$7,100
2018	23	0.19	$2,000	$4,000	$8,700	$5,800	$3,400	$17,000	$11,000	$6,700
2019	23	0.19	$2,000	$4,000	$8,700	$5,600	$3,200	$17,000	$11,000	$6,200
2020	23	0.19	$2,000	$4,000	$8,700	$5,400	$3,000	$17,000	$11,000	$5,800
2021	23	0.19	$2,000	$4,000	$8,700	$5,300	$2,800	$17,000	$10,000	$5,400
2022	23	0.19	$2,000	$4,000	$8,700	$5,100	$2,600	$17,000	$10,000	$5,100
2023	23	0.19	$2,000	$4,000	$8,700	$5,000	$2,400	$17,000	$9,700	$4,700
2024	23	0.19	$2,000	$4,000	$8,700	$4,800	$2,300	$17,000	$9,400	$4,400
2025	23	0.19	$2,000	$4,000	$8,700	$4,700	$2,100	$17,000	$9,200	$4,100
2026	23	0.19	$2,000	$4,000	$8,700	$4,500	$2,000	$17,000	$8,900	$3,900
2027	23	0.19	$2,000	$4,000	$8,700	$4,400	$1,900	$17,000	$8,600	$3,600
2028	23	0.19	$2,000	$4,000	$8,700	$4,300	$1,700	$17,000	$8,400	$3,400
2029	23	0.19	$2,000	$4,000	$8,700	$4,200	$1,600	$17,000	$8,100	$3,200
2030	23	0.19	$2,000	$4,000	$8,700	$4,000	$1,500	$17,000	$7,900	$3,000
2031	23	0.19	$2,000	$4,000	$8,700	$3,900	$1,400	$17,000	$7,700	$2,800
2032	23	0.19	$2,000	$4,000	$8,700	$3,800	$1,300	$17,000	$7,400	$2,600
2033	23	0.19	$2,000	$4,000	$8,700	$3,700	$1,200	$17,000	$7,200	$2,400
2034	23	0.19	$2,000	$4,000	$8,700	$3,600	$1,200	$17,000	$7,000	$2,300
2035	23	0.19	$2,000	$4,000	$8,700	$3,500	$1,100	$17,000	$6,800	$2,100
2036	23	0.19	$2,000	$4,000	$8,700	$3,400	$1,000	$17,000	$6,600	$2,000
2037	23	0.19	$2,000	$4,000	$8,700	$3,300	$940	$17,000	$6,400	$1,800
	Total per unit:	**4.9**		**Total:**	**$230,000**	**$130,000**	**$65,000**	**$440,000**	**$250,000**	**$130,000**
	Total:	**110**								

Table 12 – Occupational Health (Accident) Short-Term – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.0011	$2,000	$4,000	$51	$51	$51	$100	$100	$100
2013	23	0.0011	$2,000	$4,000	$51	$50	$48	$100	$97	$93
2014	23	0.0011	$2,000	$4,000	$51	$48	$45	$100	$94	$87
2015	23	0.0011	$2,000	$4,000	$51	$47	$42	$100	$92	$82
2016	23	0.0011	$2,000	$4,000	$51	$45	$39	$100	$89	$76
2017	23	0.0011	$2,000	$4,000	$51	$44	$36	$100	$86	$71
2018	23	0.0011	$2,000	$4,000	$51	$43	$34	$100	$84	$67
2019	23	0.0011	$2,000	$4,000	$51	$41	$32	$100	$81	$62
2020	23	0.0011	$2,000	$4,000	$51	$40	$30	$100	$79	$58
2021	23	0.0011	$2,000	$4,000	$51	$39	$28	$100	$77	$54
2022	23	0.0011	$2,000	$4,000	$51	$38	$26	$100	$74	$51
2023	23	0.0011	$2,000	$4,000	$51	$37	$24	$100	$72	$48
2024	23	0.0011	$2,000	$4,000	$51	$36	$23	$100	$70	$44
2025	23	0.0011	$2,000	$4,000	$51	$35	$21	$100	$68	$41
2026	23	0.0011	$2,000	$4,000	$51	$34	$20	$100	$66	$39
2027	23	0.0011	$2,000	$4,000	$51	$33	$18	$100	$64	$36
2028	23	0.0011	$2,000	$4,000	$51	$32	$17	$100	$62	$34
2029	23	0.0011	$2,000	$4,000	$51	$31	$16	$100	$61	$32
2030	23	0.0011	$2,000	$4,000	$51	$30	$15	$100	$59	$30
2031	23	0.0011	$2,000	$4,000	$51	$29	$14	$100	$57	$28
2032	23	0.0011	$2,000	$4,000	$51	$28	$13	$100	$55	$26
2033	23	0.0011	$2,000	$4,000	$51	$27	$12	$100	$54	$24
2034	23	0.0011	$2,000	$4,000	$51	$27	$12	$100	$52	$23
2035	23	0.0011	$2,000	$4,000	$51	$26	$11	$100	$51	$21
2036	23	0.0011	$2,000	$4,000	$51	$25	$10	$100	$49	$20
2037	23	0.0011	$2,000	$4,000	$51	$24	$9	$100	$48	$18
Total per unit:		**0.029**		**Total:**	**$1,300**	**$940**	**$650**	**$2,600**	**$1,800**	**$1,300**
Total:		**0.67**								

Table 13 – Occupational Health (Accident) Long-Term – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.0010	$2,000	$4,000	$45	$36	$26	$89	$70	$52
2013	23	0.0010	$2,000	$4,000	$45	$35	$25	$89	$68	$49
2014	23	0.0010	$2,000	$4,000	$45	$34	$23	$89	$66	$46
2015	23	0.0010	$2,000	$4,000	$45	$33	$22	$89	$64	$43
2016	23	0.0010	$2,000	$4,000	$45	$32	$20	$89	$63	$40
2017	23	0.0010	$2,000	$4,000	$45	$31	$19	$89	$61	$37
2018	23	0.0010	$2,000	$4,000	$45	$30	$18	$89	$59	$35
2019	23	0.0010	$2,000	$4,000	$45	$29	$16	$89	$57	$33
2020	23	0.0010	$2,000	$4,000	$45	$28	$15	$89	$56	$30
2021	23	0.0010	$2,000	$4,000	$45	$27	$14	$89	$54	$28
2022	23	0.0010	$2,000	$4,000	$45	$26	$13	$89	$52	$27
2023	23	0.0010	$2,000	$4,000	$45	$26	$13	$89	$51	$25
2024	23	0.0010	$2,000	$4,000	$45	$25	$12	$89	$49	$23
2025	23	0.0010	$2,000	$4,000	$45	$24	$11	$89	$48	$22
2026	23	0.0010	$2,000	$4,000	$45	$24	$10	$89	$47	$20
2027	23	0.0010	$2,000	$4,000	$45	$23	$10	$89	$45	$19
2028	23	0.0010	$2,000	$4,000	$45	$22	$9	$89	$44	$18
2029	23	0.0010	$2,000	$4,000	$45	$22	$8	$89	$43	$17
2030	23	0.0010	$2,000	$4,000	$45	$21	$8	$89	$41	$15
2031	23	0.0010	$2,000	$4,000	$45	$20	$7	$89	$40	$14
2032	23	0.0010	$2,000	$4,000	$45	$20	$7	$89	$39	$14
2033	23	0.0010	$2,000	$4,000	$45	$19	$6	$89	$38	$13
2034	23	0.0010	$2,000	$4,000	$45	$19	$6	$89	$37	$12
2035	23	0.0010	$2,000	$4,000	$45	$18	$6	$89	$36	$11
2036	23	0.0010	$2,000	$4,000	$45	$18	$5	$89	$35	$10
2037	23	0.0010	$2,000	$4,000	$45	$17	$5	$89	$34	$10
	Total per unit:	**0.025**		**Total:**	**$1,200**	**$660**	**$330**	**$2,300**	**$1,300**	**$660**
	Total:	**0.58**								

Table 14 – Occupational Health (Accident) Short-Term – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.89	$2,000	$4,000	$41,000	$41,000	$41,000	$82,000	$82,000	$82,000
2013	23	0.89	$2,000	$4,000	$41,000	$40,000	$38,000	$82,000	$80,000	$77,000
2014	23	0.89	$2,000	$4,000	$41,000	$39,000	$36,000	$82,000	$77,000	$72,000
2015	23	0.89	$2,000	$4,000	$41,000	$38,000	$33,000	$82,000	$75,000	$67,000
2016	23	0.89	$2,000	$4,000	$41,000	$36,000	$31,000	$82,000	$73,000	$63,000
2017	23	0.89	$2,000	$4,000	$41,000	$35,000	$29,000	$82,000	$71,000	$58,000
2018	23	0.89	$2,000	$4,000	$41,000	$34,000	$27,000	$82,000	$69,000	$55,000
2019	23	0.89	$2,000	$4,000	$41,000	$33,000	$26,000	$82,000	$67,000	$51,000
2020	23	0.89	$2,000	$4,000	$41,000	$32,000	$24,000	$82,000	$65,000	$48,000
2021	23	0.89	$2,000	$4,000	$41,000	$31,000	$22,000	$82,000	$63,000	$45,000
2022	23	0.89	$2,000	$4,000	$41,000	$31,000	$21,000	$82,000	$61,000	$42,000
2023	23	0.89	$2,000	$4,000	$41,000	$30,000	$19,000	$82,000	$59,000	$39,000
2024	23	0.89	$2,000	$4,000	$41,000	$29,000	$18,000	$82,000	$58,000	$36,000
2025	23	0.89	$2,000	$4,000	$41,000	$28,000	$17,000	$82,000	$56,000	$34,000
2026	23	0.89	$2,000	$4,000	$41,000	$27,000	$16,000	$82,000	$54,000	$32,000
2027	23	0.89	$2,000	$4,000	$41,000	$26,000	$15,000	$82,000	$53,000	$30,000
2028	23	0.89	$2,000	$4,000	$41,000	$26,000	$14,000	$82,000	$51,000	$28,000
2029	23	0.89	$2,000	$4,000	$41,000	$25,000	$13,000	$82,000	$50,000	$26,000
2030	23	0.89	$2,000	$4,000	$41,000	$24,000	$12,000	$82,000	$48,000	$24,000
2031	23	0.89	$2,000	$4,000	$41,000	$23,000	$11,000	$82,000	$47,000	$23,000
2032	23	0.89	$2,000	$4,000	$41,000	$23,000	$11,000	$82,000	$45,000	$21,000
2033	23	0.89	$2,000	$4,000	$41,000	$22,000	$9,900	$82,000	$44,000	$20,000
2034	23	0.89	$2,000	$4,000	$41,000	$21,000	$9,300	$82,000	$43,000	$19,000
2035	23	0.89	$2,000	$4,000	$41,000	$21,000	$8,600	$82,000	$42,000	$17,000
2036	23	0.89	$2,000	$4,000	$41,000	$20,000	$8,100	$82,000	$40,000	$16,000
2037	23	0.89	$2,000	$4,000	$41,000	$20,000	$7,600	$82,000	$39,000	$15,000
Total per unit:		**23**		**Total:**	**$1,100,000**	**$760,000**	**$520,000**	**$2,100,000**	**$1,500,000**	**$1,000,000**
Total:		**530**								

Table 15 – Occupational Health (Accident) Long-Term – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	0.72	$2,000	$4,000	$33,000	$26,000	$19,000	$66,000	$52,000	$39,000
2013	23	0.72	$2,000	$4,000	$33,000	$25,000	$18,000	$66,000	$51,000	$36,000
2014	23	0.72	$2,000	$4,000	$33,000	$25,000	$17,000	$66,000	$49,000	$34,000
2015	23	0.72	$2,000	$4,000	$33,000	$24,000	$16,000	$66,000	$48,000	$32,000
2016	23	0.72	$2,000	$4,000	$33,000	$23,000	$15,000	$66,000	$46,000	$30,000
2017	23	0.72	$2,000	$4,000	$33,000	$23,000	$14,000	$66,000	$45,000	$28,000
2018	23	0.72	$2,000	$4,000	$33,000	$22,000	$13,000	$66,000	$44,000	$26,000
2019	23	0.72	$2,000	$4,000	$33,000	$21,000	$12,000	$66,000	$42,000	$24,000
2020	23	0.72	$2,000	$4,000	$33,000	$21,000	$11,000	$66,000	$41,000	$23,000
2021	23	0.72	$2,000	$4,000	$33,000	$20,000	$11,000	$66,000	$40,000	$21,000
2022	23	0.72	$2,000	$4,000	$33,000	$19,000	$9,900	$66,000	$39,000	$20,000
2023	23	0.72	$2,000	$4,000	$33,000	$19,000	$9,200	$66,000	$38,000	$18,000
2024	23	0.72	$2,000	$4,000	$33,000	$18,000	$8,600	$66,000	$37,000	$17,000
2025	23	0.72	$2,000	$4,000	$33,000	$18,000	$8,000	$66,000	$36,000	$16,000
2026	23	0.72	$2,000	$4,000	$33,000	$17,000	$7,500	$66,000	$35,000	$15,000
2027	23	0.72	$2,000	$4,000	$33,000	$17,000	$7,000	$66,000	$34,000	$14,000
2028	23	0.72	$2,000	$4,000	$33,000	$16,000	$6,600	$66,000	$33,000	$13,000
2029	23	0.72	$2,000	$4,000	$33,000	$16,000	$6,100	$66,000	$32,000	$12,000
2030	23	0.72	$2,000	$4,000	$33,000	$15,000	$5,700	$66,000	$31,000	$11,000
2031	23	0.72	$2,000	$4,000	$33,000	$15,000	$5,400	$66,000	$30,000	$11,000
2032	23	0.72	$2,000	$4,000	$33,000	$14,000	$5,000	$66,000	$29,000	$10,000
2033	23	0.72	$2,000	$4,000	$33,000	$14,000	$4,700	$66,000	$28,000	$9,400
2034	23	0.72	$2,000	$4,000	$33,000	$14,000	$4,400	$66,000	$27,000	$8,700
2035	23	0.72	$2,000	$4,000	$33,000	$13,000	$4,100	$66,000	$26,000	$8,200
2036	23	0.72	$2,000	$4,000	$33,000	$13,000	$3,800	$66,000	$26,000	$7,600
2037	23	0.72	$2,000	$4,000	$33,000	$12,000	$3,600	$66,000	$25,000	$7,100
	Total per unit:	**19**		**Total:**	**$860,000**	**$480,000**	**$250,000**	**$1,700,000**	**$960,000**	**$490,000**
	Total:	**440**								

Table 17 – Occupational Health (Accident) Short-Term – Severe Accident Capable Vents – Mark II Containments

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.20	$2,000	$4,000	$3,200	$3,200	$3,200	$6,400	$6,400	$6,400
2013	8	0.20	$2,000	$4,000	$3,200	$3,100	$3,000	$6,400	$6,200	$6,000
2014	8	0.20	$2,000	$4,000	$3,200	$3,000	$2,800	$6,400	$6,000	$5,600
2015	8	0.20	$2,000	$4,000	$3,200	$2,900	$2,600	$6,400	$5,900	$5,200
2016	8	0.20	$2,000	$4,000	$3,200	$2,800	$2,400	$6,400	$5,700	$4,900
2017	8	0.20	$2,000	$4,000	$3,200	$2,800	$2,300	$6,400	$5,500	$4,600
2018	8	0.20	$2,000	$4,000	$3,200	$2,700	$2,100	$6,400	$5,400	$4,300
2019	8	0.20	$2,000	$4,000	$3,200	$2,600	$2,000	$6,400	$5,200	$4,000
2020	8	0.20	$2,000	$4,000	$3,200	$2,500	$1,900	$6,400	$5,100	$3,700
2021	8	0.20	$2,000	$4,000	$3,200	$2,500	$1,700	$6,400	$4,900	$3,500
2022	8	0.20	$2,000	$4,000	$3,200	$2,400	$1,600	$6,400	$4,800	$3,300
2023	8	0.20	$2,000	$4,000	$3,200	$2,300	$1,500	$6,400	$4,600	$3,000
2024	8	0.20	$2,000	$4,000	$3,200	$2,200	$1,400	$6,400	$4,500	$2,800
2025	8	0.20	$2,000	$4,000	$3,200	$2,200	$1,300	$6,400	$4,400	$2,700
2026	8	0.20	$2,000	$4,000	$3,200	$2,100	$1,200	$6,400	$4,200	$2,500
2027	8	0.20	$2,000	$4,000	$3,200	$2,100	$1,200	$6,400	$4,100	$2,300
2028	8	0.20	$2,000	$4,000	$3,200	$2,000	$1,100	$6,400	$4,000	$2,200
2029	8	0.20	$2,000	$4,000	$3,200	$1,900	$1,000	$6,400	$3,900	$2,000
2030	8	0.20	$2,000	$4,000	$3,200	$1,900	$950	$6,400	$3,800	$1,900
2031	8	0.20	$2,000	$4,000	$3,200	$1,800	$880	$6,400	$3,600	$1,800
2032	8	0.20	$2,000	$4,000	$3,200	$1,800	$830	$6,400	$3,500	$1,700
2033	8	0.20	$2,000	$4,000	$3,200	$1,700	$770	$6,400	$3,400	$1,500
2034	8	0.20	$2,000	$4,000	$3,200	$1,700	$720	$6,400	$3,300	$1,400
2035	8	0.20	$2,000	$4,000	$3,200	$1,600	$680	$6,400	$3,200	$1,400
2036	8	0.20	$2,000	$4,000	$3,200	$1,600	$630	$6,400	$3,100	$1,300
2037	8	0.20	$2,000	$4,000	$3,200	$1,500	$590	$6,400	$3,100	$1,200
Total per unit:		**5.2**		**Total:**	**$83,000**	**$59,000**	**$40,000**	**$170,000**	**$120,000**	**$81,000**
Total:		**42**								

Table 18 – Occupational Health (Accident) Long-Term – Severe Accident Capable Vents – Mark II Containments

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.19	$2,000	$4,000	$3,000	$2,400	$1,800	$6,100	$4,800	$3,600
2013	8	0.19	$2,000	$4,000	$3,000	$2,300	$1,600	$6,100	$4,700	$3,300
2014	8	0.19	$2,000	$4,000	$3,000	$2,200	$1,500	$6,100	$4,500	$3,100
2015	8	0.19	$2,000	$4,000	$3,000	$2,200	$1,400	$6,100	$4,400	$2,900
2016	8	0.19	$2,000	$4,000	$3,000	$2,100	$1,300	$6,100	$4,300	$2,700
2017	8	0.19	$2,000	$4,000	$3,000	$2,000	$1,300	$6,100	$4,200	$2,600
2018	8	0.19	$2,000	$4,000	$3,000	$2,000	$1,200	$6,100	$4,000	$2,400
2019	8	0.19	$2,000	$4,000	$3,000	$1,900	$1,100	$6,100	$3,900	$2,200
2020	8	0.19	$2,000	$4,000	$3,000	$1,900	$1,000	$6,100	$3,800	$2,100
2021	8	0.19	$2,000	$4,000	$3,000	$1,800	$960	$6,100	$3,700	$1,900
2022	8	0.19	$2,000	$4,000	$3,000	$1,800	$900	$6,100	$3,600	$1,800
2023	8	0.19	$2,000	$4,000	$3,000	$1,700	$840	$6,100	$3,500	$1,700
2024	8	0.19	$2,000	$4,000	$3,000	$1,700	$780	$6,100	$3,400	$1,600
2025	8	0.19	$2,000	$4,000	$3,000	$1,600	$730	$6,100	$3,300	$1,500
2026	8	0.19	$2,000	$4,000	$3,000	$1,600	$680	$6,100	$3,200	$1,400
2027	8	0.19	$2,000	$4,000	$3,000	$1,500	$640	$6,100	$3,100	$1,300
2028	8	0.19	$2,000	$4,000	$3,000	$1,500	$600	$6,100	$3,000	$1,200
2029	8	0.19	$2,000	$4,000	$3,000	$1,400	$560	$6,100	$2,900	$1,100
2030	8	0.19	$2,000	$4,000	$3,000	$1,400	$520	$6,100	$2,800	$1,100
2031	8	0.19	$2,000	$4,000	$3,000	$1,400	$490	$6,100	$2,800	$990
2032	8	0.19	$2,000	$4,000	$3,000	$1,300	$460	$6,100	$2,700	$930
2033	8	0.19	$2,000	$4,000	$3,000	$1,300	$430	$6,100	$2,600	$870
2034	8	0.19	$2,000	$4,000	$3,000	$1,200	$400	$6,100	$2,500	$810
2035	8	0.19	$2,000	$4,000	$3,000	$1,200	$370	$6,100	$2,400	$760
2036	8	0.19	$2,000	$4,000	$3,000	$1,200	$350	$6,100	$2,400	$710
2037	8	0.19	$2,000	$4,000	$3,000	$1,100	$320	$6,100	$2,300	$660
	Total per unit:	**4.9**		**Total:**	**$78,000**	**$44,000**	**$22,000**	**$160,000**	**$89,000**	**$45,000**
	Total:	**39**								

Table 19 – Occupational Health (Accident) Short-Term – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.0011	$2,000	$4,000	$18	$18	$18	$35	$35	$35
2013	8	0.0011	$2,000	$4,000	$18	$17	$17	$35	$34	$33
2014	8	0.0011	$2,000	$4,000	$18	$17	$16	$35	$33	$31
2015	8	0.0011	$2,000	$4,000	$18	$16	$15	$35	$32	$29
2016	8	0.0011	$2,000	$4,000	$18	$16	$14	$35	$31	$27
2017	8	0.0011	$2,000	$4,000	$18	$16	$13	$35	$30	$25
2018	8	0.0011	$2,000	$4,000	$18	$15	$12	$35	$29	$23
2019	8	0.0011	$2,000	$4,000	$18	$15	$11	$35	$28	$22
2020	8	0.0011	$2,000	$4,000	$18	$14	$10	$35	$28	$20
2021	8	0.0011	$2,000	$4,000	$18	$14	$10	$35	$27	$19
2022	8	0.0011	$2,000	$4,000	$18	$13	$9	$35	$26	$18
2023	8	0.0011	$2,000	$4,000	$18	$13	$9	$35	$25	$17
2024	8	0.0011	$2,000	$4,000	$18	$13	$8	$35	$25	$16
2025	8	0.0011	$2,000	$4,000	$18	$12	$8	$35	$24	$15
2026	8	0.0011	$2,000	$4,000	$18	$12	$7	$35	$23	$14
2027	8	0.0011	$2,000	$4,000	$18	$12	$7	$35	$22	$13
2028	8	0.0011	$2,000	$4,000	$18	$11	$6	$35	$22	$12
2029	8	0.0011	$2,000	$4,000	$18	$11	$6	$35	$21	$11
2030	8	0.0011	$2,000	$4,000	$18	$11	$5	$35	$21	$10
2031	8	0.0011	$2,000	$4,000	$18	$10	$5	$35	$20	$10
2032	8	0.0011	$2,000	$4,000	$18	$10	$5	$35	$19	$9
2033	8	0.0011	$2,000	$4,000	$18	$10	$4	$35	$19	$9
2034	8	0.0011	$2,000	$4,000	$18	$9	$4	$35	$18	$8
2035	8	0.0011	$2,000	$4,000	$18	$9	$4	$35	$18	$7
2036	8	0.0011	$2,000	$4,000	$18	$9	$4	$35	$17	$7
2037	8	0.0011	$2,000	$4,000	$18	$9	$3	$35	$17	$6
Total per unit:		**0.029**		**Total:**	**$470**	**$330**	**$230**	**$910**	**$640**	**$450**
Total:		**0.23**								

Table 20 – Occupational Health (Accident) Long-Term – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.0010	$2,000	$4,000	$16	$13	$9	$31	$25	$18
2013	8	0.0010	$2,000	$4,000	$16	$12	$9	$31	$24	$17
2014	8	0.0010	$2,000	$4,000	$16	$12	$8	$31	$23	$16
2015	8	0.0010	$2,000	$4,000	$16	$12	$8	$31	$22	$15
2016	8	0.0010	$2,000	$4,000	$16	$11	$7	$31	$22	$14
2017	8	0.0010	$2,000	$4,000	$16	$11	$7	$31	$21	$13
2018	8	0.0010	$2,000	$4,000	$16	$11	$6	$31	$21	$12
2019	8	0.0010	$2,000	$4,000	$16	$10	$6	$31	$20	$11
2020	8	0.0010	$2,000	$4,000	$16	$10	$6	$31	$19	$11
2021	8	0.0010	$2,000	$4,000	$16	$10	$5	$31	$19	$10
2022	8	0.0010	$2,000	$4,000	$16	$9	$5	$31	$18	$9
2023	8	0.0010	$2,000	$4,000	$16	$9	$5	$31	$18	$9
2024	8	0.0010	$2,000	$4,000	$16	$9	$4	$31	$17	$8
2025	8	0.0010	$2,000	$4,000	$16	$9	$4	$31	$17	$8
2026	8	0.0010	$2,000	$4,000	$16	$8	$4	$31	$16	$7
2027	8	0.0010	$2,000	$4,000	$16	$8	$3	$31	$16	$7
2028	8	0.0010	$2,000	$4,000	$16	$8	$3	$31	$15	$6
2029	8	0.0010	$2,000	$4,000	$16	$8	$3	$31	$15	$6
2030	8	0.0010	$2,000	$4,000	$16	$7	$3	$31	$14	$5
2031	8	0.0010	$2,000	$4,000	$16	$7	$3	$31	$14	$5
2032	8	0.0010	$2,000	$4,000	$16	$7	$2	$31	$14	$5
2033	8	0.0010	$2,000	$4,000	$16	$7	$2	$31	$13	$4
2034	8	0.0010	$2,000	$4,000	$16	$7	$2	$31	$13	$4
2035	8	0.0010	$2,000	$4,000	$16	$6	$2	$31	$12	$4
2036	8	0.0010	$2,000	$4,000	$16	$6	$2	$31	$12	$4
2037	8	0.0010	$2,000	$4,000	$16	$6	$2	$31	$12	$3
	Total per unit:	**0.025**		**Total:**	**$420**	**$230**	**$120**	**$810**	**$450**	**$230**
	Total:	**0.20**								

Table 21 – Occupational Health (Accident) Short-Term – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.89	$2,000	$4,000	$14,000	$14,000	$14,000	$28,000	$28,000	$28,000
2013	8	0.89	$2,000	$4,000	$14,000	$14,000	$13,000	$28,000	$27,000	$26,000
2014	8	0.89	$2,000	$4,000	$14,000	$13,000	$12,000	$28,000	$26,000	$24,000
2015	8	0.89	$2,000	$4,000	$14,000	$13,000	$11,000	$28,000	$26,000	$23,000
2016	8	0.89	$2,000	$4,000	$14,000	$12,000	$11,000	$28,000	$25,000	$21,000
2017	8	0.89	$2,000	$4,000	$14,000	$12,000	$10,000	$28,000	$24,000	$20,000
2018	8	0.89	$2,000	$4,000	$14,000	$12,000	$9,300	$28,000	$23,000	$19,000
2019	8	0.89	$2,000	$4,000	$14,000	$11,000	$8,700	$28,000	$23,000	$17,000
2020	8	0.89	$2,000	$4,000	$14,000	$11,000	$8,100	$28,000	$22,000	$16,000
2021	8	0.89	$2,000	$4,000	$14,000	$11,000	$7,600	$28,000	$21,000	$15,000
2022	8	0.89	$2,000	$4,000	$14,000	$10,000	$7,100	$28,000	$21,000	$14,000
2023	8	0.89	$2,000	$4,000	$14,000	$10,000	$6,700	$28,000	$20,000	$13,000
2024	8	0.89	$2,000	$4,000	$14,000	$9,800	$6,200	$28,000	$20,000	$12,000
2025	8	0.89	$2,000	$4,000	$14,000	$9,500	$5,800	$28,000	$19,000	$12,000
2026	8	0.89	$2,000	$4,000	$14,000	$9,300	$5,400	$28,000	$19,000	$11,000
2027	8	0.89	$2,000	$4,000	$14,000	$9,000	$5,100	$28,000	$18,000	$10,000
2028	8	0.89	$2,000	$4,000	$14,000	$8,700	$4,700	$28,000	$17,000	$9,500
2029	8	0.89	$2,000	$4,000	$14,000	$8,500	$4,400	$28,000	$17,000	$8,900
2030	8	0.89	$2,000	$4,000	$14,000	$8,200	$4,100	$28,000	$16,000	$8,300
2031	8	0.89	$2,000	$4,000	$14,000	$8,000	$3,900	$28,000	$16,000	$7,700
2032	8	0.89	$2,000	$4,000	$14,000	$7,800	$3,600	$28,000	$16,000	$7,200
2033	8	0.89	$2,000	$4,000	$14,000	$7,500	$3,400	$28,000	$15,000	$6,800
2034	8	0.89	$2,000	$4,000	$14,000	$7,300	$3,200	$28,000	$15,000	$6,300
2035	8	0.89	$2,000	$4,000	$14,000	$7,100	$3,000	$28,000	$14,000	$5,900
2036	8	0.89	$2,000	$4,000	$14,000	$6,900	$2,800	$28,000	$14,000	$5,500
2037	8	0.89	$2,000	$4,000	$14,000	$6,700	$2,600	$28,000	$13,000	$5,200
Total per unit:		**23**		**Total:**	**$360,000**	**$260,000**	**$180,000**	**$730,000**	**$520,000**	**$350,000**
Total:		**180**								

Table 22 – Occupational Health (Accident) Long-Term – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	0.72	$2,000	$4,000	$12,000	$9,500	$7,000	$23,000	$18,000	$14,000
2013	8	0.72	$2,000	$4,000	$12,000	$9,200	$6,600	$23,000	$18,000	$13,000
2014	8	0.72	$2,000	$4,000	$12,000	$8,900	$6,200	$23,000	$17,000	$12,000
2015	8	0.72	$2,000	$4,000	$12,000	$8,700	$5,800	$23,000	$17,000	$11,000
2016	8	0.72	$2,000	$4,000	$12,000	$8,400	$5,400	$23,000	$16,000	$10,000
2017	8	0.72	$2,000	$4,000	$12,000	$8,200	$5,000	$23,000	$16,000	$9,600
2018	8	0.72	$2,000	$4,000	$12,000	$7,900	$4,700	$23,000	$15,000	$9,000
2019	8	0.72	$2,000	$4,000	$12,000	$7,700	$4,400	$23,000	$15,000	$8,400
2020	8	0.72	$2,000	$4,000	$12,000	$7,500	$4,100	$23,000	$14,000	$7,900
2021	8	0.72	$2,000	$4,000	$12,000	$7,300	$3,800	$23,000	$14,000	$7,300
2022	8	0.72	$2,000	$4,000	$12,000	$7,100	$3,600	$23,000	$14,000	$6,900
2023	8	0.72	$2,000	$4,000	$12,000	$6,900	$3,300	$23,000	$13,000	$6,400
2024	8	0.72	$2,000	$4,000	$12,000	$6,700	$3,100	$23,000	$13,000	$6,000
2025	8	0.72	$2,000	$4,000	$12,000	$6,500	$2,900	$23,000	$12,000	$5,600
2026	8	0.72	$2,000	$4,000	$12,000	$6,300	$2,700	$23,000	$12,000	$5,200
2027	8	0.72	$2,000	$4,000	$12,000	$6,100	$2,600	$23,000	$12,000	$4,900
2028	8	0.72	$2,000	$4,000	$12,000	$5,900	$2,400	$23,000	$11,000	$4,600
2029	8	0.72	$2,000	$4,000	$12,000	$5,700	$2,200	$23,000	$11,000	$4,300
2030	8	0.72	$2,000	$4,000	$12,000	$5,600	$2,100	$23,000	$11,000	$4,000
2031	8	0.72	$2,000	$4,000	$12,000	$5,400	$1,900	$23,000	$10,000	$3,700
2032	8	0.72	$2,000	$4,000	$12,000	$5,300	$1,800	$23,000	$10,000	$3,500
2033	8	0.72	$2,000	$4,000	$12,000	$5,100	$1,700	$23,000	$9,800	$3,300
2034	8	0.72	$2,000	$4,000	$12,000	$5,000	$1,600	$23,000	$9,500	$3,000
2035	8	0.72	$2,000	$4,000	$12,000	$4,800	$1,500	$23,000	$9,200	$2,800
2036	8	0.72	$2,000	$4,000	$12,000	$4,700	$1,400	$23,000	$8,900	$2,700
2037	8	0.72	$2,000	$4,000	$12,000	$4,500	$1,300	$23,000	$8,700	$2,500
	Total per unit:	**19**		**Total:**	**$310,000**	**$170,000**	**$89,000**	**$600,000**	**$340,000**	**$170,000**
	Total:	**150**								

Table 24 – Offsite Property – Severe Accident Capable Vents – Mark I Containments

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	23	$20,000	$460,000	$460,000	$460,000
2013	23	$20,000	$460,000	$450,000	$430,000
2014	23	$20,000	$460,000	$430,000	$400,000
2015	23	$20,000	$460,000	$420,000	$380,000
2016	23	$20,000	$460,000	$410,000	$350,000
2017	23	$20,000	$460,000	$400,000	$330,000
2018	23	$20,000	$460,000	$390,000	$310,000
2019	23	$20,000	$460,000	$370,000	$290,000
2020	23	$20,000	$460,000	$360,000	$270,000
2021	23	$20,000	$460,000	$350,000	$250,000
2022	23	$20,000	$460,000	$340,000	$230,000
2023	23	$20,000	$460,000	$330,000	$220,000
2024	23	$20,000	$460,000	$320,000	$200,000
2025	23	$20,000	$460,000	$310,000	$190,000
2026	23	$20,000	$460,000	$300,000	$180,000
2027	23	$20,000	$460,000	$300,000	$170,000
2028	23	$20,000	$460,000	$290,000	$160,000
2029	23	$20,000	$460,000	$280,000	$150,000
2030	23	$20,000	$460,000	$270,000	$140,000
2031	23	$20,000	$460,000	$260,000	$130,000
2032	23	$20,000	$460,000	$250,000	$120,000
2033	23	$20,000	$460,000	$250,000	$110,000
2034	23	$20,000	$460,000	$240,000	$100,000
2035	23	$20,000	$460,000	$230,000	$97,000
2036	23	$20,000	$460,000	$230,000	$91,000
2037	23	$20,000	$460,000	$220,000	$85,000
		Total:	**$12,000,000**	**$8,500,000**	**$5,800,000**

Table 25 – Offsite Property – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	23	$99	$2,300	$2,300	$2,300
2013	23	$99	$2,300	$2,200	$2,100
2014	23	$99	$2,300	$2,200	$2,000
2015	23	$99	$2,300	$2,100	$1,900
2016	23	$99	$2,300	$2,000	$1,800
2017	23	$99	$2,300	$2,000	$1,600
2018	23	$99	$2,300	$1,900	$1,500
2019	23	$99	$2,300	$1,900	$1,400
2020	23	$99	$2,300	$1,800	$1,300
2021	23	$99	$2,300	$1,800	$1,300
2022	23	$99	$2,300	$1,700	$1,200
2023	23	$99	$2,300	$1,700	$1,100
2024	23	$99	$2,300	$1,600	$1,000
2025	23	$99	$2,300	$1,600	$950
2026	23	$99	$2,300	$1,500	$890
2027	23	$99	$2,300	$1,500	$830
2028	23	$99	$2,300	$1,400	$780
2029	23	$99	$2,300	$1,400	$730
2030	23	$99	$2,300	$1,400	$680
2031	23	$99	$2,300	$1,300	$640
2032	23	$99	$2,300	$1,300	$590
2033	23	$99	$2,300	$1,200	$560
2034	23	$99	$2,300	$1,200	$520
2035	23	$99	$2,300	$1,200	$490
2036	23	$99	$2,300	$1,100	$450
2037	23	$99	$2,300	$1,100	$420
		Total:	**$60,000**	**$42,000**	**$29,000**

Table 26 – Offsite Property – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	23	$75,000	$1,700,000	$1,700,000	$1,700,000
2013	23	$75,000	$1,700,000	$1,700,000	$1,600,000
2014	23	$75,000	$1,700,000	$1,600,000	$1,500,000
2015	23	$75,000	$1,700,000	$1,600,000	$1,400,000
2016	23	$75,000	$1,700,000	$1,500,000	$1,300,000
2017	23	$75,000	$1,700,000	$1,500,000	$1,200,000
2018	23	$75,000	$1,700,000	$1,400,000	$1,100,000
2019	23	$75,000	$1,700,000	$1,400,000	$1,100,000
2020	23	$75,000	$1,700,000	$1,300,000	$990,000
2021	23	$75,000	$1,700,000	$1,300,000	$920,000
2022	23	$75,000	$1,700,000	$1,300,000	$860,000
2023	23	$75,000	$1,700,000	$1,200,000	$810,000
2024	23	$75,000	$1,700,000	$1,200,000	$750,000
2025	23	$75,000	$1,700,000	$1,200,000	$710,000
2026	23	$75,000	$1,700,000	$1,100,000	$660,000
2027	23	$75,000	$1,700,000	$1,100,000	$620,000
2028	23	$75,000	$1,700,000	$1,100,000	$580,000
2029	23	$75,000	$1,700,000	$1,000,000	$540,000
2030	23	$75,000	$1,700,000	$1,000,000	$500,000
2031	23	$75,000	$1,700,000	$970,000	$470,000
2032	23	$75,000	$1,700,000	$940,000	$440,000
2033	23	$75,000	$1,700,000	$910,000	$410,000
2034	23	$75,000	$1,700,000	$890,000	$380,000
2035	23	$75,000	$1,700,000	$860,000	$360,000
2036	23	$75,000	$1,700,000	$840,000	$340,000
2037	23	$75,000	$1,700,000	$810,000	$310,000
		Total:	**$44,000,000**	**$31,000,000**	**$22,000,000**

Table 28 – Offsite Property – Severe Accident Capable Vents – Mark II Containments

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	8	$20,000	$160,000	$160,000	$160,000
2013	8	$20,000	$160,000	$160,000	$150,000
2014	8	$20,000	$160,000	$150,000	$140,000
2015	8	$20,000	$160,000	$150,000	$130,000
2016	8	$20,000	$160,000	$140,000	$120,000
2017	8	$20,000	$160,000	$140,000	$110,000
2018	8	$20,000	$160,000	$130,000	$110,000
2019	8	$20,000	$160,000	$130,000	$100,000
2020	8	$20,000	$160,000	$130,000	$93,000
2021	8	$20,000	$160,000	$120,000	$87,000
2022	8	$20,000	$160,000	$120,000	$81,000
2023	8	$20,000	$160,000	$120,000	$76,000
2024	8	$20,000	$160,000	$110,000	$71,000
2025	8	$20,000	$160,000	$110,000	$66,000
2026	8	$20,000	$160,000	$110,000	$62,000
2027	8	$20,000	$160,000	$100,000	$58,000
2028	8	$20,000	$160,000	$100,000	$54,000
2029	8	$20,000	$160,000	$97,000	$51,000
2030	8	$20,000	$160,000	$94,000	$47,000
2031	8	$20,000	$160,000	$91,000	$44,000
2032	8	$20,000	$160,000	$89,000	$41,000
2033	8	$20,000	$160,000	$86,000	$39,000
2034	8	$20,000	$160,000	$84,000	$36,000
2035	8	$20,000	$160,000	$81,000	$34,000
2036	8	$20,000	$160,000	$79,000	$32,000
2037	8	$20,000	$160,000	$76,000	$29,000
		Total:	**$4,200,000**	**$3,000,000**	**$2,000,000**

Table 29 – Offsite Property – Severe Accident Capable Vents – Mark II Containments –5th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	8	$99	$790	$790	$790
2013	8	$99	$790	$770	$740
2014	8	$99	$790	$740	$690
2015	8	$99	$790	$720	$640
2016	8	$99	$790	$700	$600
2017	8	$99	$790	$680	$560
2018	8	$99	$790	$660	$530
2019	8	$99	$790	$640	$490
2020	8	$99	$790	$620	$460
2021	8	$99	$790	$610	$430
2022	8	$99	$790	$590	$400
2023	8	$99	$790	$570	$380
2024	8	$99	$790	$550	$350
2025	8	$99	$790	$540	$330
2026	8	$99	$790	$520	$310
2027	8	$99	$790	$510	$290
2028	8	$99	$790	$490	$270
2029	8	$99	$790	$480	$250
2030	8	$99	$790	$460	$230
2031	8	$99	$790	$450	$220
2032	8	$99	$790	$440	$200
2033	8	$99	$790	$420	$190
2034	8	$99	$790	$410	$180
2035	8	$99	$790	$400	$170
2036	8	$99	$790	$390	$160
2037	8	$99	$790	$380	$150
		Total:	**$21,000**	**$15,000**	**$10,000**

Table 30 – Offsite Property – Severe Accident Capable Vents – Mark II Containments –95th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	8	$75,000	$600,000	$600,000	$600,000
2013	8	$75,000	$600,000	$580,000	$560,000
2014	8	$75,000	$600,000	$570,000	$520,000
2015	8	$75,000	$600,000	$550,000	$490,000
2016	8	$75,000	$600,000	$530,000	$460,000
2017	8	$75,000	$600,000	$520,000	$430,000
2018	8	$75,000	$600,000	$500,000	$400,000
2019	8	$75,000	$600,000	$490,000	$370,000
2020	8	$75,000	$600,000	$470,000	$350,000
2021	8	$75,000	$600,000	$460,000	$330,000
2022	8	$75,000	$600,000	$450,000	$310,000
2023	8	$75,000	$600,000	$430,000	$290,000
2024	8	$75,000	$600,000	$420,000	$270,000
2025	8	$75,000	$600,000	$410,000	$250,000
2026	8	$75,000	$600,000	$400,000	$230,000
2027	8	$75,000	$600,000	$390,000	$220,000
2028	8	$75,000	$600,000	$370,000	$200,000
2029	8	$75,000	$600,000	$360,000	$190,000
2030	8	$75,000	$600,000	$350,000	$180,000
2031	8	$75,000	$600,000	$340,000	$170,000
2032	8	$75,000	$600,000	$330,000	$160,000
2033	8	$75,000	$600,000	$320,000	$140,000
2034	8	$75,000	$600,000	$310,000	$140,000
2035	8	$75,000	$600,000	$300,000	$130,000
2036	8	$75,000	$600,000	$300,000	$120,000
2037	8	$75,000	$600,000	$290,000	$110,000
		Total:	**$16,000,000**	**$11,000,000**	**$7,600,000**

Table 32 – Onsite Property – Severe Accident Capable Vents – Mark I Containments

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	$15,000	$13,000	$11,000	$350,000	$300,000	$250,000
2013	23	$15,000	$13,000	$11,000	$350,000	$290,000	$240,000
2014	23	$15,000	$13,000	$11,000	$350,000	$280,000	$220,000
2015	23	$15,000	$13,000	$11,000	$350,000	$270,000	$210,000
2016	23	$15,000	$13,000	$11,000	$350,000	$270,000	$190,000
2017	23	$15,000	$13,000	$11,000	$350,000	$260,000	$180,000
2018	23	$15,000	$13,000	$11,000	$350,000	$250,000	$170,000
2019	23	$15,000	$13,000	$11,000	$350,000	$240,000	$160,000
2020	23	$15,000	$13,000	$11,000	$350,000	$240,000	$150,000
2021	23	$15,000	$13,000	$11,000	$350,000	$230,000	$140,000
2022	23	$15,000	$13,000	$11,000	$350,000	$220,000	$130,000
2023	23	$15,000	$13,000	$11,000	$350,000	$220,000	$120,000
2024	23	$15,000	$13,000	$11,000	$350,000	$210,000	$110,000
2025	23	$15,000	$13,000	$11,000	$350,000	$200,000	$100,000
2026	23	$15,000	$13,000	$11,000	$350,000	$200,000	$100,000
2027	23	$15,000	$13,000	$11,000	$350,000	$190,000	$90,000
2028	23	$15,000	$13,000	$11,000	$350,000	$190,000	$90,000
2029	23	$15,000	$13,000	$11,000	$350,000	$180,000	$80,000
2030	23	$15,000	$13,000	$11,000	$350,000	$180,000	$75,000
2031	23	$15,000	$13,000	$11,000	$350,000	$170,000	$70,000
2032	23	$15,000	$13,000	$11,000	$350,000	$170,000	$65,000
2033	23	$15,000	$13,000	$11,000	$350,000	$160,000	$61,000
2034	23	$15,000	$13,000	$11,000	$350,000	$160,000	$57,000
2035	23	$15,000	$13,000	$11,000	$350,000	$150,000	$53,000
2036	23	$15,000	$13,000	$11,000	$350,000	$150,000	$50,000
2037	23	$15,000	$13,000	$11,000	$350,000	$140,000	$47,000
				Total:	**$9,100,000**	**$5,500,000**	**$3,200,000**

Table 33 – Onsite Property – Severe Accident Capable Vents – Mark I Containments –5th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	$78	$68	$56	$1,800	$1,600	$1,300
2013	23	$78	$68	$56	$1,800	$1,500	$1,200
2014	23	$78	$68	$56	$1,800	$1,500	$1,100
2015	23	$78	$68	$56	$1,800	$1,400	$1,100
2016	23	$78	$68	$56	$1,800	$1,400	$1,000
2017	23	$78	$68	$56	$1,800	$1,300	$900
2018	23	$78	$68	$56	$1,800	$1,300	$900
2019	23	$78	$68	$56	$1,800	$1,300	$800
2020	23	$78	$68	$56	$1,800	$1,200	$750
2021	23	$78	$68	$56	$1,800	$1,200	$700
2022	23	$78	$68	$56	$1,800	$1,200	$650
2023	23	$78	$68	$56	$1,800	$1,100	$610
2024	23	$78	$68	$56	$1,800	$1,100	$570
2025	23	$78	$68	$56	$1,800	$1,100	$530
2026	23	$78	$68	$56	$1,800	$1,000	$500
2027	23	$78	$68	$56	$1,800	$1,000	$470
2028	23	$78	$68	$56	$1,800	$970	$440
2029	23	$78	$68	$56	$1,800	$950	$410
2030	23	$78	$68	$56	$1,800	$920	$380
2031	23	$78	$68	$56	$1,800	$890	$360
2032	23	$78	$68	$56	$1,800	$870	$330
2033	23	$78	$68	$56	$1,800	$840	$310
2034	23	$78	$68	$56	$1,800	$820	$290
2035	23	$78	$68	$56	$1,800	$790	$270
2036	23	$78	$68	$56	$1,800	$770	$250
2037	23	$78	$68	$56	$1,800	$750	$240
				Total:	**$47,000**	**$29,000**	**$16,000**

Table 34 – Onsite Property – Severe Accident Capable Vents – Mark I Containments –95th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	23	$56,000	$48,000	$40,000	$1,300,000	$1,100,000	$900,000
2013	23	$56,000	$48,000	$40,000	$1,300,000	$1,100,000	$900,000
2014	23	$56,000	$48,000	$40,000	$1,300,000	$1,000,000	$800,000
2015	23	$56,000	$48,000	$40,000	$1,300,000	$1,000,000	$750,000
2016	23	$56,000	$48,000	$40,000	$1,300,000	$980,000	$700,000
2017	23	$56,000	$48,000	$40,000	$1,300,000	$950,000	$660,000
2018	23	$56,000	$48,000	$40,000	$1,300,000	$920,000	$610,000
2019	23	$56,000	$48,000	$40,000	$1,300,000	$900,000	$570,000
2020	23	$56,000	$48,000	$40,000	$1,300,000	$870,000	$540,000
2021	23	$56,000	$48,000	$40,000	$1,300,000	$850,000	$500,000
2022	23	$56,000	$48,000	$40,000	$1,300,000	$820,000	$470,000
2023	23	$56,000	$48,000	$40,000	$1,300,000	$800,000	$440,000
2024	23	$56,000	$48,000	$40,000	$1,300,000	$770,000	$410,000
2025	23	$56,000	$48,000	$40,000	$1,300,000	$750,000	$380,000
2026	23	$56,000	$48,000	$40,000	$1,300,000	$730,000	$360,000
2027	23	$56,000	$48,000	$40,000	$1,300,000	$710,000	$330,000
2028	23	$56,000	$48,000	$40,000	$1,300,000	$690,000	$310,000
2029	23	$56,000	$48,000	$40,000	$1,300,000	$670,000	$290,000
2030	23	$56,000	$48,000	$40,000	$1,300,000	$650,000	$270,000
2031	23	$56,000	$48,000	$40,000	$1,300,000	$630,000	$250,000
2032	23	$56,000	$48,000	$40,000	$1,300,000	$610,000	$240,000
2033	23	$56,000	$48,000	$40,000	$1,300,000	$590,000	$220,000
2034	23	$56,000	$48,000	$40,000	$1,300,000	$580,000	$210,000
2035	23	$56,000	$48,000	$40,000	$1,300,000	$560,000	$190,000
2036	23	$56,000	$48,000	$40,000	$1,300,000	$540,000	$180,000
2037	23	$56,000	$48,000	$40,000	$1,300,000	$530,000	$170,000
				Total:	**$34,000,000**	**$20,000,000**	**$12,000,000**

Table 36 – Onsite Property – Severe Accident Capable Vents – Mark II Containments

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	$15,000	$13,000	$11,000	$120,000	$100,000	$90,000
2013	8	$15,000	$13,000	$11,000	$120,000	$100,000	$82,000
2014	8	$15,000	$13,000	$11,000	$120,000	$98,000	$77,000
2015	8	$15,000	$13,000	$11,000	$120,000	$95,000	$72,000
2016	8	$15,000	$13,000	$11,000	$120,000	$92,000	$67,000
2017	8	$15,000	$13,000	$11,000	$120,000	$90,000	$63,000
2018	8	$15,000	$13,000	$11,000	$120,000	$87,000	$59,000
2019	8	$15,000	$13,000	$11,000	$120,000	$85,000	$55,000
2020	8	$15,000	$13,000	$11,000	$120,000	$82,000	$51,000
2021	8	$15,000	$13,000	$11,000	$120,000	$80,000	$48,000
2022	8	$15,000	$13,000	$11,000	$120,000	$77,000	$45,000
2023	8	$15,000	$13,000	$11,000	$120,000	$75,000	$42,000
2024	8	$15,000	$13,000	$11,000	$120,000	$73,000	$39,000
2025	8	$15,000	$13,000	$11,000	$120,000	$71,000	$37,000
2026	8	$15,000	$13,000	$11,000	$120,000	$69,000	$34,000
2027	8	$15,000	$13,000	$11,000	$120,000	$67,000	$32,000
2028	8	$15,000	$13,000	$11,000	$120,000	$65,000	$30,000
2029	8	$15,000	$13,000	$11,000	$120,000	$63,000	$28,000
2030	8	$15,000	$13,000	$11,000	$120,000	$61,000	$26,000
2031	8	$15,000	$13,000	$11,000	$120,000	$59,000	$24,000
2032	8	$15,000	$13,000	$11,000	$120,000	$58,000	$23,000
2033	8	$15,000	$13,000	$11,000	$120,000	$56,000	$21,000
2034	8	$15,000	$13,000	$11,000	$120,000	$54,000	$20,000
2035	8	$15,000	$13,000	$11,000	$120,000	$53,000	$19,000
2036	8	$15,000	$13,000	$11,000	$120,000	$51,000	$17,000
2037	8	$15,000	$13,000	$11,000	$120,000	$50,000	$16,000
				Total:	**$3,100,000**	**$1,900,000**	**$1,100,000**

Table 37 – Onsite Property – Severe Accident Capable Vents – Mark II Containments –5th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	$78	$68	$56	$620	$540	$450
2013	8	$78	$68	$56	$620	$530	$420
2014	8	$78	$68	$56	$620	$510	$390
2015	8	$78	$68	$56	$620	$500	$370
2016	8	$78	$68	$56	$620	$480	$340
2017	8	$78	$68	$56	$620	$470	$320
2018	8	$78	$68	$56	$620	$460	$300
2019	8	$78	$68	$56	$620	$440	$280
2020	8	$78	$68	$56	$620	$430	$260
2021	8	$78	$68	$56	$620	$420	$240
2022	8	$78	$68	$56	$620	$400	$230
2023	8	$78	$68	$56	$620	$390	$210
2024	8	$78	$68	$56	$620	$380	$200
2025	8	$78	$68	$56	$620	$370	$190
2026	8	$78	$68	$56	$620	$360	$170
2027	8	$78	$68	$56	$620	$350	$160
2028	8	$78	$68	$56	$620	$340	$150
2029	8	$78	$68	$56	$620	$330	$140
2030	8	$78	$68	$56	$620	$320	$130
2031	8	$78	$68	$56	$620	$310	$120
2032	8	$78	$68	$56	$620	$300	$120
2033	8	$78	$68	$56	$620	$290	$110
2034	8	$78	$68	$56	$620	$280	$100
2035	8	$78	$68	$56	$620	$280	$90
2036	8	$78	$68	$56	$620	$270	$90
2037	8	$78	$68	$56	$620	$260	$80
				Total:	**$16,000**	**$10,000**	**$5,700**

Table 38 – Onsite Property – Severe Accident Capable Vents – Mark II Containments –95th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	8	$56,000	$48,000	$40,000	$450,000	$380,000	$320,000
2013	8	$56,000	$48,000	$40,000	$450,000	$370,000	$300,000
2014	8	$56,000	$48,000	$40,000	$450,000	$360,000	$280,000
2015	8	$56,000	$48,000	$40,000	$450,000	$350,000	$260,000
2016	8	$56,000	$48,000	$40,000	$450,000	$340,000	$240,000
2017	8	$56,000	$48,000	$40,000	$450,000	$330,000	$230,000
2018	8	$56,000	$48,000	$40,000	$450,000	$320,000	$210,000
2019	8	$56,000	$48,000	$40,000	$450,000	$310,000	$200,000
2020	8	$56,000	$48,000	$40,000	$450,000	$300,000	$190,000
2021	8	$56,000	$48,000	$40,000	$450,000	$290,000	$170,000
2022	8	$56,000	$48,000	$40,000	$450,000	$290,000	$160,000
2023	8	$56,000	$48,000	$40,000	$450,000	$280,000	$150,000
2024	8	$56,000	$48,000	$40,000	$450,000	$270,000	$140,000
2025	8	$56,000	$48,000	$40,000	$450,000	$260,000	$130,000
2026	8	$56,000	$48,000	$40,000	$450,000	$250,000	$120,000
2027	8	$56,000	$48,000	$40,000	$450,000	$250,000	$120,000
2028	8	$56,000	$48,000	$40,000	$450,000	$240,000	$110,000
2029	8	$56,000	$48,000	$40,000	$450,000	$230,000	$100,000
2030	8	$56,000	$48,000	$40,000	$450,000	$230,000	$90,000
2031	8	$56,000	$48,000	$40,000	$450,000	$220,000	$90,000
2032	8	$56,000	$48,000	$40,000	$450,000	$210,000	$83,000
2033	8	$56,000	$48,000	$40,000	$450,000	$210,000	$77,000
2034	8	$56,000	$48,000	$40,000	$450,000	$200,000	$72,000
2035	8	$56,000	$48,000	$40,000	$450,000	$190,000	$68,000
2036	8	$56,000	$48,000	$40,000	$450,000	$190,000	$63,000
2037	8	$56,000	$48,000	$40,000	$450,000	$180,000	$59,000
				Total:	**$12,000,000**	**$7,100,000**	**$4,000,000**

Table 39 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Capable Vents – Mark I Containments

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I Reactors		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,300,000	$1,100,000
2013	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,300,000	$1,000,000
2014	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,200,000	$970,000
2015	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,200,000	$900,000
2016	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,100,000	$850,000
2017	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,100,000	$790,000
2018	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,100,000	$740,000
2019	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,100,000	$690,000
2020	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$1,000,000	$640,000
2021	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$990,000	$600,000
2022	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$960,000	$560,000
2023	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$930,000	$530,000
2024	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$910,000	$490,000
2025	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$880,000	$460,000
2026	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$850,000	$430,000
2027	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$830,000	$400,000
2028	30	23	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$1,500,000	$810,000	$380,000
2029	30	23	1.3E-05	$4,300,000,000	$3,800,000,000	$3,300,000,000	$1,300,000	$710,000	$320,000
2030	30	23	1.3E-05	$3,800,000,000	$3,400,000,000	$3,000,000,000	$1,200,000	$610,000	$270,000
2031	30	23	1.3E-05	$3,300,000,000	$3,100,000,000	$2,800,000,000	$1,000,000	$540,000	$240,000
2032	30	23	1.3E-05	$2,900,000,000	$2,700,000,000	$2,400,000,000	$890,000	$460,000	$190,000
2033	30	23	1.3E-05	$2,400,000,000	$2,300,000,000	$2,100,000,000	$740,000	$380,000	$160,000
2034	30	23	1.3E-05	$1,900,000,000	$1,800,000,000	$1,700,000,000	$580,000	$290,000	$120,000
2035	30	23	1.3E-05	$1,400,000,000	$1,400,000,000	$1,300,000,000	$430,000	$220,000	$84,000
2036	30	23	1.3E-05	$950,000,000	$940,000,000	$920,000,000	$290,000	$140,000	$56,000
2037	30	23	1.3E-05	$480,000,000	$480,000,000	$480,000,000	$150,000	$71,000	$27,000
						Total:	**$32,000,000**	**$21,000,000**	**$13,000,000**

Table 40 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Capable Vents – Mark I Containments – Low Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I Reactors		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$58,000	$49,000
2013	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$57,000	$46,000
2014	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$55,000	$43,000
2015	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$54,000	$40,000
2016	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$52,000	$38,000
2017	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$50,000	$35,000
2018	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$49,000	$33,000
2019	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$48,000	$31,000
2020	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$46,000	$29,000
2021	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$45,000	$27,000
2022	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$44,000	$25,000
2023	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$42,000	$23,000
2024	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$41,000	$22,000
2025	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$40,000	$20,000
2026	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$39,000	$19,000
2027	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$38,000	$18,000
2028	30	23	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$65,000	$36,000	$17,000
2029	30	23	1.3E-05	$190,000,000	$170,000,000	$150,000,000	$58,000	$32,000	$15,000
2030	30	23	1.3E-05	$170,000,000	$160,000,000	$140,000,000	$52,000	$29,000	$13,000
2031	30	23	1.3E-05	$150,000,000	$140,000,000	$120,000,000	$46,000	$25,000	$10,000
2032	30	23	1.3E-05	$130,000,000	$120,000,000	$110,000,000	$40,000	$20,000	$8,700
2033	30	23	1.3E-05	$110,000,000	$100,000,000	$94,000,000	$34,000	$17,000	$7,000
2034	30	23	1.3E-05	$86,000,000	$82,000,000	$78,000,000	$26,000	$13,000	$5,400
2035	30	23	1.3E-05	$64,000,000	$63,000,000	$60,000,000	$20,000	$9,800	$3,900
2036	30	23	1.3E-05	$43,000,000	$42,000,000	$42,000,000	$13,000	$6,400	$2,500
2037	30	23	1.3E-05	$21,000,000	$21,000,000	$21,000,000	$6,500	$3,100	$1,200
						Total:	**$1,400,000**	**$950,000**	**$580,000**

Table 41 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Capable Vents – Mark I Containments – High Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I Reactors		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$4,600,000	$4,000,000
2013	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$4,500,000	$3,700,000
2014	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$4,400,000	$3,500,000
2015	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$4,200,000	$3,300,000
2016	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$4,100,000	$3,100,000
2017	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$4,000,000	$2,900,000
2018	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,900,000	$2,700,000
2019	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,800,000	$2,500,000
2020	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,600,000	$2,300,000
2021	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,500,000	$2,200,000
2022	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,400,000	$2,000,000
2023	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,300,000	$1,900,000
2024	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,200,000	$1,800,000
2025	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,100,000	$1,700,000
2026	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,100,000	$1,600,000
2027	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$3,000,000	$1,500,000
2028	30	23	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$5,200,000	$2,900,000	$1,400,000
2029	30	23	1.3E-05	$15,000,000,000	$14,000,000,000	$12,000,000,000	$4,600,000	$2,600,000	$1,200,000
2030	30	23	1.3E-05	$14,000,000,000	$12,000,000,000	$11,000,000,000	$4,300,000	$2,200,000	$1,000,000
2031	30	23	1.3E-05	$12,000,000,000	$11,000,000,000	$9,700,000,000	$3,700,000	$1,900,000	$830,000
2032	30	23	1.3E-05	$10,000,000,000	$9,400,000,000	$8,600,000,000	$3,100,000	$1,600,000	$680,000
2033	30	23	1.3E-05	$8,400,000,000	$8,000,000,000	$7,400,000,000	$2,600,000	$1,300,000	$550,000
2034	30	23	1.3E-05	$6,800,000,000	$6,500,000,000	$6,100,000,000	$2,100,000	$1,000,000	$420,000
2035	30	23	1.3E-05	$5,100,000,000	$4,900,000,000	$4,700,000,000	$1,600,000	$760,000	$310,000
2036	30	23	1.3E-05	$3,400,000,000	$3,300,000,000	$3,300,000,000	$1,000,000	$500,000	$200,000
2037	30	23	1.3E-05	$1,700,000,000	$1,700,000,000	$1,700,000,000	$520,000	$250,000	$96,000
						Total:	**$110,000,000**	**$75,000,000**	**$47,000,000**

Table 42 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Capable Vents – Mark II Containments

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark II Reactors		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$450,000	$390,000
2013	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$440,000	$360,000
2014	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$420,000	$340,000
2015	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$410,000	$310,000
2016	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$400,000	$290,000
2017	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$390,000	$270,000
2018	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$380,000	$260,000
2019	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$370,000	$240,000
2020	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$350,000	$220,000
2021	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$340,000	$210,000
2022	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$330,000	$200,000
2023	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$320,000	$180,000
2024	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$320,000	$170,000
2025	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$310,000	$160,000
2026	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$300,000	$150,000
2027	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$290,000	$140,000
2028	30	8	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$510,000	$280,000	$130,000
2029	30	8	1.3E-05	$4,300,000,000	$3,800,000,000	$3,300,000,000	$460,000	$250,000	$110,000
2030	30	8	1.3E-05	$3,800,000,000	$3,400,000,000	$3,000,000,000	$410,000	$210,000	$95,000
2031	30	8	1.3E-05	$3,300,000,000	$3,100,000,000	$2,800,000,000	$350,000	$190,000	$83,000
2032	30	8	1.3E-05	$2,900,000,000	$2,700,000,000	$2,400,000,000	$310,000	$160,000	$66,000
2033	30	8	1.3E-05	$2,400,000,000	$2,300,000,000	$2,100,000,000	$260,000	$130,000	$54,000
2034	30	8	1.3E-05	$1,900,000,000	$1,800,000,000	$1,700,000,000	$200,000	$100,000	$41,000
2035	30	8	1.3E-05	$1,400,000,000	$1,400,000,000	$1,300,000,000	$150,000	$76,000	$29,000
2036	30	8	1.3E-05	$950,000,000	$940,000,000	$920,000,000	$100,000	$49,000	$19,000
2037	30	8	1.3E-05	$480,000,000	$480,000,000	$480,000,000	$51,000	$25,000	$9,500
						Total:	**$11,000,000**	**$7,300,000**	**$4,500,000**

Table 43 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Capable Vents – Mark II Containments – Low Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark II Reactors		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$20,000	$17,000
2013	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$20,000	$16,000
2014	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$19,000	$15,000
2015	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$19,000	$14,000
2016	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$18,000	$13,000
2017	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$18,000	$12,000
2018	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$17,000	$11,000
2019	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$17,000	$11,000
2020	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$16,000	$10,000
2021	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$16,000	$9,300
2022	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$15,000	$8,700
2023	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$15,000	$8,100
2024	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$14,000	$7,600
2025	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$14,000	$7,100
2026	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$13,000	$6,600
2027	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$13,000	$6,200
2028	30	8	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$22,000	$13,000	$5,800
2029	30	8	1.3E-05	$190,000,000	$170,000,000	$150,000,000	$20,000	$11,000	$5,100
2030	30	8	1.3E-05	$170,000,000	$160,000,000	$140,000,000	$18,000	$10,000	$4,400
2031	30	8	1.3E-05	$150,000,000	$140,000,000	$120,000,000	$16,000	$8,500	$3,600
2032	30	8	1.3E-05	$130,000,000	$120,000,000	$110,000,000	$14,000	$7,100	$3,000
2033	30	8	1.3E-05	$110,000,000	$100,000,000	$94,000,000	$12,000	$5,800	$2,400
2034	30	8	1.3E-05	$86,000,000	$82,000,000	$78,000,000	$9,200	$4,600	$1,900
2035	30	8	1.3E-05	$64,000,000	$63,000,000	$60,000,000	$6,900	$3,400	$1,400
2036	30	8	1.3E-05	$43,000,000	$42,000,000	$42,000,000	$4,600	$2,200	$890
2037	30	8	1.3E-05	$21,000,000	$21,000,000	$21,000,000	$2,200	$1,100	$410
						Total:	**$480,000**	**$330,000**	**$200,000**

Table 44 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Capable Vents – Mark II Containments – High Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark II Reactors		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,600,000	$1,400,000
2013	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,600,000	$1,300,000
2014	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,500,000	$1,200,000
2015	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,500,000	$1,100,000
2016	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,400,000	$1,100,000
2017	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,400,000	$990,000
2018	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,300,000	$930,000
2019	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,300,000	$870,000
2020	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,300,000	$810,000
2021	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,200,000	$760,000
2022	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,200,000	$710,000
2023	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,200,000	$660,000
2024	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,100,000	$620,000
2025	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,100,000	$580,000
2026	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,100,000	$540,000
2027	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,000,000	$500,000
2028	30	8	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$1,800,000	$1,000,000	$470,000
2029	30	8	1.3E-05	$15,000,000,000	$14,000,000,000	$12,000,000,000	$1,600,000	$910,000	$410,000
2030	30	8	1.3E-05	$14,000,000,000	$12,000,000,000	$11,000,000,000	$1,500,000	$750,000	$350,000
2031	30	8	1.3E-05	$12,000,000,000	$11,000,000,000	$9,700,000,000	$1,300,000	$670,000	$290,000
2032	30	8	1.3E-05	$10,000,000,000	$9,400,000,000	$8,600,000,000	$1,100,000	$560,000	$240,000
2033	30	8	1.3E-05	$8,400,000,000	$8,000,000,000	$7,400,000,000	$900,000	$460,000	$190,000
2034	30	8	1.3E-05	$6,800,000,000	$6,500,000,000	$6,100,000,000	$730,000	$360,000	$150,000
2035	30	8	1.3E-05	$5,100,000,000	$4,900,000,000	$4,700,000,000	$550,000	$270,000	$110,000
2036	30	8	1.3E-05	$3,400,000,000	$3,300,000,000	$3,300,000,000	$360,000	$170,000	$70,000
2037	30	8	1.3E-05	$1,700,000,000	$1,700,000,000	$1,700,000,000	$180,000	$87,000	$34,000
						Total:	**$39,000,000**	**$26,000,000**	**$16,000,000**

Table 45 – Industry Implementation Costs – Severe Accident Capable Vents – Mark I Containments

Year	Units	Cost per Unit		Total Cost	
		Low	High	Low	High
2012	23	$2,000,000	$3,000,000	$46,000,000	$69,000,000

Table 46 – Industry Implementation Costs – Severe Accident Capable Vents – Mark II Containments

Year	Units	Cost per Unit		Total Cost	
		Low	High	Low	High
2012	8	$5,000,000	$13,000,000	$40,000,000	$100,000,000

Table 47 – Industry Operation Costs – Severe Accident Capable Vents – Mark I Containments

Year	Units	FTE		Yearly Wage	Cost		3% NPV		7% NPV	
		Unit	Total		Unit	Total	Cost		Cost	
							Unit	Total	Unit	Total
2012	23	0.10	2.3	$400,000	$40,000	$920,000	$40,000	$920,000	$40,000	$920,000
2013	23	0.10	2.3	$400,000	$40,000	$920,000	$39,000	$890,000	$37,000	$860,000
2014	23	0.10	2.3	$400,000	$40,000	$920,000	$38,000	$870,000	$35,000	$800,000
2015	23	0.10	2.3	$400,000	$40,000	$920,000	$37,000	$840,000	$33,000	$750,000
2016	23	0.10	2.3	$400,000	$40,000	$920,000	$36,000	$820,000	$31,000	$700,000
2017	23	0.10	2.3	$400,000	$40,000	$920,000	$35,000	$790,000	$29,000	$660,000
2018	23	0.10	2.3	$400,000	$40,000	$920,000	$33,000	$770,000	$27,000	$610,000
2019	23	0.10	2.3	$400,000	$40,000	$920,000	$33,000	$750,000	$25,000	$570,000
2020	23	0.10	2.3	$400,000	$40,000	$920,000	$32,000	$730,000	$23,000	$540,000
2021	23	0.10	2.3	$400,000	$40,000	$920,000	$31,000	$710,000	$22,000	$500,000
2022	23	0.10	2.3	$400,000	$40,000	$920,000	$30,000	$680,000	$20,000	$470,000
2023	23	0.10	2.3	$400,000	$40,000	$920,000	$29,000	$660,000	$19,000	$440,000
2024	23	0.10	2.3	$400,000	$40,000	$920,000	$28,000	$650,000	$18,000	$410,000
2025	23	0.10	2.3	$400,000	$40,000	$920,000	$27,000	$630,000	$17,000	$380,000
2026	23	0.10	2.3	$400,000	$40,000	$920,000	$26,000	$610,000	$16,000	$360,000
2027	23	0.10	2.3	$400,000	$40,000	$920,000	$26,000	$590,000	$14,000	$330,000
2028	23	0.10	2.3	$400,000	$40,000	$920,000	$25,000	$570,000	$14,000	$310,000
2029	23	0.10	2.3	$400,000	$40,000	$920,000	$24,000	$560,000	$13,000	$290,000
2030	23	0.10	2.3	$400,000	$40,000	$920,000	$23,000	$540,000	$12,000	$270,000
2031	23	0.10	2.3	$400,000	$40,000	$920,000	$23,000	$520,000	$11,000	$250,000
2032	23	0.10	2.3	$400,000	$40,000	$920,000	$22,000	$510,000	$10,000	$240,000
2033	23	0.10	2.3	$400,000	$40,000	$920,000	$22,000	$490,000	$9,700	$220,000
2034	23	0.10	2.3	$400,000	$40,000	$920,000	$21,000	$480,000	$9,000	$210,000
2035	23	0.10	2.3	$400,000	$40,000	$920,000	$20,000	$470,000	$8,400	$190,000
2036	23	0.10	2.3	$400,000	$40,000	$920,000	$20,000	$450,000	$7,900	$180,000
2037	23	0.10	2.3	$400,000	$40,000	$920,000	$19,000	$440,000	$7,400	$170,000
				Total:	**$1,000,000**	**$24,000,000**	**$740,000**	**$17,000,000**	**$510,000**	**$12,000,000**

Table 48 – Industry Operation Costs – Severe Accident Capable Vents – Mark II Containments

Year	Units	FTE		Yearly Wage	Cost		3% NPV		7% NPV	
		Unit	Total		Unit	Total	Cost		Cost	
							Unit	Total	Unit	Total
2012	8	0.15	1.2	$400,000	$60,000	$480,000	$60,000	$480,000	$60,000	$480,000
2013	8	0.15	1.2	$400,000	$60,000	$480,000	$58,000	$470,000	$56,000	$450,000
2014	8	0.15	1.2	$400,000	$60,000	$480,000	$57,000	$450,000	$52,000	$420,000
2015	8	0.15	1.2	$400,000	$60,000	$480,000	$55,000	$440,000	$49,000	$390,000
2016	8	0.15	1.2	$400,000	$60,000	$480,000	$53,000	$430,000	$46,000	$370,000
2017	8	0.15	1.2	$400,000	$60,000	$480,000	$52,000	$410,000	$43,000	$340,000
2018	8	0.15	1.2	$400,000	$60,000	$480,000	$50,000	$400,000	$40,000	$320,000
2019	8	0.15	1.2	$400,000	$60,000	$480,000	$49,000	$390,000	$37,000	$300,000
2020	8	0.15	1.2	$400,000	$60,000	$480,000	$47,000	$380,000	$35,000	$280,000
2021	8	0.15	1.2	$400,000	$60,000	$480,000	$46,000	$370,000	$33,000	$260,000
2022	8	0.15	1.2	$400,000	$60,000	$480,000	$45,000	$360,000	$31,000	$240,000
2023	8	0.15	1.2	$400,000	$60,000	$480,000	$43,000	$350,000	$29,000	$230,000
2024	8	0.15	1.2	$400,000	$60,000	$480,000	$42,000	$340,000	$27,000	$210,000
2025	8	0.15	1.2	$400,000	$60,000	$480,000	$41,000	$330,000	$25,000	$200,000
2026	8	0.15	1.2	$400,000	$60,000	$480,000	$40,000	$320,000	$23,000	$190,000
2027	8	0.15	1.2	$400,000	$60,000	$480,000	$39,000	$310,000	$22,000	$170,000
2028	8	0.15	1.2	$400,000	$60,000	$480,000	$37,000	$300,000	$20,000	$160,000
2029	8	0.15	1.2	$400,000	$60,000	$480,000	$36,000	$290,000	$19,000	$150,000
2030	8	0.15	1.2	$400,000	$60,000	$480,000	$35,000	$280,000	$18,000	$140,000
2031	8	0.15	1.2	$400,000	$60,000	$480,000	$34,000	$270,000	$17,000	$130,000
2032	8	0.15	1.2	$400,000	$60,000	$480,000	$33,000	$270,000	$16,000	$120,000
2033	8	0.15	1.2	$400,000	$60,000	$480,000	$32,000	$260,000	$14,000	$120,000
2034	8	0.15	1.2	$400,000	$60,000	$480,000	$31,000	$250,000	$14,000	$110,000
2035	8	0.15	1.2	$400,000	$60,000	$480,000	$30,000	$240,000	$13,000	$100,000
2036	8	0.15	1.2	$400,000	$60,000	$480,000	$30,000	$240,000	$12,000	$95,000
2037	8	0.15	1.2	$400,000	$60,000	$480,000	$29,000	$230,000	$11,000	$88,000
				Total:	**$1,600,000**	**$12,000,000**	**$1,100,000**	**$8,900,000**	**$760,000**	**$6,100,000**

Table 49 – NRC Implementation Costs – Severe Accident Capable Vents – Mark I Containments

Year	Units	Hours per unit		Cost per hour	Cost per unit	Total		
						Hours		Cost
		Initial Review	Plant Inspection			Initial Review	Plant	
2012	23	80	80	$119	$19,000	1,840	1,840	$440,000

Table 50 – NRC Implementation Costs – Severe Accident Capable Vents – Mark II Containments

Year	Units	Hours per unit		Cost per hour	Cost per unit	Total		
						Hours		Cost
		Initial Review	Plant Inspection			Initial Review	Plant Inspection	
2012	8	160	160	$119	$38,000	1,280	1,280	$300,000

Table 51 – NRC Operation Costs – Severe Accident Capable Vents – Mark I Containments

Year	Units	FTE		Yearly Wage	Cost		3% NPV		7% NPV	
		Unit	Total		Unit	Total	Cost		Cost	
							Unit	Total	Unit	Total
2012	23	0.050	1.2	$400,000	$20,000	$460,000	$20,000	$460,000	$20,000	$460,000
2013	23	0.050	1.2	$400,000	$20,000	$460,000	$19,000	$450,000	$19,000	$430,000
2014	23	0.050	1.2	$400,000	$20,000	$460,000	$19,000	$430,000	$17,000	$400,000
2015	23	0.050	1.2	$400,000	$20,000	$460,000	$18,000	$420,000	$16,000	$380,000
2016	23	0.050	1.2	$400,000	$20,000	$460,000	$18,000	$410,000	$15,000	$350,000
2017	23	0.050	1.2	$400,000	$20,000	$460,000	$17,000	$400,000	$14,000	$330,000
2018	23	0.050	1.2	$400,000	$20,000	$460,000	$17,000	$390,000	$13,000	$310,000
2019	23	0.050	1.2	$400,000	$20,000	$460,000	$16,000	$370,000	$12,000	$290,000
2020	23	0.050	1.2	$400,000	$20,000	$460,000	$16,000	$360,000	$12,000	$270,000
2021	23	0.050	1.2	$400,000	$20,000	$460,000	$15,000	$350,000	$11,000	$250,000
2022	23	0.050	1.2	$400,000	$20,000	$460,000	$15,000	$340,000	$10,000	$230,000
2023	23	0.050	1.2	$400,000	$20,000	$460,000	$14,000	$330,000	$9,500	$220,000
2024	23	0.050	1.2	$400,000	$20,000	$460,000	$14,000	$320,000	$8,900	$200,000
2025	23	0.050	1.2	$400,000	$20,000	$460,000	$14,000	$310,000	$8,300	$190,000
2026	23	0.050	1.2	$400,000	$20,000	$460,000	$13,000	$300,000	$7,800	$180,000
2027	23	0.050	1.2	$400,000	$20,000	$460,000	$13,000	$300,000	$7,200	$170,000
2028	23	0.050	1.2	$400,000	$20,000	$460,000	$12,000	$290,000	$6,800	$160,000
2029	23	0.050	1.2	$400,000	$20,000	$460,000	$12,000	$280,000	$6,300	$150,000
2030	23	0.050	1.2	$400,000	$20,000	$460,000	$12,000	$270,000	$5,900	$140,000
2031	23	0.050	1.2	$400,000	$20,000	$460,000	$11,000	$260,000	$5,500	$130,000
2032	23	0.050	1.2	$400,000	$20,000	$460,000	$11,000	$250,000	$5,200	$120,000
2033	23	0.050	1.2	$400,000	$20,000	$460,000	$11,000	$250,000	$4,800	$110,000
2034	23	0.050	1.2	$400,000	$20,000	$460,000	$10,000	$240,000	$4,500	$100,000
2035	23	0.050	1.2	$400,000	$20,000	$460,000	$10,000	$230,000	$4,200	$97,000
2036	23	0.050	1.2	$400,000	$20,000	$460,000	$9,800	$230,000	$3,900	$91,000
2037	23	0.050	1.2	$400,000	$20,000	$460,000	$9,600	$220,000	$3,700	$85,000
				Total:	**$500,000**	**$12,000,000**	**$370,000**	**$8,500,000**	**$250,000**	**$5,800,000**

Table 52 – NRC Operation Costs – Severe Accident Capable Vents – Mark II Containments

Year	Units	FTE		Yearly Wage	Cost		3% NPV Cost		7% NPV Cost	
		Unit	Total		Unit	Total	Unit	Total	Unit	Total
2012	8	0.050	0.40	$400,000	$20,000	$160,000	$20,000	$160,000	$20,000	$160,000
2013	8	0.050	0.40	$400,000	$20,000	$160,000	$19,000	$160,000	$19,000	$150,000
2014	8	0.050	0.40	$400,000	$20,000	$160,000	$19,000	$150,000	$17,000	$140,000
2015	8	0.050	0.40	$400,000	$20,000	$160,000	$18,000	$150,000	$16,000	$130,000
2016	8	0.050	0.40	$400,000	$20,000	$160,000	$18,000	$140,000	$15,000	$120,000
2017	8	0.050	0.40	$400,000	$20,000	$160,000	$17,000	$140,000	$14,000	$110,000
2018	8	0.050	0.40	$400,000	$20,000	$160,000	$17,000	$130,000	$13,000	$110,000
2019	8	0.050	0.40	$400,000	$20,000	$160,000	$16,000	$130,000	$12,000	$100,000
2020	8	0.050	0.40	$400,000	$20,000	$160,000	$16,000	$130,000	$12,000	$93,000
2021	8	0.050	0.40	$400,000	$20,000	$160,000	$15,000	$120,000	$11,000	$87,000
2022	8	0.050	0.40	$400,000	$20,000	$160,000	$15,000	$120,000	$10,000	$81,000
2023	8	0.050	0.40	$400,000	$20,000	$160,000	$14,000	$120,000	$9,500	$76,000
2024	8	0.050	0.40	$400,000	$20,000	$160,000	$14,000	$110,000	$8,900	$71,000
2025	8	0.050	0.40	$400,000	$20,000	$160,000	$14,000	$110,000	$8,300	$66,000
2026	8	0.050	0.40	$400,000	$20,000	$160,000	$13,000	$110,000	$7,800	$62,000
2027	8	0.050	0.40	$400,000	$20,000	$160,000	$13,000	$100,000	$7,200	$58,000
2028	8	0.050	0.40	$400,000	$20,000	$160,000	$12,000	$100,000	$6,800	$54,000
2029	8	0.050	0.40	$400,000	$20,000	$160,000	$12,000	$97,000	$6,300	$51,000
2030	8	0.050	0.40	$400,000	$20,000	$160,000	$12,000	$94,000	$5,900	$47,000
2031	8	0.050	0.40	$400,000	$20,000	$160,000	$11,000	$91,000	$5,500	$44,000
2032	8	0.050	0.40	$400,000	$20,000	$160,000	$11,000	$89,000	$5,200	$41,000
2033	8	0.050	0.40	$400,000	$20,000	$160,000	$11,000	$86,000	$4,800	$39,000
2034	8	0.050	0.40	$400,000	$20,000	$160,000	$10,000	$84,000	$4,500	$36,000
2035	8	0.050	0.40	$400,000	$20,000	$160,000	$10,000	$81,000	$4,200	$34,000
2036	8	0.050	0.40	$400,000	$20,000	$160,000	$9,800	$79,000	$3,900	$32,000
2037	8	0.050	0.40	$400,000	$20,000	$160,000	$9,600	$76,000	$3,700	$29,000
				Total:	**$500,000**	**$4,200,000**	**$370,000**	**$3,000,000**	**$250,000**	**$2,000,000**

Table 56 – Public Health (Accident) – Filtered Vents

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	8.1	$2,000	$4,000	$500,000	$500,000	$500,000	$1,000,000	$1,000,000	$1,000,000
2013	31	8.1	$2,000	$4,000	$500,000	$490,000	$470,000	$1,000,000	$970,000	$930,000
2014	31	8.1	$2,000	$4,000	$500,000	$470,000	$440,000	$1,000,000	$940,000	$870,000
2015	31	8.1	$2,000	$4,000	$500,000	$460,000	$410,000	$1,000,000	$920,000	$820,000
2016	31	8.1	$2,000	$4,000	$500,000	$440,000	$380,000	$1,000,000	$890,000	$760,000
2017	31	8.1	$2,000	$4,000	$500,000	$430,000	$360,000	$1,000,000	$860,000	$710,000
2018	31	8.1	$2,000	$4,000	$500,000	$420,000	$330,000	$1,000,000	$840,000	$670,000
2019	31	8.1	$2,000	$4,000	$500,000	$410,000	$310,000	$1,000,000	$810,000	$620,000
2020	31	8.1	$2,000	$4,000	$500,000	$390,000	$290,000	$1,000,000	$790,000	$580,000
2021	31	8.1	$2,000	$4,000	$500,000	$380,000	$270,000	$1,000,000	$770,000	$540,000
2022	31	8.1	$2,000	$4,000	$500,000	$370,000	$250,000	$1,000,000	$740,000	$510,000
2023	31	8.1	$2,000	$4,000	$500,000	$360,000	$240,000	$1,000,000	$720,000	$480,000
2024	31	8.1	$2,000	$4,000	$500,000	$350,000	$220,000	$1,000,000	$700,000	$440,000
2025	31	8.1	$2,000	$4,000	$500,000	$340,000	$210,000	$1,000,000	$680,000	$410,000
2026	31	8.1	$2,000	$4,000	$500,000	$330,000	$190,000	$1,000,000	$660,000	$390,000
2027	31	8.1	$2,000	$4,000	$500,000	$320,000	$180,000	$1,000,000	$640,000	$360,000
2028	31	8.1	$2,000	$4,000	$500,000	$310,000	$170,000	$1,000,000	$620,000	$340,000
2029	31	8.1	$2,000	$4,000	$500,000	$300,000	$160,000	$1,000,000	$610,000	$320,000
2030	31	8.1	$2,000	$4,000	$500,000	$290,000	$150,000	$1,000,000	$590,000	$300,000
2031	31	8.1	$2,000	$4,000	$500,000	$290,000	$140,000	$1,000,000	$570,000	$280,000
2032	31	8.1	$2,000	$4,000	$500,000	$280,000	$130,000	$1,000,000	$550,000	$260,000
2033	31	8.1	$2,000	$4,000	$500,000	$270,000	$120,000	$1,000,000	$540,000	$240,000
2034	31	8.1	$2,000	$4,000	$500,000	$260,000	$110,000	$1,000,000	$520,000	$230,000
2035	31	8.1	$2,000	$4,000	$500,000	$250,000	$110,000	$1,000,000	$510,000	$210,000
2036	31	8.1	$2,000	$4,000	$500,000	$250,000	$99,000	$1,000,000	$490,000	$200,000
2037	31	8.1	$2,000	$4,000	$500,000	$240,000	$92,000	$1,000,000	$480,000	$180,000
Total per unit:		**210**		**Total:**	**$13,000,000**	**$9,200,000**	**$6,300,000**	**$26,000,000**	**$18,000,000**	**$13,000,000**
Total:		**6,500**								

Table 57 – Public Health (Accident) – Filtered Vents – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.044	$2,000	$4,000	$2,700	$2,700	$2,700	$5,500	$5,500	$5,500
2013	31	0.044	$2,000	$4,000	$2,700	$2,600	$2,500	$5,500	$5,300	$5,100
2014	31	0.044	$2,000	$4,000	$2,700	$2,500	$2,400	$5,500	$5,200	$4,800
2015	31	0.044	$2,000	$4,000	$2,700	$2,500	$2,200	$5,500	$5,000	$4,500
2016	31	0.044	$2,000	$4,000	$2,700	$2,400	$2,100	$5,500	$4,900	$4,200
2017	31	0.044	$2,000	$4,000	$2,700	$2,300	$1,900	$5,500	$4,700	$3,900
2018	31	0.044	$2,000	$4,000	$2,700	$2,300	$1,800	$5,500	$4,600	$3,700
2019	31	0.044	$2,000	$4,000	$2,700	$2,200	$1,700	$5,500	$4,500	$3,400
2020	31	0.044	$2,000	$4,000	$2,700	$2,100	$1,600	$5,500	$4,300	$3,200
2021	31	0.044	$2,000	$4,000	$2,700	$2,100	$1,500	$5,500	$4,200	$3,000
2022	31	0.044	$2,000	$4,000	$2,700	$2,000	$1,400	$5,500	$4,100	$2,800
2023	31	0.044	$2,000	$4,000	$2,700	$2,000	$1,300	$5,500	$4,000	$2,600
2024	31	0.044	$2,000	$4,000	$2,700	$1,900	$1,200	$5,500	$3,900	$2,400
2025	31	0.044	$2,000	$4,000	$2,700	$1,800	$1,100	$5,500	$3,700	$2,300
2026	31	0.044	$2,000	$4,000	$2,700	$1,800	$1,000	$5,500	$3,600	$2,100
2027	31	0.044	$2,000	$4,000	$2,700	$1,700	$980	$5,500	$3,500	$2,000
2028	31	0.044	$2,000	$4,000	$2,700	$1,700	$910	$5,500	$3,400	$1,900
2029	31	0.044	$2,000	$4,000	$2,700	$1,600	$850	$5,500	$3,300	$1,700
2030	31	0.044	$2,000	$4,000	$2,700	$1,600	$800	$5,500	$3,200	$1,600
2031	31	0.044	$2,000	$4,000	$2,700	$1,500	$750	$5,500	$3,100	$1,500
2032	31	0.044	$2,000	$4,000	$2,700	$1,500	$700	$5,500	$3,000	$1,400
2033	31	0.044	$2,000	$4,000	$2,700	$1,500	$650	$5,500	$3,000	$1,300
2034	31	0.044	$2,000	$4,000	$2,700	$1,400	$610	$5,500	$2,900	$1,200
2035	31	0.044	$2,000	$4,000	$2,700	$1,400	$570	$5,500	$2,800	$1,200
2036	31	0.044	$2,000	$4,000	$2,700	$1,300	$530	$5,500	$2,700	$1,100
2037	31	0.044	$2,000	$4,000	$2,700	$1,300	$500	$5,500	$2,600	$1,000
Total per unit:		**1.1**		**Total:**	**$70,000**	**$50,000**	**$34,000**	**$140,000**	**$100,000**	**$69,000**
Total:		**34**								

Table 58 – Public Health (Accident) – Filtered Vents – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	31	$2,000	$4,000	$1,900,000	$1,900,000	$1,900,000	$3,800,000	$3,800,000	$3,800,000
2013	31	31	$2,000	$4,000	$1,900,000	$1,800,000	$1,800,000	$3,800,000	$3,700,000	$3,600,000
2014	31	31	$2,000	$4,000	$1,900,000	$1,800,000	$1,700,000	$3,800,000	$3,600,000	$3,300,000
2015	31	31	$2,000	$4,000	$1,900,000	$1,700,000	$1,600,000	$3,800,000	$3,500,000	$3,100,000
2016	31	31	$2,000	$4,000	$1,900,000	$1,700,000	$1,400,000	$3,800,000	$3,400,000	$2,900,000
2017	31	31	$2,000	$4,000	$1,900,000	$1,600,000	$1,400,000	$3,800,000	$3,300,000	$2,700,000
2018	31	31	$2,000	$4,000	$1,900,000	$1,600,000	$1,300,000	$3,800,000	$3,200,000	$2,500,000
2019	31	31	$2,000	$4,000	$1,900,000	$1,500,000	$1,200,000	$3,800,000	$3,100,000	$2,400,000
2020	31	31	$2,000	$4,000	$1,900,000	$1,500,000	$1,100,000	$3,800,000	$3,000,000	$2,200,000
2021	31	31	$2,000	$4,000	$1,900,000	$1,500,000	$1,000,000	$3,800,000	$2,900,000	$2,100,000
2022	31	31	$2,000	$4,000	$1,900,000	$1,400,000	$970,000	$3,800,000	$2,800,000	$1,900,000
2023	31	31	$2,000	$4,000	$1,900,000	$1,400,000	$900,000	$3,800,000	$2,700,000	$1,800,000
2024	31	31	$2,000	$4,000	$1,900,000	$1,300,000	$840,000	$3,800,000	$2,700,000	$1,700,000
2025	31	31	$2,000	$4,000	$1,900,000	$1,300,000	$790,000	$3,800,000	$2,600,000	$1,600,000
2026	31	31	$2,000	$4,000	$1,900,000	$1,300,000	$740,000	$3,800,000	$2,500,000	$1,500,000
2027	31	31	$2,000	$4,000	$1,900,000	$1,200,000	$690,000	$3,800,000	$2,400,000	$1,400,000
2028	31	31	$2,000	$4,000	$1,900,000	$1,200,000	$640,000	$3,800,000	$2,400,000	$1,300,000
2029	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$600,000	$3,800,000	$2,300,000	$1,200,000
2030	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$560,000	$3,800,000	$2,200,000	$1,100,000
2031	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$530,000	$3,800,000	$2,200,000	$1,100,000
2032	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$490,000	$3,800,000	$2,100,000	$980,000
2033	31	31	$2,000	$4,000	$1,900,000	$1,000,000	$460,000	$3,800,000	$2,000,000	$920,000
2034	31	31	$2,000	$4,000	$1,900,000	$990,000	$430,000	$3,800,000	$2,000,000	$860,000
2035	31	31	$2,000	$4,000	$1,900,000	$960,000	$400,000	$3,800,000	$1,900,000	$800,000
2036	31	31	$2,000	$4,000	$1,900,000	$930,000	$370,000	$3,800,000	$1,900,000	$750,000
2037	31	31	$2,000	$4,000	$1,900,000	$910,000	$350,000	$3,800,000	$1,800,000	$700,000
Total per unit:		**810**		**Total:**	**$49,000,000**	**$35,000,000**	**$24,000,000**	**$99,000,000**	**$70,000,000**	**$48,000,000**
Total:		**25,000**								

Table 60 – Occupational Health (Accident) Short-Term – Filtered Vents

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.25	$2,000	$4,000	$16,000	$16,000	$16,000	$31,000	$31,000	$31,000
2013	31	0.25	$2,000	$4,000	$16,000	$16,000	$15,000	$31,000	$30,000	$29,000
2014	31	0.25	$2,000	$4,000	$16,000	$15,000	$14,000	$31,000	$29,000	$27,000
2015	31	0.25	$2,000	$4,000	$16,000	$15,000	$13,000	$31,000	$28,000	$25,000
2016	31	0.25	$2,000	$4,000	$16,000	$14,000	$12,000	$31,000	$28,000	$24,000
2017	31	0.25	$2,000	$4,000	$16,000	$14,000	$11,000	$31,000	$27,000	$22,000
2018	31	0.25	$2,000	$4,000	$16,000	$13,000	$11,000	$31,000	$26,000	$21,000
2019	31	0.25	$2,000	$4,000	$16,000	$13,000	$10,000	$31,000	$25,000	$19,000
2020	31	0.25	$2,000	$4,000	$16,000	$13,000	$9,300	$31,000	$24,000	$18,000
2021	31	0.25	$2,000	$4,000	$16,000	$12,000	$8,700	$31,000	$24,000	$17,000
2022	31	0.25	$2,000	$4,000	$16,000	$12,000	$8,100	$31,000	$23,000	$16,000
2023	31	0.25	$2,000	$4,000	$16,000	$12,000	$7,600	$31,000	$22,000	$15,000
2024	31	0.25	$2,000	$4,000	$16,000	$11,000	$7,100	$31,000	$22,000	$14,000
2025	31	0.25	$2,000	$4,000	$16,000	$11,000	$6,600	$31,000	$21,000	$13,000
2026	31	0.25	$2,000	$4,000	$16,000	$11,000	$6,200	$31,000	$20,000	$12,000
2027	31	0.25	$2,000	$4,000	$16,000	$10,000	$5,800	$31,000	$20,000	$11,000
2028	31	0.25	$2,000	$4,000	$16,000	$10,000	$5,400	$31,000	$19,000	$11,000
2029	31	0.25	$2,000	$4,000	$16,000	$9,700	$5,100	$31,000	$19,000	$9,800
2030	31	0.25	$2,000	$4,000	$16,000	$9,400	$4,700	$31,000	$18,000	$9,200
2031	31	0.25	$2,000	$4,000	$16,000	$9,100	$4,400	$31,000	$18,000	$8,600
2032	31	0.25	$2,000	$4,000	$16,000	$8,900	$4,100	$31,000	$17,000	$8,000
2033	31	0.25	$2,000	$4,000	$16,000	$8,600	$3,900	$31,000	$17,000	$7,500
2034	31	0.25	$2,000	$4,000	$16,000	$8,400	$3,600	$31,000	$16,000	$7,000
2035	31	0.25	$2,000	$4,000	$16,000	$8,100	$3,400	$31,000	$16,000	$6,500
2036	31	0.25	$2,000	$4,000	$16,000	$7,900	$3,200	$31,000	$15,000	$6,100
2037	31	0.25	$2,000	$4,000	$16,000	$7,600	$2,900	$31,000	$15,000	$5,700
Total per unit:		**6.5**		**Total:**	**$420,000**	**$300,000**	**$200,000**	**$810,000**	**$570,000**	**$390,000**
Total:		**200**								

Table 61 – Occupational Health (Accident) Long-Term – Filtered Vents

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.38	$2,000	$4,000	$24,000	$19,000	$14,000	$47,000	$37,000	$28,000
2013	31	0.38	$2,000	$4,000	$24,000	$18,000	$13,000	$47,000	$36,000	$26,000
2014	31	0.38	$2,000	$4,000	$24,000	$18,000	$12,000	$47,000	$35,000	$24,000
2015	31	0.38	$2,000	$4,000	$24,000	$17,000	$12,000	$47,000	$34,000	$23,000
2016	31	0.38	$2,000	$4,000	$24,000	$17,000	$11,000	$47,000	$33,000	$21,000
2017	31	0.38	$2,000	$4,000	$24,000	$16,000	$10,000	$47,000	$32,000	$20,000
2018	31	0.38	$2,000	$4,000	$24,000	$16,000	$9,400	$47,000	$31,000	$18,000
2019	31	0.38	$2,000	$4,000	$24,000	$15,000	$8,800	$47,000	$30,000	$17,000
2020	31	0.38	$2,000	$4,000	$24,000	$15,000	$8,200	$47,000	$29,000	$16,000
2021	31	0.38	$2,000	$4,000	$24,000	$15,000	$7,700	$47,000	$28,000	$15,000
2022	31	0.38	$2,000	$4,000	$24,000	$14,000	$7,200	$47,000	$28,000	$14,000
2023	31	0.38	$2,000	$4,000	$24,000	$14,000	$6,700	$47,000	$27,000	$13,000
2024	31	0.38	$2,000	$4,000	$24,000	$13,000	$6,300	$47,000	$26,000	$12,000
2025	31	0.38	$2,000	$4,000	$24,000	$13,000	$5,800	$47,000	$25,000	$11,000
2026	31	0.38	$2,000	$4,000	$24,000	$13,000	$5,500	$47,000	$25,000	$11,000
2027	31	0.38	$2,000	$4,000	$24,000	$12,000	$5,100	$47,000	$24,000	$10,000
2028	31	0.38	$2,000	$4,000	$24,000	$12,000	$4,800	$47,000	$23,000	$9,400
2029	31	0.38	$2,000	$4,000	$24,000	$11,000	$4,500	$47,000	$22,000	$8,700
2030	31	0.38	$2,000	$4,000	$24,000	$11,000	$4,200	$47,000	$22,000	$8,200
2031	31	0.38	$2,000	$4,000	$24,000	$11,000	$3,900	$47,000	$21,000	$7,600
2032	31	0.38	$2,000	$4,000	$24,000	$11,000	$3,600	$47,000	$21,000	$7,100
2033	31	0.38	$2,000	$4,000	$24,000	$10,000	$3,400	$47,000	$20,000	$6,700
2034	31	0.38	$2,000	$4,000	$24,000	$9,900	$3,200	$47,000	$19,000	$6,200
2035	31	0.38	$2,000	$4,000	$24,000	$9,600	$3,000	$47,000	$19,000	$5,800
2036	31	0.38	$2,000	$4,000	$24,000	$9,300	$2,800	$47,000	$18,000	$5,400
2037	31	0.38	$2,000	$4,000	$24,000	$9,100	$2,600	$47,000	$18,000	$5,100
Total per unit:		**9.9**		**Total:**	**$620,000**	**$350,000**	**$180,000**	**$1,200,000**	**$680,000**	**$350,000**
Total:		**310**								

Table 62 – Occupational Health (Accident) Short-Term – Filtered Vents – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.0014	$2,000	$4,000	$87	$87	$87	$170	$170	$170
2013	31	0.0014	$2,000	$4,000	$87	$84	$81	$170	$170	$160
2014	31	0.0014	$2,000	$4,000	$87	$82	$76	$170	$160	$150
2015	31	0.0014	$2,000	$4,000	$87	$80	$71	$170	$160	$140
2016	31	0.0014	$2,000	$4,000	$87	$77	$66	$170	$150	$130
2017	31	0.0014	$2,000	$4,000	$87	$75	$62	$170	$150	$120
2018	31	0.0014	$2,000	$4,000	$87	$73	$58	$170	$140	$110
2019	31	0.0014	$2,000	$4,000	$87	$71	$54	$170	$140	$110
2020	31	0.0014	$2,000	$4,000	$87	$69	$51	$170	$130	$99
2021	31	0.0014	$2,000	$4,000	$87	$67	$47	$170	$130	$92
2022	31	0.0014	$2,000	$4,000	$87	$65	$44	$170	$130	$86
2023	31	0.0014	$2,000	$4,000	$87	$63	$41	$170	$120	$81
2024	31	0.0014	$2,000	$4,000	$87	$61	$39	$170	$120	$75
2025	31	0.0014	$2,000	$4,000	$87	$59	$36	$170	$120	$71
2026	31	0.0014	$2,000	$4,000	$87	$58	$34	$170	$110	$66
2027	31	0.0014	$2,000	$4,000	$87	$56	$32	$170	$110	$62
2028	31	0.0014	$2,000	$4,000	$87	$54	$29	$170	$110	$58
2029	31	0.0014	$2,000	$4,000	$87	$53	$28	$170	$100	$54
2030	31	0.0014	$2,000	$4,000	$87	$51	$26	$170	$100	$50
2031	31	0.0014	$2,000	$4,000	$87	$50	$24	$170	$97	$47
2032	31	0.0014	$2,000	$4,000	$87	$48	$22	$170	$94	$44
2033	31	0.0014	$2,000	$4,000	$87	$47	$21	$170	$91	$41
2034	31	0.0014	$2,000	$4,000	$87	$45	$20	$170	$89	$38
2035	31	0.0014	$2,000	$4,000	$87	$44	$18	$170	$86	$36
2036	31	0.0014	$2,000	$4,000	$87	$43	$17	$170	$84	$34
2037	31	0.0014	$2,000	$4,000	$87	$42	$16	$170	$81	$31
Total per unit:		**0.036**		**Total:**	**$2,300**	**$1,600**	**$1,100**	**$4,400**	**$3,100**	**$2,200**
Total:		**1.1**								

Table 63 – Occupational Health (Accident) Long-Term – Filtered Vents – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.0019	$2,000	$4,000	$120	$95	$70	$240	$190	$140
2013	31	0.0019	$2,000	$4,000	$120	$92	$66	$240	$180	$130
2014	31	0.0019	$2,000	$4,000	$120	$89	$62	$240	$180	$120
2015	31	0.0019	$2,000	$4,000	$120	$87	$58	$240	$170	$120
2016	31	0.0019	$2,000	$4,000	$120	$84	$54	$240	$170	$110
2017	31	0.0019	$2,000	$4,000	$120	$82	$50	$240	$160	$100
2018	31	0.0019	$2,000	$4,000	$120	$79	$47	$240	$160	$94
2019	31	0.0019	$2,000	$4,000	$120	$77	$44	$240	$150	$88
2020	31	0.0019	$2,000	$4,000	$120	$75	$41	$240	$150	$82
2021	31	0.0019	$2,000	$4,000	$120	$73	$38	$240	$150	$77
2022	31	0.0019	$2,000	$4,000	$120	$71	$36	$240	$140	$72
2023	31	0.0019	$2,000	$4,000	$120	$69	$33	$240	$140	$67
2024	31	0.0019	$2,000	$4,000	$120	$67	$31	$240	$130	$63
2025	31	0.0019	$2,000	$4,000	$120	$65	$29	$240	$130	$58
2026	31	0.0019	$2,000	$4,000	$120	$63	$27	$240	$130	$55
2027	31	0.0019	$2,000	$4,000	$120	$61	$26	$240	$120	$51
2028	31	0.0019	$2,000	$4,000	$120	$59	$24	$240	$120	$48
2029	31	0.0019	$2,000	$4,000	$120	$57	$22	$240	$110	$45
2030	31	0.0019	$2,000	$4,000	$120	$56	$21	$240	$110	$42
2031	31	0.0019	$2,000	$4,000	$120	$54	$19	$240	$110	$39
2032	31	0.0019	$2,000	$4,000	$120	$53	$18	$240	$110	$36
2033	31	0.0019	$2,000	$4,000	$120	$51	$17	$240	$100	$34
2034	31	0.0019	$2,000	$4,000	$120	$50	$16	$240	$99	$32
2035	31	0.0019	$2,000	$4,000	$120	$48	$15	$240	$96	$30
2036	31	0.0019	$2,000	$4,000	$120	$47	$14	$240	$93	$28
2037	31	0.0019	$2,000	$4,000	$120	$45	$13	$240	$91	$26
	Total per unit:	**0.049**		**Total:**	**$3,100**	**$1,700**	**$890**	**$6,200**	**$3,500**	**$1,800**
	Total:	**1.5**								

Table 64 – Occupational Health (Accident) Short-Term – Filtered Vents – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	1.1	$2,000	$4,000	$68,000	$68,000	$68,000	$140,000	$140,000	$140,000
2013	31	1.1	$2,000	$4,000	$68,000	$66,000	$64,000	$140,000	$140,000	$130,000
2014	31	1.1	$2,000	$4,000	$68,000	$64,000	$59,000	$140,000	$130,000	$120,000
2015	31	1.1	$2,000	$4,000	$68,000	$62,000	$56,000	$140,000	$130,000	$110,000
2016	31	1.1	$2,000	$4,000	$68,000	$60,000	$52,000	$140,000	$120,000	$110,000
2017	31	1.1	$2,000	$4,000	$68,000	$59,000	$48,000	$140,000	$120,000	$100,000
2018	31	1.1	$2,000	$4,000	$68,000	$57,000	$45,000	$140,000	$120,000	$93,000
2019	31	1.1	$2,000	$4,000	$68,000	$55,000	$42,000	$140,000	$110,000	$87,000
2020	31	1.1	$2,000	$4,000	$68,000	$54,000	$40,000	$140,000	$110,000	$81,000
2021	31	1.1	$2,000	$4,000	$68,000	$52,000	$37,000	$140,000	$110,000	$76,000
2022	31	1.1	$2,000	$4,000	$68,000	$51,000	$35,000	$140,000	$100,000	$71,000
2023	31	1.1	$2,000	$4,000	$68,000	$49,000	$32,000	$140,000	$100,000	$67,000
2024	31	1.1	$2,000	$4,000	$68,000	$48,000	$30,000	$140,000	$98,000	$62,000
2025	31	1.1	$2,000	$4,000	$68,000	$46,000	$28,000	$140,000	$95,000	$58,000
2026	31	1.1	$2,000	$4,000	$68,000	$45,000	$26,000	$140,000	$93,000	$54,000
2027	31	1.1	$2,000	$4,000	$68,000	$44,000	$25,000	$140,000	$90,000	$51,000
2028	31	1.1	$2,000	$4,000	$68,000	$42,000	$23,000	$140,000	$87,000	$47,000
2029	31	1.1	$2,000	$4,000	$68,000	$41,000	$22,000	$140,000	$85,000	$44,000
2030	31	1.1	$2,000	$4,000	$68,000	$40,000	$20,000	$140,000	$82,000	$41,000
2031	31	1.1	$2,000	$4,000	$68,000	$39,000	$19,000	$140,000	$80,000	$39,000
2032	31	1.1	$2,000	$4,000	$68,000	$38,000	$18,000	$140,000	$78,000	$36,000
2033	31	1.1	$2,000	$4,000	$68,000	$37,000	$16,000	$140,000	$75,000	$34,000
2034	31	1.1	$2,000	$4,000	$68,000	$35,000	$15,000	$140,000	$73,000	$32,000
2035	31	1.1	$2,000	$4,000	$68,000	$34,000	$14,000	$140,000	$71,000	$30,000
2036	31	1.1	$2,000	$4,000	$68,000	$33,000	$13,000	$140,000	$69,000	$28,000
2037	31	1.1	$2,000	$4,000	$68,000	$32,000	$13,000	$140,000	$67,000	$26,000
Total per unit:		**29**		**Total:**	**$1,800,000**	**$1,300,000**	**$860,000**	**$3,600,000**	**$2,600,000**	**$1,800,000**
Total:		**900**								

Table 65 – Occupational Health (Accident) Long-Term – Filtered Vents – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	1.4	$2,000	$4,000	$87,000	$69,000	$51,000	$170,000	$130,000	$100,000
2013	31	1.4	$2,000	$4,000	$87,000	$67,000	$48,000	$170,000	$130,000	$93,000
2014	31	1.4	$2,000	$4,000	$87,000	$65,000	$45,000	$170,000	$130,000	$87,000
2015	31	1.4	$2,000	$4,000	$87,000	$63,000	$42,000	$170,000	$120,000	$82,000
2016	31	1.4	$2,000	$4,000	$87,000	$61,000	$39,000	$170,000	$120,000	$76,000
2017	31	1.4	$2,000	$4,000	$87,000	$59,000	$36,000	$170,000	$120,000	$71,000
2018	31	1.4	$2,000	$4,000	$87,000	$58,000	$34,000	$170,000	$110,000	$67,000
2019	31	1.4	$2,000	$4,000	$87,000	$56,000	$32,000	$170,000	$110,000	$62,000
2020	31	1.4	$2,000	$4,000	$87,000	$54,000	$30,000	$170,000	$110,000	$58,000
2021	31	1.4	$2,000	$4,000	$87,000	$53,000	$28,000	$170,000	$100,000	$54,000
2022	31	1.4	$2,000	$4,000	$87,000	$51,000	$26,000	$170,000	$100,000	$51,000
2023	31	1.4	$2,000	$4,000	$87,000	$50,000	$24,000	$170,000	$97,000	$47,000
2024	31	1.4	$2,000	$4,000	$87,000	$48,000	$23,000	$170,000	$94,000	$44,000
2025	31	1.4	$2,000	$4,000	$87,000	$47,000	$21,000	$170,000	$92,000	$41,000
2026	31	1.4	$2,000	$4,000	$87,000	$45,000	$20,000	$170,000	$89,000	$39,000
2027	31	1.4	$2,000	$4,000	$87,000	$44,000	$19,000	$170,000	$86,000	$36,000
2028	31	1.4	$2,000	$4,000	$87,000	$43,000	$17,000	$170,000	$84,000	$34,000
2029	31	1.4	$2,000	$4,000	$87,000	$42,000	$16,000	$170,000	$81,000	$32,000
2030	31	1.4	$2,000	$4,000	$87,000	$40,000	$15,000	$170,000	$79,000	$30,000
2031	31	1.4	$2,000	$4,000	$87,000	$39,000	$14,000	$170,000	$77,000	$28,000
2032	31	1.4	$2,000	$4,000	$87,000	$38,000	$13,000	$170,000	$74,000	$26,000
2033	31	1.4	$2,000	$4,000	$87,000	$37,000	$12,000	$170,000	$72,000	$24,000
2034	31	1.4	$2,000	$4,000	$87,000	$36,000	$12,000	$170,000	$70,000	$23,000
2035	31	1.4	$2,000	$4,000	$87,000	$35,000	$11,000	$170,000	$68,000	$21,000
2036	31	1.4	$2,000	$4,000	$87,000	$34,000	$10,000	$170,000	$66,000	$20,000
2037	31	1.4	$2,000	$4,000	$87,000	$33,000	$9,400	$170,000	$64,000	$18,000
	Total per unit:	**36**		**Total:**	**$2,300,000**	**$1,300,000**	**$650,000**	**$4,400,000**	**$2,500,000**	**$1,300,000**
	Total:	**1,100**								

Table 67 – Offsite Property – Filtered Vents

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	31	$34,000	$1,100,000	$1,100,000	$1,100,000
2013	31	$34,000	$1,100,000	$1,100,000	$1,000,000
2014	31	$34,000	$1,100,000	$1,000,000	$960,000
2015	31	$34,000	$1,100,000	$1,000,000	$900,000
2016	31	$34,000	$1,100,000	$980,000	$840,000
2017	31	$34,000	$1,100,000	$950,000	$780,000
2018	31	$34,000	$1,100,000	$920,000	$730,000
2019	31	$34,000	$1,100,000	$890,000	$690,000
2020	31	$34,000	$1,100,000	$870,000	$640,000
2021	31	$34,000	$1,100,000	$840,000	$600,000
2022	31	$34,000	$1,100,000	$820,000	$560,000
2023	31	$34,000	$1,100,000	$790,000	$520,000
2024	31	$34,000	$1,100,000	$770,000	$490,000
2025	31	$34,000	$1,100,000	$750,000	$460,000
2026	31	$34,000	$1,100,000	$730,000	$430,000
2027	31	$34,000	$1,100,000	$710,000	$400,000
2028	31	$34,000	$1,100,000	$690,000	$370,000
2029	31	$34,000	$1,100,000	$670,000	$350,000
2030	31	$34,000	$1,100,000	$650,000	$330,000
2031	31	$34,000	$1,100,000	$630,000	$300,000
2032	31	$34,000	$1,100,000	$610,000	$280,000
2033	31	$34,000	$1,100,000	$590,000	$270,000
2034	31	$34,000	$1,100,000	$570,000	$250,000
2035	31	$34,000	$1,100,000	$560,000	$230,000
2036	31	$34,000	$1,100,000	$540,000	$220,000
2037	31	$34,000	$1,100,000	$530,000	$200,000
		Total:	**$29,000,000**	**$20,000,000**	**$14,000,000**

Table 68 – Offsite Property – Filtered Vents – 5th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	31	$200	$6,200	$6,200	$6,200
2013	31	$200	$6,200	$6,000	$5,800
2014	31	$200	$6,200	$5,800	$5,400
2015	31	$200	$6,200	$5,700	$5,100
2016	31	$200	$6,200	$5,500	$4,700
2017	31	$200	$6,200	$5,300	$4,400
2018	31	$200	$6,200	$5,200	$4,100
2019	31	$200	$6,200	$5,000	$3,900
2020	31	$200	$6,200	$4,900	$3,600
2021	31	$200	$6,200	$4,800	$3,400
2022	31	$200	$6,200	$4,600	$3,200
2023	31	$200	$6,200	$4,500	$2,900
2024	31	$200	$6,200	$4,300	$2,800
2025	31	$200	$6,200	$4,200	$2,600
2026	31	$200	$6,200	$4,100	$2,400
2027	31	$200	$6,200	$4,000	$2,200
2028	31	$200	$6,200	$3,900	$2,100
2029	31	$200	$6,200	$3,800	$2,000
2030	31	$200	$6,200	$3,600	$1,800
2031	31	$200	$6,200	$3,500	$1,700
2032	31	$200	$6,200	$3,400	$1,600
2033	31	$200	$6,200	$3,300	$1,500
2034	31	$200	$6,200	$3,200	$1,400
2035	31	$200	$6,200	$3,100	$1,300
2036	31	$200	$6,200	$3,000	$1,200
2037	31	$200	$6,200	$3,000	$1,100
		Total:	**$160,000**	**$110,000**	**$78,000**

Table 69 – Offsite Property – Filtered Vents – 95th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	31	$130,000	$4,000,000	$4,000,000	$4,000,000
2013	31	$130,000	$4,000,000	$3,900,000	$3,700,000
2014	31	$130,000	$4,000,000	$3,800,000	$3,500,000
2015	31	$130,000	$4,000,000	$3,700,000	$3,300,000
2016	31	$130,000	$4,000,000	$3,600,000	$3,100,000
2017	31	$130,000	$4,000,000	$3,500,000	$2,900,000
2018	31	$130,000	$4,000,000	$3,300,000	$2,700,000
2019	31	$130,000	$4,000,000	$3,300,000	$2,500,000
2020	31	$130,000	$4,000,000	$3,200,000	$2,300,000
2021	31	$130,000	$4,000,000	$3,100,000	$2,200,000
2022	31	$130,000	$4,000,000	$3,000,000	$2,000,000
2023	31	$130,000	$4,000,000	$2,900,000	$1,900,000
2024	31	$130,000	$4,000,000	$2,800,000	$1,800,000
2025	31	$130,000	$4,000,000	$2,700,000	$1,700,000
2026	31	$130,000	$4,000,000	$2,600,000	$1,600,000
2027	31	$130,000	$4,000,000	$2,600,000	$1,400,000
2028	31	$130,000	$4,000,000	$2,500,000	$1,400,000
2029	31	$130,000	$4,000,000	$2,400,000	$1,300,000
2030	31	$130,000	$4,000,000	$2,300,000	$1,200,000
2031	31	$130,000	$4,000,000	$2,300,000	$1,100,000
2032	31	$130,000	$4,000,000	$2,200,000	$1,000,000
2033	31	$130,000	$4,000,000	$2,200,000	$970,000
2034	31	$130,000	$4,000,000	$2,100,000	$900,000
2035	31	$130,000	$4,000,000	$2,000,000	$840,000
2036	31	$130,000	$4,000,000	$2,000,000	$790,000
2037	31	$130,000	$4,000,000	$1,900,000	$740,000
		Total:	**$100,000,000**	**$74,000,000**	**$51,000,000**

Table 71 – Onsite Property – Filtered Vents

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	$25,000	$21,000	$18,000	$780,000	$650,000	$560,000
2013	31	$25,000	$21,000	$18,000	$780,000	$630,000	$520,000
2014	31	$25,000	$21,000	$18,000	$780,000	$610,000	$490,000
2015	31	$25,000	$21,000	$18,000	$780,000	$600,000	$460,000
2016	31	$25,000	$21,000	$18,000	$780,000	$580,000	$430,000
2017	31	$25,000	$21,000	$18,000	$780,000	$560,000	$400,000
2018	31	$25,000	$21,000	$18,000	$780,000	$550,000	$370,000
2019	31	$25,000	$21,000	$18,000	$780,000	$530,000	$350,000
2020	31	$25,000	$21,000	$18,000	$780,000	$510,000	$320,000
2021	31	$25,000	$21,000	$18,000	$780,000	$500,000	$300,000
2022	31	$25,000	$21,000	$18,000	$780,000	$480,000	$280,000
2023	31	$25,000	$21,000	$18,000	$780,000	$470,000	$270,000
2024	31	$25,000	$21,000	$18,000	$780,000	$460,000	$250,000
2025	31	$25,000	$21,000	$18,000	$780,000	$440,000	$230,000
2026	31	$25,000	$21,000	$18,000	$780,000	$430,000	$220,000
2027	31	$25,000	$21,000	$18,000	$780,000	$420,000	$200,000
2028	31	$25,000	$21,000	$18,000	$780,000	$410,000	$190,000
2029	31	$25,000	$21,000	$18,000	$780,000	$390,000	$180,000
2030	31	$25,000	$21,000	$18,000	$780,000	$380,000	$170,000
2031	31	$25,000	$21,000	$18,000	$780,000	$370,000	$150,000
2032	31	$25,000	$21,000	$18,000	$780,000	$360,000	$140,000
2033	31	$25,000	$21,000	$18,000	$780,000	$350,000	$130,000
2034	31	$25,000	$21,000	$18,000	$780,000	$340,000	$130,000
2035	31	$25,000	$21,000	$18,000	$780,000	$330,000	$120,000
2036	31	$25,000	$21,000	$18,000	$780,000	$320,000	$110,000
2037	31	$25,000	$21,000	$18,000	$780,000	$310,000	$100,000
				Total:	**$20,000,000**	**$12,000,000**	**$7,100,000**

Table 72 – Onsite Property – Filtered Vents – 5th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	$130	$110	$91	$4,000	$3,400	$2,800
2013	31	$130	$110	$91	$4,000	$3,300	$2,600
2014	31	$130	$110	$91	$4,000	$3,200	$2,500
2015	31	$130	$110	$91	$4,000	$3,100	$2,300
2016	31	$130	$110	$91	$4,000	$3,000	$2,200
2017	31	$130	$110	$91	$4,000	$2,900	$2,000
2018	31	$130	$110	$91	$4,000	$2,900	$1,900
2019	31	$130	$110	$91	$4,000	$2,800	$1,800
2020	31	$130	$110	$91	$4,000	$2,700	$1,600
2021	31	$130	$110	$91	$4,000	$2,600	$1,500
2022	31	$130	$110	$91	$4,000	$2,500	$1,400
2023	31	$130	$110	$91	$4,000	$2,500	$1,300
2024	31	$130	$110	$91	$4,000	$2,400	$1,300
2025	31	$130	$110	$91	$4,000	$2,300	$1,200
2026	31	$130	$110	$91	$4,000	$2,300	$1,100
2027	31	$130	$110	$91	$4,000	$2,200	$1,000
2028	31	$130	$110	$91	$4,000	$2,100	$960
2029	31	$130	$110	$91	$4,000	$2,100	$890
2030	31	$130	$110	$91	$4,000	$2,000	$830
2031	31	$130	$110	$91	$4,000	$1,900	$780
2032	31	$130	$110	$91	$4,000	$1,900	$730
2033	31	$130	$110	$91	$4,000	$1,800	$680
2034	31	$130	$110	$91	$4,000	$1,800	$640
2035	31	$130	$110	$91	$4,000	$1,700	$600
2036	31	$130	$110	$91	$4,000	$1,700	$560
2037	31	$130	$110	$91	$4,000	$1,600	$520
				Total:	**$100,000**	**$63,000**	**$36,000**

Table 73 – Onsite Property – Filtered Vents – 95th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	$91,000	$78,000	$65,000	$2,800,000	$2,400,000	$2,000,000
2013	31	$91,000	$78,000	$65,000	$2,800,000	$2,300,000	$1,900,000
2014	31	$91,000	$78,000	$65,000	$2,800,000	$2,300,000	$1,800,000
2015	31	$91,000	$78,000	$65,000	$2,800,000	$2,200,000	$1,600,000
2016	31	$91,000	$78,000	$65,000	$2,800,000	$2,100,000	$1,500,000
2017	31	$91,000	$78,000	$65,000	$2,800,000	$2,100,000	$1,400,000
2018	31	$91,000	$78,000	$65,000	$2,800,000	$2,000,000	$1,300,000
2019	31	$91,000	$78,000	$65,000	$2,800,000	$2,000,000	$1,300,000
2020	31	$91,000	$78,000	$65,000	$2,800,000	$1,900,000	$1,200,000
2021	31	$91,000	$78,000	$65,000	$2,800,000	$1,900,000	$1,100,000
2022	31	$91,000	$78,000	$65,000	$2,800,000	$1,800,000	$1,000,000
2023	31	$91,000	$78,000	$65,000	$2,800,000	$1,700,000	$960,000
2024	31	$91,000	$78,000	$65,000	$2,800,000	$1,700,000	$890,000
2025	31	$91,000	$78,000	$65,000	$2,800,000	$1,600,000	$840,000
2026	31	$91,000	$78,000	$65,000	$2,800,000	$1,600,000	$780,000
2027	31	$91,000	$78,000	$65,000	$2,800,000	$1,600,000	$730,000
2028	31	$91,000	$78,000	$65,000	$2,800,000	$1,500,000	$680,000
2029	31	$91,000	$78,000	$65,000	$2,800,000	$1,500,000	$640,000
2030	31	$91,000	$78,000	$65,000	$2,800,000	$1,400,000	$600,000
2031	31	$91,000	$78,000	$65,000	$2,800,000	$1,400,000	$560,000
2032	31	$91,000	$78,000	$65,000	$2,800,000	$1,300,000	$520,000
2033	31	$91,000	$78,000	$65,000	$2,800,000	$1,300,000	$490,000
2034	31	$91,000	$78,000	$65,000	$2,800,000	$1,300,000	$450,000
2035	31	$91,000	$78,000	$65,000	$2,800,000	$1,200,000	$430,000
2036	31	$91,000	$78,000	$65,000	$2,800,000	$1,200,000	$400,000
2037	31	$91,000	$78,000	$65,000	$2,800,000	$1,200,000	$370,000
				Total:	**$73,000,000**	**$45,000,000**	**$25,000,000**

Table 75 – Onsite Property – Replacement Energy Cost – Filtered Vents

Year	Units	Probability	Replacement Energy Costs			Total Benefit		
			Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$620,000	$530,000
2013	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$600,000	$500,000
2014	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$580,000	$460,000
2015	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$570,000	$430,000
2016	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$550,000	$400,000
2017	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$530,000	$380,000
2018	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$520,000	$350,000
2019	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$500,000	$330,000
2020	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$490,000	$310,000
2021	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$470,000	$290,000
2022	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$460,000	$270,000
2023	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$450,000	$250,000
2024	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$430,000	$240,000
2025	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$420,000	$220,000
2026	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$410,000	$210,000
2027	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$400,000	$190,000
2028	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$390,000	$180,000
2029	11	1.3E-05	$4,300,000,000	$3,800,000,000	$3,300,000,000	$630,000	$340,000	$150,000
2030	11	1.3E-05	$3,800,000,000	$3,400,000,000	$3,000,000,000	$560,000	$290,000	$130,000
2031	11	1.3E-05	$3,300,000,000	$3,100,000,000	$2,800,000,000	$490,000	$260,000	$110,000
2032	11	1.3E-05	$2,900,000,000	$2,700,000,000	$2,400,000,000	$430,000	$220,000	$91,000
2033	11	1.3E-05	$2,400,000,000	$2,300,000,000	$2,100,000,000	$350,000	$180,000	$75,000
2034	11	1.3E-05	$1,900,000,000	$1,800,000,000	$1,700,000,000	$280,000	$140,000	$56,000
2035	11	1.3E-05	$1,400,000,000	$1,400,000,000	$1,300,000,000	$210,000	$100,000	$40,000
2036	11	1.3E-05	$950,000,000	$940,000,000	$920,000,000	$140,000	$68,000	$27,000
2037	11	1.3E-05	$480,000,000	$480,000,000	$480,000,000	$71,000	$34,000	$13,000
					Total:	**$15,000,000**	**$10,000,000**	**$6,200,000**

Table 76 – Onsite Property – Replacement Energy Cost – Filtered Vents – Low Replacement

Year	Units	Probability	Replacement Energy Costs			Total Benefit		
			Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$28,000	$24,000
2013	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$27,000	$22,000
2014	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$26,000	$21,000
2015	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$26,000	$19,000
2016	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$25,000	$18,000
2017	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$24,000	$17,000
2018	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$23,000	$16,000
2019	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$23,000	$15,000
2020	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$22,000	$14,000
2021	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$21,000	$13,000
2022	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$21,000	$12,000
2023	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$20,000	$11,000
2024	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$20,000	$10,000
2025	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$19,000	$9,800
2026	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$18,000	$9,100
2027	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$18,000	$8,500
2028	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$17,000	$8,000
2029	11	1.3E-05	$190,000,000	$170,000,000	$150,000,000	$28,000	$15,000	$7,000
2030	11	1.3E-05	$170,000,000	$160,000,000	$140,000,000	$25,000	$14,000	$6,100
2031	11	1.3E-05	$150,000,000	$140,000,000	$120,000,000	$22,000	$12,000	$4,900
2032	11	1.3E-05	$130,000,000	$120,000,000	$110,000,000	$19,000	$9,800	$4,200
2033	11	1.3E-05	$110,000,000	$100,000,000	$94,000,000	$16,000	$7,900	$3,300
2034	11	1.3E-05	$86,000,000	$82,000,000	$78,000,000	$13,000	$6,300	$2,600
2035	11	1.3E-05	$64,000,000	$63,000,000	$60,000,000	$9,400	$4,700	$1,900
2036	11	1.3E-05	$43,000,000	$42,000,000	$42,000,000	$6,300	$3,000	$1,200
2037	11	1.34E-05	$21,000,000	$21,000,000	$21,000,000	$3,100	$1,500	$570
					Total:	**$670,000**	**$450,000**	**$280,000**

Table 77 – Onsite Property – Replacement Energy Cost – Filtered Vents – High Replacement

Year	Units	Probability	Replacement Energy Costs			Total Benefit		
			Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$2,200,000	$1,900,000
2013	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$2,100,000	$1,800,000
2014	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$2,100,000	$1,700,000
2015	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$2,000,000	$1,600,000
2016	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$2,000,000	$1,500,000
2017	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,900,000	$1,400,000
2018	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,800,000	$1,300,000
2019	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,800,000	$1,200,000
2020	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,700,000	$1,100,000
2021	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,700,000	$1,000,000
2022	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,600,000	$970,000
2023	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,600,000	$910,000
2024	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,500,000	$850,000
2025	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,500,000	$790,000
2026	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,500,000	$740,000
2027	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,400,000	$690,000
2028	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,400,000	$650,000
2029	11	1.3E-05	$15,000,000,000	$14,000,000,000	$12,000,000,000	$2,200,000	$1,200,000	$560,000
2030	11	1.3E-05	$14,000,000,000	$12,000,000,000	$11,000,000,000	$2,100,000	$1,000,000	$480,000
2031	11	1.3E-05	$12,000,000,000	$11,000,000,000	$9,700,000,000	$1,800,000	$920,000	$390,000
2032	11	1.3E-05	$10,000,000,000	$9,400,000,000	$8,600,000,000	$1,500,000	$770,000	$330,000
2033	11	1.3E-05	$8,400,000,000	$8,000,000,000	$7,400,000,000	$1,200,000	$630,000	$260,000
2034	11	1.3E-05	$6,800,000,000	$6,500,000,000	$6,100,000,000	$1,000,000	$500,000	$200,000
2035	11	1.3E-05	$5,100,000,000	$4,900,000,000	$4,700,000,000	$750,000	$370,000	$150,000
2036	11	1.3E-05	$3,400,000,000	$3,300,000,000	$3,300,000,000	$500,000	$240,000	$96,000
2037	11	1.3E-05	$1,700,000,000	$1,700,000,000	$1,700,000,000	$250,000	$120,000	$46,000
					Total:	**$54,000,000**	**$36,000,000**	**$23,000,000**

Table 78 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Filtered Vents

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I and Mark II		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,700,000	$1,500,000
2013	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,700,000	$1,400,000
2014	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,600,000	$1,300,000
2015	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,600,000	$1,200,000
2016	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,500,000	$1,100,000
2017	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,500,000	$1,100,000
2018	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,500,000	$990,000
2019	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,400,000	$930,000
2020	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,400,000	$870,000
2021	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,300,000	$810,000
2022	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,300,000	$760,000
2023	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,300,000	$710,000
2024	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,200,000	$660,000
2025	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,200,000	$620,000
2026	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,200,000	$580,000
2027	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,100,000	$540,000
2028	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,100,000	$510,000
2029	30	31	1.3E-05	$4,300,000,000	$3,800,000,000	$3,300,000,000	$1,800,000	$950,000	$430,000
2030	30	31	1.3E-05	$3,800,000,000	$3,400,000,000	$3,000,000,000	$1,600,000	$830,000	$370,000
2031	30	31	1.3E-05	$3,300,000,000	$3,100,000,000	$2,800,000,000	$1,400,000	$730,000	$320,000
2032	30	31	1.3E-05	$2,900,000,000	$2,700,000,000	$2,400,000,000	$1,200,000	$620,000	$260,000
2033	30	31	1.3E-05	$2,400,000,000	$2,300,000,000	$2,100,000,000	$1,000,000	$510,000	$210,000
2034	30	31	1.3E-05	$1,900,000,000	$1,800,000,000	$1,700,000,000	$790,000	$390,000	$160,000
2035	30	31	1.3E-05	$1,400,000,000	$1,400,000,000	$1,300,000,000	$580,000	$290,000	$110,000
2036	30	31	1.3E-05	$950,000,000	$940,000,000	$920,000,000	$390,000	$190,000	$75,000
2037	30	31	1.3E-05	$480,000,000	$480,000,000	$480,000,000	$200,000	$95,000	$37,000
						Total:	**$43,000,000**	**$28,000,000**	**$18,000,000**

Table 79 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Filtered Vents – Low Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I and Mark II		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$79,000	$66,000
2013	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$77,000	$62,000
2014	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$74,000	$58,000
2015	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$72,000	$54,000
2016	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$70,000	$51,000
2017	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$68,000	$47,000
2018	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$66,000	$44,000
2019	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$64,000	$41,000
2020	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$62,000	$39,000
2021	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$60,000	$36,000
2022	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$59,000	$34,000
2023	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$57,000	$32,000
2024	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$55,000	$29,000
2025	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$54,000	$28,000
2026	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$52,000	$26,000
2027	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$51,000	$24,000
2028	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$49,000	$22,000
2029	30	31	1.3E-05	$190,000,000	$170,000,000	$150,000,000	$79,000	$43,000	$20,000
2030	30	31	1.3E-05	$170,000,000	$160,000,000	$140,000,000	$71,000	$39,000	$17,000
2031	30	31	1.3E-05	$150,000,000	$140,000,000	$120,000,000	$62,000	$33,000	$14,000
2032	30	31	1.3E-05	$130,000,000	$120,000,000	$110,000,000	$54,000	$28,000	$12,000
2033	30	31	1.3E-05	$110,000,000	$100,000,000	$94,000,000	$46,000	$22,000	$9,400
2034	30	31	1.3E-05	$86,000,000	$82,000,000	$78,000,000	$36,000	$18,000	$7,300
2035	30	31	1.3E-05	$64,000,000	$63,000,000	$60,000,000	$27,000	$13,000	$5,200
2036	30	31	1.3E-05	$43,000,000	$42,000,000	$42,000,000	$18,000	$8,600	$3,400
2037	30	31	1.3E-05	$21,000,000	$21,000,000	$21,000,000	$8,700	$4,200	$1,600
						Total:	**$1,900,000**	**$1,300,000**	**$780,000**

Table 80 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Filtered Vents – High Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I and Mark II		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$6,200,000	$5,400,000
2013	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$6,000,000	$5,000,000
2014	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,900,000	$4,700,000
2015	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,700,000	$4,400,000
2016	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,500,000	$4,100,000
2017	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,400,000	$3,800,000
2018	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,200,000	$3,600,000
2019	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,100,000	$3,400,000
2020	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,900,000	$3,100,000
2021	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,800,000	$2,900,000
2022	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,600,000	$2,700,000
2023	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,500,000	$2,600,000
2024	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,400,000	$2,400,000
2025	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,200,000	$2,200,000
2026	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,100,000	$2,100,000
2027	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,000,000	$2,000,000
2028	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$3,900,000	$1,800,000
2029	30	31	1.3E-05	$15,000,000,000	$14,000,000,000	$12,000,000,000	$6,200,000	$3,500,000	$1,600,000
2030	30	31	1.3E-05	$14,000,000,000	$12,000,000,000	$11,000,000,000	$5,800,000	$2,900,000	$1,300,000
2031	30	31	1.3E-05	$12,000,000,000	$11,000,000,000	$9,700,000,000	$5,000,000	$2,600,000	$1,100,000
2032	30	31	1.3E-05	$10,000,000,000	$9,400,000,000	$8,600,000,000	$4,100,000	$2,200,000	$920,000
2033	30	31	1.3E-05	$8,400,000,000	$8,000,000,000	$7,400,000,000	$3,500,000	$1,800,000	$740,000
2034	30	31	1.3E-05	$6,800,000,000	$6,500,000,000	$6,100,000,000	$2,800,000	$1,400,000	$570,000
2035	30	31	1.3E-05	$5,100,000,000	$4,900,000,000	$4,700,000,000	$2,100,000	$1,000,000	$410,000
2036	30	31	1.3E-05	$3,400,000,000	$3,300,000,000	$3,300,000,000	$1,400,000	$670,000	$270,000
2037	30	31	1.3E-05	$1,700,000,000	$1,700,000,000	$1,700,000,000	$710,000	$340,000	$130,000
						Total:	**$150,000,000**	**$100,000,000**	**$63,000,000**

Table 81 – Industry Implementation Costs – Filtered Vents

Year	Units	Cost per Unit		Total Cost	
		Low	High	Low	High
2012	31	$15,000,000	$20,000,000	$465,000,000	$620,000,000

Table 82 – Industry Operation Costs – Filtered Vents

Year	Units	FTE		Yearly Wage	Cost		3% NPV		7% NPV	
		Unit	Total		Unit	Total	Cost		Cost	
							Unit	Total	Unit	Total
2012	31	0.15	4.7	$400,000	$60,000	$1,900,000	$60,000	$1,900,000	$60,000	$1,900,000
2013	31	0.15	4.7	$400,000	$60,000	$1,900,000	$58,000	$1,800,000	$56,000	$1,800,000
2014	31	0.15	4.7	$400,000	$60,000	$1,900,000	$57,000	$1,800,000	$52,000	$1,700,000
2015	31	0.15	4.7	$400,000	$60,000	$1,900,000	$55,000	$1,700,000	$49,000	$1,600,000
2016	31	0.15	4.7	$400,000	$60,000	$1,900,000	$53,000	$1,700,000	$46,000	$1,400,000
2017	31	0.15	4.7	$400,000	$60,000	$1,900,000	$52,000	$1,600,000	$43,000	$1,400,000
2018	31	0.15	4.7	$400,000	$60,000	$1,900,000	$50,000	$1,600,000	$40,000	$1,300,000
2019	31	0.15	4.7	$400,000	$60,000	$1,900,000	$49,000	$1,500,000	$37,000	$1,200,000
2020	31	0.15	4.7	$400,000	$60,000	$1,900,000	$47,000	$1,500,000	$35,000	$1,100,000
2021	31	0.15	4.7	$400,000	$60,000	$1,900,000	$46,000	$1,500,000	$33,000	$1,000,000
2022	31	0.15	4.7	$400,000	$60,000	$1,900,000	$45,000	$1,400,000	$31,000	$970,000
2023	31	0.15	4.7	$400,000	$60,000	$1,900,000	$43,000	$1,400,000	$29,000	$900,000
2024	31	0.15	4.7	$400,000	$60,000	$1,900,000	$42,000	$1,300,000	$27,000	$840,000
2025	31	0.15	4.7	$400,000	$60,000	$1,900,000	$41,000	$1,300,000	$25,000	$790,000
2026	31	0.15	4.7	$400,000	$60,000	$1,900,000	$40,000	$1,300,000	$23,000	$740,000
2027	31	0.15	4.7	$400,000	$60,000	$1,900,000	$39,000	$1,200,000	$22,000	$690,000
2028	31	0.15	4.7	$400,000	$60,000	$1,900,000	$37,000	$1,200,000	$20,000	$640,000
2029	31	0.15	4.7	$400,000	$60,000	$1,900,000	$36,000	$1,100,000	$19,000	$600,000
2030	31	0.15	4.7	$400,000	$60,000	$1,900,000	$35,000	$1,100,000	$18,000	$560,000
2031	31	0.15	4.7	$400,000	$60,000	$1,900,000	$34,000	$1,100,000	$17,000	$530,000
2032	31	0.15	4.7	$400,000	$60,000	$1,900,000	$33,000	$1,100,000	$16,000	$490,000
2033	31	0.15	4.7	$400,000	$60,000	$1,900,000	$32,000	$1,000,000	$14,000	$460,000
2034	31	0.15	4.7	$400,000	$60,000	$1,900,000	$31,000	$990,000	$14,000	$430,000
2035	31	0.15	4.7	$400,000	$60,000	$1,900,000	$30,000	$960,000	$13,000	$400,000
2036	31	0.15	4.7	$400,000	$60,000	$1,900,000	$30,000	$930,000	$12,000	$370,000
2037	31	0.15	4.7	$400,000	$60,000	$1,900,000	$29,000	$910,000	$11,000	$350,000
				Total:	**$1,600,000**	**$49,000,000**	**$1,100,000**	**$35,000,000**	**$760,000**	**$24,000,000**

Table 83 – NRC Implementation Costs – Filtered Vents

Year	Units	Hours per unit		Cost per hour	Cost per unit	Total		
						Hours		Cost
		Initial Review	Plant Inspection			Initial Review	Plant Inspection	
2012	31	145	80	$119	$27,000	4,495	2,480	$840,000

Table 84 – NRC Operation Costs – Filtered Vents

Year	Units	FTE		Yearly Wage	Cost		3% NPV		7% NPV	
		Unit	Total		Unit	Total	Cost		Cost	
							Unit	Total	Unit	Total
2012	31	0.050	1.6	$400,000	$20,000	$620,000	$20,000	$620,000	$20,000	$620,000
2013	31	0.050	1.6	$400,000	$20,000	$620,000	$19,000	$600,000	$19,000	$580,000
2014	31	0.050	1.6	$400,000	$20,000	$620,000	$19,000	$580,000	$17,000	$540,000
2015	31	0.050	1.6	$400,000	$20,000	$620,000	$18,000	$570,000	$16,000	$510,000
2016	31	0.050	1.6	$400,000	$20,000	$620,000	$18,000	$550,000	$15,000	$470,000
2017	31	0.050	1.6	$400,000	$20,000	$620,000	$17,000	$530,000	$14,000	$440,000
2018	31	0.050	1.6	$400,000	$20,000	$620,000	$17,000	$520,000	$13,000	$410,000
2019	31	0.050	1.6	$400,000	$20,000	$620,000	$16,000	$500,000	$12,000	$390,000
2020	31	0.050	1.6	$400,000	$20,000	$620,000	$16,000	$490,000	$12,000	$360,000
2021	31	0.050	1.6	$400,000	$20,000	$620,000	$15,000	$480,000	$11,000	$340,000
2022	31	0.050	1.6	$400,000	$20,000	$620,000	$15,000	$460,000	$10,000	$320,000
2023	31	0.050	1.6	$400,000	$20,000	$620,000	$14,000	$450,000	$9,500	$290,000
2024	31	0.050	1.6	$400,000	$20,000	$620,000	$14,000	$430,000	$8,900	$280,000
2025	31	0.050	1.6	$400,000	$20,000	$620,000	$14,000	$420,000	$8,300	$260,000
2026	31	0.050	1.6	$400,000	$20,000	$620,000	$13,000	$410,000	$7,800	$240,000
2027	31	0.050	1.6	$400,000	$20,000	$620,000	$13,000	$400,000	$7,200	$220,000
2028	31	0.050	1.6	$400,000	$20,000	$620,000	$12,000	$390,000	$6,800	$210,000
2029	31	0.050	1.6	$400,000	$20,000	$620,000	$12,000	$380,000	$6,300	$200,000
2030	31	0.050	1.6	$400,000	$20,000	$620,000	$12,000	$360,000	$5,900	$180,000
2031	31	0.050	1.6	$400,000	$20,000	$620,000	$11,000	$350,000	$5,500	$170,000
2032	31	0.050	1.6	$400,000	$20,000	$620,000	$11,000	$340,000	$5,200	$160,000
2033	31	0.050	1.6	$400,000	$20,000	$620,000	$11,000	$330,000	$4,800	$150,000
2034	31	0.050	1.6	$400,000	$20,000	$620,000	$10,000	$320,000	$4,500	$140,000
2035	31	0.050	1.6	$400,000	$20,000	$620,000	$10,000	$310,000	$4,200	$130,000
2036	31	0.050	1.6	$400,000	$20,000	$620,000	$9,800	$300,000	$3,900	$120,000
2037	31	0.050	1.6	$400,000	$20,000	$620,000	$9,600	$300,000	$3,700	$110,000
				Total:	**$500,000**	**$16,000,000**	**$370,000**	**$11,000,000**	**$250,000**	**$7,800,000**

Table 87 – Public Health (Accident) – Severe Accident Confinement Strategy

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	4.2	$2,000	$4,000	$260,000	$260,000	$260,000	$520,000	$520,000	$520,000
2013	31	4.2	$2,000	$4,000	$260,000	$250,000	$240,000	$520,000	$500,000	$490,000
2014	31	4.2	$2,000	$4,000	$260,000	$250,000	$230,000	$520,000	$490,000	$450,000
2015	31	4.2	$2,000	$4,000	$260,000	$240,000	$210,000	$520,000	$480,000	$420,000
2016	31	4.2	$2,000	$4,000	$260,000	$230,000	$200,000	$520,000	$460,000	$400,000
2017	31	8.1	$2,000	$4,000	$500,000	$430,000	$360,000	$1,000,000	$860,000	$710,000
2018	31	8.1	$2,000	$4,000	$500,000	$420,000	$330,000	$1,000,000	$840,000	$670,000
2019	31	8.1	$2,000	$4,000	$500,000	$410,000	$310,000	$1,000,000	$810,000	$620,000
2020	31	8.1	$2,000	$4,000	$500,000	$390,000	$290,000	$1,000,000	$790,000	$580,000
2021	31	8.1	$2,000	$4,000	$500,000	$380,000	$270,000	$1,000,000	$770,000	$540,000
2022	31	8.1	$2,000	$4,000	$500,000	$370,000	$250,000	$1,000,000	$740,000	$510,000
2023	31	8.1	$2,000	$4,000	$500,000	$360,000	$240,000	$1,000,000	$720,000	$480,000
2024	31	8.1	$2,000	$4,000	$500,000	$350,000	$220,000	$1,000,000	$700,000	$440,000
2025	31	8.1	$2,000	$4,000	$500,000	$340,000	$210,000	$1,000,000	$680,000	$410,000
2026	31	8.1	$2,000	$4,000	$500,000	$330,000	$190,000	$1,000,000	$660,000	$390,000
2027	31	8.1	$2,000	$4,000	$500,000	$320,000	$180,000	$1,000,000	$640,000	$360,000
2028	31	8.1	$2,000	$4,000	$500,000	$310,000	$170,000	$1,000,000	$620,000	$340,000
2029	31	8.1	$2,000	$4,000	$500,000	$300,000	$160,000	$1,000,000	$610,000	$320,000
2030	31	8.1	$2,000	$4,000	$500,000	$290,000	$150,000	$1,000,000	$590,000	$300,000
2031	31	8.1	$2,000	$4,000	$500,000	$290,000	$140,000	$1,000,000	$570,000	$280,000
2032	31	8.1	$2,000	$4,000	$500,000	$280,000	$130,000	$1,000,000	$550,000	$260,000
2033	31	8.1	$2,000	$4,000	$500,000	$270,000	$120,000	$1,000,000	$540,000	$240,000
2034	31	8.1	$2,000	$4,000	$500,000	$260,000	$110,000	$1,000,000	$520,000	$230,000
2035	31	8.1	$2,000	$4,000	$500,000	$250,000	$110,000	$1,000,000	$510,000	$210,000
2036	31	8.1	$2,000	$4,000	$500,000	$250,000	$99,000	$1,000,000	$490,000	$200,000
2037	31	8.1	$2,000	$4,000	$500,000	$240,000	$92,000	$1,000,000	$480,000	$180,000
Total per unit:		**190**		**Total:**	**$12,000,000**	**$8,100,000**	**$5,300,000**	**$24,000,000**	**$16,000,000**	**$11,000,000**
Total:		**5,900**								

Table 88 – Public Health (Accident) – Severe Accident Confinement Strategy – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.023	$2,000	$4,000	$1,400	$1,400	$1,400	$2,900	$2,900	$2,900
2013	31	0.023	$2,000	$4,000	$1,400	$1,400	$1,300	$2,900	$2,800	$2,700
2014	31	0.023	$2,000	$4,000	$1,400	$1,300	$1,200	$2,900	$2,700	$2,500
2015	31	0.023	$2,000	$4,000	$1,400	$1,300	$1,100	$2,900	$2,700	$2,400
2016	31	0.023	$2,000	$4,000	$1,400	$1,200	$1,100	$2,900	$2,600	$2,200
2017	31	0.044	$2,000	$4,000	$2,700	$2,300	$1,900	$5,500	$4,700	$3,900
2018	31	0.044	$2,000	$4,000	$2,700	$2,300	$1,800	$5,500	$4,600	$3,700
2019	31	0.044	$2,000	$4,000	$2,700	$2,200	$1,700	$5,500	$4,500	$3,400
2020	31	0.044	$2,000	$4,000	$2,700	$2,100	$1,600	$5,500	$4,300	$3,200
2021	31	0.044	$2,000	$4,000	$2,700	$2,100	$1,500	$5,500	$4,200	$3,000
2022	31	0.044	$2,000	$4,000	$2,700	$2,000	$1,400	$5,500	$4,100	$2,800
2023	31	0.044	$2,000	$4,000	$2,700	$2,000	$1,300	$5,500	$4,000	$2,600
2024	31	0.044	$2,000	$4,000	$2,700	$1,900	$1,200	$5,500	$3,900	$2,400
2025	31	0.044	$2,000	$4,000	$2,700	$1,800	$1,100	$5,500	$3,700	$2,300
2026	31	0.044	$2,000	$4,000	$2,700	$1,800	$1,000	$5,500	$3,600	$2,100
2027	31	0.044	$2,000	$4,000	$2,700	$1,700	$980	$5,500	$3,500	$2,000
2028	31	0.044	$2,000	$4,000	$2,700	$1,700	$910	$5,500	$3,400	$1,900
2029	31	0.044	$2,000	$4,000	$2,700	$1,600	$850	$5,500	$3,300	$1,700
2030	31	0.044	$2,000	$4,000	$2,700	$1,600	$800	$5,500	$3,200	$1,600
2031	31	0.044	$2,000	$4,000	$2,700	$1,500	$750	$5,500	$3,100	$1,500
2032	31	0.044	$2,000	$4,000	$2,700	$1,500	$700	$5,500	$3,000	$1,400
2033	31	0.044	$2,000	$4,000	$2,700	$1,500	$650	$5,500	$3,000	$1,300
2034	31	0.044	$2,000	$4,000	$2,700	$1,400	$610	$5,500	$2,900	$1,200
2035	31	0.044	$2,000	$4,000	$2,700	$1,400	$570	$5,500	$2,800	$1,200
2036	31	0.044	$2,000	$4,000	$2,700	$1,300	$530	$5,500	$2,700	$1,100
2037	31	0.044	$2,000	$4,000	$2,700	$1,300	$500	$5,500	$2,600	$1,000
Total per unit:		**1.0**		**Total:**	**$64,000**	**$44,000**	**$28,000**	**$130,000**	**$89,000**	**$58,000**
Total:		**31**								

Table 89 – Public Health (Accident) – Severe Accident Confinement Strategy – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	17	$2,000	$4,000	$1,100,000	$1,100,000	$1,100,000	$2,100,000	$2,100,000	$2,100,000
2013	31	17	$2,000	$4,000	$1,100,000	$1,100,000	$1,000,000	$2,100,000	$2,000,000	$2,000,000
2014	31	17	$2,000	$4,000	$1,100,000	$1,000,000	$960,000	$2,100,000	$2,000,000	$1,800,000
2015	31	17	$2,000	$4,000	$1,100,000	$1,000,000	$900,000	$2,100,000	$1,900,000	$1,700,000
2016	31	17	$2,000	$4,000	$1,100,000	$980,000	$840,000	$2,100,000	$1,900,000	$1,600,000
2017	31	31	$2,000	$4,000	$1,900,000	$1,600,000	$1,400,000	$3,800,000	$3,300,000	$2,700,000
2018	31	31	$2,000	$4,000	$1,900,000	$1,600,000	$1,300,000	$3,800,000	$3,200,000	$2,500,000
2019	31	31	$2,000	$4,000	$1,900,000	$1,500,000	$1,200,000	$3,800,000	$3,100,000	$2,400,000
2020	31	31	$2,000	$4,000	$1,900,000	$1,500,000	$1,100,000	$3,800,000	$3,000,000	$2,200,000
2021	31	31	$2,000	$4,000	$1,900,000	$1,500,000	$1,000,000	$3,800,000	$2,900,000	$2,100,000
2022	31	31	$2,000	$4,000	$1,900,000	$1,400,000	$970,000	$3,800,000	$2,800,000	$1,900,000
2023	31	31	$2,000	$4,000	$1,900,000	$1,400,000	$900,000	$3,800,000	$2,700,000	$1,800,000
2024	31	31	$2,000	$4,000	$1,900,000	$1,300,000	$840,000	$3,800,000	$2,700,000	$1,700,000
2025	31	31	$2,000	$4,000	$1,900,000	$1,300,000	$790,000	$3,800,000	$2,600,000	$1,600,000
2026	31	31	$2,000	$4,000	$1,900,000	$1,300,000	$740,000	$3,800,000	$2,500,000	$1,500,000
2027	31	31	$2,000	$4,000	$1,900,000	$1,200,000	$690,000	$3,800,000	$2,400,000	$1,400,000
2028	31	31	$2,000	$4,000	$1,900,000	$1,200,000	$640,000	$3,800,000	$2,400,000	$1,300,000
2029	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$600,000	$3,800,000	$2,300,000	$1,200,000
2030	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$560,000	$3,800,000	$2,200,000	$1,100,000
2031	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$530,000	$3,800,000	$2,200,000	$1,100,000
2032	31	31	$2,000	$4,000	$1,900,000	$1,100,000	$490,000	$3,800,000	$2,100,000	$980,000
2033	31	31	$2,000	$4,000	$1,900,000	$1,000,000	$460,000	$3,800,000	$2,000,000	$920,000
2034	31	31	$2,000	$4,000	$1,900,000	$990,000	$430,000	$3,800,000	$2,000,000	$860,000
2035	31	31	$2,000	$4,000	$1,900,000	$960,000	$400,000	$3,800,000	$1,900,000	$800,000
2036	31	31	$2,000	$4,000	$1,900,000	$930,000	$370,000	$3,800,000	$1,900,000	$750,000
2037	31	31	$2,000	$4,000	$1,900,000	$910,000	$350,000	$3,800,000	$1,800,000	$700,000
Total per unit:		**740**		**Total:**	**$45,000,000**	**$31,000,000**	**$21,000,000**	**$90,000,000**	**$62,000,000**	**$41,000,000**
Total:		**23,000**								

Table 91 – Occupational Health (Accident) Short-Term – Severe Accident Confinement Strategy

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.20	$2,000	$4,000	$12,000	$12,000	$12,000	$25,000	$25,000	$25,000
2013	31	0.20	$2,000	$4,000	$12,000	$12,000	$11,000	$25,000	$24,000	$23,000
2014	31	0.20	$2,000	$4,000	$12,000	$11,000	$10,000	$25,000	$24,000	$22,000
2015	31	0.20	$2,000	$4,000	$12,000	$11,000	$9,800	$25,000	$23,000	$20,000
2016	31	0.20	$2,000	$4,000	$12,000	$11,000	$9,200	$25,000	$22,000	$19,000
2017	31	0.25	$2,000	$4,000	$16,000	$14,000	$11,000	$31,000	$27,000	$22,000
2018	31	0.25	$2,000	$4,000	$16,000	$13,000	$11,000	$31,000	$26,000	$21,000
2019	31	0.25	$2,000	$4,000	$16,000	$13,000	$10,000	$31,000	$25,000	$19,000
2020	31	0.25	$2,000	$4,000	$16,000	$13,000	$9,300	$31,000	$24,000	$18,000
2021	31	0.25	$2,000	$4,000	$16,000	$12,000	$8,700	$31,000	$24,000	$17,000
2022	31	0.25	$2,000	$4,000	$16,000	$12,000	$8,100	$31,000	$23,000	$16,000
2023	31	0.25	$2,000	$4,000	$16,000	$12,000	$7,600	$31,000	$22,000	$15,000
2024	31	0.25	$2,000	$4,000	$16,000	$11,000	$7,100	$31,000	$22,000	$14,000
2025	31	0.25	$2,000	$4,000	$16,000	$11,000	$6,600	$31,000	$21,000	$13,000
2026	31	0.25	$2,000	$4,000	$16,000	$11,000	$6,200	$31,000	$20,000	$12,000
2027	31	0.25	$2,000	$4,000	$16,000	$10,000	$5,800	$31,000	$20,000	$11,000
2028	31	0.25	$2,000	$4,000	$16,000	$10,000	$5,400	$31,000	$19,000	$11,000
2029	31	0.25	$2,000	$4,000	$16,000	$9,700	$5,100	$31,000	$19,000	$9,800
2030	31	0.25	$2,000	$4,000	$16,000	$9,400	$4,700	$31,000	$18,000	$9,200
2031	31	0.25	$2,000	$4,000	$16,000	$9,100	$4,400	$31,000	$18,000	$8,600
2032	31	0.25	$2,000	$4,000	$16,000	$8,900	$4,100	$31,000	$17,000	$8,000
2033	31	0.25	$2,000	$4,000	$16,000	$8,600	$3,900	$31,000	$17,000	$7,500
2034	31	0.25	$2,000	$4,000	$16,000	$8,400	$3,600	$31,000	$16,000	$7,000
2035	31	0.25	$2,000	$4,000	$16,000	$8,100	$3,400	$31,000	$16,000	$6,500
2036	31	0.25	$2,000	$4,000	$16,000	$7,900	$3,200	$31,000	$15,000	$6,100
2037	31	0.25	$2,000	$4,000	$16,000	$7,600	$2,900	$31,000	$15,000	$5,700
Total per unit:		**6.3**		**Total:**	**$400,000**	**$280,000**	**$180,000**	**$780,000**	**$540,000**	**$370,000**
Total:		**200**								

Table 92 – Occupational Health (Accident) Long-Term – Severe Accident Confinement Strategy

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.19	$2,000	$4,000	$12,000	$9,500	$7,000	$24,000	$19,000	$14,000
2013	31	0.19	$2,000	$4,000	$12,000	$9,200	$6,600	$24,000	$18,000	$13,000
2014	31	0.19	$2,000	$4,000	$12,000	$8,900	$6,200	$24,000	$18,000	$12,000
2015	31	0.19	$2,000	$4,000	$12,000	$8,700	$5,800	$24,000	$17,000	$12,000
2016	31	0.19	$2,000	$4,000	$12,000	$8,400	$5,400	$24,000	$17,000	$11,000
2017	31	0.38	$2,000	$4,000	$24,000	$16,000	$10,000	$47,000	$32,000	$20,000
2018	31	0.38	$2,000	$4,000	$24,000	$16,000	$9,400	$47,000	$31,000	$18,000
2019	31	0.38	$2,000	$4,000	$24,000	$15,000	$8,800	$47,000	$30,000	$17,000
2020	31	0.38	$2,000	$4,000	$24,000	$15,000	$8,200	$47,000	$29,000	$16,000
2021	31	0.38	$2,000	$4,000	$24,000	$15,000	$7,700	$47,000	$28,000	$15,000
2022	31	0.38	$2,000	$4,000	$24,000	$14,000	$7,200	$47,000	$28,000	$14,000
2023	31	0.38	$2,000	$4,000	$24,000	$14,000	$6,700	$47,000	$27,000	$13,000
2024	31	0.38	$2,000	$4,000	$24,000	$13,000	$6,300	$47,000	$26,000	$12,000
2025	31	0.38	$2,000	$4,000	$24,000	$13,000	$5,800	$47,000	$25,000	$11,000
2026	31	0.38	$2,000	$4,000	$24,000	$13,000	$5,500	$47,000	$25,000	$11,000
2027	31	0.38	$2,000	$4,000	$24,000	$12,000	$5,100	$47,000	$24,000	$10,000
2028	31	0.38	$2,000	$4,000	$24,000	$12,000	$4,800	$47,000	$23,000	$9,400
2029	31	0.38	$2,000	$4,000	$24,000	$11,000	$4,500	$47,000	$22,000	$8,700
2030	31	0.38	$2,000	$4,000	$24,000	$11,000	$4,200	$47,000	$22,000	$8,200
2031	31	0.38	$2,000	$4,000	$24,000	$11,000	$3,900	$47,000	$21,000	$7,600
2032	31	0.38	$2,000	$4,000	$24,000	$11,000	$3,600	$47,000	$21,000	$7,100
2033	31	0.38	$2,000	$4,000	$24,000	$10,000	$3,400	$47,000	$20,000	$6,700
2034	31	0.38	$2,000	$4,000	$24,000	$9,900	$3,200	$47,000	$19,000	$6,200
2035	31	0.38	$2,000	$4,000	$24,000	$9,600	$3,000	$47,000	$19,000	$5,800
2036	31	0.38	$2,000	$4,000	$24,000	$9,300	$2,800	$47,000	$18,000	$5,400
2037	31	0.38	$2,000	$4,000	$24,000	$9,100	$2,600	$47,000	$18,000	$5,100
	Total per unit:	**8.9**		**Total:**	**$560,000**	**$300,000**	**$150,000**	**$1,100,000**	**$600,000**	**$290,000**
	Total:	**280**								

Table 93 – Occupational Health (Accident) Short-Term – Severe Accident Confinement Strategy – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.0011	$2,000	$4,000	$68	$68	$68	$140	$140	$140
2013	31	0.0011	$2,000	$4,000	$68	$66	$64	$140	$140	$130
2014	31	0.0011	$2,000	$4,000	$68	$64	$59	$140	$130	$120
2015	31	0.0011	$2,000	$4,000	$68	$62	$56	$140	$130	$110
2016	31	0.0011	$2,000	$4,000	$68	$60	$52	$140	$120	$110
2017	31	0.0014	$2,000	$4,000	$87	$75	$62	$170	$150	$120
2018	31	0.0014	$2,000	$4,000	$87	$73	$58	$170	$140	$110
2019	31	0.0014	$2,000	$4,000	$87	$71	$54	$170	$140	$110
2020	31	0.0014	$2,000	$4,000	$87	$69	$51	$170	$130	$99
2021	31	0.0014	$2,000	$4,000	$87	$67	$47	$170	$130	$92
2022	31	0.0014	$2,000	$4,000	$87	$65	$44	$170	$130	$86
2023	31	0.0014	$2,000	$4,000	$87	$63	$41	$170	$120	$81
2024	31	0.0014	$2,000	$4,000	$87	$61	$39	$170	$120	$75
2025	31	0.0014	$2,000	$4,000	$87	$59	$36	$170	$120	$71
2026	31	0.0014	$2,000	$4,000	$87	$58	$34	$170	$110	$66
2027	31	0.0014	$2,000	$4,000	$87	$56	$32	$170	$110	$62
2028	31	0.0014	$2,000	$4,000	$87	$54	$29	$170	$110	$58
2029	31	0.0014	$2,000	$4,000	$87	$53	$28	$170	$100	$54
2030	31	0.0014	$2,000	$4,000	$87	$51	$26	$170	$100	$50
2031	31	0.0014	$2,000	$4,000	$87	$50	$24	$170	$97	$47
2032	31	0.0014	$2,000	$4,000	$87	$48	$22	$170	$94	$44
2033	31	0.0014	$2,000	$4,000	$87	$47	$21	$170	$91	$41
2034	31	0.0014	$2,000	$4,000	$87	$45	$20	$170	$89	$38
2035	31	0.0014	$2,000	$4,000	$87	$44	$18	$170	$86	$36
2036	31	0.0014	$2,000	$4,000	$87	$43	$17	$170	$84	$34
2037	31	0.0014	$2,000	$4,000	$87	$42	$16	$170	$81	$31
Total per unit:		**0.035**		**Total:**	**$2,200**	**$1,500**	**$1,000**	**$4,300**	**$3,000**	**$2,000**
Total:		**1.1**								

Table 94 – Occupational Health (Accident) Long-Term – Severe Accident Confinement Strategy – 5th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
			NUREG-1530	EPA + ICRP No. 103	Total Benefit			Total Benefit		
					Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.0010	$2,000	$4,000	$60	$47	$35	$120	$95	$70
2013	31	0.0010	$2,000	$4,000	$60	$46	$33	$120	$92	$66
2014	31	0.0010	$2,000	$4,000	$60	$45	$31	$120	$89	$62
2015	31	0.0010	$2,000	$4,000	$60	$43	$29	$120	$87	$58
2016	31	0.0010	$2,000	$4,000	$60	$42	$27	$120	$84	$54
2017	31	0.0019	$2,000	$4,000	$120	$82	$50	$240	$160	$100
2018	31	0.0019	$2,000	$4,000	$120	$79	$47	$240	$160	$94
2019	31	0.0019	$2,000	$4,000	$120	$77	$44	$240	$150	$88
2020	31	0.0019	$2,000	$4,000	$120	$75	$41	$240	$150	$82
2021	31	0.0019	$2,000	$4,000	$120	$73	$38	$240	$150	$77
2022	31	0.0019	$2,000	$4,000	$120	$71	$36	$240	$140	$72
2023	31	0.0019	$2,000	$4,000	$120	$69	$33	$240	$140	$67
2024	31	0.0019	$2,000	$4,000	$120	$67	$31	$240	$130	$63
2025	31	0.0019	$2,000	$4,000	$120	$65	$29	$240	$130	$58
2026	31	0.0019	$2,000	$4,000	$120	$63	$27	$240	$130	$55
2027	31	0.0019	$2,000	$4,000	$120	$61	$26	$240	$120	$51
2028	31	0.0019	$2,000	$4,000	$120	$59	$24	$240	$120	$48
2029	31	0.0019	$2,000	$4,000	$120	$57	$22	$240	$110	$45
2030	31	0.0019	$2,000	$4,000	$120	$56	$21	$240	$110	$42
2031	31	0.0019	$2,000	$4,000	$120	$54	$19	$240	$110	$39
2032	31	0.0019	$2,000	$4,000	$120	$53	$18	$240	$110	$36
2033	31	0.0019	$2,000	$4,000	$120	$51	$17	$240	$100	$34
2034	31	0.0019	$2,000	$4,000	$120	$50	$16	$240	$99	$32
2035	31	0.0019	$2,000	$4,000	$120	$48	$15	$240	$96	$30
2036	31	0.0019	$2,000	$4,000	$120	$47	$14	$240	$93	$28
2037	31	0.0019	$2,000	$4,000	$120	$45	$13	$240	$91	$26
	Total per unit:	**0.045**		**Total:**	**$2,800**	**$1,500**	**$740**	**$5,600**	**$3,000**	**$1,500**
	Total:	**1.4**								

Table 95 – Occupational Health (Accident) Short-Term – Severe Accident Confinement Strategy – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
					Total Benefit			Total Benefit		
			NUREG-1530	EPA + ICRP No. 103	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.89	$2,000	$4,000	$55,000	$55,000	$55,000	$110,000	$110,000	$110,000
2013	31	0.89	$2,000	$4,000	$55,000	$53,000	$51,000	$110,000	$110,000	$100,000
2014	31	0.89	$2,000	$4,000	$55,000	$52,000	$48,000	$110,000	$100,000	$96,000
2015	31	0.89	$2,000	$4,000	$55,000	$50,000	$45,000	$110,000	$100,000	$90,000
2016	31	0.89	$2,000	$4,000	$55,000	$49,000	$42,000	$110,000	$98,000	$84,000
2017	31	1.1	$2,000	$4,000	$68,000	$59,000	$48,000	$140,000	$120,000	$100,000
2018	31	1.1	$2,000	$4,000	$68,000	$57,000	$45,000	$140,000	$120,000	$93,000
2019	31	1.1	$2,000	$4,000	$68,000	$55,000	$42,000	$140,000	$110,000	$87,000
2020	31	1.1	$2,000	$4,000	$68,000	$54,000	$40,000	$140,000	$110,000	$81,000
2021	31	1.1	$2,000	$4,000	$68,000	$52,000	$37,000	$140,000	$110,000	$76,000
2022	31	1.1	$2,000	$4,000	$68,000	$51,000	$35,000	$140,000	$100,000	$71,000
2023	31	1.1	$2,000	$4,000	$68,000	$49,000	$32,000	$140,000	$100,000	$67,000
2024	31	1.1	$2,000	$4,000	$68,000	$48,000	$30,000	$140,000	$98,000	$62,000
2025	31	1.1	$2,000	$4,000	$68,000	$46,000	$28,000	$140,000	$95,000	$58,000
2026	31	1.1	$2,000	$4,000	$68,000	$45,000	$26,000	$140,000	$93,000	$54,000
2027	31	1.1	$2,000	$4,000	$68,000	$44,000	$25,000	$140,000	$90,000	$51,000
2028	31	1.1	$2,000	$4,000	$68,000	$42,000	$23,000	$140,000	$87,000	$47,000
2029	31	1.1	$2,000	$4,000	$68,000	$41,000	$22,000	$140,000	$85,000	$44,000
2030	31	1.1	$2,000	$4,000	$68,000	$40,000	$20,000	$140,000	$82,000	$41,000
2031	31	1.1	$2,000	$4,000	$68,000	$39,000	$19,000	$140,000	$80,000	$39,000
2032	31	1.1	$2,000	$4,000	$68,000	$38,000	$18,000	$140,000	$78,000	$36,000
2033	31	1.1	$2,000	$4,000	$68,000	$37,000	$16,000	$140,000	$75,000	$34,000
2034	31	1.1	$2,000	$4,000	$68,000	$35,000	$15,000	$140,000	$73,000	$32,000
2035	31	1.1	$2,000	$4,000	$68,000	$34,000	$14,000	$140,000	$71,000	$30,000
2036	31	1.1	$2,000	$4,000	$68,000	$33,000	$13,000	$140,000	$69,000	$28,000
2037	31	1.1	$2,000	$4,000	$68,000	$32,000	$13,000	$140,000	$67,000	$26,000
Total per unit:		**28**		**Total:**	**$1,700,000**	**$1,200,000**	**$800,000**	**$3,500,000**	**$2,400,000**	**$1,600,000**
Total:		**870**								

Table 96 – Occupational Health (Accident) Long-Term – Severe Accident Confinement Strategy – 95th Percentile

Year	Units	Change in Exposure to People (person-rem)	Dollar per Person-Rem Averted		(Current Framework)			EPA + ICRP No. 103		
			NUREG-1530	EPA + ICRP No. 103	Total Benefit			Total Benefit		
					Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	0.72	$2,000	$4,000	$45,000	$36,000	$26,000	$89,000	$70,000	$52,000
2013	31	0.72	$2,000	$4,000	$45,000	$35,000	$25,000	$89,000	$68,000	$49,000
2014	31	0.72	$2,000	$4,000	$45,000	$34,000	$23,000	$89,000	$66,000	$46,000
2015	31	0.72	$2,000	$4,000	$45,000	$33,000	$22,000	$89,000	$64,000	$43,000
2016	31	0.72	$2,000	$4,000	$45,000	$32,000	$20,000	$89,000	$63,000	$40,000
2017	31	1.4	$2,000	$4,000	$87,000	$59,000	$36,000	$170,000	$120,000	$71,000
2018	31	1.4	$2,000	$4,000	$87,000	$58,000	$34,000	$170,000	$110,000	$67,000
2019	31	1.4	$2,000	$4,000	$87,000	$56,000	$32,000	$170,000	$110,000	$62,000
2020	31	1.4	$2,000	$4,000	$87,000	$54,000	$30,000	$170,000	$110,000	$58,000
2021	31	1.4	$2,000	$4,000	$87,000	$53,000	$28,000	$170,000	$100,000	$54,000
2022	31	1.4	$2,000	$4,000	$87,000	$51,000	$26,000	$170,000	$100,000	$51,000
2023	31	1.4	$2,000	$4,000	$87,000	$50,000	$24,000	$170,000	$97,000	$47,000
2024	31	1.4	$2,000	$4,000	$87,000	$48,000	$23,000	$170,000	$94,000	$44,000
2025	31	1.4	$2,000	$4,000	$87,000	$47,000	$21,000	$170,000	$92,000	$41,000
2026	31	1.4	$2,000	$4,000	$87,000	$45,000	$20,000	$170,000	$89,000	$39,000
2027	31	1.4	$2,000	$4,000	$87,000	$44,000	$19,000	$170,000	$86,000	$36,000
2028	31	1.4	$2,000	$4,000	$87,000	$43,000	$17,000	$170,000	$84,000	$34,000
2029	31	1.4	$2,000	$4,000	$87,000	$42,000	$16,000	$170,000	$81,000	$32,000
2030	31	1.4	$2,000	$4,000	$87,000	$40,000	$15,000	$170,000	$79,000	$30,000
2031	31	1.4	$2,000	$4,000	$87,000	$39,000	$14,000	$170,000	$77,000	$28,000
2032	31	1.4	$2,000	$4,000	$87,000	$38,000	$13,000	$170,000	$74,000	$26,000
2033	31	1.4	$2,000	$4,000	$87,000	$37,000	$12,000	$170,000	$72,000	$24,000
2034	31	1.4	$2,000	$4,000	$87,000	$36,000	$12,000	$170,000	$70,000	$23,000
2035	31	1.4	$2,000	$4,000	$87,000	$35,000	$11,000	$170,000	$68,000	$21,000
2036	31	1.4	$2,000	$4,000	$87,000	$34,000	$10,000	$170,000	$66,000	$20,000
2037	31	1.4	$2,000	$4,000	$87,000	$33,000	$9,400	$170,000	$64,000	$18,000
	Total per unit:	**33**		**Total:**	**$2,100,000**	**$1,100,000**	**$540,000**	**$4,000,000**	**$2,200,000**	**$1,100,000**
	Total:	**1,000**								

Table 98 – Offsite Property – Severe Accident Confinement Strategy

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	31	$20,000	$620,000	$620,000	$620,000
2013	31	$20,000	$620,000	$600,000	$580,000
2014	31	$20,000	$620,000	$580,000	$540,000
2015	31	$20,000	$620,000	$570,000	$510,000
2016	31	$20,000	$620,000	$550,000	$470,000
2017	31	$34,000	$1,100,000	$950,000	$780,000
2018	31	$34,000	$1,100,000	$920,000	$730,000
2019	31	$34,000	$1,100,000	$890,000	$690,000
2020	31	$34,000	$1,100,000	$870,000	$640,000
2021	31	$34,000	$1,100,000	$840,000	$600,000
2022	31	$34,000	$1,100,000	$820,000	$560,000
2023	31	$34,000	$1,100,000	$790,000	$520,000
2024	31	$34,000	$1,100,000	$770,000	$490,000
2025	31	$34,000	$1,100,000	$750,000	$460,000
2026	31	$34,000	$1,100,000	$730,000	$430,000
2027	31	$34,000	$1,100,000	$710,000	$400,000
2028	31	$34,000	$1,100,000	$690,000	$370,000
2029	31	$34,000	$1,100,000	$670,000	$350,000
2030	31	$34,000	$1,100,000	$650,000	$330,000
2031	31	$34,000	$1,100,000	$630,000	$300,000
2032	31	$34,000	$1,100,000	$610,000	$280,000
2033	31	$34,000	$1,100,000	$590,000	$270,000
2034	31	$34,000	$1,100,000	$570,000	$250,000
2035	31	$34,000	$1,100,000	$560,000	$230,000
2036	31	$34,000	$1,100,000	$540,000	$220,000
2037	31	$34,000	$1,100,000	$530,000	$200,000
		Total:	**$26,000,000**	**$18,000,000**	**$12,000,000**

Table 99 – Offsite Property – Severe Accident Confinement Strategy – 5th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	31	$99	$3,100	$3,100	$3,100
2013	31	$99	$3,100	$3,000	$2,900
2014	31	$99	$3,100	$2,900	$2,700
2015	31	$99	$3,100	$2,800	$2,500
2016	31	$99	$3,100	$2,800	$2,400
2017	31	$200	$6,200	$5,300	$4,400
2018	31	$200	$6,200	$5,200	$4,100
2019	31	$200	$6,200	$5,000	$3,900
2020	31	$200	$6,200	$4,900	$3,600
2021	31	$200	$6,200	$4,800	$3,400
2022	31	$200	$6,200	$4,600	$3,200
2023	31	$200	$6,200	$4,500	$2,900
2024	31	$200	$6,200	$4,300	$2,800
2025	31	$200	$6,200	$4,200	$2,600
2026	31	$200	$6,200	$4,100	$2,400
2027	31	$200	$6,200	$4,000	$2,200
2028	31	$200	$6,200	$3,900	$2,100
2029	31	$200	$6,200	$3,800	$2,000
2030	31	$200	$6,200	$3,600	$1,800
2031	31	$200	$6,200	$3,500	$1,700
2032	31	$200	$6,200	$3,400	$1,600
2033	31	$200	$6,200	$3,300	$1,500
2034	31	$200	$6,200	$3,200	$1,400
2035	31	$200	$6,200	$3,100	$1,300
2036	31	$200	$6,200	$3,000	$1,200
2037	31	$200	$6,200	$3,000	$1,100
		Total:	**$150,000**	**$99,000**	**$65,000**

Table 100 – Offsite Property – Severe Accident Confinement Strategy – 95th Percentile

Year	Units	Offsite Property Damage	Total Benefit		
			Undiscounted	3% NPV	7% NPV
2012	31	$75,000	$2,300,000	$2,300,000	$2,300,000
2013	31	$75,000	$2,300,000	$2,200,000	$2,100,000
2014	31	$75,000	$2,300,000	$2,200,000	$2,000,000
2015	31	$75,000	$2,300,000	$2,100,000	$1,900,000
2016	31	$75,000	$2,300,000	$2,000,000	$1,800,000
2017	31	$130,000	$4,000,000	$3,500,000	$2,900,000
2018	31	$130,000	$4,000,000	$3,300,000	$2,700,000
2019	31	$130,000	$4,000,000	$3,300,000	$2,500,000
2020	31	$130,000	$4,000,000	$3,200,000	$2,300,000
2021	31	$130,000	$4,000,000	$3,100,000	$2,200,000
2022	31	$130,000	$4,000,000	$3,000,000	$2,000,000
2023	31	$130,000	$4,000,000	$2,900,000	$1,900,000
2024	31	$130,000	$4,000,000	$2,800,000	$1,800,000
2025	31	$130,000	$4,000,000	$2,700,000	$1,700,000
2026	31	$130,000	$4,000,000	$2,600,000	$1,600,000
2027	31	$130,000	$4,000,000	$2,600,000	$1,400,000
2028	31	$130,000	$4,000,000	$2,500,000	$1,400,000
2029	31	$130,000	$4,000,000	$2,400,000	$1,300,000
2030	31	$130,000	$4,000,000	$2,300,000	$1,200,000
2031	31	$130,000	$4,000,000	$2,300,000	$1,100,000
2032	31	$130,000	$4,000,000	$2,200,000	$1,000,000
2033	31	$130,000	$4,000,000	$2,200,000	$970,000
2034	31	$130,000	$4,000,000	$2,100,000	$900,000
2035	31	$130,000	$4,000,000	$2,000,000	$840,000
2036	31	$130,000	$4,000,000	$2,000,000	$790,000
2037	31	$130,000	$4,000,000	$1,900,000	$740,000
		Total:	**$96,000,000**	**$66,000,000**	**$43,000,000**

Table 102 – Onsite Property – Severe Accident Confinement Strategy

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	$15,000	$13,000	$11,000	$470,000	$400,000	$340,000
2013	31	$15,000	$13,000	$11,000	$470,000	$390,000	$320,000
2014	31	$15,000	$13,000	$11,000	$470,000	$380,000	$300,000
2015	31	$15,000	$13,000	$11,000	$470,000	$370,000	$280,000
2016	31	$15,000	$13,000	$11,000	$470,000	$360,000	$260,000
2017	31	$25,000	$21,000	$18,000	$780,000	$560,000	$400,000
2018	31	$25,000	$21,000	$18,000	$780,000	$550,000	$370,000
2019	31	$25,000	$21,000	$18,000	$780,000	$530,000	$350,000
2020	31	$25,000	$21,000	$18,000	$780,000	$510,000	$320,000
2021	31	$25,000	$21,000	$18,000	$780,000	$500,000	$300,000
2022	31	$25,000	$21,000	$18,000	$780,000	$480,000	$280,000
2023	31	$25,000	$21,000	$18,000	$780,000	$470,000	$270,000
2024	31	$25,000	$21,000	$18,000	$780,000	$460,000	$250,000
2025	31	$25,000	$21,000	$18,000	$780,000	$440,000	$230,000
2026	31	$25,000	$21,000	$18,000	$780,000	$430,000	$220,000
2027	31	$25,000	$21,000	$18,000	$780,000	$420,000	$200,000
2028	31	$25,000	$21,000	$18,000	$780,000	$410,000	$190,000
2029	31	$25,000	$21,000	$18,000	$780,000	$390,000	$180,000
2030	31	$25,000	$21,000	$18,000	$780,000	$380,000	$170,000
2031	31	$25,000	$21,000	$18,000	$780,000	$370,000	$150,000
2032	31	$25,000	$21,000	$18,000	$780,000	$360,000	$140,000
2033	31	$25,000	$21,000	$18,000	$780,000	$350,000	$130,000
2034	31	$25,000	$21,000	$18,000	$780,000	$340,000	$130,000
2035	31	$25,000	$21,000	$18,000	$780,000	$330,000	$120,000
2036	31	$25,000	$21,000	$18,000	$780,000	$320,000	$110,000
2037	31	$25,000	$21,000	$18,000	$780,000	$310,000	$100,000
				Total:	**$19,000,000**	**$11,000,000**	**$6,100,000**

Table 103 – Onsite Property – Severe Accident Confinement Strategy – 5th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	$78	$68	$56	$2,400	$2,100	$1,700
2013	31	$78	$68	$56	$2,400	$2,000	$1,600
2014	31	$78	$68	$56	$2,400	$2,000	$1,500
2015	31	$78	$68	$56	$2,400	$1,900	$1,400
2016	31	$78	$68	$56	$2,400	$1,900	$1,300
2017	31	$130	$110	$91	$4,000	$2,900	$2,000
2018	31	$130	$110	$91	$4,000	$2,900	$1,900
2019	31	$130	$110	$91	$4,000	$2,800	$1,800
2020	31	$130	$110	$91	$4,000	$2,700	$1,600
2021	31	$130	$110	$91	$4,000	$2,600	$1,500
2022	31	$130	$110	$91	$4,000	$2,500	$1,400
2023	31	$130	$110	$91	$4,000	$2,500	$1,300
2024	31	$130	$110	$91	$4,000	$2,400	$1,300
2025	31	$130	$110	$91	$4,000	$2,300	$1,200
2026	31	$130	$110	$91	$4,000	$2,300	$1,100
2027	31	$130	$110	$91	$4,000	$2,200	$1,000
2028	31	$130	$110	$91	$4,000	$2,100	$1,000
2029	31	$130	$110	$91	$4,000	$2,100	$900
2030	31	$130	$110	$91	$4,000	$2,000	$800
2031	31	$130	$110	$91	$4,000	$1,900	$780
2032	31	$130	$110	$91	$4,000	$1,900	$730
2033	31	$130	$110	$91	$4,000	$1,800	$680
2034	31	$130	$110	$91	$4,000	$1,800	$640
2035	31	$130	$110	$91	$4,000	$1,700	$600
2036	31	$130	$110	$91	$4,000	$1,700	$560
2037	31	$130	$110	$91	$4,000	$1,600	$520
				Total:	**$96,000**	**$57,000**	**$31,000**

Table 104 – Onsite Property – Severe Accident Confinement Strategy – 95th Percentile

Year	Units	Onsite Property Damage			Total Benefit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	31	$91,000	$78,000	$65,000	$2,800,000	$2,400,000	$2,000,000
2013	31	$91,000	$78,000	$65,000	$2,800,000	$2,300,000	$1,900,000
2014	31	$91,000	$78,000	$65,000	$2,800,000	$2,300,000	$1,800,000
2015	31	$91,000	$78,000	$65,000	$2,800,000	$2,200,000	$1,600,000
2016	31	$91,000	$78,000	$65,000	$2,800,000	$2,100,000	$1,500,000
2017	31	$91,000	$78,000	$65,000	$2,800,000	$2,100,000	$1,400,000
2018	31	$91,000	$78,000	$65,000	$2,800,000	$2,000,000	$1,300,000
2019	31	$91,000	$78,000	$65,000	$2,800,000	$2,000,000	$1,300,000
2020	31	$91,000	$78,000	$65,000	$2,800,000	$1,900,000	$1,200,000
2021	31	$91,000	$78,000	$65,000	$2,800,000	$1,900,000	$1,100,000
2022	31	$91,000	$78,000	$65,000	$2,800,000	$1,800,000	$1,000,000
2023	31	$91,000	$78,000	$65,000	$2,800,000	$1,700,000	$960,000
2024	31	$91,000	$78,000	$65,000	$2,800,000	$1,700,000	$890,000
2025	31	$91,000	$78,000	$65,000	$2,800,000	$1,600,000	$840,000
2026	31	$91,000	$78,000	$65,000	$2,800,000	$1,600,000	$780,000
2027	31	$91,000	$78,000	$65,000	$2,800,000	$1,600,000	$730,000
2028	31	$91,000	$78,000	$65,000	$2,800,000	$1,500,000	$680,000
2029	31	$91,000	$78,000	$65,000	$2,800,000	$1,500,000	$640,000
2030	31	$91,000	$78,000	$65,000	$2,800,000	$1,400,000	$600,000
2031	31	$91,000	$78,000	$65,000	$2,800,000	$1,400,000	$560,000
2032	31	$91,000	$78,000	$65,000	$2,800,000	$1,300,000	$520,000
2033	31	$91,000	$78,000	$65,000	$2,800,000	$1,300,000	$490,000
2034	31	$91,000	$78,000	$65,000	$2,800,000	$1,300,000	$450,000
2035	31	$91,000	$78,000	$65,000	$2,800,000	$1,200,000	$430,000
2036	31	$91,000	$78,000	$65,000	$2,800,000	$1,200,000	$400,000
2037	31	$91,000	$78,000	$65,000	$2,800,000	$1,200,000	$370,000
				Total:	**$73,000,000**	**$45,000,000**	**$25,000,000**

Table 106 – Onsite Property – Replacement Energy Cost – Severe Accident Confinement Strategy

Year	Units	Probability	Replacement Energy Costs			Total Benefit		
			Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	11	1.3E-05	$0	$0	$0	$0	$0	$0
2013	11	1.3E-05	$0	$0	$0	$0	$0	$0
2014	11	1.3E-05	$0	$0	$0	$0	$0	$0
2015	11	1.3E-05	$0	$0	$0	$0	$0	$0
2016	11	1.3E-05	$0	$0	$0	$0	$0	$0
2017	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$530,000	$380,000
2018	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$520,000	$350,000
2019	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$500,000	$330,000
2020	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$490,000	$310,000
2021	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$470,000	$290,000
2022	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$460,000	$270,000
2023	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$450,000	$250,000
2024	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$430,000	$240,000
2025	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$420,000	$220,000
2026	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$410,000	$210,000
2027	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$400,000	$190,000
2028	11	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$710,000	$390,000	$180,000
2029	11	1.3E-05	$4,300,000,000	$3,800,000,000	$3,300,000,000	$630,000	$340,000	$150,000
2030	11	1.3E-05	$3,800,000,000	$3,400,000,000	$3,000,000,000	$560,000	$290,000	$130,000
2031	11	1.3E-05	$3,300,000,000	$3,100,000,000	$2,800,000,000	$490,000	$260,000	$110,000
2032	11	1.3E-05	$2,900,000,000	$2,700,000,000	$2,400,000,000	$430,000	$220,000	$91,000
2033	11	1.3E-05	$2,400,000,000	$2,300,000,000	$2,100,000,000	$350,000	$180,000	$75,000
2034	11	1.3E-05	$1,900,000,000	$1,800,000,000	$1,700,000,000	$280,000	$140,000	$56,000
2035	11	1.3E-05	$1,400,000,000	$1,400,000,000	$1,300,000,000	$210,000	$100,000	$40,000
2036	11	1.3E-05	$950,000,000	$940,000,000	$920,000,000	$140,000	$68,000	$27,000
2037	11	1.3E-05	$480,000,000	$480,000,000	$480,000,000	$71,000	$34,000	$13,000
					Total:	**$12,000,000**	**$7,100,000**	**$3,900,000**

Table 107 – Onsite Property – Replacement Energy Cost – Severe Accident Confinement Strategy – Low Replacement

Year	Units	Probability	Replacement Energy Costs			Total Benefit		
			Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	11	1.3E-05	$0	$0	$0	$0	$0	$0
2013	11	1.3E-05	$0	$0	$0	$0	$0	$0
2014	11	1.3E-05	$0	$0	$0	$0	$0	$0
2015	11	1.3E-05	$0	$0	$0	$0	$0	$0
2016	11	1.3E-05	$0	$0	$0	$0	$0	$0
2017	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$24,000	$17,000
2018	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$23,000	$16,000
2019	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$23,000	$15,000
2020	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$22,000	$14,000
2021	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$21,000	$13,000
2022	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$21,000	$12,000
2023	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$20,000	$11,000
2024	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$20,000	$10,000
2025	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$19,000	$9,800
2026	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$18,000	$9,100
2027	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$18,000	$8,500
2028	11	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$31,000	$17,000	$8,000
2029	11	1.3E-05	$190,000,000	$170,000,000	$150,000,000	$28,000	$15,000	$7,000
2030	11	1.3E-05	$170,000,000	$160,000,000	$140,000,000	$25,000	$14,000	$6,100
2031	11	1.3E-05	$150,000,000	$140,000,000	$120,000,000	$22,000	$12,000	$4,900
2032	11	1.3E-05	$130,000,000	$120,000,000	$110,000,000	$19,000	$9,800	$4,200
2033	11	1.3E-05	$110,000,000	$100,000,000	$94,000,000	$16,000	$7,900	$3,300
2034	11	1.3E-05	$86,000,000	$82,000,000	$78,000,000	$13,000	$6,300	$2,600
2035	11	1.3E-05	$64,000,000	$63,000,000	$60,000,000	$9,400	$4,700	$1,900
2036	11	1.3E-05	$43,000,000	$42,000,000	$42,000,000	$6,300	$3,000	$1,200
2037	11	1.3E-05	$21,000,000	$21,000,000	$21,000,000	$3,100	$1,500	$570
					Total:	**$510,000**	**$320,000**	**$180,000**

Table 108 – Onsite Property – Replacement Energy Cost – Severe Accident Confinement Strategy – High Replacement

Year	Units	Probability	Replacement Energy Costs			Total Benefit		
			Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	11	1.3E-05	$0	$0	$0	$0	$0	$0
2013	11	1.3E-05	$0	$0	$0	$0	$0	$0
2014	11	1.3E-05	$0	$0	$0	$0	$0	$0
2015	11	1.3E-05	$0	$0	$0	$0	$0	$0
2016	11	1.3E-05	$0	$0	$0	$0	$0	$0
2017	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,900,000	$1,400,000
2018	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,800,000	$1,300,000
2019	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,800,000	$1,200,000
2020	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,700,000	$1,100,000
2021	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,700,000	$1,000,000
2022	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,600,000	$970,000
2023	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,600,000	$910,000
2024	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,500,000	$850,000
2025	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,500,000	$790,000
2026	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,500,000	$740,000
2027	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,400,000	$690,000
2028	11	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$2,500,000	$1,400,000	$650,000
2029	11	1.3E-05	$15,000,000,000	$14,000,000,000	$12,000,000,000	$2,200,000	$1,200,000	$560,000
2030	11	1.3E-05	$14,000,000,000	$12,000,000,000	$11,000,000,000	$2,100,000	$1,000,000	$480,000
2031	11	1.3E-05	$12,000,000,000	$11,000,000,000	$9,700,000,000	$1,800,000	$920,000	$390,000
2032	11	1.3E-05	$10,000,000,000	$9,400,000,000	$8,600,000,000	$1,500,000	$770,000	$330,000
2033	11	1.3E-05	$8,400,000,000	$8,000,000,000	$7,400,000,000	$1,200,000	$630,000	$260,000
2034	11	1.3E-05	$6,800,000,000	$6,500,000,000	$6,100,000,000	$1,000,000	$500,000	$200,000
2035	11	1.3E-05	$5,100,000,000	$4,900,000,000	$4,700,000,000	$750,000	$370,000	$150,000
2036	11	1.3E-05	$3,400,000,000	$3,300,000,000	$3,300,000,000	$500,000	$240,000	$96,000
2037	11	1.3E-05	$1,700,000,000	$1,700,000,000	$1,700,000,000	$250,000	$120,000	$46,000
					Total:	**$41,000,000**	**$25,000,000**	**$14,000,000**

Table 109 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Confinement Strategy

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I and Mark II		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,700,000	$1,500,000
2013	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,700,000	$1,400,000
2014	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,600,000	$1,300,000
2015	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,600,000	$1,200,000
2016	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,500,000	$1,100,000
2017	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,500,000	$1,100,000
2018	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,500,000	$990,000
2019	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,400,000	$930,000
2020	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,400,000	$870,000
2021	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,300,000	$810,000
2022	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,300,000	$760,000
2023	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,300,000	$710,000
2024	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,200,000	$660,000
2025	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,200,000	$620,000
2026	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,200,000	$580,000
2027	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,100,000	$540,000
2028	30	31	1.3E-05	$4,800,000,000	$4,200,000,000	$3,600,000,000	$2,000,000	$1,100,000	$510,000
2029	30	31	1.3E-05	$4,300,000,000	$3,800,000,000	$3,300,000,000	$1,800,000	$950,000	$430,000
2030	30	31	1.3E-05	$3,800,000,000	$3,400,000,000	$3,000,000,000	$1,600,000	$830,000	$370,000
2031	30	31	1.3E-05	$3,300,000,000	$3,100,000,000	$2,800,000,000	$1,400,000	$730,000	$320,000
2032	30	31	1.3E-05	$2,900,000,000	$2,700,000,000	$2,400,000,000	$1,200,000	$620,000	$260,000
2033	30	31	1.3E-05	$2,400,000,000	$2,300,000,000	$2,100,000,000	$1,000,000	$510,000	$210,000
2034	30	31	1.3E-05	$1,900,000,000	$1,800,000,000	$1,700,000,000	$790,000	$390,000	$160,000
2035	30	31	1.3E-05	$1,400,000,000	$1,400,000,000	$1,300,000,000	$580,000	$290,000	$110,000
2036	30	31	1.3E-05	$950,000,000	$940,000,000	$920,000,000	$390,000	$190,000	$75,000
2037	30	31	1.3E-05	$480,000,000	$480,000,000	$480,000,000	$200,000	$95,000	$37,000
						Total:	**$43,000,000**	**$28,000,000**	**$18,000,000**

Table 110 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Confinement Strategy – Low Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I and Mark II		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$79,000	$66,000
2013	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$77,000	$62,000
2014	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$74,000	$58,000
2015	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$72,000	$54,000
2016	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$70,000	$51,000
2017	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$68,000	$47,000
2018	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$66,000	$44,000
2019	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$64,000	$41,000
2020	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$62,000	$39,000
2021	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$60,000	$36,000
2022	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$59,000	$34,000
2023	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$57,000	$32,000
2024	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$55,000	$29,000
2025	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$54,000	$28,000
2026	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$52,000	$26,000
2027	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$51,000	$24,000
2028	30	31	1.3E-05	$210,000,000	$190,000,000	$160,000,000	$87,000	$49,000	$22,000
2029	30	31	1.3E-05	$190,000,000	$170,000,000	$150,000,000	$79,000	$43,000	$20,000
2030	30	31	1.3E-05	$170,000,000	$160,000,000	$140,000,000	$71,000	$39,000	$17,000
2031	30	31	1.3E-05	$150,000,000	$140,000,000	$120,000,000	$62,000	$33,000	$14,000
2032	30	31	1.3E-05	$130,000,000	$120,000,000	$110,000,000	$54,000	$28,000	$12,000
2033	30	31	1.3E-05	$110,000,000	$100,000,000	$94,000,000	$46,000	$22,000	$9,400
2034	30	31	1.3E-05	$86,000,000	$82,000,000	$78,000,000	$36,000	$18,000	$7,300
2035	30	31	1.3E-05	$64,000,000	$63,000,000	$60,000,000	$27,000	$13,000	$5,200
2036	30	31	1.3E-05	$43,000,000	$42,000,000	$42,000,000	$18,000	$8,600	$3,400
2037	30	31	1.3E-05	$21,000,000	$21,000,000	$21,000,000	$8,700	$4,200	$1,600
						Total:	**$1,900,000**	**$1,300,000**	**$780,000**

Table 111 – Onsite Property – Replacement Energy Cost – All Mark I/IIs Shutdown – Severe Accident Confinement Strategy – High Replacement

Year	Units		Probability	Replacement Energy Costs			Total Benefit		
	Shutdown due to Unmitigated Accident	Mark I and Mark II		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
2012	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$6,200,000	$5,400,000
2013	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$6,000,000	$5,000,000
2014	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,900,000	$4,700,000
2015	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,700,000	$4,400,000
2016	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,500,000	$4,100,000
2017	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,400,000	$3,800,000
2018	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,200,000	$3,600,000
2019	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$5,100,000	$3,400,000
2020	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,900,000	$3,100,000
2021	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,800,000	$2,900,000
2022	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,600,000	$2,700,000
2023	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,500,000	$2,600,000
2024	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,400,000	$2,400,000
2025	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,200,000	$2,200,000
2026	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,100,000	$2,100,000
2027	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$4,000,000	$2,000,000
2028	30	31	1.3E-05	$17,000,000,000	$15,000,000,000	$13,000,000,000	$7,100,000	$3,900,000	$1,800,000
2029	30	31	1.3E-05	$15,000,000,000	$14,000,000,000	$12,000,000,000	$6,200,000	$3,500,000	$1,600,000
2030	30	31	1.3E-05	$14,000,000,000	$12,000,000,000	$11,000,000,000	$5,800,000	$2,900,000	$1,300,000
2031	30	31	1.3E-05	$12,000,000,000	$11,000,000,000	$9,700,000,000	$5,000,000	$2,600,000	$1,100,000
2032	30	31	1.3E-05	$10,000,000,000	$9,400,000,000	$8,600,000,000	$4,100,000	$2,200,000	$920,000
2033	30	31	1.3E-05	$8,400,000,000	$8,000,000,000	$7,400,000,000	$3,500,000	$1,800,000	$740,000
2034	30	31	1.3E-05	$6,800,000,000	$6,500,000,000	$6,100,000,000	$2,800,000	$1,400,000	$570,000
2035	30	31	1.3E-05	$5,100,000,000	$4,900,000,000	$4,700,000,000	$2,100,000	$1,000,000	$410,000
2036	30	31	1.3E-05	$3,400,000,000	$3,300,000,000	$3,300,000,000	$1,400,000	$670,000	$270,000
2037	30	31	1.3E-05	$1,700,000,000	$1,700,000,000	$1,700,000,000	$710,000	$340,000	$130,000
						Total:	**$150,000,000**	**$100,000,000**	**$63,000,000**

Table 113 – Industry Implementation Costs – Severe Accident Confinement Strategy

Year	Mark I Units	Mark II Units	Cost per Unit				Total Cost	
			Low		High			
			Mark I Units	Mark II Units	Mark I Units	Mark II Units	Low	High
2012	23	8	$2,000,000	$5,000,000	$3,000,000	$13,000,000	**$86,000,000**	**$170,000,000**

Table 114 – Industry Implementation Costs – Severe Accident Confinement Strategy – Level 2 PRA

Year	Action	Hours per Action	Number of Units	Cost per hour	Total Cost		
					Undiscounted	3% NPV	7% NPV
2017	Upgrade plant-specific PRA	3,120	31	$200	$19,000,000	$16,000,000	$14,000,000
2017	Peer Review of PRA	624	31	$200	$3,900,000	$3,400,000	$2,800,000
				Total:	**$23,000,000**	**$19,000,000**	**$17,000,000**

Table 116 – Industry Operation Costs – Severe Accident Confinement Strategy

Year	Mark I Units	Mark II Units	FTE		Yearly Wage	Total Cost		
			Mark I Units	Mark II Units		Undiscounted	3% NPV	7% NPV
2012	31	8	0.10	0.15	$400,000	$1,700,000	$1,700,000	$1,700,000
2013	31	8	0.10	0.15	$400,000	$1,700,000	$1,700,000	$1,600,000
2014	31	8	0.10	0.15	$400,000	$1,700,000	$1,600,000	$1,500,000
2015	31	8	0.10	0.15	$400,000	$1,700,000	$1,600,000	$1,400,000
2016	31	8	0.10	0.15	$400,000	$1,700,000	$1,500,000	$1,300,000
2017	31	8	0.10	0.15	$400,000	$1,700,000	$1,500,000	$1,200,000
2018	31	8	0.10	0.15	$400,000	$1,700,000	$1,400,000	$1,100,000
2019	31	8	0.10	0.15	$400,000	$1,700,000	$1,400,000	$1,100,000
2020	31	8	0.10	0.15	$400,000	$1,700,000	$1,300,000	$990,000
2021	31	8	0.10	0.15	$400,000	$1,700,000	$1,300,000	$920,000
2022	31	8	0.10	0.15	$400,000	$1,700,000	$1,300,000	$860,000
2023	31	8	0.10	0.15	$400,000	$1,700,000	$1,200,000	$810,000
2024	31	8	0.10	0.15	$400,000	$1,700,000	$1,200,000	$750,000
2025	31	8	0.10	0.15	$400,000	$1,700,000	$1,200,000	$710,000
2026	31	8	0.10	0.15	$400,000	$1,700,000	$1,100,000	$660,000
2027	31	8	0.10	0.15	$400,000	$1,700,000	$1,100,000	$620,000
2028	31	8	0.10	0.15	$400,000	$1,700,000	$1,100,000	$580,000
2029	31	8	0.10	0.15	$400,000	$1,700,000	$1,000,000	$540,000
2030	31	8	0.10	0.15	$400,000	$1,700,000	$1,000,000	$500,000
2031	31	8	0.10	0.15	$400,000	$1,700,000	$970,000	$470,000
2032	31	8	0.10	0.15	$400,000	$1,700,000	$940,000	$440,000
2033	31	8	0.10	0.15	$400,000	$1,700,000	$910,000	$410,000
2034	31	8	0.10	0.15	$400,000	$1,700,000	$890,000	$380,000
2035	31	8	0.10	0.15	$400,000	$1,700,000	$860,000	$360,000
2036	31	8	0.10	0.15	$400,000	$1,700,000	$840,000	$340,000
2037	31	8	0.10	0.15	$400,000	$1,700,000	$810,000	$310,000
					Total:	**$44,000,000**	**$31,000,000**	**$22,000,000**

Table 117 – Industry Operation Costs – Severe Accident Confinement Strategy – Level 2 PRA

Year	Action	Hours per Action	Units	Cost per hour	Total Cost		
					Undiscounted	3% NPV	7% NPV
2017	Maintenance of PRA	200	31	$200	$1,200,000	$1,000,000	$860,000
2018	Maintenance of PRA	200	31	$200	$1,200,000	$1,000,000	$800,000
2019	Maintenance of PRA	200	31	$200	$1,200,000	$980,000	$750,000
2020	Maintenance of PRA	200	31	$200	$1,200,000	$950,000	$700,000
2020	Upgrades of PRA	480	31	$200	$3,000,000	$2,400,000	$1,700,000
2021	Maintenance of PRA	200	31	$200	$1,200,000	$920,000	$650,000
2022	Maintenance of PRA	200	31	$200	$1,200,000	$890,000	$610,000
2023	Maintenance of PRA	200	31	$200	$1,200,000	$870,000	$570,000
2024	Maintenance of PRA	200	31	$200	$1,200,000	$840,000	$530,000
2024	Upgrades of PRA	480	31	$200	$3,000,000	$2,100,000	$1,300,000
2025	Maintenance of PRA	200	31	$200	$1,200,000	$820,000	$500,000
2026	Maintenance of PRA	200	31	$200	$1,200,000	$790,000	$470,000
2027	Maintenance of PRA	200	31	$200	$1,200,000	$770,000	$430,000
2028	Maintenance of PRA	200	31	$200	$1,200,000	$750,000	$410,000
2029	Maintenance of PRA	200	31	$200	$1,200,000	$730,000	$380,000
2030	Maintenance of PRA	200	31	$200	$1,200,000	$700,000	$360,000
2031	Maintenance of PRA	200	31	$200	$1,200,000	$680,000	$330,000
2032	Maintenance of PRA	200	31	$200	$1,200,000	$660,000	$310,000
2032	Upgrades of PRA	480	31	$200	$3,000,000	$1,700,000	$780,000
2033	Maintenance of PRA	200	31	$200	$1,200,000	$650,000	$290,000
2034	Maintenance of PRA	200	31	$200	$1,200,000	$630,000	$270,000
2035	Maintenance of PRA	200	31	$200	$1,200,000	$610,000	$250,000
2036	Maintenance of PRA	200	31	$200	$1,200,000	$590,000	$240,000
2036	Upgrades of PRA	480	31	$200	$3,000,000	$1,500,000	$590,000
2037	Maintenance of PRA	200	31	$200	$1,200,000	$570,000	$220,000
				Total:	**$37,000,000**	**$24,000,000**	**$14,000,000**

Table 119 – NRC Implementation Costs – Severe Accident Confinement Strategy

Year	Mark I Units	Mark II Units	Hours per unit				Cost per hour	Total		
			Initial Review		Plant Inspection			Hours		Cost
			Mark I Units	Mark II Units	Mark I Units	Mark II Units		Initial Review	Plant Inspection	
2012	23	8	80	160	$80	$160	$119	3,120	3,120	**$740,000**

Table 120 – NRC Implementation Costs – Severe Accident Confinement Strategy – Level 2 PRA

Year	Action	Hours per Action	Number of Units	Cost per hour	Total Cost		
					Undiscounted	3% NPV	7% NPV
2018	Review of Level 2 PRA	740	31	$119	$2,700,000	$2,300,000	$1,800,000
				Total:	**$2,700,000**	**$2,300,000**	**$1,800,000**

Table 122 – NRC Operation Costs – Severe Accident Confinement Strategy

Year	Mark I Units	Mark II Units	FTE		Yearly Wage	Total Cost		
			Mark I Units	Mark II Units		Undiscounted	3% NPV	7% NPV
2012	31	8	0.050	0.050	$400,000	$780,000	$780,000	$780,000
2013	31	8	0.050	0.050	$400,000	$780,000	$760,000	$730,000
2014	31	8	0.050	0.050	$400,000	$780,000	$740,000	$680,000
2015	31	8	0.050	0.050	$400,000	$780,000	$710,000	$640,000
2016	31	8	0.050	0.050	$400,000	$780,000	$690,000	$600,000
2017	31	8	0.050	0.050	$400,000	$780,000	$670,000	$560,000
2018	31	8	0.050	0.050	$400,000	$780,000	$650,000	$520,000
2019	31	8	0.050	0.050	$400,000	$780,000	$630,000	$490,000
2020	31	8	0.050	0.050	$400,000	$780,000	$620,000	$450,000
2021	31	8	0.050	0.050	$400,000	$780,000	$600,000	$420,000
2022	31	8	0.050	0.050	$400,000	$780,000	$580,000	$400,000
2023	31	8	0.050	0.050	$400,000	$780,000	$560,000	$370,000
2024	31	8	0.050	0.050	$400,000	$780,000	$550,000	$350,000
2025	31	8	0.050	0.050	$400,000	$780,000	$530,000	$320,000
2026	31	8	0.050	0.050	$400,000	$780,000	$520,000	$300,000
2027	31	8	0.050	0.050	$400,000	$780,000	$500,000	$280,000
2028	31	8	0.050	0.050	$400,000	$780,000	$490,000	$260,000
2029	31	8	0.050	0.050	$400,000	$780,000	$470,000	$250,000
2030	31	8	0.050	0.050	$400,000	$780,000	$460,000	$230,000
2031	31	8	0.050	0.050	$400,000	$780,000	$440,000	$220,000
2032	31	8	0.050	0.050	$400,000	$780,000	$430,000	$200,000
2033	31	8	0.050	0.050	$400,000	$780,000	$420,000	$190,000
2034	31	8	0.050	0.050	$400,000	$780,000	$410,000	$180,000
2035	31	8	0.050	0.050	$400,000	$780,000	$400,000	$160,000
2036	31	8	0.050	0.050	$400,000	$780,000	$380,000	$150,000
2037	31	8	0.050	0.050	$400,000	$780,000	$370,000	$140,000
					Total:	**$20,000,000**	**$14,000,000**	**$9,900,000**

Table 126 – Total Implementation and Operation Costs – Severe Accident Capable Vents – Mark I Containments

Range	Industry Costs				NRC Costs			
	Implementation	Operation			Implementation	Operation		
		Undiscounted	3% NPV	7% NPV		Undiscounted	3% NPV	7% NPV
Low	$46,000,000	$24,000,000	$17,000,000	$12,000,000	$440,000	$12,000,000	$8,500,000	$5,800,000
High	$69,000,000	$24,000,000	$17,000,000	$12,000,000	$440,000	$12,000,000	$8,500,000	$5,800,000

Range	Total Costs						
	Implementation	Operation			Total:		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Low	$46,000,000	$36,000,000	$26,000,000	$18,000,000	$82,000,000	$72,000,000	$64,000,000
High	$69,000,000	$36,000,000	$26,000,000	$18,000,000	$110,000,000	$95,000,000	$87,000,000

Table 127 – Total Implementation and Operation Costs per Unit – Severe Accident Capable Vents – Mark I Containments

Range	Units	Total Cost			Total Cost per Unit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Low	23	$82,000,000	$72,000,000	$64,000,000	$3,600,000	$3,100,000	$2,800,000
High	23	$110,000,000	$95,000,000	$87,000,000	$4,800,000	$4,100,000	$3,800,000

Table 129 – Total Implementation and Operation Costs – Severe Accident Capable Vents – Mark II Containments

Range	Industry Costs				NRC Costs			
	Implementation	Operation			Implementation	Operation		
		Undiscounted	3% NPV	7% NPV		Undiscounted	3% NPV	7% NPV
Low	$40,000,000	$12,000,000	$8,900,000	$6,100,000	$300,000	$4,200,000	$3,000,000	$2,000,000
High	$100,000,000	$12,000,000	$8,900,000	$6,100,000	$300,000	$4,200,000	$3,000,000	$2,000,000

Total Costs						
Implementation	Operation			Total:		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
$40,000,000	$16,000,000	$12,000,000	$8,100,000	$56,000,000	$52,000,000	$48,000,000
$100,000,000	$16,000,000	$12,000,000	$8,100,000	$120,000,000	$110,000,000	$110,000,000

Table 130 – Total Implementation and Operation Costs per Unit – Severe Accident Capable Vents – Mark II Containments

Range	Units	Total Cost			Total Cost per Unit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Low	8	$56,000,000	$52,000,000	$48,000,000	$7,000,000	$6,500,000	$6,000,000
High	8	$120,000,000	$110,000,000	$110,000,000	$15,000,000	$14,000,000	$14,000,000

Table 132 – Total Implementation and Operation Costs – Filtered Vents

Range	Industry Costs				NRC Costs			
	Implementation	Operation			Implementation	Operation		
		Undiscounted	3% NPV	7% NPV		Undiscounted	3% NPV	7% NPV
Low	$470,000,000	$49,000,000	$35,000,000	$24,000,000	$840,000	$16,000,000	$11,000,000	$7,800,000
High	$620,000,000	$49,000,000	$35,000,000	$24,000,000	$840,000	$16,000,000	$11,000,000	$7,800,000

Range	Total Costs						
	Implementation	Operation			Total:		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Low	$470,000,000	$65,000,000	$46,000,000	$32,000,000	$540,000,000	$520,000,000	$500,000,000
High	$620,000,000	$65,000,000	$46,000,000	$32,000,000	$690,000,000	$670,000,000	$650,000,000

Table 133 – Total Implementation and Operation Costs per Unit – Filtered Vents

Range	Units	Total Cost			Total Cost per Unit		
		Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Low	31	$540,000,000	$520,000,000	$500,000,000	$17,000,000	$17,000,000	$16,000,000
High	31	$690,000,000	$670,000,000	$650,000,000	$22,000,000	$22,000,000	$21,000,000

Table 136 – Total Benefits – Severe Accident Capable Vents – Mark I Containments

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	2,500	$4,900,000	$3,500,000	$2,400,000	$10,000,000	$7,200,000	$4,900,000
Occupational Health (Accident) - Short-Term	120	$240,000	$170,000	$120,000	$470,000	$330,000	$230,000
Occupational Health (Accident) - Long-Term	110	$230,000	$130,000	$65,000	$440,000	$250,000	$130,000
Total:	**2,700**	**$5,400,000**	**$3,800,000**	**$2,600,000**	**$11,000,000**	**$7,800,000**	**$5,300,000**

Table 137 – Total Benefits and Cost Offsets per Unit – Severe Accident Capable Vents – Mark I Containments

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$210,000	$150,000	$100,000
Occupational Health (Accident)	$10,000	$7,400	$5,200
Offsite Property	$520,000	$370,000	$250,000
Onsite Property	$400,000	$240,000	$140,000
Replacement Energy	$0	$0	$0
Total:	**$1,100,000**	**$770,000**	**$500,000**

Table 138 – Total Benefits – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	14	$29,000	$20,000	$14,000	$55,000	$39,000	$27,000
Occupational Health (Accident) - Short-Term	0.67	$1,300	$940	$650	$2,600	$1,800	$1,300
Occupational Health (Accident) - Long-Term	0.58	$1,200	$660	$330	$2,300	$1,300	$660
Total:	**15**	**$32,000**	**$22,000**	**$15,000**	**$60,000**	**$42,000**	**$29,000**

Table 139 – Total Benefits – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	10,000	$20,000,000	$14,000,000	$9,900,000	$42,000,000	$30,000,000	$20,000,000
Occupational Health (Accident) - Short-Term	530	$1,100,000	$760,000	$520,000	$2,100,000	$1,500,000	$1,000,000
Occupational Health (Accident) - Long-Term	440	$860,000	$480,000	$250,000	$1,700,000	$960,000	$490,000
Total:	**11,000**	**$22,000,000**	**$15,000,000**	**$11,000,000**	**$46,000,000**	**$32,000,000**	**$21,000,000**

Table 140 – Total Benefits and Cost Offsets – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$29,000	$20,000	$14,000
Occupational Health (Accident)	$1,300	$940	$650
Offsite Property	$60,000	$42,000	$29,000
Onsite Property	$47,000	$29,000	$16,000
Replacement Energy	$0	$0	$0
Total:	**$140,000**	**$92,000**	**$60,000**

Table 141 – Total Benefits and Cost Offsets – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$20,000,000	$14,000,000	$9,900,000
Occupational Health (Accident)	$1,100,000	$760,000	$520,000
Offsite Property	$44,000,000	$31,000,000	$22,000,000
Onsite Property	$34,000,000	$20,000,000	$12,000,000
Replacement Energy	$0	$0	$0
Total:	**$99,000,000**	**$66,000,000**	**$44,000,000**

Table 142 – Total Benefits and Cost Offsets per Unit– Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,300	$870	$610
Occupational Health (Accident)	$57	$41	$28
Offsite Property	$2,600	$1,800	$1,300
Onsite Property	$2,000	$1,300	$700
Replacement Energy	$0	$0	$0
Total:	**$6,000**	**$4,000**	**$2,600**

Table 143 – Total Benefits and Cost Offsets per Unit – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$870,000	$610,000	$430,000
Occupational Health (Accident)	$48,000	$33,000	$23,000
Offsite Property	$1,900,000	$1,300,000	$960,000
Onsite Property	$1,500,000	$870,000	$520,000
Replacement Energy	$0	$0	$0
Total:	**$4,300,000**	**$2,800,000**	**$1,900,000**

Table 145 – Total Benefits – Severe Accident Capable Vents – Mark II Containments

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	880	$1,700,000	$1,200,000	$850,000	$3,400,000	$2,400,000	$1,600,000
Occupational Health (Accident) - Short-Term	42	$83,000	$59,000	$40,000	$170,000	$120,000	$81,000
Occupational Health (Accident) - Long-Term	39	$78,000	$44,000	$22,000	$160,000	$89,000	$45,000
Total:	**960**	**$1,900,000**	**$1,300,000**	**$910,000**	**$3,700,000**	**$2,600,000**	**$1,700,000**

Table 146 – Total Benefits and Cost Offsets per Unit – Severe Accident Capable Vents – Mark II Containments

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$210,000	$150,000	$110,000
Occupational Health (Accident)	$10,000	$7,400	$5,000
Offsite Property	$530,000	$380,000	$250,000
Onsite Property	$390,000	$240,000	$140,000
Replacement Energy	$0	$0	$0
Total:	**$1,100,000**	**$780,000**	**$510,000**

Table 147 – Total Benefits – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	4.8	$9,600	$6,800	$4,700	$19,000	$14,000	$9,400
Occupational Health (Accident) - Short-Term	0.23	$470	$330	$230	$910	$640	$450
Occupational Health (Accident) - Long-Term	0.20	$420	$230	$120	$810	$450	$230
Total:	**5.2**	**$10,000**	**$7,400**	**$5,100**	**$21,000**	**$15,000**	**$10,000**

Table 148 – Total Benefits – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	3,500	$7,000,000	$5,000,000	$3,400,000	$14,000,000	$10,000,000	$6,800,000
Occupational Health (Accident) - Short-Term	180	$360,000	$260,000	$180,000	$730,000	$520,000	$350,000
Occupational Health (Accident) - Long-Term	150	$310,000	$170,000	$89,000	$600,000	$340,000	$170,000
Total:	**3,800**	**$7,700,000**	**$5,400,000**	**$3,700,000**	**$15,000,000**	**$11,000,000**	**$7,300,000**

Table 149 – Total Benefits and Cost Offsets – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$9,600	$6,800	$4,700
Occupational Health (Accident)	$470	$330	$230
Offsite Property	$21,000	$15,000	$10,000
Onsite Property	$16,000	$10,000	$5,700
Replacement Energy	$0	$0	$0
Total:	**$47,000**	**$32,000**	**$21,000**

Table 150 – Total Benefits and Cost Offsets – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$7,000,000	$5,000,000	$3,400,000
Occupational Health (Accident)	$360,000	$260,000	$180,000
Offsite Property	$16,000,000	$11,000,000	$7,600,000
Onsite Property	$12,000,000	$7,100,000	$4,000,000
Replacement Energy	$0	$0	$0
Total:	**$35,000,000**	**$23,000,000**	**$15,000,000**

Table 151 – Total Benefits and Cost Offsets per Unit– Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,200	$850	$590
Occupational Health (Accident)	$59	$41	$29
Offsite Property	$2,600	$1,900	$1,300
Onsite Property	$2,000	$1,300	$710
Replacement Energy	$0	$0	$0
Total:	**$5,900**	**$4,100**	**$2,600**

Table 152 – Total Benefits and Cost Offsets per Unit – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$880,000	$630,000	$430,000
Occupational Health (Accident)	$45,000	$33,000	$23,000
Offsite Property	$2,000,000	$1,400,000	$950,000
Onsite Property	$1,500,000	$890,000	$500,000
Replacement Energy	$0	$0	$0
Total:	**$4,400,000**	**$3,000,000**	**$1,900,000**

Table 154 – Total Benefits – Filtered Vents

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	6,500	$13,000,000	$9,200,000	$6,300,000	$26,000,000	$18,000,000	$13,000,000
Occupational Health (Accident) - Short-Term	200	$420,000	$300,000	$200,000	$810,000	$570,000	$390,000
Occupational Health (Accident) - Long-Term	310	$620,000	$350,000	$180,000	$1,200,000	$680,000	$350,000
Total:	**7,000**	**$14,000,000**	**$9,900,000**	**$6,700,000**	**$28,000,000**	**$19,000,000**	**$14,000,000**

Table 155 – Total Benefits and Cost Offsets per Unit – Filtered Vents

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$420,000	$300,000	$200,000
Occupational Health (Accident)	$14,000	$9,700	$6,500
Offsite Property	$940,000	$650,000	$450,000
Onsite Property	$650,000	$390,000	$230,000
Replacement Energy	$480,000	$320,000	$200,000
Total:	**$2,500,000**	**$1,700,000**	**$1,100,000**

Table 156 – Total Benefits – Filtered Vents – 5th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	34	$70,000	$50,000	$34,000	$140,000	$100,000	$69,000
Occupational Health (Accident) - Short-Term	1.1	$2,300	$1,600	$1,100	$4,400	$3,100	$2,200
Occupational Health (Accident) - Long-Term	1.5	$3,100	$1,700	$890	$6,200	$3,500	$1,800
Total:	**37**	**$75,000**	**$53,000**	**$36,000**	**$150,000**	**$110,000**	**$73,000**

Table 157 – Total Benefits – Filtered Vents – 95th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	25,000	$49,000,000	$35,000,000	$24,000,000	$99,000,000	$70,000,000	$48,000,000
Occupational Health (Accident) - Short-Term	900	$1,800,000	$1,300,000	$860,000	$3,600,000	$2,600,000	$1,800,000
Occupational Health (Accident) - Long-Term	1,100	$2,300,000	$1,300,000	$650,000	$4,400,000	$2,500,000	$1,300,000
Total:	**27,000**	**$53,000,000**	**$38,000,000**	**$26,000,000**	**$110,000,000**	**$75,000,000**	**$51,000,000**

Table 158 – Total Benefits and Cost Offsets – Filtered Vents – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$70,000	$50,000	$34,000
Occupational Health (Accident)	$2,300	$1,600	$1,100
Offsite Property	$160,000	$110,000	$78,000
Onsite Property	$100,000	$63,000	$36,000
Replacement Energy	$15,000,000	$10,000,000	$6,200,000
Total:	**$15,000,000**	**$10,000,000**	**$6,300,000**

Table 159 – Total Benefits and Cost Offsets – Filtered Vents – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$49,000,000	$35,000,000	$24,000,000
Occupational Health (Accident)	$1,800,000	$1,300,000	$860,000
Offsite Property	$100,000,000	$74,000,000	$51,000,000
Onsite Property	$73,000,000	$45,000,000	$25,000,000
Replacement Energy	$15,000,000	$10,000,000	$6,200,000
Total:	**$240,000,000**	**$170,000,000**	**$110,000,000**

Table 160 – Total Benefits and Cost Offsets per Unit– Filtered Vents – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$2,300	$1,600	$1,100
Occupational Health (Accident)	$74	$52	$35
Offsite Property	$5,200	$3,500	$2,500
Onsite Property	$3,200	$2,000	$1,200
Replacement Energy	$480,000	$320,000	$200,000
Total:	**$490,000**	**$330,000**	**$200,000**

Table 161 – Total Benefits and Cost Offsets per Unit – Filtered Vents – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,600,000	$1,100,000	$770,000
Occupational Health (Accident)	$58,000	$42,000	$28,000
Offsite Property	$3,200,000	$2,400,000	$1,600,000
Onsite Property	$2,400,000	$1,500,000	$810,000
Replacement Energy	$480,000	$320,000	$200,000
Total:	**$7,700,000**	**$5,400,000**	**$3,400,000**

Table 163 – Total Benefits – Severe Accident Confinement Strategy

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	5,900	$12,000,000	$8,100,000	$5,300,000	$24,000,000	$16,000,000	$11,000,000
Occupational Health (Accident) - Short-Term	200	$400,000	$280,000	$180,000	$780,000	$540,000	$370,000
Occupational Health (Accident) - Long-Term	280	$560,000	$300,000	$150,000	$1,100,000	$600,000	$290,000
Total:	**6,400**	**$13,000,000**	**$8,700,000**	**$5,600,000**	**$26,000,000**	**$17,000,000**	**$12,000,000**

Table 164 – Total Benefits and Cost Offsets per Unit – Severe Accident Confinement Strategy

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$390,000	$260,000	$170,000
Occupational Health (Accident)	$13,000	$9,000	$5,800
Offsite Property	$840,000	$580,000	$390,000
Onsite Property	$610,000	$350,000	$200,000
Replacement Energy	$390,000	$230,000	$130,000
Total:	**$2,200,000**	**$1,400,000**	**$900,000**

Table 165 – Total Benefits – Severe Accident Confinement Strategy – 5th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	31	$64,000	$44,000	$28,000	$130,000	$89,000	$58,000
Occupational Health (Accident) - Short-Term	1.1	$2,200	$1,500	$1,000	$4,300	$3,000	$2,000
Occupational Health (Accident) - Long-Term	1.4	$2,800	$1,500	$740	$5,600	$3,000	$1,500
Total:	**34**	**$69,000**	**$47,000**	**$30,000**	**$140,000**	**$95,000**	**$62,000**

Table 166 – Total Benefits – Severe Accident Confinement Strategy – 95th Percentile

Attribute	Person-Rem Averted	$2,000 per person-rem			$4,000 per person-rem		
		Undiscounted	3% NPV	7%NPV	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	23,000	$45,000,000	$31,000,000	$21,000,000	$90,000,000	$62,000,000	$41,000,000
Occupational Health (Accident) - Short-Term	870	$1,700,000	$1,200,000	$800,000	$3,500,000	$2,400,000	$1,600,000
Occupational Health (Accident) - Long-Term	1000	$2,100,000	$1,100,000	$540,000	$4,000,000	$2,200,000	$1,100,000
Total:	**25,000**	**$49,000,000**	**$33,000,000**	**$22,000,000**	**$98,000,000**	**$67,000,000**	**$44,000,000**

Table 167 – Total Benefits and Cost Offsets – Severe Accident Confinement Strategy – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$64,000	$44,000	$28,000
Occupational Health (Accident)	$2,200	$1,500	$1,000
Offsite Property	$150,000	$99,000	$65,000
Onsite Property	$96,000	$57,000	$31,000
Replacement Energy	$12,000,000	$7,100,000	$3,900,000
Total:	**$12,000,000**	**$7,300,000**	**$4,000,000**

Table 168 – Total Benefits and Cost Offsets – Severe Accident Confinement Strategy – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$45,000,000	$31,000,000	$21,000,000
Occupational Health (Accident)	$1,700,000	$1,200,000	$800,000
Offsite Property	$96,000,000	$66,000,000	$43,000,000
Onsite Property	$67,000,000	$40,000,000	$22,000,000
Replacement Energy	$12,000,000	$7,100,000	$3,900,000
Total:	**$220,000,000**	**$150,000,000**	**$91,000,000**

Table 169 – Total Benefits and Cost Offsets per Unit– Severe Accident Confinement Strategy – 5th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$2,100	$1,400	$900
Occupational Health (Accident)	$71	$48	$32
Offsite Property	$4,800	$3,200	$2,100
Onsite Property	$3,100	$1,800	$1,000
Replacement Energy	$390,000	$230,000	$130,000
Total:	**$400,000**	**$240,000**	**$130,000**

Table 170 – Total Benefits and Cost Offsets per Unit – Severe Accident Confinement Strategy – 95th Percentile

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,500,000	$1,000,000	$680,000
Occupational Health (Accident)	$55,000	$39,000	$26,000
Offsite Property	$3,100,000	$2,100,000	$1,400,000
Onsite Property	$2,200,000	$1,300,000	$710,000
Replacement Energy	$390,000	$230,000	$130,000
Total:	**$7,200,000**	**$4,700,000**	**$2,900,000**

Table 171 – Sensitivity Analysis – Severe Accident Capable Vents – Mark I Containments

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$26,000,000	**$18,000,000**	**$12,000,000**	$140,000	**$93,000**	**$60,000**	$100,000,000	**$66,000,000**	**$45,000,000**
$4000 per person-rem	$32,000,000	$22,000,000	$14,000,000	$170,000	$110,000	$74,000	$120,000,000	$83,000,000	$55,000,000
Current Framework w/ High Replacement	$26,000,000	$18,000,000	$12,000,000	$140,000	$93,000	$60,000	$100,000,000	$66,000,000	$45,000,000
Current Framework w/ Low Replacement	$26,000,000	$18,000,000	$12,000,000	$140,000	$93,000	$60,000	$100,000,000	$66,000,000	$45,000,000
$4000 per person-rem w/High Replacement	$32,000,000	$22,000,000	$14,000,000	$170,000	$110,000	$74,000	$120,000,000	$83,000,000	$55,000,000
$4000 per person-rem w/Low Replacement	$32,000,000	$22,000,000	$14,000,000	$170,000	$110,000	$74,000	$120,000,000	$83,000,000	$55,000,000
Current Framework w/all Mark I/II shutdown	$58,000,000	$39,000,000	$25,000,000	$32,000,000	$21,000,000	$13,000,000	$130,000,000	$87,000,000	$58,000,000
Current Framework w/all Mark I/II shutdown and high replacement	$140,000,000	$93,000,000	$59,000,000	$110,000,000	$75,000,000	$47,000,000	$210,000,000	$140,000,000	$92,000,000
Current Framework w/all Mark I/II shutdown and low replacement	$28,000,000	$19,000,000	$12,000,000	$1,500,000	$1,000,000	$640,000	$100,000,000	$67,000,000	$45,000,000
$4000 per person-rem w/all Mark I/II shutdown	$64,000,000	$43,000,000	$27,000,000	$32,000,000	$21,000,000	$13,000,000	$160,000,000	$100,000,000	$68,000,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$140,000,000	$97,000,000	$61,000,000	$110,000,000	$75,000,000	$47,000,000	$230,000,000	$160,000,000	$100,000,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$33,000,000	$23,000,000	$15,000,000	$1,600,000	$1,100,000	$650,000	$130,000,000	$84,000,000	$56,000,000

Table 172 – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark I Containments

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$1,100,000	**$780,000**	**$520,000**	$6,100	**$4,000**	**$2,600**	$4,300,000	**$2,900,000**	**$2,000,000**
$4000 per person-rem	$1,400,000	$960,000	$610,000	$7,400	$4,800	$3,200	$5,200,000	$3,600,000	$2,400,000
Current Framework w/ High Replacement	$1,100,000	$780,000	$520,000	$6,100	$4,000	$2,600	$4,300,000	$2,900,000	$2,000,000
Current Framework w/ Low Replacement	$1,100,000	$780,000	$520,000	$6,100	$4,000	$2,600	$4,300,000	$2,900,000	$2,000,000
$4000 per person-rem w/High Replacement	$1,400,000	$960,000	$610,000	$7,400	$4,800	$3,200	$5,200,000	$3,600,000	$2,400,000
$4000 per person-rem w/Low Replacement	$1,400,000	$960,000	$610,000	$7,400	$4,800	$3,200	$5,200,000	$3,600,000	$2,400,000
Current Framework w/all Mark I/II shutdown	$2,500,000	$1,700,000	$1,100,000	$1,400,000	$910,000	$570,000	$5,700,000	$3,800,000	$2,500,000
Current Framework w/all Mark I/II shutdown and high replacement	$6,100,000	$4,000,000	$2,600,000	$4,800,000	$3,300,000	$2,000,000	$9,100,000	$6,100,000	$4,000,000
Current Framework w/all Mark I/II shutdown and low replacement	$1,200,000	$830,000	$520,000	$65,000	$43,000	$28,000	$4,300,000	$2,900,000	$2,000,000
$4000 per person-rem w/all Mark I/II shutdown	$2,800,000	$1,900,000	$1,200,000	$1,400,000	$910,000	$570,000	$7,000,000	$4,300,000	$3,000,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$6,100,000	$4,200,000	$2,700,000	$4,800,000	$3,300,000	$2,000,000	$10,000,000	$7,000,000	$4,300,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$1,400,000	$1,000,000	$650,000	$70,000	$48,000	$28,000	$5,700,000	$3,700,000	$2,400,000

Table 174 (Chart 2) – Sensitivity Analysis – Severe Accident Capable Vents – Mark I Containments – 7 Percent Net Present Value

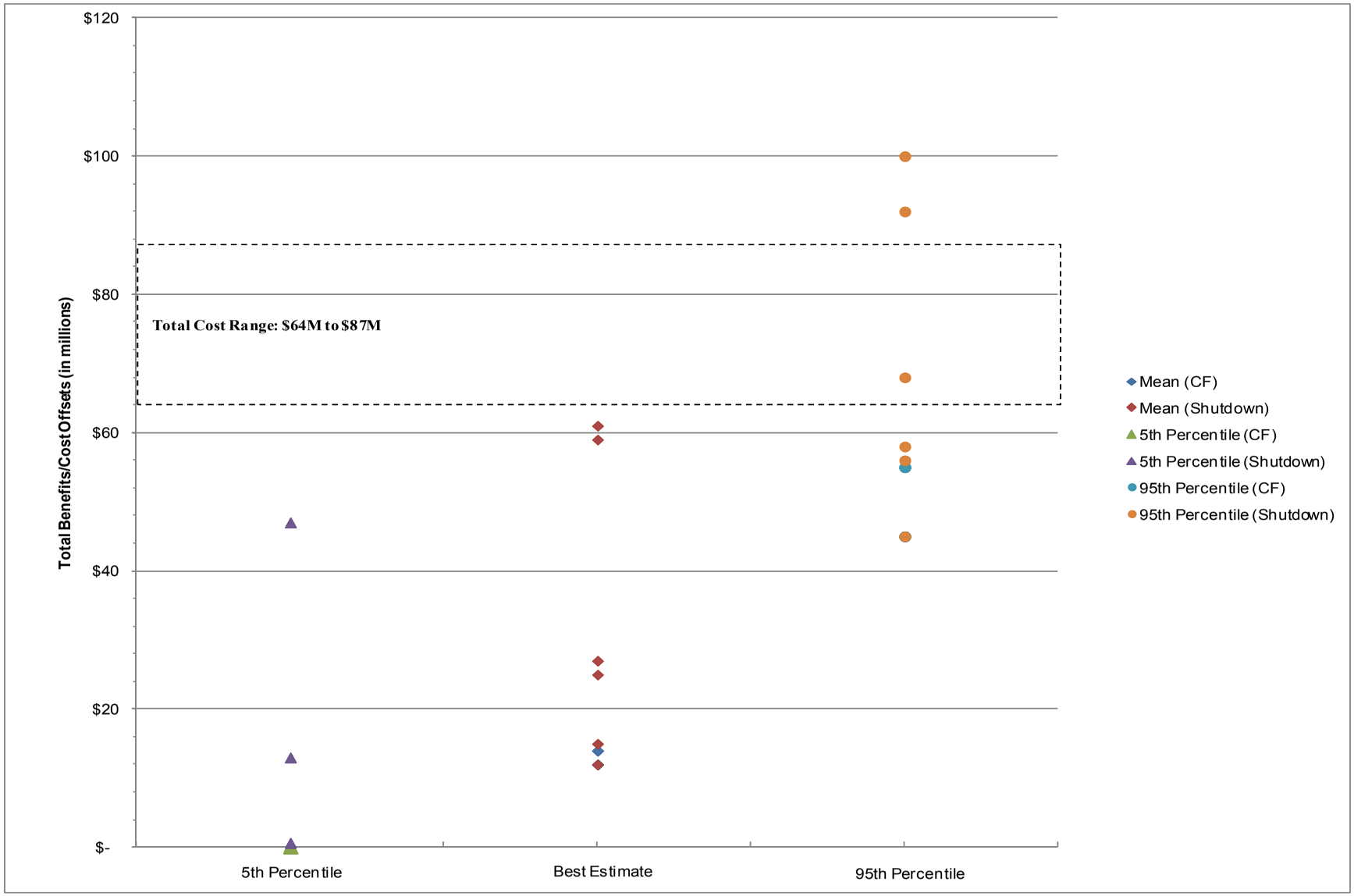


Table 175 (Chart 3) – Sensitivity Analysis – Severe Accident Capable Vents – Mark I Containments – Undiscounted

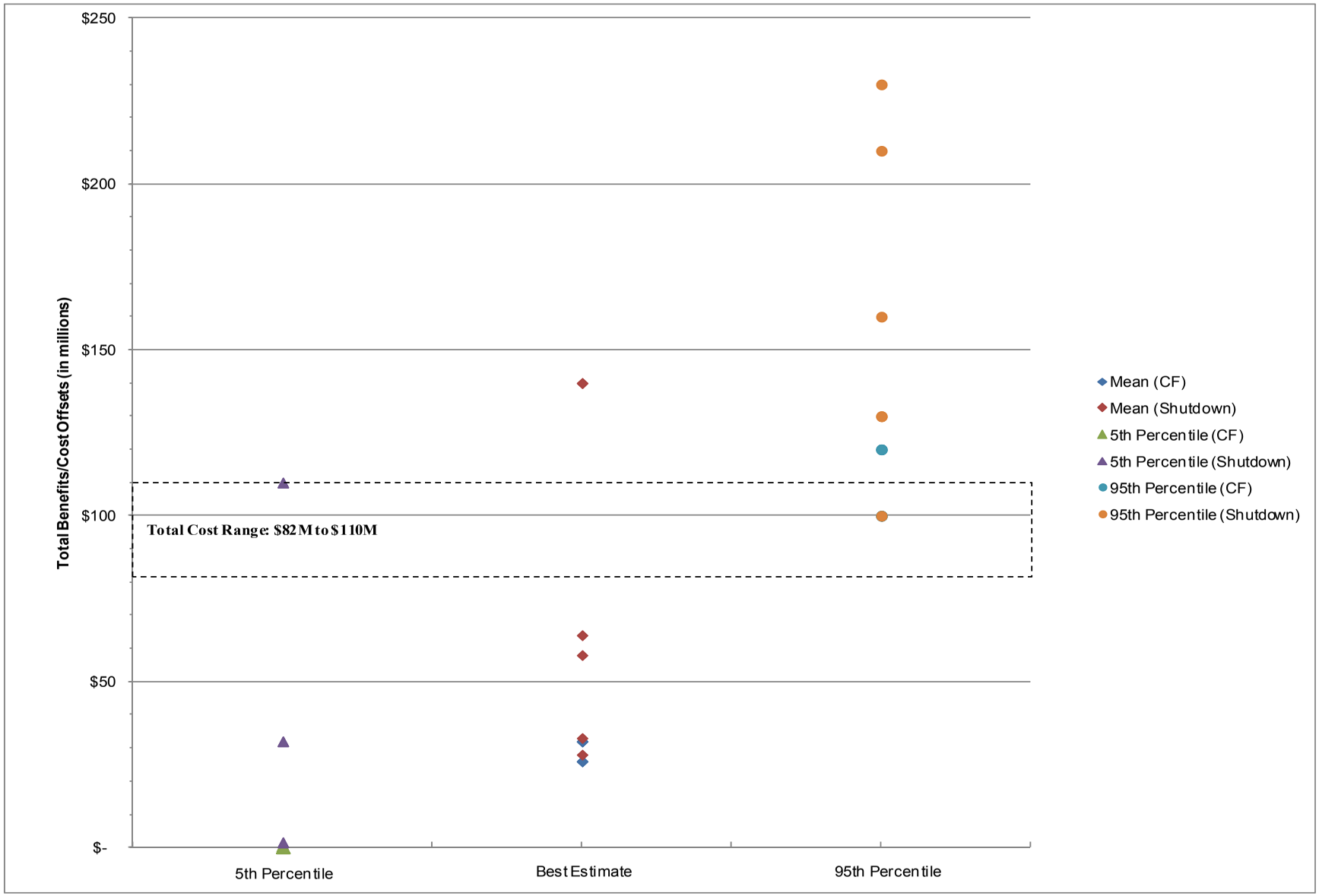


Table 176 (Chart 4) – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark I Containments – 3 Percent Net Present Value

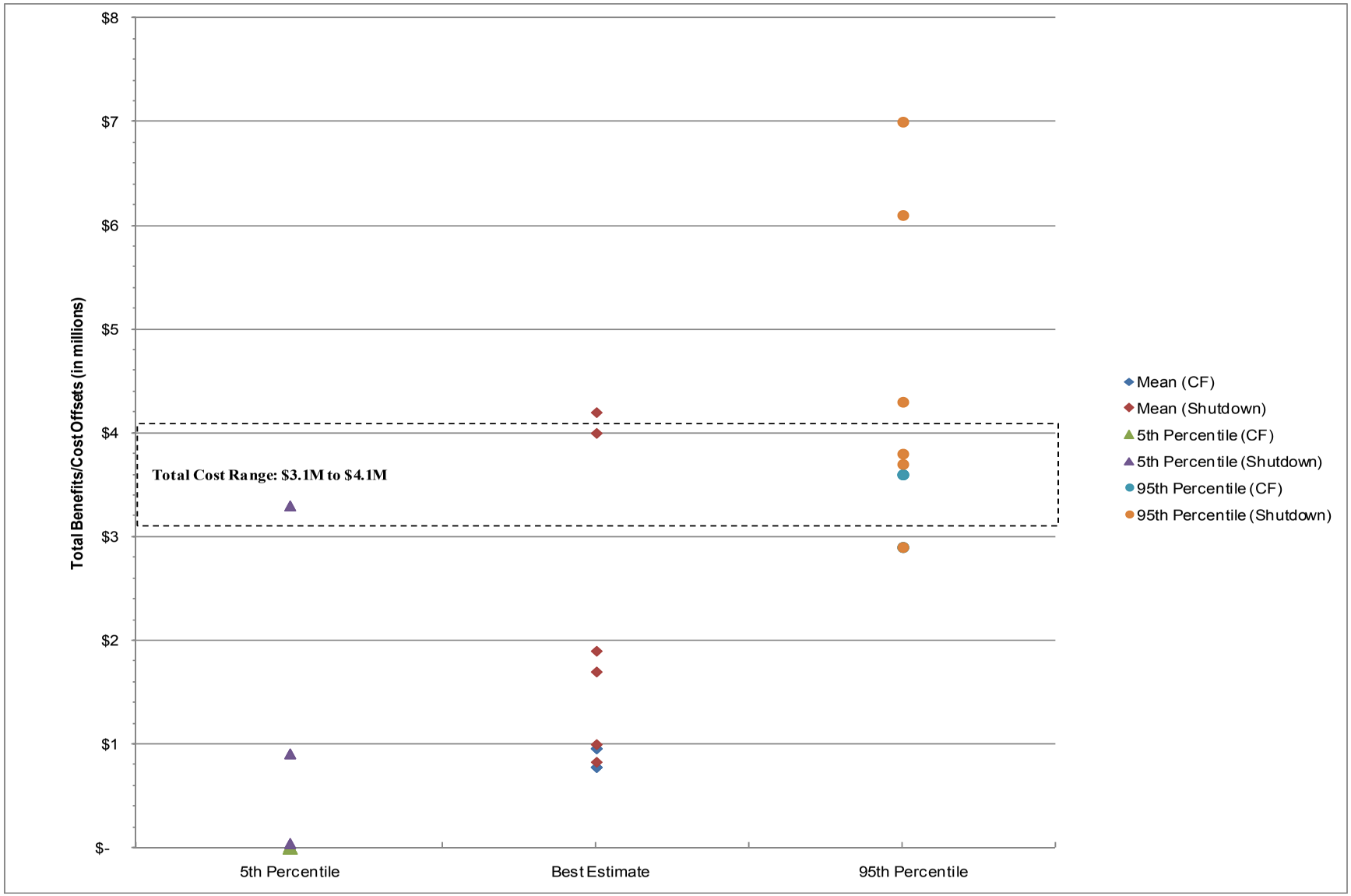


Table 177 (Chart 5) – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark I Containments – 7 Percent Net Present Value

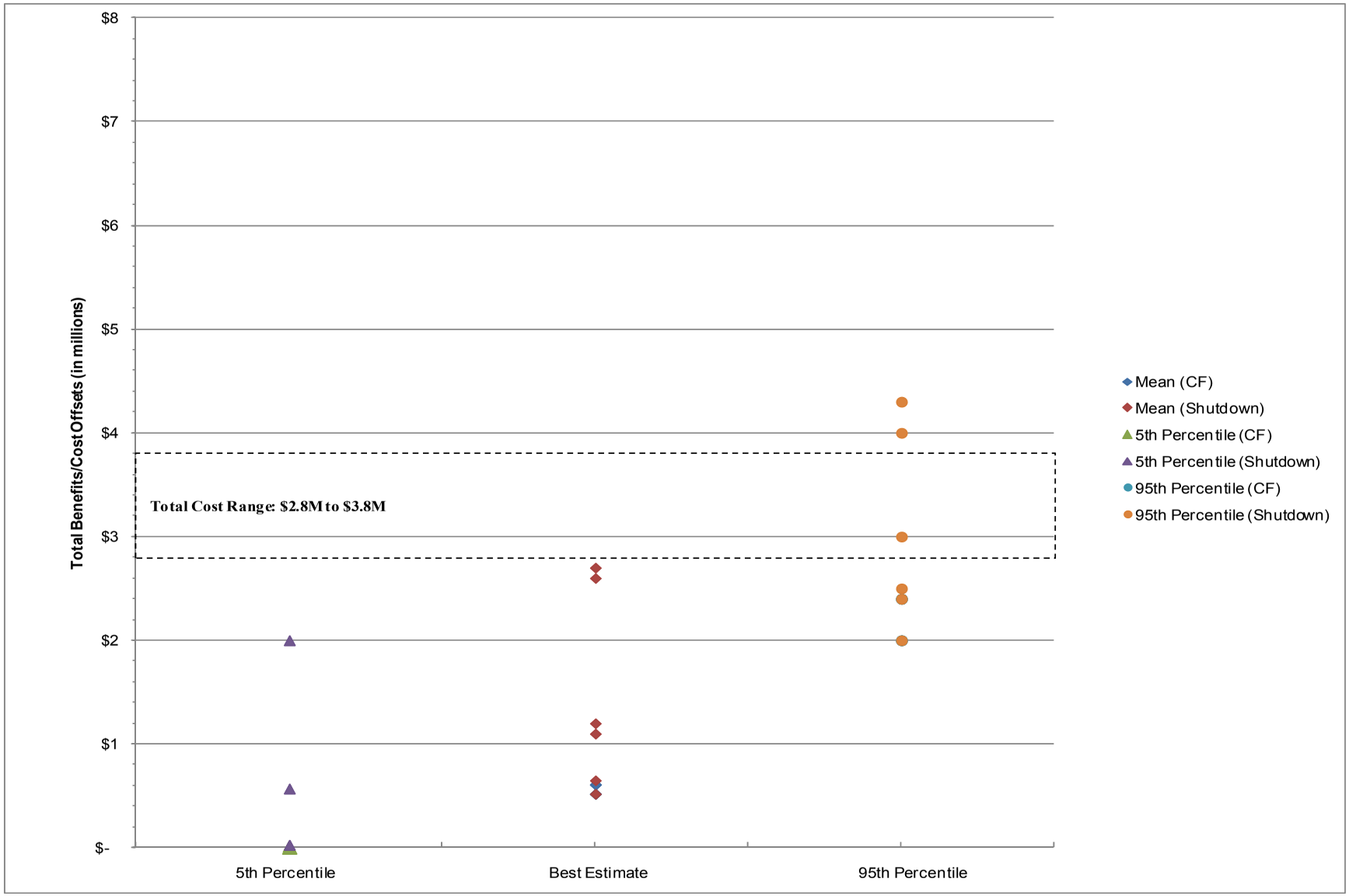


Table 178 (Chart 6) – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark I Containments – Undiscounted

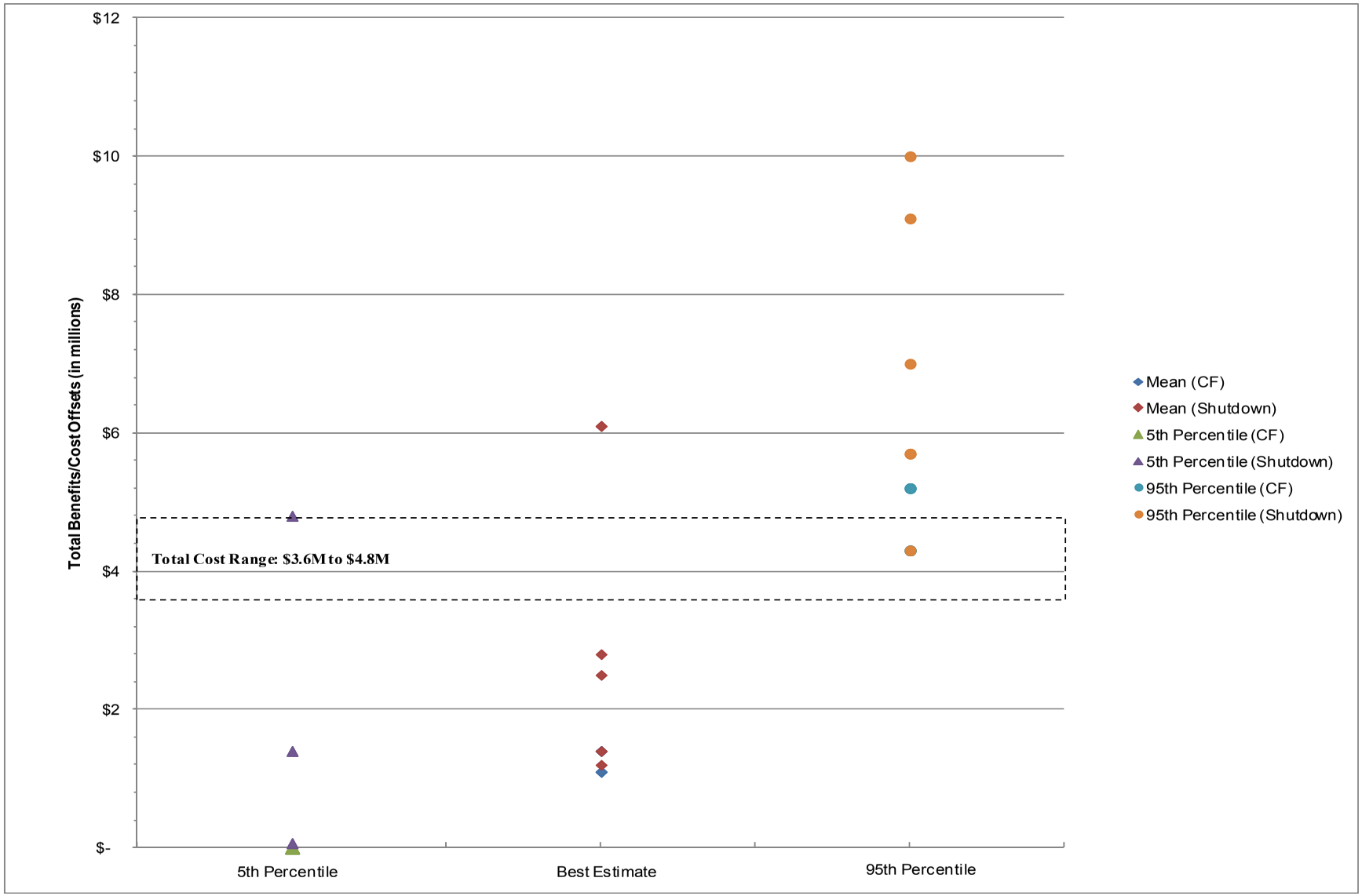


Table 179 – Sensitivity Analysis – Severe Accident Capable Vents – Mark II Containments

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$9,200,000	**$6,200,000**	**$4,000,000**	$47,000	**$32,000**	**$21,000**	$36,000,000	**$24,000,000**	**$15,000,000**
$4000 per person-rem	$11,000,000	$7,500,000	$4,800,000	$58,000	$40,000	$26,000	$43,000,000	$29,000,000	$19,000,000
Current Framework w/ High Replacement	$9,200,000	$6,200,000	$4,000,000	$47,000	$32,000	$21,000	$36,000,000	$24,000,000	$15,000,000
Current Framework w/ Low Replacement	$9,200,000	$6,200,000	$4,000,000	$47,000	$32,000	$21,000	$36,000,000	$24,000,000	$15,000,000
$4000 per person-rem w/High Replacement	$11,000,000	$7,500,000	$4,800,000	$58,000	$40,000	$26,000	$43,000,000	$29,000,000	$19,000,000
$4000 per person-rem w/Low Replacement	$11,000,000	$7,500,000	$4,800,000	$58,000	$40,000	$26,000	$43,000,000	$29,000,000	$19,000,000
Current Framework w/all Mark I/II shutdown	$20,000,000	$14,000,000	$8,500,000	$11,000,000	$7,300,000	$4,500,000	$47,000,000	$31,000,000	$20,000,000
Current Framework w/all Mark I/II shutdown and high replacement	$48,000,000	$32,000,000	$20,000,000	$39,000,000	$26,000,000	$16,000,000	$75,000,000	$50,000,000	$31,000,000
Current Framework w/all Mark I/II shutdown and low replacement	$9,600,000	$6,500,000	$4,200,000	$530,000	$360,000	$220,000	$36,000,000	$24,000,000	$15,000,000
$4000 per person-rem w/all Mark I/II shutdown	$22,000,000	$15,000,000	$9,300,000	$11,000,000	$7,300,000	$4,500,000	$54,000,000	$36,000,000	$23,000,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$50,000,000	$34,000,000	$21,000,000	$39,000,000	$26,000,000	$16,000,000	$82,000,000	$55,000,000	$35,000,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$12,000,000	$7,800,000	$5,000,000	$540,000	$370,000	$230,000	$44,000,000	$29,000,000	$19,000,000

Table 180 – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark II Containments

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$1,200,000	**$780,000**	**$500,000**	$5,900	**$4,000**	**$2,600**	$4,500,000	**$3,000,000**	**$1,900,000**
$4000 per person-rem	$1,400,000	$940,000	$600,000	$7,300	$5,000	$3,300	$5,400,000	$3,600,000	$2,400,000
Current Framework w/ High Replacement	$1,200,000	$780,000	$500,000	$5,900	$4,000	$2,600	$4,500,000	$3,000,000	$1,900,000
Current Framework w/ Low Replacement	$1,200,000	$780,000	$500,000	$5,900	$4,000	$2,600	$4,500,000	$3,000,000	$1,900,000
$4000 per person-rem w/High Replacement	$1,400,000	$940,000	$600,000	$7,300	$5,000	$3,300	$5,400,000	$3,600,000	$2,400,000
$4000 per person-rem w/Low Replacement	$1,400,000	$940,000	$600,000	$7,300	$5,000	$3,300	$5,400,000	$3,600,000	$2,400,000
Current Framework w/all Mark I/II shutdown	$2,500,000	$1,800,000	$1,100,000	$1,400,000	$910,000	$560,000	$5,900,000	$3,900,000	$2,500,000
Current Framework w/all Mark I/II shutdown and high replacement	$6,000,000	$4,000,000	$2,500,000	$4,900,000	$3,300,000	$2,000,000	$9,400,000	$6,300,000	$3,900,000
Current Framework w/all Mark I/II shutdown and low replacement	$1,200,000	$810,000	$530,000	$66,000	$45,000	$28,000	$4,500,000	$3,000,000	$1,900,000
$4000 per person-rem w/all Mark I/II shutdown	$2,800,000	$1,900,000	$1,200,000	$1,400,000	$910,000	$560,000	$6,800,000	$4,500,000	$2,900,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$6,300,000	$4,300,000	$2,600,000	$4,900,000	$3,300,000	$2,000,000	$10,000,000	$6,900,000	$4,400,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$1,500,000	$980,000	$630,000	$68,000	$46,000	$29,000	$5,500,000	$3,600,000	$2,400,000

Table 182 (Chart 8) – Sensitivity Analysis – Severe Accident Capable Vents – Mark II Containments – 7 Percent Net Present Value

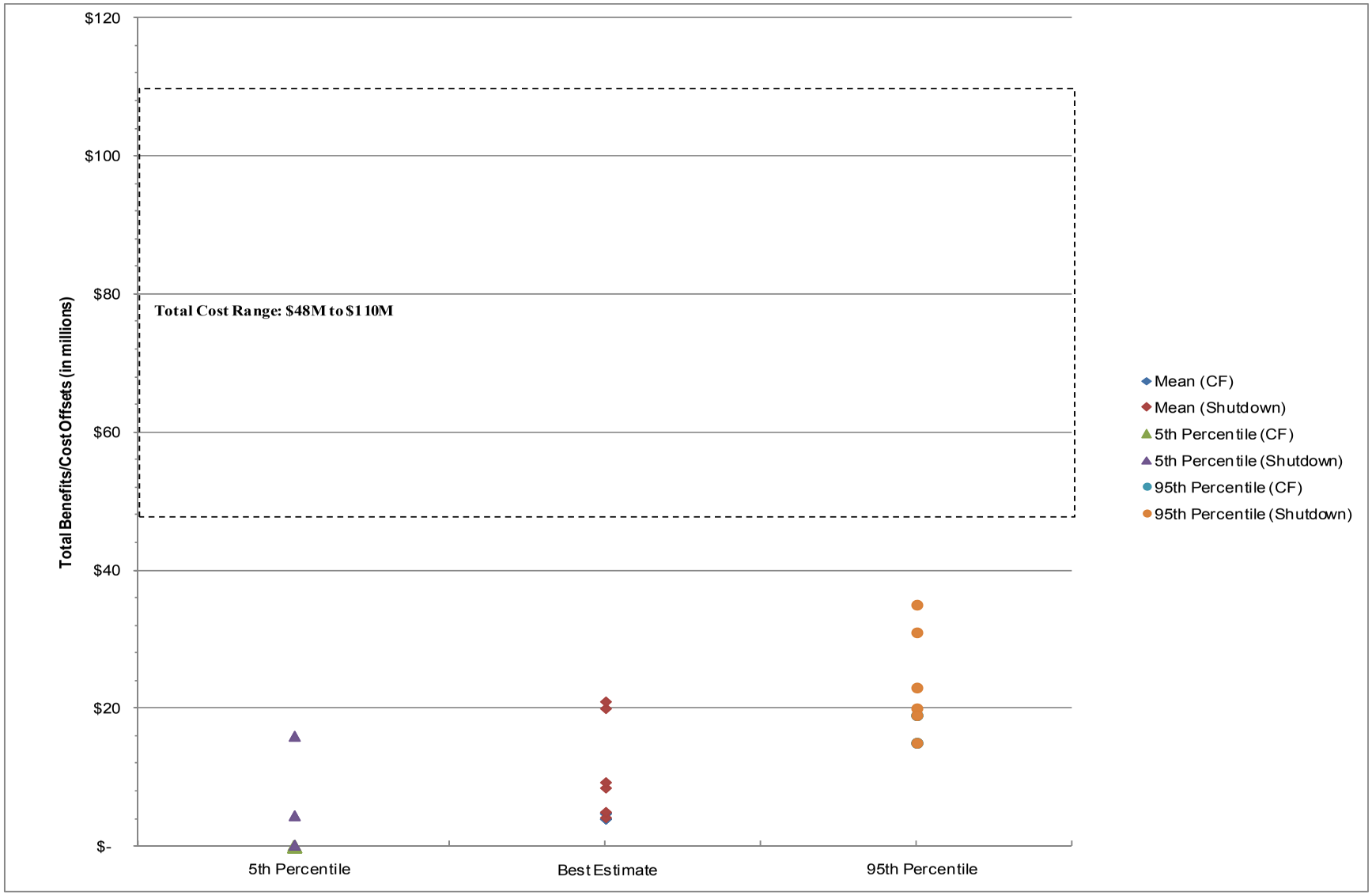


Table 183 (Chart 9) – Sensitivity Analysis – Severe Accident Capable Vents – Mark II Containments – Undiscounted

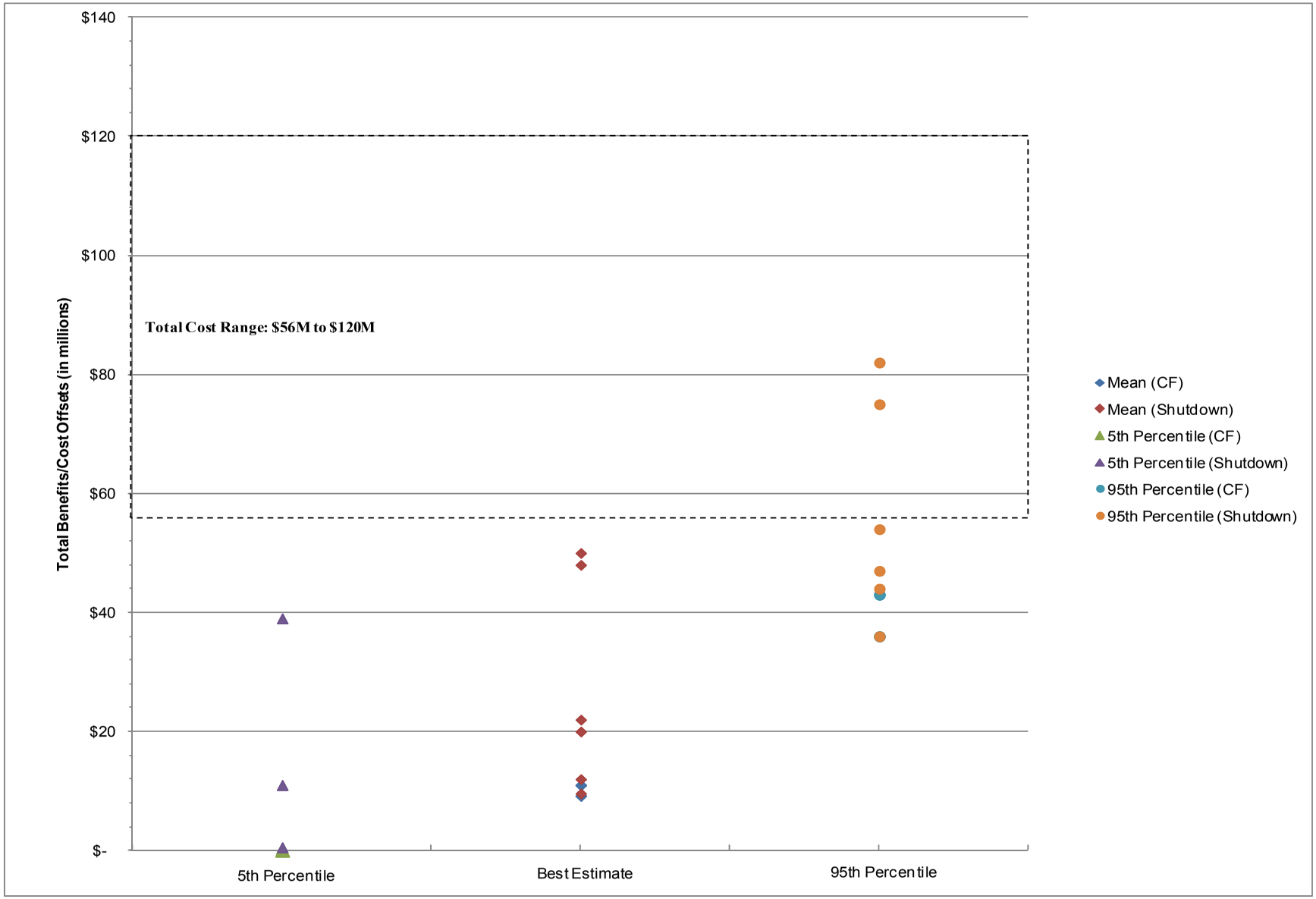


Table 184 (Chart 10) – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark II Containments – 3 Percent Net Present Value

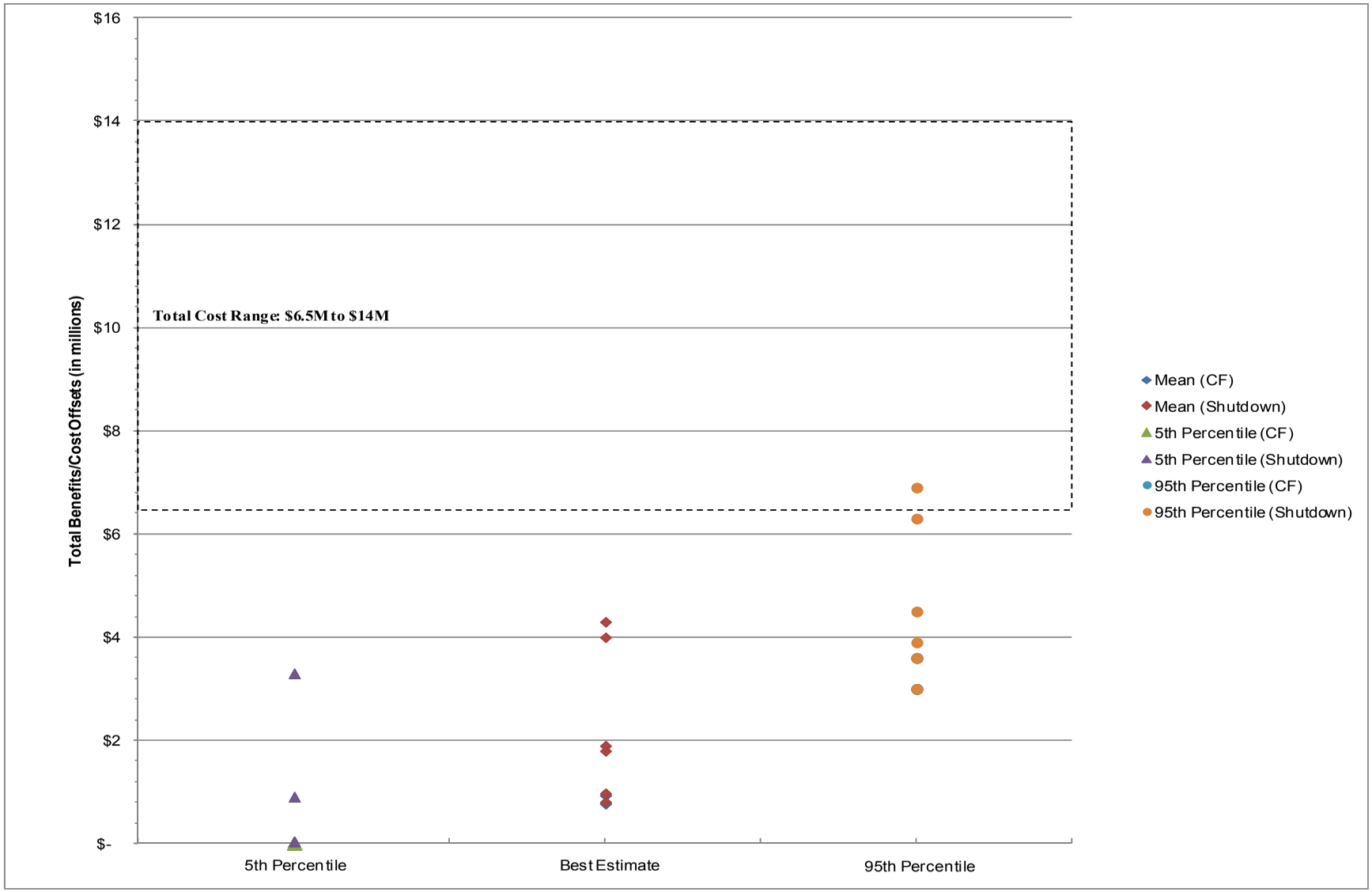


Table 185 (Chart 11) – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark II Containments – 7 Percent Net Present Value

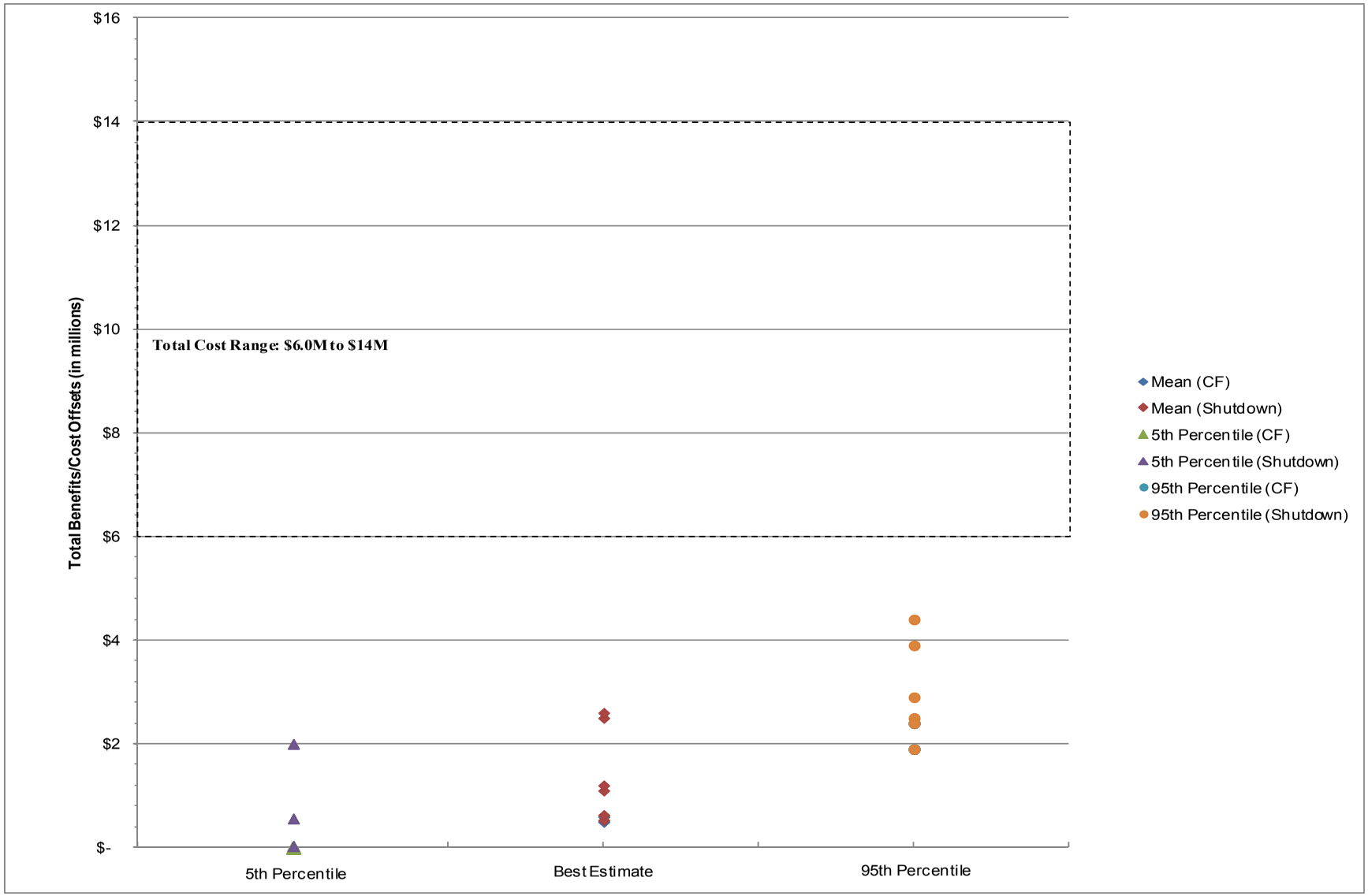


Table 186 (Chart 12) – Sensitivity Analysis per Unit – Severe Accident Capable Vents – Mark II Containments – Undiscounted

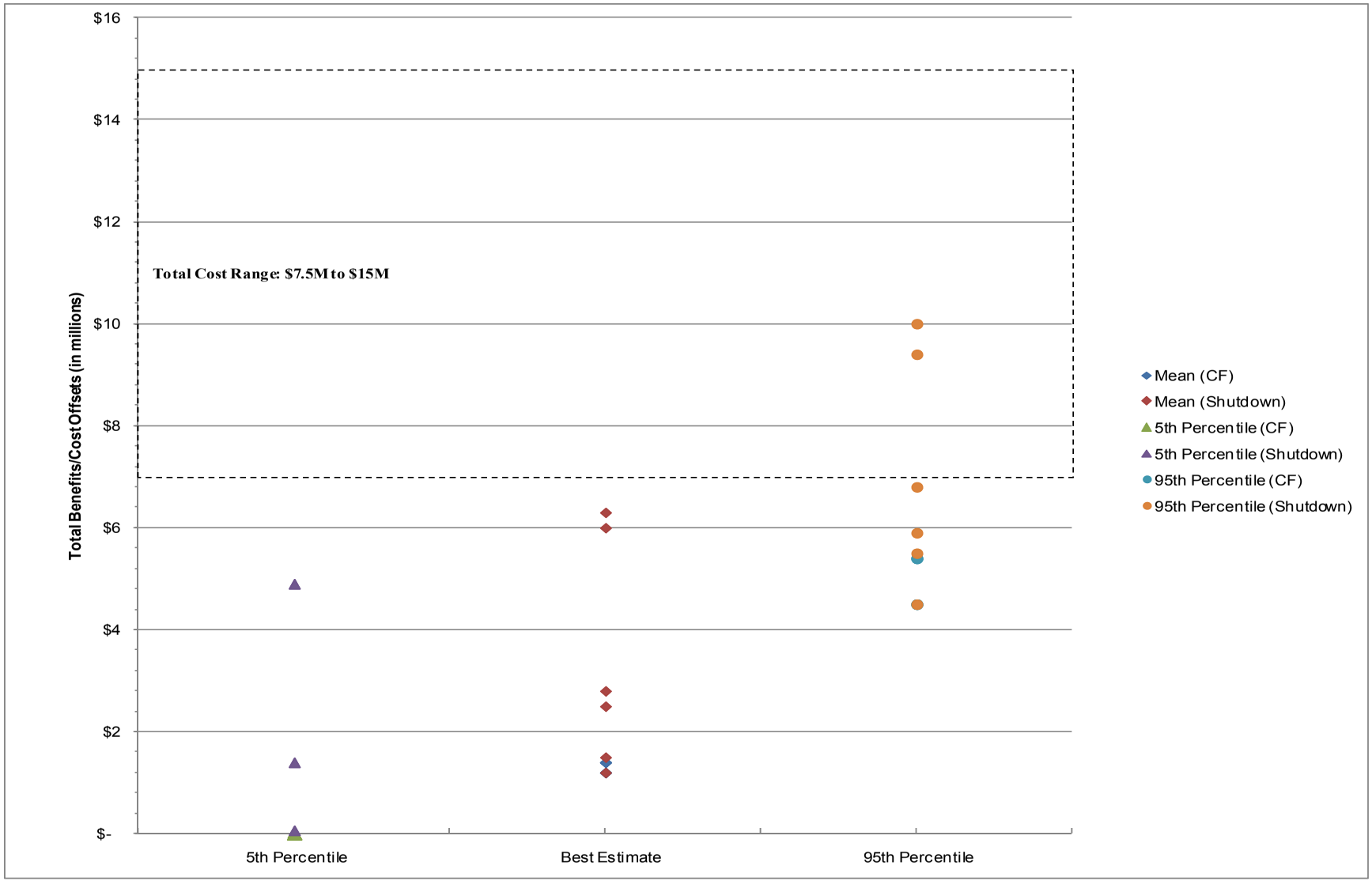


Table 187 – Sensitivity Analysis – Filtered Vents

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$78,000,000	**$52,000,000**	**$34,000,000**	$15,000,000	**$10,000,000**	**$6,300,000**	$240,000,000	**$170,000,000**	**$110,000,000**
$4000 per person-rem	$92,000,000	$61,000,000	$41,000,000	$15,000,000	$10,000,000	$6,400,000	$300,000,000	$200,000,000	$130,000,000
Current Framework w/ High Replacement	$120,000,000	$78,000,000	$51,000,000	$54,000,000	$36,000,000	$23,000,000	$280,000,000	$190,000,000	$120,000,000
Current Framework w/ Low Replacement	$64,000,000	$42,000,000	$28,000,000	$1,000,000	$680,000	$430,000	$230,000,000	$160,000,000	$100,000,000
$4000 per person-rem w/High Replacement	$130,000,000	$87,000,000	$58,000,000	$54,000,000	$36,000,000	$23,000,000	$330,000,000	$230,000,000	$150,000,000
$4000 per person-rem w/Low Replacement	$78,000,000	$52,000,000	$35,000,000	$1,100,000	$730,000	$470,000	$280,000,000	$190,000,000	$130,000,000
Current Framework w/all Mark I/II shutdown	$110,000,000	$70,000,000	$46,000,000	$43,000,000	$28,000,000	$18,000,000	$270,000,000	$180,000,000	$120,000,000
Current Framework w/all Mark I/II shutdown and high replacement	$210,000,000	$140,000,000	$91,000,000	$150,000,000	$100,000,000	$63,000,000	$380,000,000	$260,000,000	$160,000,000
Current Framework w/all Mark I/II shutdown and low replacement	$65,000,000	$43,000,000	$29,000,000	$2,200,000	$1,500,000	$930,000	$230,000,000	$160,000,000	$100,000,000
$4000 per person-rem w/all Mark I/II shutdown	$120,000,000	$79,000,000	$53,000,000	$43,000,000	$28,000,000	$18,000,000	$320,000,000	$220,000,000	$150,000,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$230,000,000	$150,000,000	$98,000,000	$150,000,000	$100,000,000	$63,000,000	$430,000,000	$290,000,000	$190,000,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$79,000,000	$53,000,000	$36,000,000	$2,300,000	$1,600,000	$970,000	$280,000,000	$200,000,000	$130,000,000

Table 188 – Sensitivity Analysis per Unit – Filtered Vents

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$2,500,000	**$1,700,000**	**$1,100,000**	$480,000	**$320,000**	**$200,000**	$7,700,000	**$5,500,000**	**$3,500,000**
$4000 per person-rem	$3,000,000	$2,000,000	$1,300,000	$480,000	$320,000	$210,000	$9,700,000	$6,500,000	$4,200,000
Current Framework w/ High Replacement	$3,900,000	$2,500,000	$1,600,000	$1,700,000	$1,200,000	$740,000	$9,000,000	$6,100,000	$3,900,000
Current Framework w/ Low Replacement	$2,100,000	$1,400,000	$900,000	$32,000	$22,000	$14,000	$7,400,000	$5,200,000	$3,200,000
$4000 per person-rem w/High Replacement	$4,200,000	$2,800,000	$1,900,000	$1,700,000	$1,200,000	$740,000	$11,000,000	$7,400,000	$4,800,000
$4000 per person-rem w/Low Replacement	$2,500,000	$1,700,000	$1,100,000	$35,000	$24,000	$15,000	$9,000,000	$6,100,000	$4,200,000
Current Framework w/all Mark I/II shutdown	$3,500,000	$2,300,000	$1,500,000	$1,400,000	$900,000	$580,000	$8,700,000	$5,800,000	$3,900,000
Current Framework w/all Mark I/II shutdown and high replacement	$6,800,000	$4,500,000	$2,900,000	$4,800,000	$3,200,000	$2,000,000	$12,000,000	$8,400,000	$5,200,000
Current Framework w/all Mark I/II shutdown and low replacement	$2,100,000	$1,400,000	$940,000	$71,000	$48,000	$30,000	$7,400,000	$5,200,000	$3,200,000
$4000 per person-rem w/all Mark I/II shutdown	$3,900,000	$2,500,000	$1,700,000	$1,400,000	$900,000	$580,000	$10,000,000	$7,100,000	$4,800,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$7,400,000	$4,800,000	$3,200,000	$4,800,000	$3,200,000	$2,000,000	$14,000,000	$9,400,000	$6,100,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$2,500,000	$1,700,000	$1,200,000	$74,000	$52,000	$31,000	$9,000,000	$6,500,000	$4,200,000

Table 190 (Chart 14) – Sensitivity Analysis – Filtered Vents – 7 Percent Net Present Value

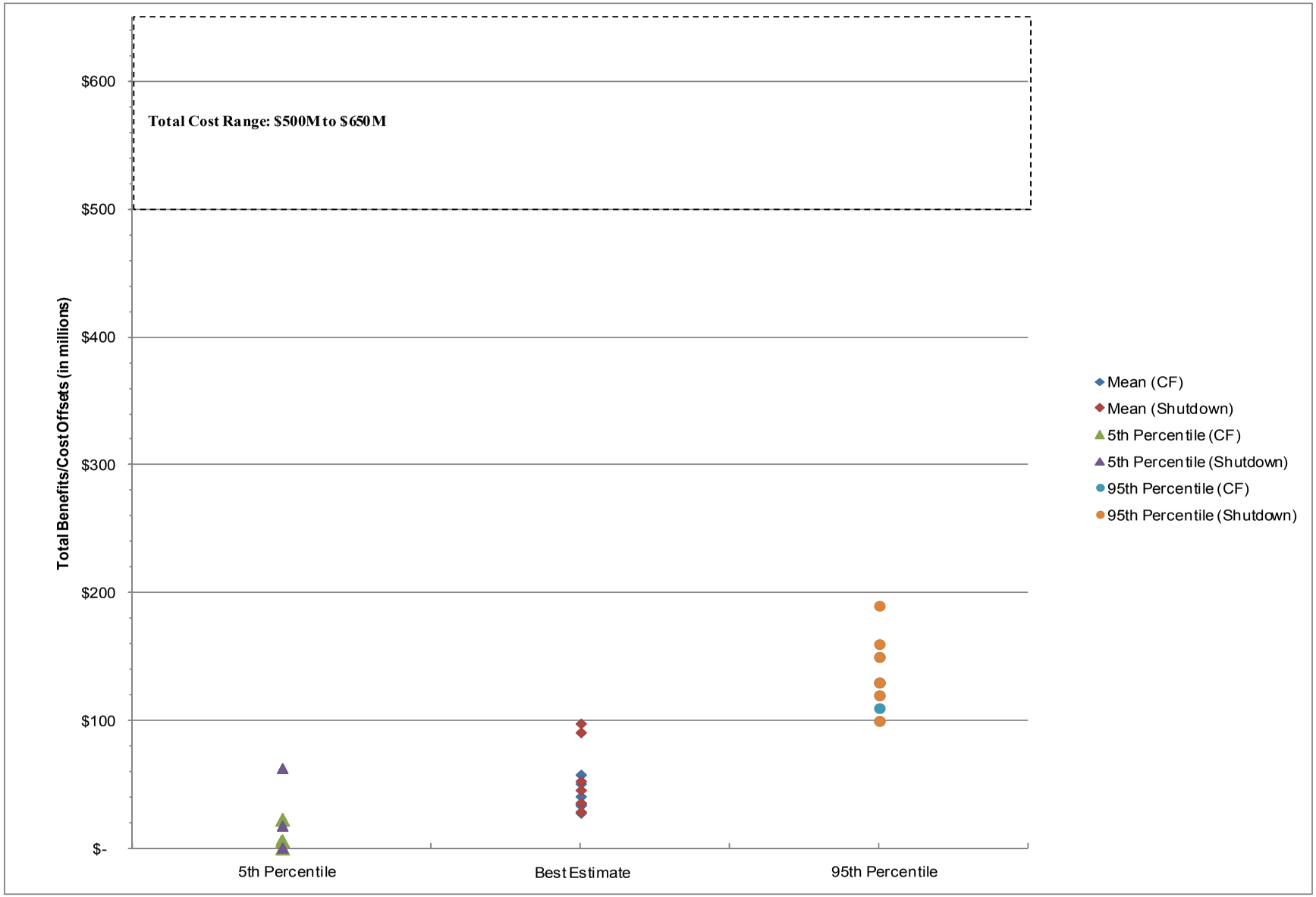


Table 191 (Chart 15) – Sensitivity Analysis – Filtered Vents – Undiscounted

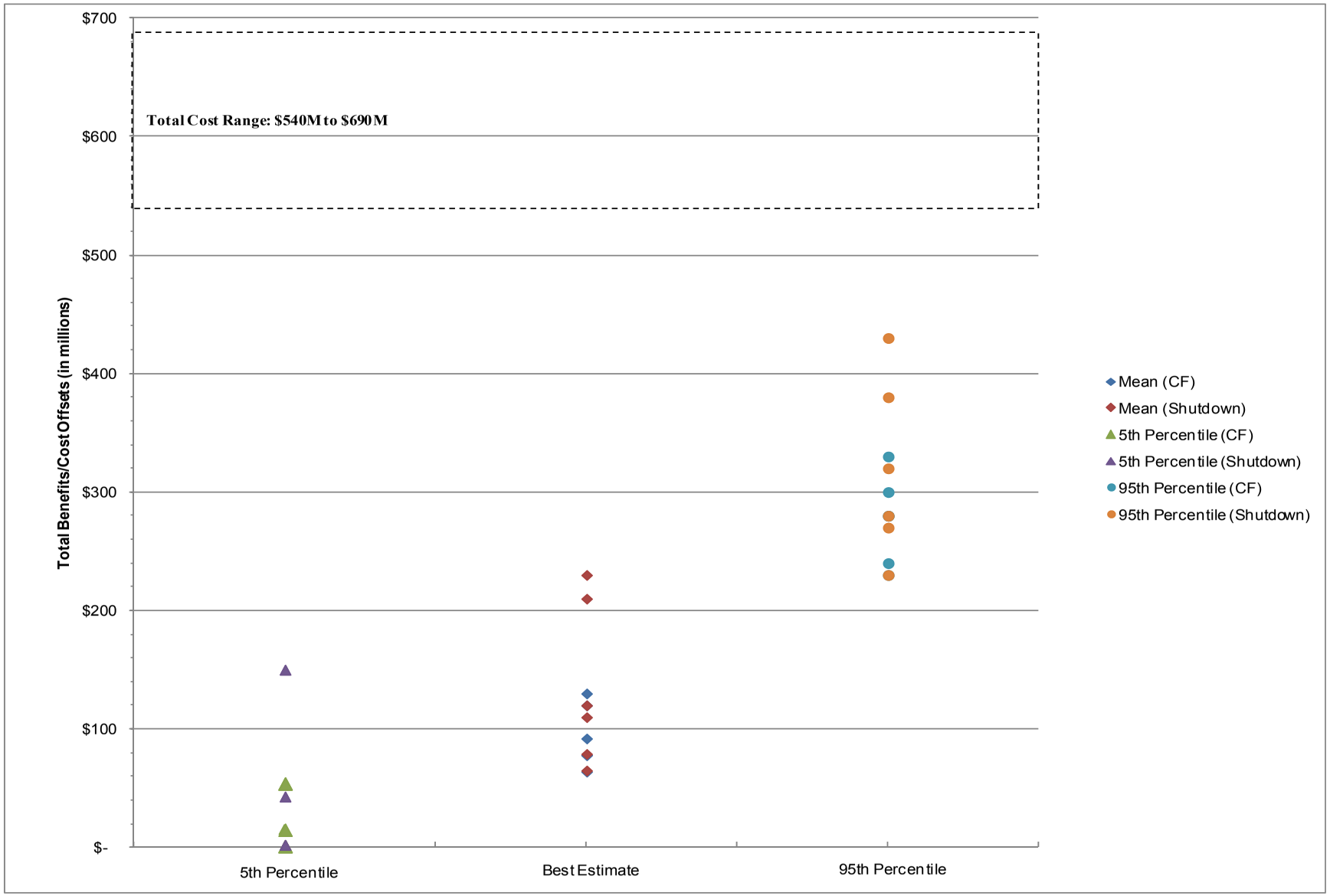


Table 192 (Chart 16) – Sensitivity Analysis per Unit – Filtered Vents – 3 Percent Net Present Value

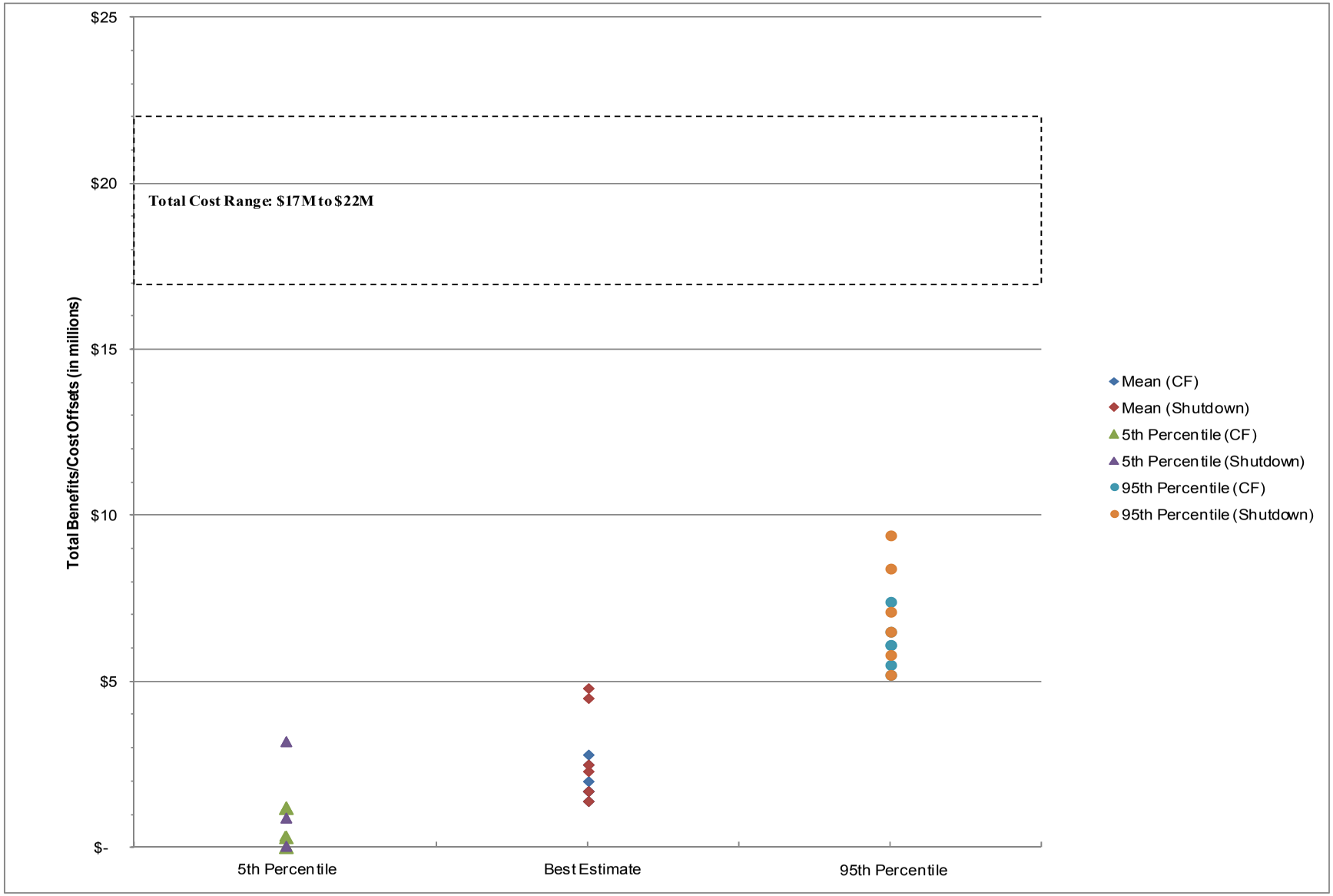


Table 193 (Chart 17) – Sensitivity Analysis per Unit – Filtered Vents – 7 Percent Net Present Value

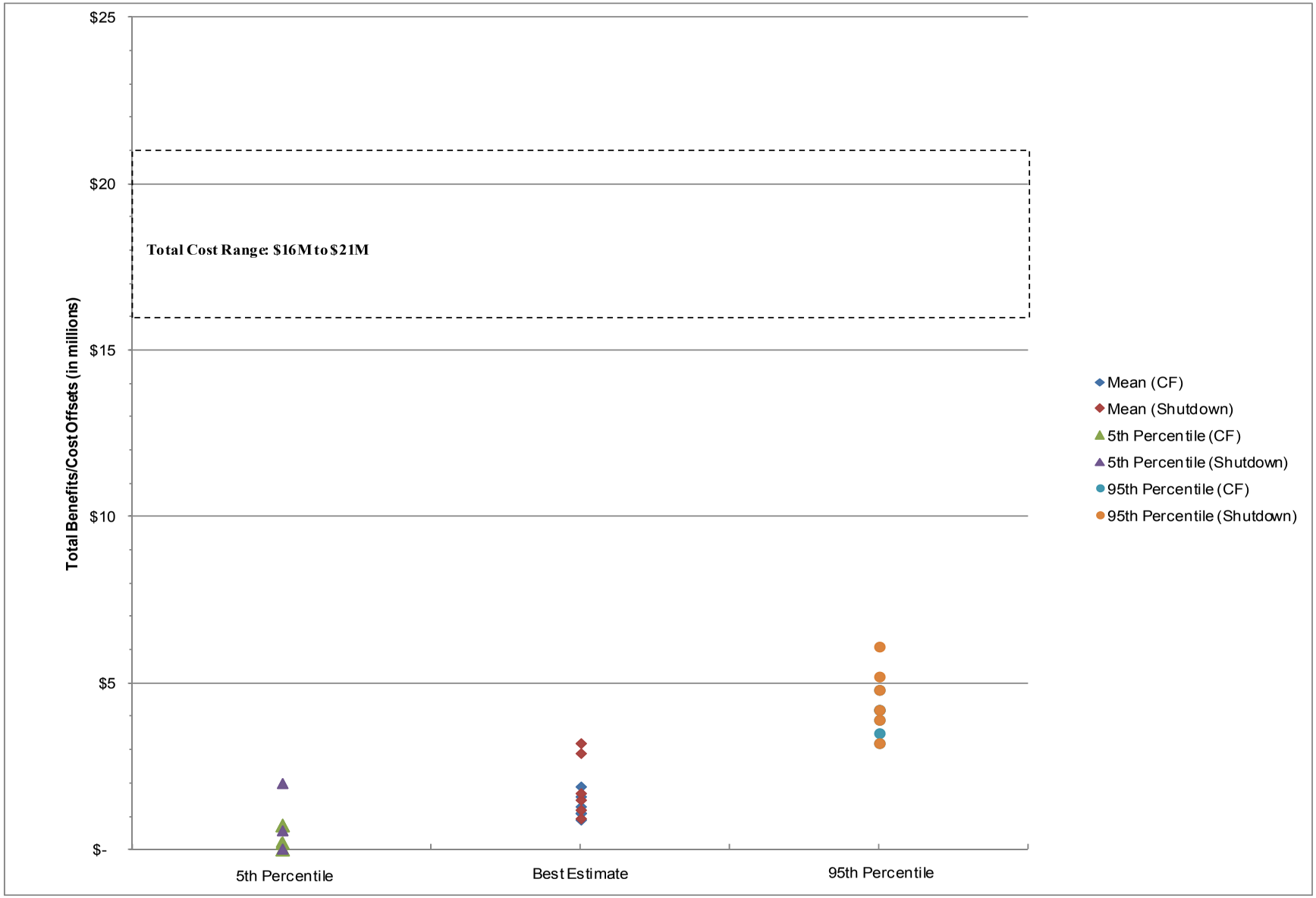


Table 194 (Chart 18) – Sensitivity Analysis per Unit – Filtered Vents – Undiscounted

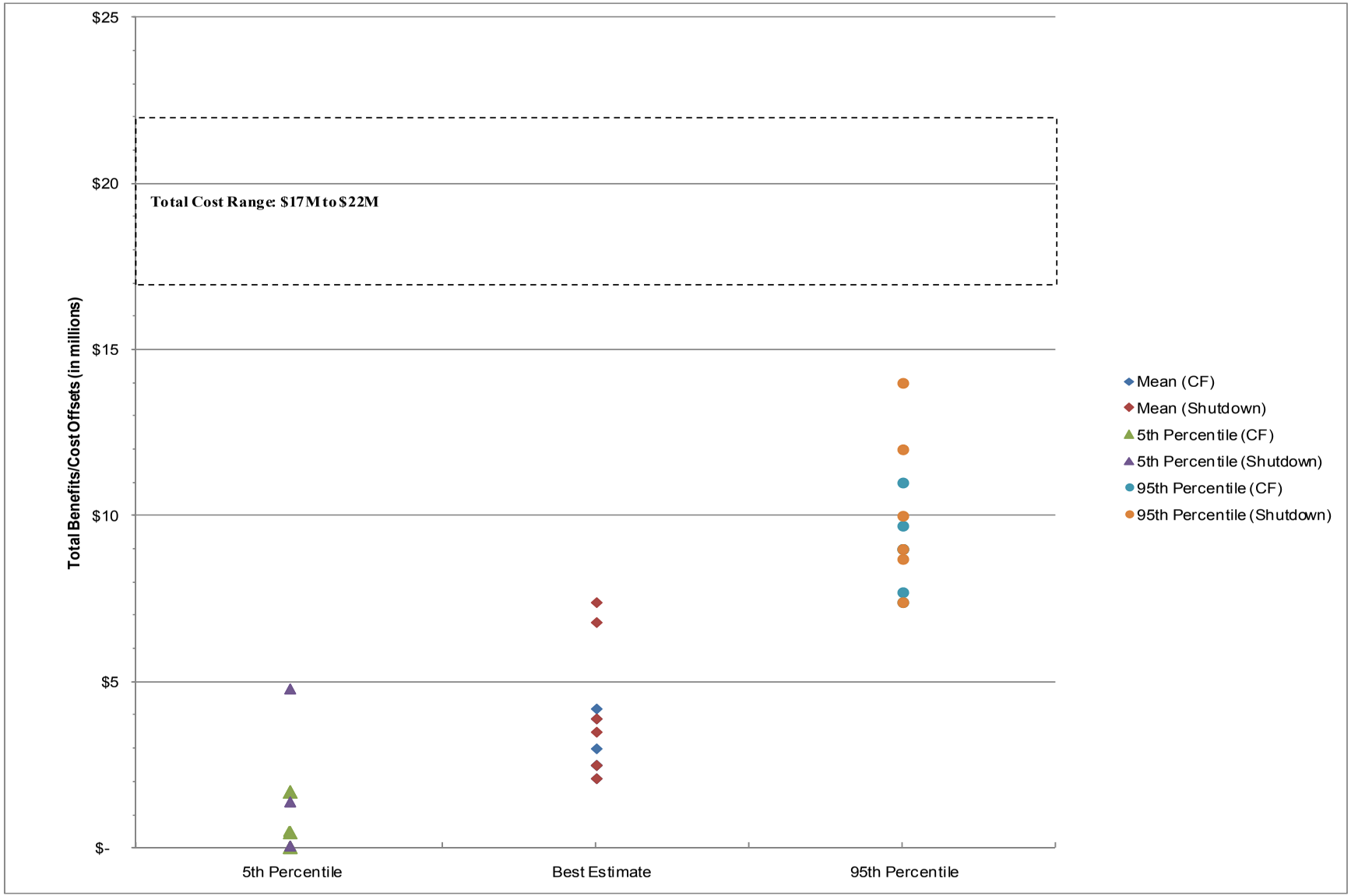


Table 195 – Sensitivity Analysis – Severe Accident Confinement Strategy

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$70,000,000	**$45,000,000**	**$28,000,000**	$12,000,000	**$7,300,000**	**$4,000,000**	$220,000,000	**$150,000,000**	**$91,000,000**
$4000 per person-rem	$83,000,000	$53,000,000	$34,000,000	$12,000,000	$7,400,000	$4,100,000	$270,000,000	$180,000,000	$110,000,000
Current Framework w/ High Replacement	$99,000,000	$63,000,000	$38,000,000	$41,000,000	$25,000,000	$14,000,000	$250,000,000	$160,000,000	$100,000,000
Current Framework w/ Low Replacement	$58,000,000	$38,000,000	$24,000,000	$830,000	$520,000	$310,000	$210,000,000	$140,000,000	$88,000,000
$4000 per person-rem w/High Replacement	$110,000,000	$71,000,000	$44,000,000	$41,000,000	$25,000,000	$14,000,000	$300,000,000	$200,000,000	$120,000,000
$4000 per person-rem w/Low Replacement	$71,000,000	$46,000,000	$30,000,000	$900,000	$570,000	$340,000	$260,000,000	$170,000,000	$110,000,000
Current Framework w/all Mark I/II shutdown	$100,000,000	$66,000,000	$42,000,000	$43,000,000	$28,000,000	$18,000,000	$250,000,000	$170,000,000	$110,000,000
Current Framework w/all Mark I/II shutdown and high replacement	$210,000,000	$140,000,000	$87,000,000	$150,000,000	$100,000,000	$63,000,000	$360,000,000	$240,000,000	$150,000,000
Current Framework w/all Mark I/II shutdown and low replacement	$60,000,000	$39,000,000	$25,000,000	$2,200,000	$1,500,000	$910,000	$210,000,000	$140,000,000	$88,000,000
$4000 per person-rem w/all Mark I/II shutdown	$110,000,000	$74,000,000	$48,000,000	$43,000,000	$28,000,000	$18,000,000	$300,000,000	$200,000,000	$130,000,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$220,000,000	$150,000,000	$93,000,000	$150,000,000	$100,000,000	$63,000,000	$410,000,000	$270,000,000	$170,000,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$73,000,000	$47,000,000	$31,000,000	$2,300,000	$1,600,000	$940,000	$260,000,000	$170,000,000	$110,000,000

Table 196 – Sensitivity Analysis per Unit – Severe Accident Confinement Strategy

Framework	Mean			5th Percentile			95th Percentile		
	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV	Undiscounted	3% NPV	7% NPV
Current Framework	$2,300,000	**$1,500,000**	**$900,000**	$390,000	**$240,000**	**$130,000**	$7,100,000	**$4,800,000**	**$2,900,000**
$4000 per person-rem	$2,700,000	$1,700,000	$1,100,000	$390,000	$240,000	$130,000	$8,700,000	$5,800,000	$3,500,000
Current Framework w/ High Replacement	$3,200,000	$2,000,000	$1,200,000	$1,300,000	$810,000	$450,000	$8,100,000	$5,200,000	$3,200,000
Current Framework w/ Low Replacement	$1,900,000	$1,200,000	$770,000	$27,000	$17,000	$10,000	$6,800,000	$4,500,000	$2,800,000
$4000 per person-rem w/High Replacement	$3,500,000	$2,300,000	$1,400,000	$1,300,000	$810,000	$450,000	$9,700,000	$6,500,000	$3,900,000
$4000 per person-rem w/Low Replacement	$2,300,000	$1,500,000	$970,000	$29,000	$18,000	$11,000	$8,400,000	$5,500,000	$3,500,000
Current Framework w/all Mark I/II shutdown	$3,200,000	$2,100,000	$1,400,000	$1,400,000	$900,000	$580,000	$8,100,000	$5,500,000	$3,500,000
Current Framework w/all Mark I/II shutdown and high replacement	$6,800,000	$4,500,000	$2,800,000	$4,800,000	$3,200,000	$2,000,000	$12,000,000	$7,700,000	$4,800,000
Current Framework w/all Mark I/II shutdown and low replacement	$1,900,000	$1,300,000	$810,000	$71,000	$48,000	$29,000	$6,800,000	$4,500,000	$2,800,000
$4000 per person-rem w/all Mark I/II shutdown	$3,500,000	$2,400,000	$1,500,000	$1,400,000	$900,000	$580,000	$9,700,000	$6,500,000	$4,200,000
$4000 per person-rem w/all Mark I/II shutdown and high replacement	$7,100,000	$4,800,000	$3,000,000	$4,800,000	$3,200,000	$2,000,000	$13,000,000	$8,700,000	$5,500,000
$4000 per person-rem w/all Mark I/II shutdown and low replacement	$2,400,000	$1,500,000	$1,000,000	$74,000	$52,000	$30,000	$8,400,000	$5,500,000	$3,500,000

Table 198 (Chart 20) – Sensitivity Analysis – Severe Accident Confinement Strategy – 7 Percent Net Present Value

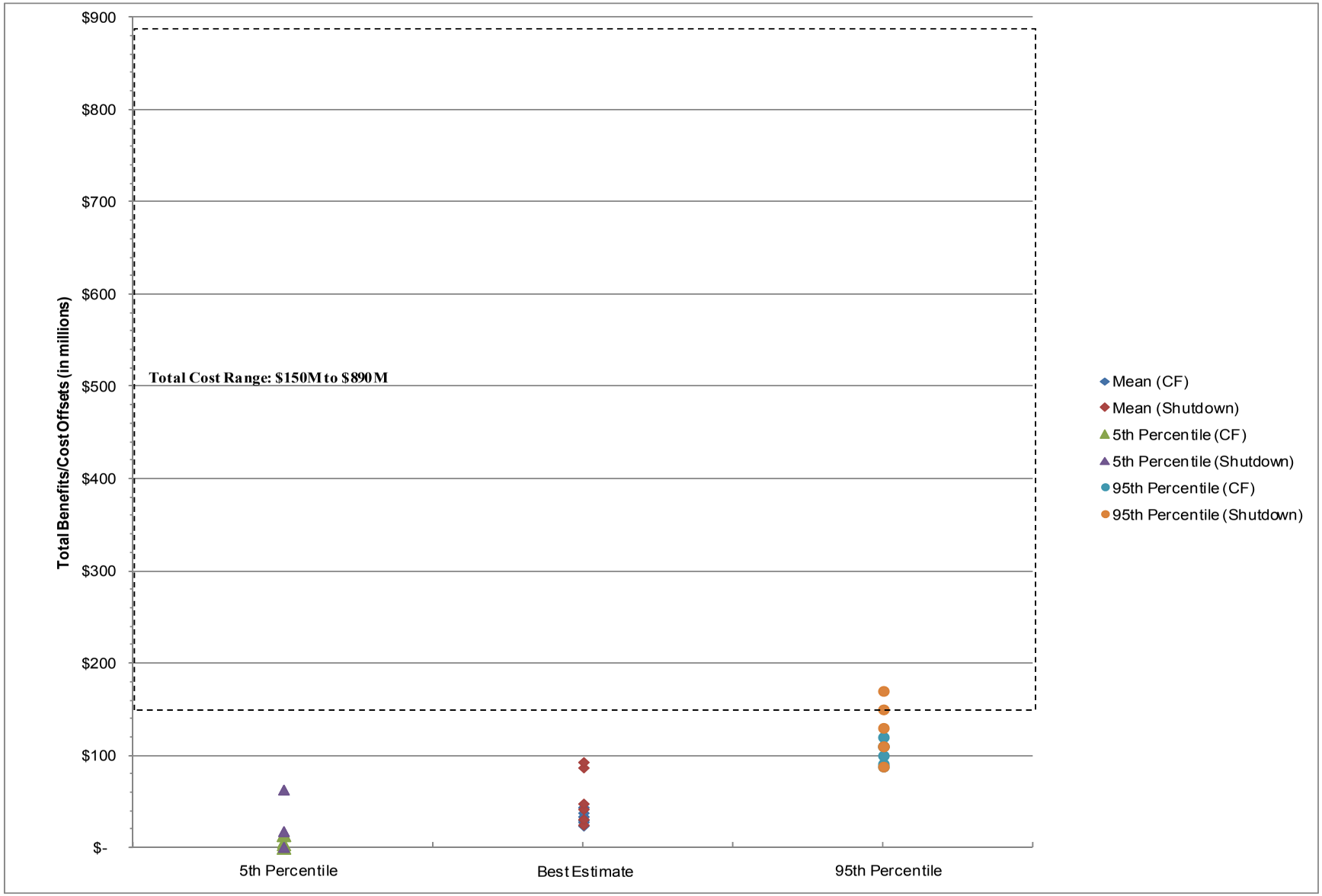


Table 199 (Chart 21) – Sensitivity Analysis – Severe Accident Confinement Strategy – Undiscounted

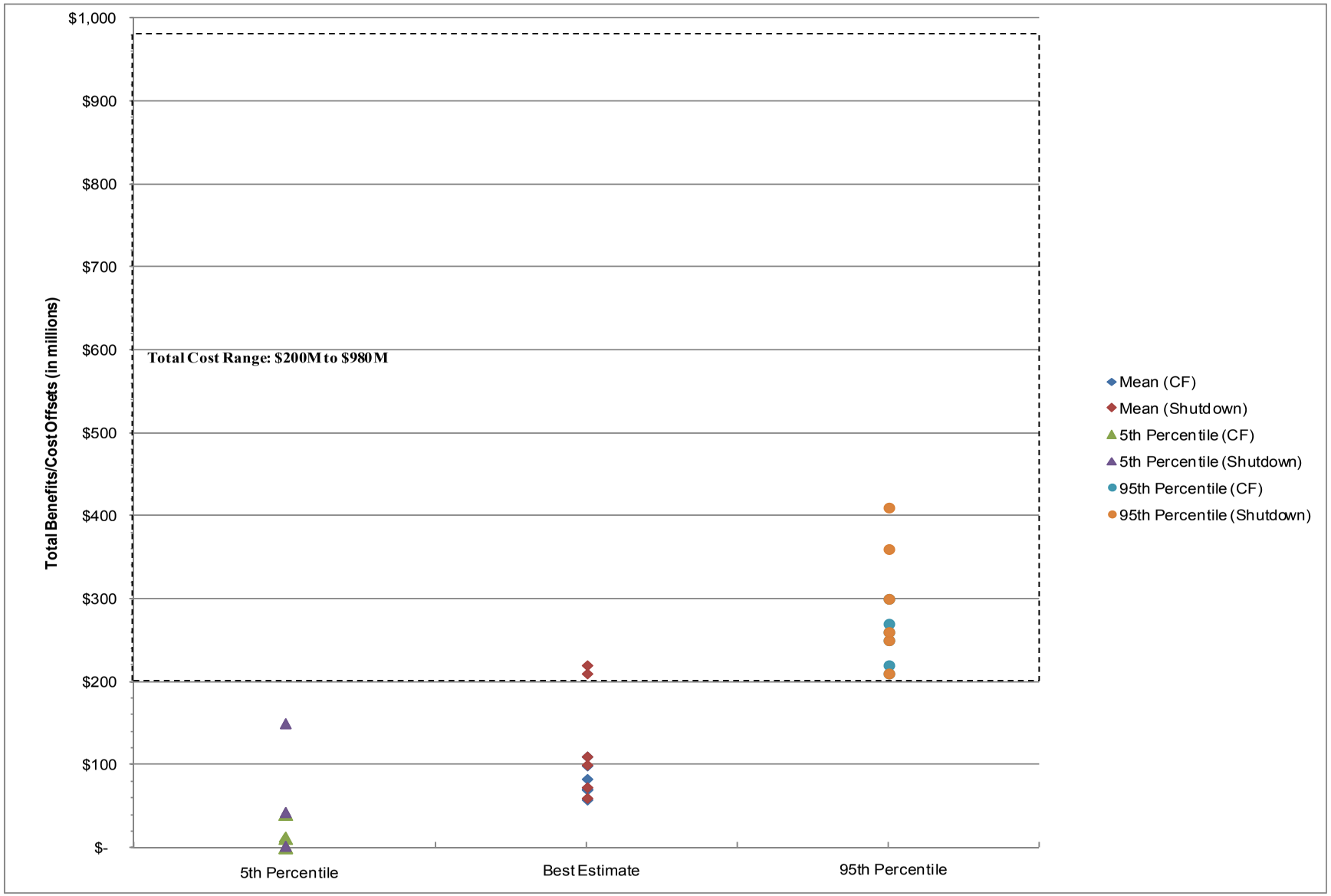


Table 200 (Chart 22) – Sensitivity Analysis per Unit – Severe Accident Confinement Strategy – 3 Percent Net Present Value

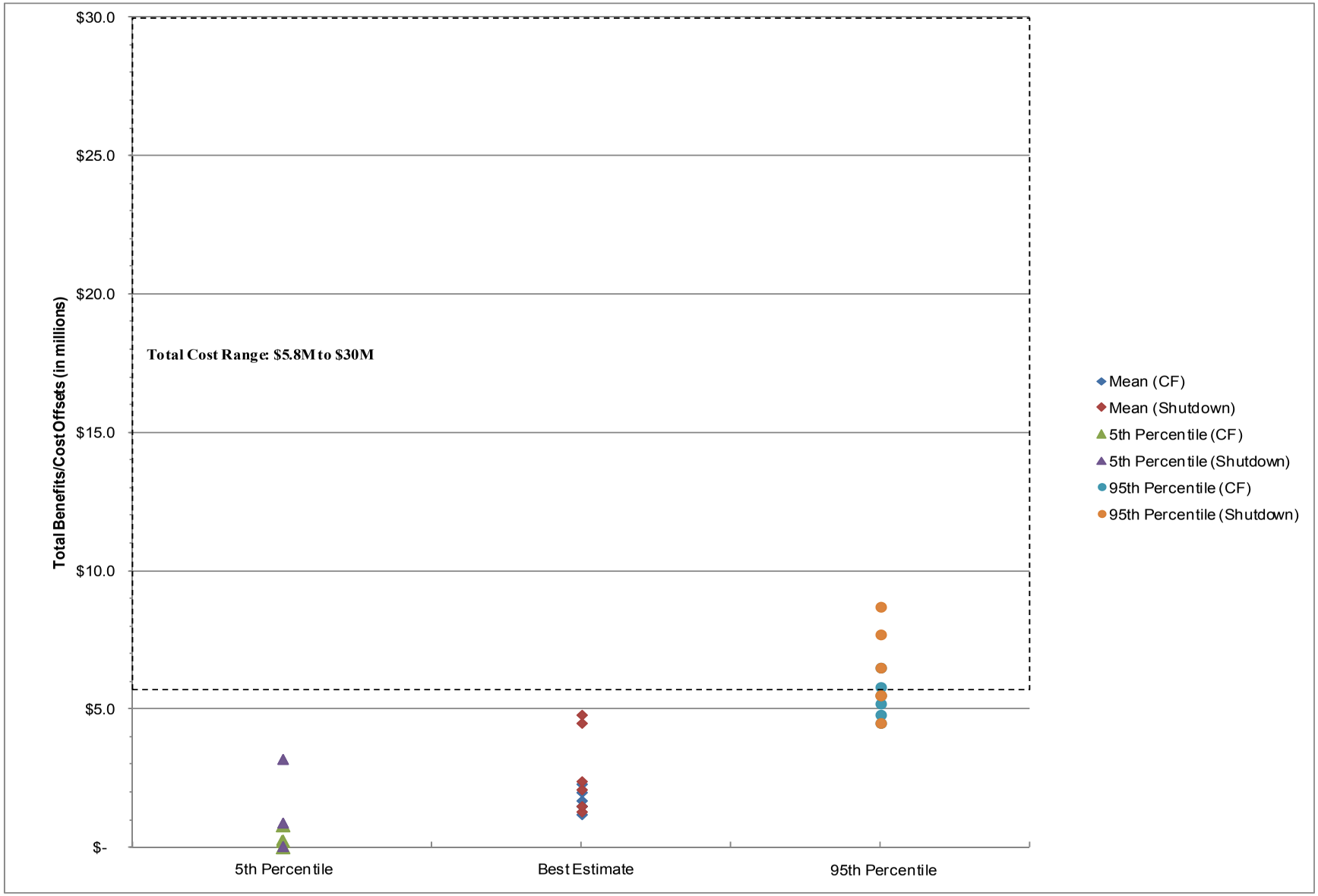


Table 201 (Chart 23) – Sensitivity Analysis per Unit – Severe Accident Confinement Strategy – 7 Percent Net Present Value

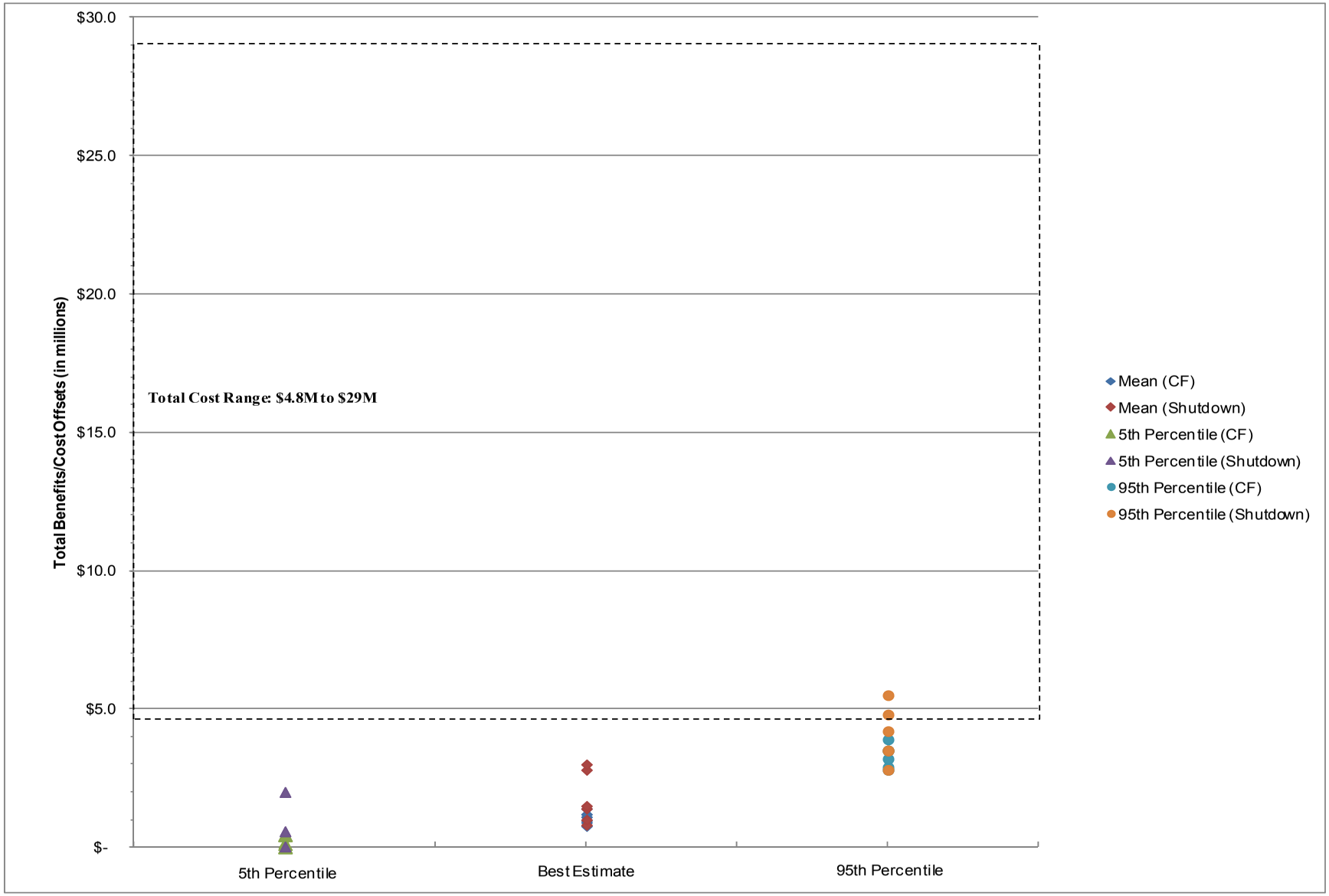


Table 202 (Chart 24) – Sensitivity Analysis per Unit – Severe Accident Confinement Strategy – Undiscounted

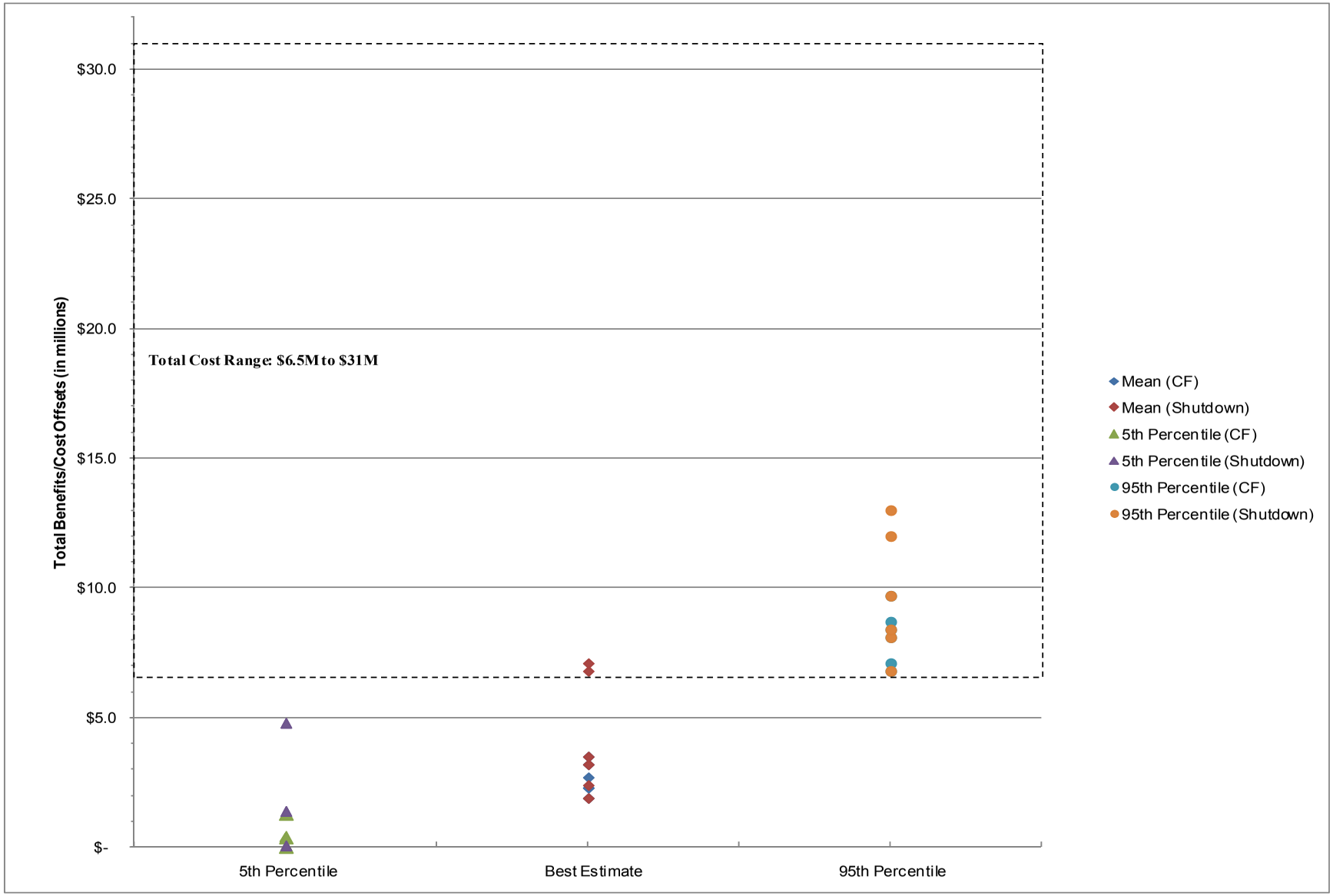


Table 206 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Capable Vents – Mark I Containments

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$210,000	$150,000	$100,000
Occupational Health (Accident)	$10,000	$7,400	$5,200
Offsite Property	$520,000	$370,000	$250,000
Onsite Property	$400,000	$240,000	$140,000
Replacement Energy	$0	$0	$0
Industry Implementation	($2,000,000)	($2,000,000)	($2,000,000)
Industry Operation	($1,000,000)	($740,000)	($520,000)
NRC Implementation	($19,000)	($19,000)	($19,000)
NRC Operation	($520,000)	($370,000)	($250,000)
Total:	**($2,400,000)**	**($2,400,000)**	**($2,300,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$210,000	$150,000	$100,000
Occupational Health (Accident)	$10,000	$7,400	$5,200
Offsite Property	$520,000	$370,000	$250,000
Onsite Property	$400,000	$240,000	$140,000
Replacement Energy	$0	$0	$0
Industry Implementation	($3,000,000)	($3,000,000)	($3,000,000)
Industry Operation	($1,000,000)	($740,000)	($520,000)
NRC Implementation	($19,000)	($19,000)	($19,000)
NRC Operation	($520,000)	($370,000)	($250,000)
Total:	**($3,400,000)**	**($3,400,000)**	**($3,300,000)**

Table 207 – "Best Estimate" Costs and Benefits – Severe Accident Capable Vents – Mark I Containments – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$29,000	$20,000	$14,000
Occupational Health (Accident)	$1,300	$940	$650
Offsite Property	$60,000	$42,000	$29,000
Onsite Property	$47,000	$29,000	$16,000
Replacement Energy	$0	$0	$0
Industry Implementation	($46,000,000)	($46,000,000)	($46,000,000)
Industry Operation	($24,000,000)	($17,000,000)	($12,000,000)
NRC Implementation	($440,000)	($440,000)	($440,000)
NRC Operation	($12,000,000)	($8,500,000)	($5,800,000)
Total:	**($82,000,000)**	**($72,000,000)**	**($64,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$29,000	$20,000	$14,000
Occupational Health (Accident)	$1,300	$940	$650
Offsite Property	$60,000	$42,000	$29,000
Onsite Property	$47,000	$29,000	$16,000
Replacement Energy	$0	$0	$0
Industry Implementation	($69,000,000)	($69,000,000)	($69,000,000)
Industry Operation	($24,000,000)	($17,000,000)	($12,000,000)
NRC Implementation	($440,000)	($440,000)	($440,000)
NRC Operation	($12,000,000)	($8,500,000)	($5,800,000)
Total:	**($110,000,000)**	**($95,000,000)**	**($87,000,000)**

Table 208 – "Best Estimate" Costs and Benefits – Severe Accident Capable Vents per Unit – Mark I Containments – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,300	$870	$610
Occupational Health (Accident)	$57	$41	$28
Offsite Property	$2,600	$1,800	$1,300
Onsite Property	$2,000	$1,300	$700
Replacement Energy	$0	$0	$0
Industry Implementation	($2,000,000)	($2,000,000)	($2,000,000)
Industry Operation	($1,000,000)	($740,000)	($520,000)
NRC Implementation	($19,000)	($19,000)	($19,000)
NRC Operation	($520,000)	($370,000)	($250,000)
Total:	**($3,500,000)**	**($3,100,000)**	**($2,800,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,300	$870	$610
Occupational Health (Accident)	$57	$41	$28
Offsite Property	$2,600	$1,800	$1,300
Onsite Property	$2,000	$1,300	$700
Replacement Energy	$0	$0	$0
Industry Implementation	($3,000,000)	($3,000,000)	($3,000,000)
Industry Operation	($1,000,000)	($740,000)	($520,000)
NRC Implementation	($19,000)	($19,000)	($19,000)
NRC Operation	($520,000)	($370,000)	($250,000)
Total:	**($4,500,000)**	**($4,100,000)**	**($3,800,000)**

Table 209 – "Best Estimate" Costs and Benefits – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$20,000,000	$14,000,000	$9,900,000
Occupational Health (Accident)	$1,100,000	$760,000	$520,000
Offsite Property	$44,000,000	$31,000,000	$22,000,000
Onsite Property	$34,000,000	$20,000,000	$12,000,000
Replacement Energy	$0	$0	$0
Industry Implementation	($46,000,000)	($46,000,000)	($46,000,000)
Industry Operation	($24,000,000)	($17,000,000)	($12,000,000)
NRC Implementation	($440,000)	($440,000)	($440,000)
NRC Operation	($12,000,000)	($8,500,000)	($5,800,000)
Total:	**$17,000,000**	**($6,200,000)**	**($20,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$20,000,000	$14,000,000	$9,900,000
Occupational Health (Accident)	$1,100,000	$760,000	$520,000
Offsite Property	$44,000,000	$31,000,000	$22,000,000
Onsite Property	$34,000,000	$20,000,000	$12,000,000
Replacement Energy	$0	$0	$0
Industry Implementation	($69,000,000)	($69,000,000)	($69,000,000)
Industry Operation	($24,000,000)	($17,000,000)	($12,000,000)
NRC Implementation	($440,000)	($440,000)	($440,000)
NRC Operation	($12,000,000)	($8,500,000)	($5,800,000)
Total:	**($6,300,000)**	**($29,000,000)**	**($43,000,000)**

Table 210 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Capable Vents – Mark I Containments – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$870,000	$610,000	$430,000
Occupational Health (Accident)	$48,000	$33,000	$23,000
Offsite Property	$1,900,000	$1,300,000	$960,000
Onsite Property	$1,500,000	$870,000	$520,000
Replacement Energy	$0	$0	$0
Industry Implementation	($2,000,000)	($2,000,000)	($2,000,000)
Industry Operation	($1,000,000)	($740,000)	($520,000)
NRC Implementation	($19,000)	($19,000)	($19,000)
NRC Operation	($520,000)	($370,000)	($250,000)
Total:	**$780,000**	**($320,000)**	**($860,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$870,000	$610,000	$430,000
Occupational Health (Accident)	$48,000	$33,000	$23,000
Offsite Property	$1,900,000	$1,300,000	$960,000
Onsite Property	$1,500,000	$870,000	$520,000
Replacement Energy	$0	$0	$0
Industry Implementation	($3,000,000)	($3,000,000)	($3,000,000)
Industry Operation	($1,000,000)	($740,000)	($520,000)
NRC Implementation	($19,000)	($19,000)	($19,000)
NRC Operation	($520,000)	($370,000)	($250,000)
Total:	**($220,000)**	**($1,300,000)**	**($1,900,000)**

Table 212 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark I Containments at 7 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5th Percentile)	Best Estimate (Point-Estimate)	High Estimate (95th Percentile)
Costs	$64 to $87	$64 to $87	$64 to $87
Benefits	$0.060 to $0.074 + B_Q	$12 to $14 + B_Q	$45 to $55 + B_Q
Net benefits (benefits – costs)	($87) to ($64) + B_Q	($75) to ($50) + B_Q	($42) to $9.0 + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

Table 213 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark I Containments at Undiscounted Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$82 to $110	$82 to $110	$82 to $110
Benefits	$0.14 to $0.17 + B_Q	$26 to $32 + B_Q	$100 to $120 + B_Q
Net benefits (benefits – costs)	($110) to ($82) + B_Q	($84) to ($50) + B_Q	($10) to $38 + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

Table 25 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Capable Vents – Mark II Containments

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$210,000	$150,000	$110,000
Occupational Health (Accident)	$10,000	$7,400	$5,000
Offsite Property	$530,000	$380,000	$250,000
Onsite Property	$390,000	$240,000	$140,000
Replacement Energy	$0	$0	$0
Industry Implementation	($5,000,000)	($5,000,000)	($5,000,000)
Industry Operation	($1,500,000)	($1,100,000)	($760,000)
NRC Implementation	($38,000)	($38,000)	($38,000)
NRC Operation	($530,000)	($380,000)	($250,000)
Total:	**($5,900,000)**	**($5,700,000)**	**($5,500,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$210,000	$150,000	$110,000
Occupational Health (Accident)	$10,000	$7,400	$5,000
Offsite Property	$530,000	$380,000	$250,000
Onsite Property	$390,000	$240,000	$140,000
Replacement Energy	$0	$0	$0
Industry Implementation	($13,000,000)	($13,000,000)	($13,000,000)
Industry Operation	($1,500,000)	($1,100,000)	($760,000)
NRC Implementation	($38,000)	($38,000)	($38,000)
NRC Operation	($530,000)	($380,000)	($250,000)
Total:	**($14,000,000)**	**($14,000,000)**	**($14,000,000)**

Table 216 – "Best Estimate" Costs and Benefits – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$9,600	$6,800	$4,700
Occupational Health (Accident)	$470	$330	$230
Offsite Property	$21,000	$15,000	$10,000
Onsite Property	$16,000	$10,000	$5,700
Replacement Energy	$0	$0	$0
Industry Implementation	($40,000,000)	($40,000,000)	($40,000,000)
Industry Operation	($12,000,000)	($8,900,000)	($6,100,000)
NRC Implementation	($300,000)	($300,000)	($300,000)
NRC Operation	($4,200,000)	($3,000,000)	($2,000,000)
Total:	**($56,000,000)**	**($52,000,000)**	**($48,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$9,600	$6,800	$4,700
Occupational Health (Accident)	$470	$330	$230
Offsite Property	$21,000	$15,000	$10,000
Onsite Property	$16,000	$10,000	$5,700
Replacement Energy	$0	$0	$0
Industry Implementation	($100,000,000)	($100,000,000)	($100,000,000)
Industry Operation	($12,000,000)	($8,900,000)	($6,100,000)
NRC Implementation	($300,000)	($300,000)	($300,000)
NRC Operation	($4,200,000)	($3,000,000)	($2,000,000)
Total:	**($120,000,000)**	**($110,000,000)**	**($110,000,000)**

Table 217 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Capable Vents – Mark II Containments – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,200	$850	$590
Occupational Health (Accident)	$59	$41	$29
Offsite Property	$2,600	$1,900	$1,300
Onsite Property	$2,000	$1,300	$710
Replacement Energy	$0	$0	$0
Industry Implementation	($5,000,000)	($5,000,000)	($5,000,000)
Industry Operation	($1,500,000)	($1,100,000)	($760,000)
NRC Implementation	($38,000)	($38,000)	($38,000)
NRC Operation	($530,000)	($380,000)	($250,000)
Total:	**($7,100,000)**	**($6,500,000)**	**($6,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,200	$850	$590
Occupational Health (Accident)	$59	$41	$29
Offsite Property	$2,600	$1,900	$1,300
Onsite Property	$2,000	$1,300	$710
Replacement Energy	$0	$0	$0
Industry Implementation	($13,000,000)	($13,000,000)	($13,000,000)
Industry Operation	($1,500,000)	($1,100,000)	($760,000)
NRC Implementation	($38,000)	($38,000)	($38,000)
NRC Operation	($530,000)	($380,000)	($250,000)
Total:	**($15,000,000)**	**($15,000,000)**	**($14,000,000)**

Table 218 – "Best Estimate" Costs and Benefits – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$7,000,000	$5,000,000	$3,400,000
Occupational Health (Accident)	$360,000	$260,000	$180,000
Offsite Property	$16,000,000	$11,000,000	$7,600,000
Onsite Property	$12,000,000	$7,100,000	$4,000,000
Replacement Energy	$0	$0	$0
Industry Implementation	($40,000,000)	($40,000,000)	($40,000,000)
Industry Operation	($12,000,000)	($8,900,000)	($6,100,000)
NRC Implementation	($300,000)	($300,000)	($300,000)
NRC Operation	($4,200,000)	($3,000,000)	($2,000,000)
Total:	**($21,000,000)**	**($29,000,000)**	**($33,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$7,000,000	$5,000,000	$3,400,000
Occupational Health (Accident)	$360,000	$260,000	$180,000
Offsite Property	$16,000,000	$11,000,000	$7,600,000
Onsite Property	$12,000,000	$7,100,000	$4,000,000
Replacement Energy	$0	$0	$0
Industry Implementation	($100,000,000)	($100,000,000)	($100,000,000)
Industry Operation	($12,000,000)	($8,900,000)	($6,100,000)
NRC Implementation	($300,000)	($300,000)	($300,000)
NRC Operation	($4,200,000)	($3,000,000)	($2,000,000)
Total:	**($81,000,000)**	**($89,000,000)**	**($93,000,000)**

Table 219 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Capable Vents – Mark II Containments – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$880,000	$630,000	$430,000
Occupational Health (Accident)	$45,000	$33,000	$23,000
Offsite Property	$2,000,000	$1,400,000	$950,000
Onsite Property	$1,500,000	$890,000	$500,000
Replacement Energy	$0	$0	$0
Industry Implementation	($5,000,000)	($5,000,000)	($5,000,000)
Industry Operation	($1,500,000)	($1,100,000)	($760,000)
NRC Implementation	($38,000)	($38,000)	($38,000)
NRC Operation	($530,000)	($380,000)	($250,000)
Total:	**($2,600,000)**	**($3,600,000)**	**($4,100,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$880,000	$630,000	$430,000
Occupational Health (Accident)	$45,000	$33,000	$23,000
Offsite Property	$2,000,000	$1,400,000	$950,000
Onsite Property	$1,500,000	$890,000	$500,000
Replacement Energy	$0	$0	$0
Industry Implementation	($13,000,000)	($13,000,000)	($13,000,000)
Industry Operation	($1,500,000)	($1,100,000)	($760,000)
NRC Implementation	($38,000)	($38,000)	($38,000)
NRC Operation	($530,000)	($380,000)	($250,000)
Total:	**($11,000,000)**	**($12,000,000)**	**($12,000,000)**

Table 221 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark II Containments at 3 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$48 to $110	$48 to $110	$48 to $110
Benefits	$0.021 to $0.026 + B_Q	$4.0 to $4.8 + B_Q	$15 to $19 + B_Q
Net benefits (benefits – costs)	($110) to ($48) + B_Q	($110) to ($43) + B_Q	($95) to ($29) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

Table 222 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Severe Accident Capable Vents for Mark II Containments at Undiscounted Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$56 to $120	$56 to $120	$56 to $120
Benefits	$0.047 to $0.058 + B_Q	$9.2 to $11 + B_Q	$36 to $43 + B_Q
Net benefits (benefits – costs)	($120) to ($56) + B_Q	($110) to ($45) + B_Q	($84) to ($13) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

Table 224 – "Best Estimate" Costs and Benefits per Unit – Filtered Vents

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$570,000	$400,000	$270,000
Occupational Health (Accident)	$18,000	$13,000	$8,700
Offsite Property	$1,300,000	$870,000	$610,000
Onsite Property	$870,000	$520,000	$310,000
Replacement Energy	$650,000	$430,000	$270,000
Industry Implementation	($20,000,000)	($20,000,000)	($20,000,000)
Industry Operation	($2,100,000)	($1,500,000)	($1,000,000)
NRC Implementation	($37,000)	($37,000)	($37,000)
NRC Operation	($700,000)	($480,000)	($340,000)
Total:	**($19,000,000)**	**($20,000,000)**	**($20,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$570,000	$400,000	$270,000
Occupational Health (Accident)	$18,000	$13,000	$8,700
Offsite Property	$1,300,000	$870,000	$610,000
Onsite Property	$870,000	$520,000	$310,000
Replacement Energy	$650,000	$430,000	$270,000
Industry Implementation	($27,000,000)	($27,000,000)	($27,000,000)
Industry Operation	($2,100,000)	($1,500,000)	($1,000,000)
NRC Implementation	($37,000)	($37,000)	($37,000)
NRC Operation	($700,000)	($480,000)	($340,000)
Total:	**($26,000,000)**	**($27,000,000)**	**($27,000,000)**

Table 225 – "Best Estimate" Costs and Benefits – Filtered Vents – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$70,000	$50,000	$34,000
Occupational Health (Accident)	$2,300	$1,600	$1,100
Offsite Property	$160,000	$110,000	$78,000
Onsite Property	$100,000	$63,000	$36,000
Replacement Energy	$15,000,000	$10,000,000	$6,200,000
Industry Implementation	($470,000,000)	($470,000,000)	($470,000,000)
Industry Operation	($49,000,000)	($35,000,000)	($24,000,000)
NRC Implementation	($840,000)	($840,000)	($840,000)
NRC Operation	($16,000,000)	($11,000,000)	($7,800,000)
Total:	**($520,000,000)**	**($510,000,000)**	**($500,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$70,000	$50,000	$34,000
Occupational Health (Accident)	$2,300	$1,600	$1,100
Offsite Property	$160,000	$110,000	$78,000
Onsite Property	$100,000	$63,000	$36,000
Replacement Energy	$15,000,000	$10,000,000	$6,200,000
Industry Implementation	($620,000,000)	($620,000,000)	($620,000,000)
Industry Operation	($49,000,000)	($35,000,000)	($24,000,000)
NRC Implementation	($840,000)	($840,000)	($840,000)
NRC Operation	($16,000,000)	($11,000,000)	($7,800,000)
Total:	**($670,000,000)**	**($660,000,000)**	**($650,000,000)**

Table 226 – "Best Estimate" Costs and Benefits per Unit – Filtered Vents – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$3,000	$2,200	$1,500
Occupational Health (Accident)	$100	$70	$48
Offsite Property	$7,000	$4,800	$3,400
Onsite Property	$4,300	$2,700	$1,600
Replacement Energy	$650,000	$430,000	$270,000
Industry Implementation	($20,000,000)	($20,000,000)	($20,000,000)
Industry Operation	($2,100,000)	($1,500,000)	($1,000,000)
NRC Implementation	($37,000)	($37,000)	($37,000)
NRC Operation	($700,000)	($480,000)	($340,000)
Total:	**($22,000,000)**	**($22,000,000)**	**($21,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$3,000	$2,200	$1,500
Occupational Health (Accident)	$100	$70	$48
Offsite Property	$7,000	$4,800	$3,400
Onsite Property	$4,300	$2,700	$1,600
Replacement Energy	$650,000	$430,000	$270,000
Industry Implementation	($27,000,000)	($27,000,000)	($27,000,000)
Industry Operation	($2,100,000)	($1,500,000)	($1,000,000)
NRC Implementation	($37,000)	($37,000)	($37,000)
NRC Operation	($700,000)	($480,000)	($340,000)
Total:	**($29,000,000)**	**($29,000,000)**	**($28,000,000)**

Table 227 – "Best Estimate" Costs and Benefits – Filtered Vents – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$49,000,000	$35,000,000	$24,000,000
Occupational Health (Accident)	$1,800,000	$1,300,000	$860,000
Offsite Property	$100,000,000	$74,000,000	$51,000,000
Onsite Property	$73,000,000	$45,000,000	$25,000,000
Replacement Energy	$15,000,000	$10,000,000	$6,200,000
Industry Implementation	($470,000,000)	($470,000,000)	($470,000,000)
Industry Operation	($49,000,000)	($35,000,000)	($24,000,000)
NRC Implementation	($840,000)	($840,000)	($840,000)
NRC Operation	($16,000,000)	($11,000,000)	($7,800,000)
Total:	**($300,000,000)**	**($350,000,000)**	**($400,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$49,000,000	$35,000,000	$24,000,000
Occupational Health (Accident)	$1,800,000	$1,300,000	$860,000
Offsite Property	$100,000,000	$74,000,000	$51,000,000
Onsite Property	$73,000,000	$45,000,000	$25,000,000
Replacement Energy	$15,000,000	$10,000,000	$6,200,000
Industry Implementation	($620,000,000)	($620,000,000)	($620,000,000)
Industry Operation	($49,000,000)	($35,000,000)	($24,000,000)
NRC Implementation	($840,000)	($840,000)	($840,000)
NRC Operation	($16,000,000)	($11,000,000)	($7,800,000)
Total:	**($450,000,000)**	**($500,000,000)**	**($550,000,000)**

Table 228 – "Best Estimate" Costs and Benefits per Unit – Filtered Vents – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$2,100,000	$1,500,000	$1,000,000
Occupational Health (Accident)	$78,000	$57,000	$37,000
Offsite Property	$4,300,000	$3,200,000	$2,200,000
Onsite Property	$3,200,000	$2,000,000	$1,100,000
Replacement Energy	$650,000	$430,000	$270,000
Industry Implementation	($20,000,000)	($20,000,000)	($20,000,000)
Industry Operation	($2,100,000)	($1,500,000)	($1,000,000)
NRC Implementation	($37,000)	($37,000)	($37,000)
NRC Operation	($700,000)	($480,000)	($340,000)
Total:	**($13,000,000)**	**($15,000,000)**	**($17,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$2,100,000	$1,500,000	$1,000,000
Occupational Health (Accident)	$78,000	$57,000	$37,000
Offsite Property	$4,300,000	$3,200,000	$2,200,000
Onsite Property	$3,200,000	$2,000,000	$1,100,000
Replacement Energy	$650,000	$430,000	$270,000
Industry Implementation	($27,000,000)	($27,000,000)	($27,000,000)
Industry Operation	($2,100,000)	($1,500,000)	($1,000,000)
NRC Implementation	($37,000)	($37,000)	($37,000)
NRC Operation	($700,000)	($480,000)	($340,000)
Total:	**($20,000,000)**	**($22,000,000)**	**($24,000,000)**

Table 230 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Filtered Vents at 7 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5th Percentile)	Best Estimate (Point-Estimate)	High Estimate (95th Percentile)
Costs	$500 to $650	$500 to $650	$500 to $650
Benefits	$0.43 to $23 + B_Q	$28 to $58 + B_Q	$100 to $150 + B_Q
Net benefits (benefits – costs)	($650) to ($480) + B_Q	($620) to ($440) + B_Q	($550) to ($350) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

Table 231 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of Filtered Vents at Undiscounted Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	$540 to $690	$540 to $690	$540 to $690
Benefits	$1.0 to $54 + B_Q	$64 to $130 + B_Q	$230 to $330 + B_Q
Net benefits (benefits – costs)	($690) to ($490) + B_Q	($630) to ($410) + B_Q	($460) to ($210) + B_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

Table 233 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Confinement Strategy

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$390,000	$260,000	$170,000
Occupational Health (Accident)	$13,000	$9,000	$5,800
Offsite Property	$840,000	$580,000	$390,000
Onsite Property	$610,000	$350,000	$200,000
Replacement Energy	$390,000	$230,000	$130,000
Industry Implementation	($3,200,000)	($3,200,000)	($3,200,000)
Industry Operation	($2,600,000)	($1,800,000)	($1,200,000)
NRC Implementation	($81,000)	($81,000)	($81,000)
NRC Operation	($650,000)	($450,000)	($320,000)
Total:	**($4,300,000)**	**($4,100,000)**	**($3,900,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$390,000	$260,000	$170,000
Occupational Health (Accident)	$13,000	$9,000	$5,800
Offsite Property	$840,000	$580,000	$390,000
Onsite Property	$610,000	$350,000	$200,000
Replacement Energy	$390,000	$230,000	$130,000
Industry Implementation	($6,100,000)	($6,100,000)	($6,100,000)
Industry Operation	($2,600,000)	($1,800,000)	($1,200,000)
NRC Implementation	($97,000)	($97,000)	($97,000)
NRC Operation	($650,000)	($450,000)	($320,000)
Total:	**($7,200,000)**	**($7,000,000)**	**($6,800,000)**

Table 234 – "Best Estimate" Costs and Benefits – Severe Accident Confinement Strategy – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$64,000	$44,000	$28,000
Occupational Health (Accident)	$2,200	$1,500	$1,000
Offsite Property	$150,000	$99,000	$65,000
Onsite Property	$96,000	$57,000	$31,000
Replacement Energy	$12,000,000	$7,100,000	$3,900,000
Industry Implementation	($100,000,000)	($100,000,000)	($100,000,000)
Industry Operation	($81,000,000)	($55,000,000)	($36,000,000)
NRC Implementation	($2,500,000)	($2,500,000)	($2,500,000)
NRC Operation	($20,000,000)	($14,000,000)	($9,900,000)
Total:	**($190,000,000)**	**($160,000,000)**	**($140,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$64,000	$44,000	$28,000
Occupational Health (Accident)	$2,200	$1,500	$1,000
Offsite Property	$150,000	$99,000	$65,000
Onsite Property	$96,000	$57,000	$31,000
Replacement Energy	$12,000,000	$7,100,000	$3,900,000
Industry Implementation	($190,000,000)	($190,000,000)	($190,000,000)
Industry Operation	($81,000,000)	($55,000,000)	($36,000,000)
NRC Implementation	($3,000,000)	($3,000,000)	($3,000,000)
NRC Operation	($20,000,000)	($14,000,000)	($9,900,000)
Total:	**($280,000,000)**	**($250,000,000)**	**($230,000,000)**

Table 235 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Confinement Strategy – 5th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$2,100	$1,400	$900
Occupational Health (Accident)	$71	$48	$32
Offsite Property	$4,800	$3,200	$2,100
Onsite Property	$3,100	$1,800	$1,000
Replacement Energy	$390,000	$230,000	$130,000
Industry Implementation	($3,200,000)	($3,200,000)	($3,200,000)
Industry Operation	($2,600,000)	($1,800,000)	($1,200,000)
NRC Implementation	($81,000)	($81,000)	($81,000)
NRC Operation	($650,000)	($450,000)	($320,000)
Total:	**($6,100,000)**	**($5,300,000)**	**($4,700,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$2,100	$1,400	$900
Occupational Health (Accident)	$71	$48	$32
Offsite Property	$4,800	$3,200	$2,100
Onsite Property	$3,100	$1,800	$1,000
Replacement Energy	$390,000	$230,000	$130,000
Industry Implementation	($6,100,000)	($6,100,000)	($6,100,000)
Industry Operation	($2,600,000)	($1,800,000)	($1,200,000)
NRC Implementation	($97,000)	($97,000)	($97,000)
NRC Operation	($650,000)	($450,000)	($320,000)
Total:	**($9,000,000)**	**($8,200,000)**	**($7,600,000)**

Table 236 – "Best Estimate" Costs and Benefits – Severe Accident Confinement Strategy – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$45,000,000	$31,000,000	$21,000,000
Occupational Health (Accident)	$1,700,000	$1,200,000	$800,000
Offsite Property	$96,000,000	$66,000,000	$43,000,000
Onsite Property	$67,000,000	$40,000,000	$22,000,000
Replacement Energy	$12,000,000	$7,100,000	$3,900,000
Industry Implementation	($100,000,000)	($100,000,000)	($100,000,000)
Industry Operation	($81,000,000)	($55,000,000)	($36,000,000)
NRC Implementation	($2,500,000)	($2,500,000)	($2,500,000)
NRC Operation	($20,000,000)	($14,000,000)	($9,900,000)
Total:	**$18,000,000**	**($26,000,000)**	**($58,000,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$45,000,000	$31,000,000	$21,000,000
Occupational Health (Accident)	$1,700,000	$1,200,000	$800,000
Offsite Property	$96,000,000	$66,000,000	$43,000,000
Onsite Property	$67,000,000	$40,000,000	$22,000,000
Replacement Energy	$12,000,000	$7,100,000	$3,900,000
Industry Implementation	($190,000,000)	($190,000,000)	($190,000,000)
Industry Operation	($81,000,000)	($55,000,000)	($36,000,000)
NRC Implementation	($3,000,000)	($3,000,000)	($3,000,000)
NRC Operation	($20,000,000)	($14,000,000)	($9,900,000)
Total:	**($72,000,000)**	**($120,000,000)**	**($150,000,000)**

Table 237 – "Best Estimate" Costs and Benefits per Unit – Severe Accident Confinement Strategy – 95th Percentile

Low Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,500,000	$1,000,000	$680,000
Occupational Health (Accident)	$55,000	$39,000	$26,000
Offsite Property	$3,100,000	$2,100,000	$1,400,000
Onsite Property	$2,200,000	$1,300,000	$710,000
Replacement Energy	$390,000	$230,000	$130,000
Industry Implementation	($3,200,000)	($3,200,000)	($3,200,000)
Industry Operation	($2,600,000)	($1,800,000)	($1,200,000)
NRC Implementation	($81,000)	($81,000)	($81,000)
NRC Operation	($650,000)	($450,000)	($320,000)
Total:	**$710,000**	**($860,000)**	**($1,900,000)**

High Cost

Attribute	Undiscounted	3% NPV	7%NPV
Public Health (Accident)	$1,500,000	$1,000,000	$680,000
Occupational Health (Accident)	$55,000	$39,000	$26,000
Offsite Property	$3,100,000	$2,100,000	$1,400,000
Onsite Property	$2,200,000	$1,300,000	$710,000
Replacement Energy	$390,000	$230,000	$130,000
Industry Implementation	($6,100,000)	($6,100,000)	($6,100,000)
Industry Operation	($2,600,000)	($1,800,000)	($1,200,000)
NRC Implementation	($97,000)	($97,000)	($97,000)
NRC Operation	($650,000)	($450,000)	($320,000)
Total:	**($2,200,000)**	**($3,800,000)**	**($4,800,000)**

Table 239 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of the Severe Accident Confinement Strategy at 7 Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	\$150 to \$240 + C_Q	\$150 to \$240 + C_Q	\$150 to \$240 + C_Q
Benefits	\$0.31 to \$14 + B_Q	\$24 to \$44 + B_Q	\$88 to \$120 + B_Q
Net benefits (benefits – costs)	(\$240) to (\$140) + B_Q – C_Q	(\$220) to (\$110) + B_Q – C_Q	(\$150) to (\$30) + B_Q – C_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

c Not all possible costs are quantified and monetized for this analysis. C_Q is the sum of all unquantified costs. Unquantified costs were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values. C_Q may be either positive or negative.

Table 240 – Summary of Estimates of Present Value Costs, Benefits, and Net Benefits of the Severe Accident Confinement Strategy at Undiscounted Percent Net Present Value (millions of 2012$)

Description	Low Estimate (5^{th} Percentile)	Best Estimate (Point-Estimate)	High Estimate (95^{th} Percentile)
Costs	\$200 to \$290 + C_Q	\$200 to \$290 + C_Q	\$200 to \$290 + C_Q
Benefits	\$0.83 to \$41 + B_Q	\$58 to \$110 + B_Q	\$210 to \$300 + B_Q
Net benefits (benefits – costs)	(\$290) to (\$160) + B_Q – C_Q	(\$230) to (\$90) + B_Q – C_Q	(\$80) to \$100 + B_Q – C_Q

a Benefits are composed primarily of averted onsite and offsite property costs.

b B_Q is the sum of all unquantified benefits and disbenefits. Unquantified benefits were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values.

c Not all possible costs are quantified and monetized for this analysis. C_Q is the sum of all unquantified costs. Unquantified costs were given appropriate consideration in relation to the quantified attributes due to the large uncertainty ranges in monetized values. C_Q may be either positive or negative.