ENVIRONMENTAL ASSESSMENT BY THE U.S. NUCLEAR REGULATORY COMMISSION RELATING TO THE CERTIFICATION OF THE APR1400 STANDARD DESIGN

DOCKET NO. 52-046

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UNITED STATES NUCLEAR REGULATORY COMMISSION

ENVIRONMENTAL ASSESSMENT AND FINDING OF

NO SIGNIFICANT IMPACT

RELATING TO THE CERTIFICATION OF THE

APR1400 STANDARD DESIGN

DOCKET NO. 52-046

The U.S. Nuclear Regulatory Commission (NRC) is issuing a design certification (DC) for the Advanced Power Reactor 1400 (APR1400) standard design in response to an application submitted on December 23, 2014, by Korea Electric Power Corporation and Korea Hydro & Nuclear Power Co., Ltd., hereinafter referred to as KEPCO/KHNP or the applicant. The NRC has decided to adopt DC rules as appendices to Part 52 of Title 10 of the *Code of Federal Regulations* (10 CFR).

The NRC has performed the following environmental assessment of the environmental impacts of the new rule and has documented its finding of no significant impact in accordance with the requirements of 10 CFR 51.21 and the National Environmental Policy Act of 1969, as amended (NEPA). This environmental assessment addresses the severe accident mitigation design alternatives (SAMDAs) that the NRC has considered for the APR1400 standard design. This environmental assessment does not address the site-specific environmental impacts of constructing and operating any facility that references the APR1400 DC at a particular site; those impacts will be evaluated as part of any application(s) for the siting, construction, or operation of such a facility.

As discussed in Section 5.0 of this environmental assessment, the NRC has determined that issuing this DC does not constitute a major Federal action significantly affecting the quality of the human environment. This finding is based on the generic finding made in 10 CFR 51.32(b)(1) that there is no significant environmental impact associated with the certification of a standard design under 10 CFR Part 52, Subpart B. The action does not authorize the siting, construction, or operation of a facility using the APR1400 standard design. Rather, it merely codifies the APR1400 standard design in a rule that could be referenced in a future construction permit (CP), combined license (COL), or operating license (OL) application. Furthermore, because the certification is a rule rather than a physical action, it does not involve the commitment of any resources that have alternative uses. As explained in the statements of consideration for "Licenses, Certifications, and Approvals for Nuclear Power Plants; Final Rule," (72 FR 49352, 49427; August 28, 2007), the 10 CFR 51.32(b)(1) generic finding of no significant impact is legally equivalent to a categorical exclusion. Therefore, the NRC has not prepared an environmental impact statement for the action.

Under 10 CFR 51.30(d), an environmental assessment for a DC must identify the proposed action and is otherwise limited to consideration of the costs and benefits of SAMDAs and the bases for not incorporating SAMDAs in the DC. As discussed in Section 4.0 of this environmental assessment, the NRC also reviewed KEPCO/KHNP's assessment of SAMDAs that generically apply to the APR1400 standard design. The NRC finds that KEPCO/KHNP's assessment took into consideration a reasonable set of SAMDAs, and that no additional SAMDAs beyond those currently incorporated into the APR1400 standard design would be cost-beneficial. This finding is applicable whether SAMDAs are considered at the time of the certification of the APR1400 standard design or are considered with respect to licensing a potential future facility referencing the APR1400 DC rule, provided that the plant referencing the APR1400 DC rule is sited at a location with site characteristics that are encompassed by the

postulated site parameters for the DC reference plant site in APR1400-K-X-ER-14001-NP, Revision 2, “Applicant’s Environmental Report – Standard Design Certification,” issued August 2018, and in the supporting documents.

ENVIRONMENTAL ASSESSMENT

1.0 Identification of the Proposed Action

The proposed action is to certify the APR1400 standard design in Appendix F to 10 CFR Part 52. The new rule allows applicants to reference the certified APR1400 standard design as part of a COL application under 10 CFR Part 52, or may allow this for a CP application under 10 CFR Part 50.

2.0 Need for the Proposed Action

The proposed action is to issue a rule amending 10 CFR Part 52 to certify the APR1400 standard design. The amendment allows an applicant to reference the certified APR1400 standard design as part of a COL application under 10 CFR Part 52, or may allow this for a CP application under 10 CFR Part 50. Those portions of the APR1400 standard design included in the scope of the design certification rulemaking are not subject to further safety review or approval in a COL proceeding. In addition, the DC rule could resolve SAMDAs for any future COL applications for facilities that reference the certified APR1400 standard design.

3.0 Environmental Impact of the Proposed Action

The proposed action constitutes issuance of the DC as an amendment to 10 CFR Part 52 to certify the APR1400 standard design. As stated in 10 CFR 51.32(b)(1), the NRC has determined that there is no significant environmental impact associated with the issuance of a DC. The DC merely codifies the NRC’s approval of the APR1400 standard design through its final safety evaluation report on the design issued during rulemaking (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18087A364). Furthermore,

because the certification of the design constitutes only a rule rather than a physical action, it would not involve the commitment of any resources that have alternative uses.

As described in Section 4.0 of this environmental assessment, the NRC reviewed various alternative design features for preventing and mitigating severe accidents. The National Environmental Policy Act of 1969, as amended, requires consideration of alternatives to show that the DC rule is the appropriate course of action. The NRC's regulations at 10 CFR 51.55(a) ensure that the design to be certified does not exclude any cost-beneficial design changes related to the prevention and mitigation of severe accidents.

Through its own independent analysis, the NRC concludes that KEPCO/KHNP adequately considered an appropriate set of SAMDAs and that none met the cost-beneficial criteria. Although KEPCO/KHNP made no design changes as a result of considering SAMDAs, KEPCO/KHNP had already incorporated certain features in the APR1400 standard design on the basis of probabilistic risk assessment (PRA) results. Section 4.2 of this environmental assessment gives examples of these features. These design features relate to severe accident prevention and mitigation, but they were not considered in the SAMDA evaluation because they were already part of the APR1400 standard design (refer to Sections 19.2.2 and 19.2.3 of the design control document, "Severe Accident Prevention" and "Severe Accident Mitigation," respectively).

Finally, the DC rule, itself, does not authorize the siting, construction, or operation of a nuclear power plant. An applicant for a CP, early site permit, COL, or OL that references the APR1400 standard design will be required to address the environmental impacts of construction and operation for its specific site. The NRC will then evaluate the environmental impacts for that particular site and issue an environmental impact statement in accordance with 10 CFR Part 51 and the National Environmental Policy Act of 1969, as amended. However, the SAMDA analysis that has been completed as part of this environmental assessment can be incorporated

by reference into an environmental impact statement related to an application for siting, construction, or operation of a nuclear plant that references the APR1400 standard design.

4.0 Severe Accident Mitigation Design Alternatives

The proposed action provides finality in licensing proceedings on an application under 10 CFR Part 52 referencing the APR1400 DC rule and proposing a plant located on a site whose site characteristics fall within the postulated site parameters of the DC referenced plant site (i.e., the Surry Power Station site), as described in APR1400-K-X-ER-14001-NP and the supporting documents.

This section provides a summary of the NRC's review of KEPCO/KHNP's Standard Design Certification Environmental Report and the related APR1400 SAMDAs, as provided in APR1400-K-X-ER-14001-NP and supporting documents. The specific details of the NRC's evaluation, summarized in this environmental assessment, are provided in a technical analysis report under ADAMS Accession No. ML18096A697.

4.1. Severe Accident Mitigation Design Alternatives

Consistent with the Commission's objectives of standardization and early resolution of design issues, the SAMDAs are being evaluated as part of the DC for the APR1400 standard design. In a 1985 policy statement (50 FR 32138; August 8, 1985), the Commission defined the term severe accident as an event that is beyond the substantial coverage of design-basis events, including events where there is substantial damage to the reactor core (whether or not there are serious offsite consequences). Design-basis events are events analyzed in accordance with the NRC's Standard Review Plan (NUREG-0800) and documented in Chapter 15, "Transient and Accident Analyses," of the design control document.

As part of its DC application, KEPCO/KHNP performed a PRA for the APR1400 standard design to achieve the following objectives:

- to identify the dominant severe accident sequences that account for most of the core damage frequency and associated source terms for the design;
- to modify the design, on the basis of PRA insights, to prevent severe accidents or mitigate their consequences and thereby reduce the risk of such accidents; and
- to provide a qualitative basis for concluding that all reasonable steps have been taken to reduce the chances of severe accidents occurring and to mitigate the consequences.

KEPCO/KHNP's PRA analysis is described in Chapter 19 of the APR1400 design control document, Revision 3.

The APR1400 Level 1 and Level 2 PRA models quantified six risk categories; three for operations at-power and three for low-power and shutdown operations, namely:

- at-power internal events
- at-power internal flooding events
- at-power internal fire events
- low-power and shutdown internal events
- low-power and shutdown internal flooding events
- low-power and shutdown internal fire events

The risks from other external events, such as high winds, seismic events, external flooding, and external fires, were determined by the PRA models to be negligible and were not further analyzed under the SAMDA assessment.

In addition to these safety considerations, applicants for reactor DCs or COLs must also consider alternative design features for severe accidents in support of the NRC's environmental review. These requirements can be summarized as follows:

- Section 52.79(a)(46) requires a COL applicant to describe the plant-specific PRA and its results, with the aim of identifying potential improvements in the reliability

of the core and containment heat removal systems that are significant and practical and that do not impact excessively on the plant.

- Section 51.30(d) requires consideration of SAMDAs in an environmental assessment for a DC, while 10 CFR 51.50(c) sets forth the general requirements for an environmental report accompanying a COL application, including the requirement to evaluate SAMDAs.

Although these requirements are not directly related, they share common purposes, which are to consider alternatives to the proposed design, to evaluate whether potential alternative improvements in the plant design might significantly enhance safety performance during severe accidents, and to prevent reasonable alternatives from being foreclosed.

The NRC has determined that the generic evaluation of SAMDAs for the APR1400 standard design is both practical and warranted for two reasons. First, the design and construction of all plants licensed under 10 CFR Part 52 referencing the certified APR1400 standard design will be governed by the rule certifying a single design. Second, the site parameters in APR1400-K-X-ER-14001-NP and the supporting documents establish the consequences for a reasonable set of SAMDAs for the APR1400 standard design. The low residual risk of the APR1400 standard design and the limited potential for further risk reduction provides high confidence that additional cost-beneficial SAMDAs would not be found for sites with characteristics that fit within the site parameter envelope. If an actual characteristic for a particular site does not fall within the postulated site parameters, then SAMDAs that could be affected by the value of the site characteristic must be re-evaluated in the site-specific environmental report and the environmental impact statement prepared in connection with the application for the particular site. If the actual characteristics of a proposed site fall within the postulated site parameters, then the SAMDA analysis can be incorporated by reference in the

site-specific environmental impact statement, and SAMDAs need not be re-evaluated in the environmental impact statement.

4.2. Potential Design Improvements Identified by KEPCO/KHNP

In APR1400-K-X-ER-14001-NP and the supporting documents, the applicant identified 153 candidate design alternatives, or design improvements, based on a review of the standard list of design alternatives provided in Table 14 of Nuclear Energy Institute 05-01A, “Severe Accident Mitigation Alternatives (SAMA) Analysis,” and several license renewal environmental reports. KEPCO/KHNP eliminated certain candidate design alternatives from further consideration on the following bases:

- they were already implemented in the APR1400 standard design;
- they were not applicable to the APR1400 standard design or to the APR1400 DC;
- they had excessive implementation costs; or
- they were of very low benefit.

There were 30 candidate design alternatives that the APR1400 standard design already incorporated. The following are examples of candidate design alternatives already incorporated in the APR1400 standard design:

- installing a gas turbine generator;
- installing an independent active or passive high pressure injection system;
- adding a diverse low pressure injection system;
- improving emergency core cooling system suction strainers;
- adding the ability to manually align the emergency core cooling system recirculation;
- adding the ability to automatically align the emergency core cooling system to recirculation mode upon refueling water storage tank depletion;
- providing an in-containment reactor water storage tank;
- creating a reactor coolant depressurization system; and

- installing an independent reactor coolant pump seal injection system, without a dedicated diesel.

The applicant initially screened the design alternatives based on their analysis in APR1400-K-X-ER-14001-NP, Section 4, “Unmitigated Risk Monetary Value.” As described in Section 4.6.1 of this environmental assessment, if the implementation costs for a SAMDA candidate exceeded the calculated maximum benefit resulting in a negative Net Present Value, the SAMDA was not considered further. This screening process eliminated 30 potential design alternatives that were identified as being unfeasible due to excessive implementation costs or that provided negligible benefit. Another 54 SAMDA candidates were identified as not applicable to the DC stage of plant development (such as procedural processes, training, or design features not applicable at the DC stage). One potential design alternative was determined to be of very low benefit. The applicant retained the remaining 38 SAMDAs for further assessment in the cost-benefit analysis.

KEPCO/KHNP also applied insights from the APR1400 PRA by applying relevant guidance from Section 5.1, Probabilistic Safety Assessment Importance, of Nuclear Energy Institute 05-01A. First, KEPCO/KHNP identified APR1400-specific dominant risk contributors, derived from the PRA, for further consideration for events. This subset of risk contributors was derived from an importance analysis of core damage cutsets using a Fussell-Vesely importance criterion of greater than 0.5 percent contribution to the total risk (i.e., the total core damage frequency). By applying this criterion, KEPCO/KHNP identified a number of basic events derived from the information in design control document Section 19.1. This process identified basic events in Section 7 of the environmental report that are associated with the six risk categories (see Tables 6a through 6f). Secondly, KEPCO/KHNP applied insights from the APR1400 PRA’s top 100 cutsets by identifying any that were not included as part of the Fussell-Vesely importance analysis review. KEPCO/KHNP identified these additional at-power and low-

power and shutdown basic events, as provided in Tables 7a through 7f of the environmental report, for further consideration based on the information in design control document Section 19.1.

4.3. NRC Evaluation of Potential Design Improvements

The NRC found that the set of SAMDAs and basic events evaluated by KEPCO/KHNP addressed the major contributors to core damage frequency. KEPCO/KHNP used a systematic and comprehensive process for identifying potential plant improvements for the APR1400 standard design, and the set of potential plant improvements identified by KEPCO/KHNP is reasonably comprehensive and, therefore, is acceptable for further evaluation. This process included reviewing insights from the plant-specific PRA study as well as assessing severe accident mitigation alternatives (SAMAs) based on accepted industry guidance.

The NRC has concluded that the applicant's assessment of the potential SAMDAs and their impacts on the APR1400 standard design is acceptable. The NRC's review did not reveal any additional design alternatives that the applicant should have considered.

4.4. Risk Reduction Potential of SAMDAs

4.4.1. KEPCO/KHNP Evaluation

KEPCO/KHNP evaluated the potential SAMDAs not screened out to assess their potential benefits by using bounding techniques to estimate the possible risk reduction. This was accomplished by associating the basic events identified with a Fussell-Vesely importance of greater than 0.5 percent, and from the top 100 cutsets to a particular SAMDA. This linkage to a SAMDA is provided for each basic event in APR1400-K-X-ER-14001-NP, Section 7.1 through Section 7.19. The basic event that a potential SAMDA is associated with is also provided in the "Qualitative Screening" column of Table 5 in APR1400-K-X-ER-14001-NP.

Because there are likely several basic events that are considered under a specific SAMDA, KEPCO/KHNP applied a factor of risk reduction based on the sum of Fussell-Vesely

importance values for each basic event. KEPCO/KHNP determined the sum of Fussell-Vesely values for each basic event under the six risk categories for a total risk reduction percentage associated with a particular risk category (i.e., at-power internal events, internal flooding, or internal fire; or low-power and shutdown internal events, internal flooding, or internal fire). In several basic event cases, KEPCO/KHNP found that there were no Fussell-Vesely importance values; therefore the sum for a risk category would be zero. Section 4.4.2 discusses this assessment further.

4.4.2. NRC Evaluation

The NRC reviewed KEPCO/KHNP's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable. Specifically, the sum of Fussell-Vesely importance values for risk reductions is acceptable due to its conservatism (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC based its estimates of averted risk for the potential SAMDAs on the resulting APR1400 risk reduction estimates.

4.5. Cost Impacts of Candidate SAMDAs

4.5.1. KEPCO/KHNP Evaluation

In performing the cost-benefit analysis of the SAMDAs considered, the cost of enhancement (COE) implementation associated with potential events is estimated from available information related to similar events and components of other nuclear power plant designs. The COE values of the APR1400 SAMDAs are derived from two sources. The first source is the compilation of information from the SAMA[1] analyses performed for the license renewal applications of the presently operating nuclear power plants as documented in the licensees' renewal environmental reports and in the final supplemental environmental impact statements under NUREG-1437. The second source is an assessment by the applicant, as

[1] SAMAs are a subset of SAMDAs, which are attributes for the mitigation of severe accidents of design alternatives, procedural modifications, and training activities.

presented in APR1400-K-X-ER-14001-NP. The publicly available license renewal SAMA costs are full-cost values, while the associated SAMDA costs applied by KEPCO/KHNP were conservatively set to half of the license renewal values based on an assumption that half of the cost would be from engineering and procedure updates. However, it is important to note that for license renewal SAMA evaluations, the full SAMA costs were applied in their cost-benefit analyses.

4.5.2. NRC Evaluation

On the basis of the analyses performed by KEPCO/KHNP, the NRC has concluded that the applicant's estimates of potential costs for the APR1400 SAMDAs are acceptable because the sources for the information and the cost estimates are both reasonable. First, the NRC applied this information in the cost-benefit analysis by using half of the SAMDA COE implementation value, as did KEPCO/KHNP for the APR1400 evaluation presented in APR1400-K-X-ER-14001-NP. Second, if SAMDAs were not further screened out based on the conservative assumptions, then the NRC applied the full COE implementation value. This approach facilitates the cost-benefit comparisons founded on a graded approach when assessing the averted costs using 7 percent and 3 percent discount rates. This approach is consistent with the guidance in Section 7.2 of Nuclear Energy Institute 05-01A.

4.6. Cost-Benefit Comparison

4.6.1. KEPCO/KHNP Evaluation

The methodology used by KEPCO/KHNP was based primarily on the NRC's guidance for performing cost-benefit analysis outlined in NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook." The guidance involves determining the net present value (NPV) for each SAMDA according to the following formula:

$$NPV = (APE + AOC + AOE + AOSC) - COE$$

Where:

NPV = Net present value of current risk ($);

APE = Present value of averted public exposure ($);

AOC = Present value of averted offsite property damage costs ($);

AOE = Present value of averted occupational exposure ($);

AOSC = Present value of averted onsite costs ($); and

COE = Cost of any enhancement implemented to reduce risk ($).

If the net present value of a SAMDA is negative, the cost of implementing the SAMDA is larger than the benefit associated with the SAMDA and it is not cost-beneficial. As noted above, 30 candidate SAMDAs were screened out of further analyses for this reason. If the SAMDA benefit exceeds the estimated cost resulting in a positive NPV, the SAMDA is potentially cost-beneficial.

For the representation of the maximum benefit that could be provided, the maximum benefit is calculated to be the sum of the four averted cost categories. It is represented as:

Maximum Benefit = APE + AOC + AOE + AOSC

Table 4.6.2-1 summarizes the applicant's and the NRC's estimates for each of the associated cost elements.

Table 4.6.2-1 Calculated Total Maximum Benefit

Risk Category	KEPCO/KHNP		NRC Staff	
	7%	3%	7%	3%
APE	$49,877	$98,622	$49,872	$98,612
AOC	$63,933	$126,417	$63,941	$126,429
AOE	$3,817	$8,787	$3,818	$8,786
$AOSC_{CD}$	$116,457	$276,642	$191,035	$453,773
$AOSC_{RP}$	$675,084	$1,134,638	$706,726	$1,879,727
Total Maximum Benefit	$909,168	$1,645,106	$1,015,393	$2,567,327

It is important to note that the monetary present value estimate for each risk attribute does not represent the expected reduction in risk resulting from a single accident. Rather, it is the present value of potential losses extending over the projected lifetime (in this case, 60

years) of the facility. Therefore, it reflects the expected annual loss resulting from a single accident, the possibility that such an accident could occur at any time over the licensed life, and the effect of discounting these potential future losses to present value.

The NRC issued Revision 4 of NUREG/BR-0058, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” in August 2004 to reflect the agency's policy on discount rates. NUREG/BR-0058, Revision 4, states that two sets of estimates should be developed — one at 3 percent and one at 7 percent. The applicant provided estimates using both discount rates.

Using the baseline 7 percent and the sensitivity 3 percent discount rates, KEPCO/KHNP calculated the maximum benefit for at-power internal events, internal flooding events, and internal fire events; along with low-power and shutdown internal events, internal flooding events, and internal fire events. The results of the KEPCO/KHNP evaluation are provided in Table 4.6.2-1.

As previously discussed, 38 SAMDAs were carried to the next screening phase. In addition to these remaining SAMDAs, each basic event with a Fussell-Vesely importance of greater than 0.5 percent or part of the top 100 cutsets, if not already included as a basic event, was reviewed to identify any potential SAMDAs. KEPCO/KHNP then related each of the 38 SAMDAs back to one or more of the basic events and assessed the NPV for each basic event with the following steps:

1. Assessed the maximum benefit for each basic event applying conservative assumptions for risk reductions to the AOE and AOSC categories;
2. Conservatively assessed the COE based on half of the SAMDA values obtained from source documents; and
3. Determined the NPV.

For each of the basic events/SAMDAs applying the 7 percent and 3 percent discount rates, KEPCO/KHNP evaluated the NPV and reached a conclusion of whether the enhancements were cost beneficial. KEPCO/KHNP determined, through its SAMDA analyses, that there were no potentially cost-beneficial enhancements for the 7 percent discount rate analysis. KEPCO/KHNP stated that its sensitivity analysis for the 3 percent discount rate showed a higher maximum benefit over the 7 percent discount rate. However, KEPCO/KHNP concluded that no design changes would provide a positive cost-benefit for either discount rate, if included in the APR1400 standard design.

4.6.2. NRC Evaluation

As shown in Table 4.6.2-1, the NRC's confirmatory analyses for the 7 percent and 3 percent discount rates were in general agreement with the applicant for the offsite public exposure (i.e., APE), offsite property damage cost (i.e., AOC), and onsite occupational dose (i.e., AOE) averted costs. The NRC evaluation resulted in higher values than the applicant's evaluation for the onsite cleanup and decontamination (i.e., $AOSC_{CD}$) averted costs, with a similar higher result for the replacement power (i.e., $AOSC_{RP}$) averted costs.

In the $AOSC_{CD}$ evaluation, the NRC adjusted the base averted cost per event provided by NUREG/BR-0184, which was applied by KEPCO/KHNP, to current dollars, resulting in a higher value for the NRC's evaluation. The small difference between the NRC's and the applicant's $AOSC_{RP}$ averted costs for the 7 percent discount rate evaluation is principally due to applying different inflation factors to adjust the base replacement cost to current dollars. For the 3 percent discount rate analysis of the replacement power, KEPCO/KHNP applied a linear interpolation to the NPV for discount rates below 5 percent, as described near the end of Section 5.7.6.2 of NUREG/BR-0184 (see page 5.45 of NUREG/BR-0184). Based on NRC experience in prior regulatory rulemaking analyses, the NRC applied the same replacement cost formula for both the 7 percent and 3 percent discount rates (see the formula in Section 5.7.6.2

of NUREG/BR-0184 on page 5.44). This is viewed by the NRC as being conservative as demonstrated by the larger replacement power averted cost in the NRC evaluation in comparison to the applicant's evaluation.

In its review, the NRC noted that the applicant used two assumed conservatisms in its cost-benefit analysis. The first case of conservatism involved the total averted costs in each analysis, where the applicant did not apply the percent risk reductions for the contribution to total core damage frequency to the population dose (i.e., APE) and offsite property damage (i.e., AOC) costs. The APE and AOC were based on MELCOR Accident Consequence Code System calculations and, thus, are directly tied to the size of a release. As shown by the NRC's 3 percent discount rate analysis compared to the KEPCO/KHNP 3 percent discount rate analysis, applying this reduction to only the onsite exposure (i.e., AOE) and onsite economic costs (i.e., AOSC), results in a conservative result. Namely, it will result in a total maximum benefit that is larger than if the percentage risk reduction is applied to all cost categories. The second conservative assumption involved the use of the determined COE values, as discussed in Section 4.5.1. As assessed by the NRC staff, when the applicant applies only half of the estimated COE value, the final determination of the cost-benefit analysis could more likely provide a positive NPV.

Even with the above discussed differences in the averted cost values, the NRC's confirmatory analysis also reached the same conclusion as KEPCO/KHNP that there were no cost-beneficial design alternatives when applying a 7 percent discount rate. This result was the same regardless of whether the applicant's conservative assumptions were applied in the 7 percent discount rate analysis. Based on the NRC's review of the methodology and associated analysis, KEPCO/KHNP's assessment adequately addressed the cost-benefit analysis for the 7 percent discount rate.

For the 3 percent discount rate analysis, the NRC performed a confirmatory calculation to assess the costs and benefits applying the NRC results provided in Table 4.6.2-1, without applying KEPCO/KHNP's conservative assumptions. Specifically, the NRC also applied the risk reduction percentages to the APE and AOC, since they are also dependent on the released plume, and the NRC applied the full COE values. As a result, the NRC determined that there were no cost beneficial design alternatives when applying a 3 percent discount rate.

4.7. Conclusions on SAMDAs

The NRC reviewed KEPCO/KHNP's SAMDA analysis and concludes that the methods used and the implementation of the methods are appropriate. On the basis of the applicant's treatment of SAMDA benefits and costs, the NRC finds that the evaluation performed by KEPCO/KHNP is reasonable and sufficient. Based on its own independent evaluation, the NRC reached the same conclusion as KEPCO/KHNP that none of the possible candidate design alternatives are potentially cost beneficial for the APR1400 standard design. This independent evaluation was based on a reasonable treatment of costs, benefits, and sensitivities. Based on the NRC review of KEPCO/KHNP's evaluation, including KEPCO/KHNP's response to requests for additional information, the NRC concludes that KEPCO/KHNP has adequately identified areas where risk potentially could be reduced in a cost-beneficial manner and adequately assessed whether the implementation of the identified potential SAMDAs or candidate design alternatives would be cost-beneficial for the given site parameters.

Because of the magnitude of the negative NPV values, a SAMA based on operational procedures or training for an APR1400 reactor would have to cause a significant effect on the total core damage frequency or have a low implementation cost to become cost beneficial. Based on its evaluation, the NRC concludes that it is unlikely that any of the SAMAs based on procedures or training would reduce the risk to be cost beneficial for the given site parameters.

5.0 Finding of No Significant Impact

On the basis of 10 CFR 51.32(b)(1) and the environmental assessment, the NRC concludes that the proposed action will not have a significant effect on the quality of the human environment. Accordingly, the NRC is not required to prepare an environmental impact statement for the proposed action.

For further details with respect to the proposed action, see the DC rule and the documents referenced in the statement of considerations for the final rule. Documents may be examined, and/or copied for a fee, at the NRC's Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, 20852. Publicly available records will be accessible electronically from the ADAMS Public Electronic Reading Room on the NRC Web site at https://www.nrc.gov/reading-rm/adams.html. Persons who do not have access to ADAMS or who encounter problems in accessing the documents in ADAMS should contact the NRC PDR reference staff at 1-800-397-4209 or 301-415-4737 or send an e-mail to pdr@nrc.gov.