FINAL ENVIRONMENTAL ASSESSMENT

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

U.S. NUCLEAR REGULATORY COMMISSION

RELATING TO THE CERTIFICATION OF THE

SYSTEM 80+ STANDARD NUCLEAR PLANT DESIGN

DOCKET NO. 52-002

Attachment 6

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1.0 INTRODUCTION AND SUMMARY

The U.S. Nuclear Regulatory Commission (NRC or Commission) has issued a design certification for the System 80+ standard nuclear plant design (System 80+). Design certification is a rulemaking that amends Part 52 of Title 10 of the Code of Federal Regulations (10 CFR Part 52). To comply with the requirements of the National Environmental Policy Act of 1969 (NEPA), the NRC must consider the environmental impacts of issuing this amendment to 10 CFR Part 52. In addition, the NRC decided to consider severe accident mitigation design alternatives (SAMDAs) as part of this final environmental assessment (EA) to resolve SAMDA for NEPA on a generic basis for the System 80+ design. The EA for this rulemaking is contained herein and is prepared in accordance with NEPA and 10 CFR Part 51. This EA only addresses the environmental impacts of issuing a design certification for System 80+, and SAMDAs for the System 80+ design. The environmental impacts of construction and operation of a facility at a particular site will be evaluated as part of the application(s) for siting, construction, and operation of that facility.

In an application dated March 30, 1989, Combustion Engineering, Incorporated (CE) asked the NRC to certify the System 80+ design. The application was made in accordance with the procedures of Appendix O to 10 CFR Part 50. In a letter to the NRC dated August 21, 1989, Combustion Engineering, Inc., requested that its application be considered for design approval and subsequent design certification pursuant to 10 CFR Part 52. The application was docketed on May 1, 1991, and assigned Docket Number 52-002. Combustion Engineering, Inc., notified the NRC by letter dated May 26, 1992, that it is a wholly owned subsidiary of Asea Brown Boveri, Inc., and the appropriate abbreviation for the company is ABB-CE. Therefore, throughout this report Combustion Engineering, Inc., is referred to as ABB-CE.

The NRC has determined that the issuance of this design certification is not a major Federal action significantly affecting the quality of the human environment, and therefore, has decided not to prepare an environmental impact statement (EIS) in connection with this action. The finding of no significant impact (FONSI) is based on the fact that the certification rule itself would not authorize the siting, construction, or operation of the System 80+ design; it would only codify the System 80+ design in a rule that could be referenced in a construction permit (CP), early site permit (ESP), combined license (COL), or operating license (OL) application. Further, because the action is a rule, there are no resources involved which would have alternative uses.

The NRC also reviewed, pursuant to the NEPA, ABB-CE's evaluation of design alternatives to prevent and mitigate severe accidents. Based on the review, the NRC finds that the evaluation provides a sufficient basis to conclude that there is reasonable assurance that an amendment to 10 CFR Part 52 certifying the System 80+ design will not exclude SAMDAs for a future facility that would have been cost beneficial had they been considered as part of the original design certification application. These issues are considered resolved for the System 80+ design certification.

2.0 THE NEED FOR THE PROPOSED ACTION

The NRC has long sought the safety benefits of commercial nuclear power plant standardization, as well as the early resolution of design issues and finality of design issue resolution. The NRC plans to achieve these goals by certification of standard plant designs. Subpart B to 10 CFR Part 52 allows for certification by rule of an essentially complete nuclear plant design.

The proposed action would amend 10 CFR Part 52 to certify the System 80+ design. The amendment would allow prospective applicants for a COL under Part 52 or for a CP under Part 50 to reference the certified System 80+ design. Those portions of the System 80+ design included in the scope of the design certification would not be subject to further regulatory review or approval. In addition, the amendment would resolve the issue of consideration of SAMDAs for any future facilities that reference the System 80+ design.

3.0 ALTERNATIVES TO THE PROPOSED ACTION

The alternatives to certifying the System 80+ design in an amendment to 10 CFR Part 52 are either (1) no action approving the design or (2) issuing a final design approval (FDA), but not certifying the design. These alternatives in and of themselves would not have a significant impact affecting the quality of the human environment because they do not authorize the siting, construction, or operation of a facility.

In the first case, the design would not be approved. Therefore, a facility to be built as a System 80+ would be required to be licensed under 10 CFR Part 50 or 10 CFR Part 52, Subpart C, as a custom plant application. All design issues would have to be considered as part of each application to construct and operate a System 80+ facility at a particular site. This alternative would not achieve the benefits of standardization, provide early resolution of design issues, or provide finality of design issue resolution.

In the second case, the System 80+ would be issued an FDA under 10 CFR Part 52, Appendix O, but the design would not be certified in a rulemaking. Therefore, although the NRC would have approved the design, the design could be modified and thus require reevaluation as part of each application to construct and operate a System 80+ facility at a particular site. This alternative would provide early resolution of issues, but would not achieve the benefits of standardization or provide finality of design issue resolution.

The NRC sees no advantage in either of the alternatives compared to the design certification rulemaking proposed for the System 80+. Although neither the alternatives nor the proposed design certification rulemaking would have a significant impact affecting the quality of the human environment in and of themselves, the rulemaking provides for standardization, as well as early resolution of design issues and finality of design issue resolution for design issues that are within the scope of the design certification, including SAMDAs. Therefore, the NRC concludes that the alternatives to rulemaking would not achieve the objectives of the Commission intended by certification of the System 80+ design pursuant to 10 CFR Part 52, Subpart B.

3.1 Severe Accident Design Alternatives

The Commission decided to evaluate design alternatives for severe accidents as part of the design certification for the System 80+ design, consistent with its objectives of achieving early resolution of issues for the design and standardization. The Commission, in a 1985 policy statement, defined the term "severe accident" as those events which are "beyond the substantial coverage of design-basis events" and includes those for which there is substantial damage to the reactor core whether or not there are serious offsite consequences. Design-basis events are considered to be those analyzed in accordance with the NRC's Standard Review Plan (NUREG-0800) and documented in Chapter 15 of the System 80+ Design Control Document (DCD).

As part of its design certification application, ABB-CE performed a probabilistic risk assessment (PRA) for the System 80+ design to help (1) identify the dominant severe accident sequences and associated source terms for the design; (2) modify the design, based on PRA insights, to prevent or mitigate severe accidents and reduce the risk of severe accidents; and (3) provide a basis for concluding that all reasonable steps have been taken to reduce the chances of occurrence, and to mitigate the consequences, of severe accidents. ABB-CE's analysis is documented in Chapter 19 of the System 80+ Standard Safety Analysis Report - Design Certification (System 80+ CESSAR-DC).

In addition to considering alternatives to the rulemaking process as discussed in Section 3, applicants for reactor design approvals or construction permits must also consider alternative design features for severe accidents based on (1) the requirements of 10 CFR Part 50 and (2) a court ruling relating to NEPA. These requirements can be summarized as follows:

- 10 CFR 50.34(f)(1)(i) requires the applicant to perform a plant/site specific probabilistic risk assessment, the aim of which is to seek such improvements in the reliability of core and containment heat removal systems as are significant and practical and do not impact excessively on the plant.

- The U.S. Court of Appeals decision, in Limerick Ecology Action v. NRC, 869 F.2d 719 (3rd Cir. 1989), effectively requires the NRC to include consideration of certain severe-accident-mitigation design alternatives (SAMDAs) in the environmental impact review performed as part of the OL application.

Although these two requirements are not directly related, the purpose is the same: to consider alternatives to the proposed design, to evaluate potential alternatives for improvements in the plant design for increased safety performance during severe accidents, and to prevent viable alternatives from being foreclosed. It should be noted that the Commission is not required to consider alternatives to the design in this EA on the proposed rulemaking; however, as a matter of discretion, the Commission has determined that consideration of SAMDAs is consistent with the intent of 10 CFR Part 52 for early resolution of issues and enhancing the benefits of standardization.

In its decision in *Limerick,* the Court of Appeals for the Third Circuit expressed its opinion that it was likely that evaluation of SAMDAs for NEPA purposes would be difficult to perform on a generic basis. However, the NRC has determined that generic evaluation of SAMDAs for the System 80+ design is warranted because (1) the design and construction of all plants referencing the certified System 80+ design will be governed by the rule certifying a single design, and (2) the site parameters specified in the rule and in the "Technical Support Document [TSD] for Amendments to 10 CFR Part 51 Considering Severe Accidents Under NEPA For Plants Of System 80+ Design," dated January 5, 1995, establish the consequences for a reasonable set of SAMDAs for the System 80+ design. The low residual risk of the System 80+ design and limited potential for further risk reductions provides high confidence that additional cost beneficial SAMDAs would not be found. Should the actual site parameters for a particular site exceed those assumed in the rule and TSD, SAMDAs would have to be re-evaluated in the site-specific environmental report and EIS.

ABB-CE initially submitted its response to 10 CFR 50.34(f) in Appendix A to Chapter 19 of CESSAR-DC as part of its application for an FDA and subsequent design certification for the System 80+ design. The NRC issued an FDA for the System 80+ in July 1994, and provided its evaluation of Appendix A to Chapter 19 of CESSAR-DC in Section 19.4 of the "Final Safety Evaluation Report Related to the Certification of the System 80+ Design," (FSER) published as NUREG-1462 in August 1994. Subsequently, as part of its preparation of the DCD for the design certification rulemaking, ABB-CE updated and relocated the information in Appendix A to Chapter 19 of CESSAR-DC to the TSD. ABB-CE submitted the TSD to meet the Commission's requirement to consider SAMDAs as part of the design certification application.

3.2 Estimate of Risk for the System 80+

In response to 10 CFR 50.34(f)(1)(i), ABB-CE provided an evaluation of the System 80+ design improvements in Appendix A to Chapter 19 of CESSAR-DC. ABB-CE's evaluation of risk was based on the risk-reduction potential for internal events only. The limited scope was a consequence of ABB-CE's use of alternative analyses for external events. The staff's evaluation of this approach to external events is in FSER Section 19.4.6. This EA includes an evaluation of both internal and external events. The staff's evaluation of design alternatives considering risk from external events is discussed in Section 3.5.5 of this EA.

In estimating the risk, ABB-CE used the meteorological and population data from the reference site described in the "Advanced Light Water Reactor Utility Requirements Document, Volume II, ALWR Evolutionary Plant," Chapter 1, Appendix A, PRA

Key Assumptions and Groundrules (KAG), Revision 3, EPRI, November 1991. The data from this reference site was developed by EPRI to conservatively bound 80 percent of existing reactor sites in the U.S.

ABB-CE based its risk estimate on four major elements: (1) the mean value core damage frequency (CDF) estimate from the Level 1 PRA described in Chapter 19 of CESSAR-DC; (2) source terms for each release class (RC) determined using a plant-specific version of the NRC-developed XSOR code; (3) offsite consequences for the reference site calculated for each RC using the NRC-developed MACCS code; and (4) the MAAP code and supporting deterministic analyses for modeling accident progression, containment performance, and time and energy of release. A summary of 23 RCs appears in Table 4-1 in the TSD, and a ranking of the RCs based on risk to the general population appears in Table 4-2. ABB-CE's estimate of the cumulative offsite risk of severe accidents occurring in a System 80+ standard plant to the population within 50 miles of the reference site is 0.17 person-Sv (17 person-rem). A cumulative risk of 0.17 person-Sv (17 person-rem) is considered by the NRC to be low, and can be attributed to ABB-CE's efforts to minimize initiators by incorporating results of the PRA into the System 80+ design.

As discussed in Section 19.1 of the FSER, the NRC finds the approach used by ABB-CE for assessing CDF to be logical and sufficient for describing and quantifying potential core damage sequences. The NRC reviewed ABB-CE's source term estimates for the major RCs and found these predictions to be in reasonable agreement with estimates from NUREG-1150. ABB-CE submitted additional analyses using the NRC-developed MELCOR code to verify results obtained using the MAAP code. The NRC performed a number of independent severe accident confirmatory calculations described in Section 19.2 of the FSER. On the basis of these ABB-CE and NRC verification calculations, the NRC concludes that ABB-CE's characterization of accident progression and containment performance is acceptable. The NRC considers ABB-CE's use of the NRC-developed MAACS code in conjunction with the data from the reference site to be an acceptable basis for estimating the consequences associated with severe accident releases. In summary, the NRC finds the methods and computer codes used in estimating the total risk to be acceptable, and the results to be reasonable.

3.3 Identification of Potential Design Alternatives

ABB-CE's evaluation of potential design improvements in response to the requirements of 10 CFR 50.34(f)(1)(i) also gives a technical basis for the NRC staff to evaluate the SAMDAs, as required by the Limerick decision. The NRC staff's review of ABB-CE's evaluation is presented below.

By surveying previous industry- and NRC-sponsored studies of features to prevent and mitigate severe accidents, ABB-CE prepared a set of potential severe accident design alternatives for the System 80+ and developed a composite list of 62 potential design alternatives.

ABB-CE identified 40 of the 62 potential design alternatives for risk reduction cost-benefit analysis. Of the initial 62 design alternatives screened, 26 were modifications already incorporated into the System 80+ design. However, 4 of the 26 design alternatives (numbers 26 (A1), 44 (B7), 48 (A3), and 54 (E11) of TSD Table 4-5) already incorporated into the design were retained in the set of 40 design alternatives evaluated because they addressed important generic safety issues. These 40 design alternatives were divided into 5 groups. The first 4 groups prevent core damage by:

(a) Increasing primary and secondary boundary integrity,

(b) Increasing decay heat removal reliability,

(c) Improving electrical power reliability,

(d) Reducing the risk from anticipated transient without scram (ATWS) and external events.

The last group (e) protects the containment or reduces radioactive releases.

ABB-CE quantified the cost benefit ratio for 27 of the 40 design alternatives evaluated as reflected in TSD Table 5-1. The remaining 13 design alternatives were not quantified because 4 design alternatives were already implemented in the design and 9 design alternatives had very high costs or marginal risk reduction potential for the modification.

3.4 Description of Design Alternatives

The 40 design alternatives evaluated by ABB-CE are described in Section 4.7 of the TSD. The 27 design alternatives selected by ABB-CE for cost-benefit evaluation are summarized below. The numbers in parentheses correspond to the design alternative number in the TSD.

(1) 100-Percent Steam Generator (SG) Inspection (A2) — Perform eddy-current testing on 100 percent of the SG tubes each

refueling outage in order to reduce the frequency of steam generator tube rupture (SGTR) events.

(2) Secondary Side Guard Pipes (A6) — Install guard pipes around the secondary piping between the containment and the main steam isolation valves in order to reduce the risk from SGTRs given a main steamline break initiating event.

(3) Alternative Batteries and Emergency Feedwater System (EFWS) (B1) — Increase the capacity of the EFWS-related batteries so that the probability of a loss of decay heat removal due to battery depletion is reduced.

(4) 12-Hour Batteries (B2) — Increase the battery size to accommodate a 12-hour rather than 8-hour duty cycle, thereby reducing the probability of failure to recover offsite power before core damage.

(5) Alternative Pressurizer Auxiliary Spray (B3) — Increase the redundancy and diversity of the pressurizer spray valves and charging pump, so that the probability of failures of the auxiliary spray to successfully depressurize the primary system are reduced in SGTR sequences.

(6) Alternative High-Pressure Safety Injection (HPSI) (B4) — Provide an alternative or improved HPSI system, so that the probabilities of all core-damage sequences involving HPSI failures are reduced.

(7) Alternative Reactor Coolant System Depressurization (B5) — Increase the reliability and diversity of the safety depressurization valves so that the probabilities of all sequences in which the safety depressurization system fails are reduced.

(8) Diesel-Driven Safety Injection (SI) Pumps (B6) — Replace two of the electric SI pumps with diesel-driven pumps to reduce common-cause failure of all four pumps and the risk from station blackout (SBO).

(9) Extended In-Containment Refueling Water Storage Tank (IRWST) Source (B8) — Provide a separate borated water storage tank and pump for refilling the IRWST, thereby reducing the potential for IRWST depletion in un-isolated SGTR events.

(10) Third Diesel Generator (DG) (C1) — Add a third, swing DG to lower the probability of SBO events and provide improved operational flexibility.

(11) Tornado protection for Combustion Turbine (C2) — Provide tornado protection for the gas turbine generator and associated support systems to prevent loss of the system due to tornado and high-wind events.

(12) Fuel Cells (C3) — Use fuel cells in lieu of conventional lead-acid batteries, thereby extending the availability of dc power.

(13) Hookup for Portable Generators (C4) — Provide temporary connections so that portable generators could be used to power the turbine-driven EFW pump after the station batteries are depleted.

(14) Alternative ATWS Pressure Relief Valves (D1) — Provide a system of relief valves that can prevent equipment damage from a primary coolant pressure spike in an ATWS sequence.

(15) ATWS Injection System (D2) — Modify the reactor coolant pump seal cooling system to inject boron using existing sources of boron and existing piping and valves.

(16) Diverse Plant Protection System (PPS) (D3) — Provide a third, diverse PPS to resolve instrumentation and control diversity concerns and reduce the frequency of ATWS events.

(17) Alternative Containment Spray System (CSS) (E1) — Provide an independent CSS as a backup to the front-line CSS, so that frequency of late steam overpressure failures is reduced.

(18) Filtered Containment Vent (E2) — Add a filtered containment vent similar to the multi-venturi scrubbing systems implemented in some plants in Europe to reduce the potential for late containment overpressure failures.

(19) Alternative Concrete Composition (E3) — Use an advanced concrete composition in the reactor cavity or increase the thickness of the basemat concrete so that the probability of basemat melt-through is reduced.

(20) Reactor Vessel Exterior Cooling (E4) — Provide the capability to submerge the reactor vessel lower head in water during severe accidents in order to enhance heat removal from the lower head and reduce the probability of melt-through of the lower head.

(21) Alternative Hydrogen Igniters (E5) — Provide dedicated batteries for the hydrogen mitigation system (HMS) in order to improve system reliability and further reduce the potential for containment failure from hydrogen combustion.

(22) Passive Autocatalytic Recombiners (E6) — Provide passive autocatalytic recombiners in addition to the existing HMS to provide improved hydrogen control, particularly in SBO sequences.

(23) Main Steam Safety Valve (MSSV) and Atmospheric Dump Valve (ADV) Scrubbing (E7) — Route the discharge from the MSSVs and ADVs through a structure where a water spray would condense the steam and remove most of the fission products, thereby reducing the consequences associated with a SGTR.

(24) Alternative Containment Monitoring System (E8) — Improve the containment isolation valve position indication so that risk from containment bypass sequences and interfacing-systems loss-of-coolant accidents is reduced.

(25) Cavity Cooling (E9) — Modify the reactor cavity configuration and the flow paths between the IRWST and reactor cavity so that heat from the reactor vessel lower

head or ex-vessel core debris could be transported passively to the IRWST, thereby reducing the potential for reactor vessel failure, ex-vessel steam explosions, and core-concrete interactions.

(26) Water-Cooled Rubble Bed (E12) — Provide a bed of refractory pebbles that would impede the flow of molten corium to the concrete drywell structures and increase the available heat transfer area, thereby enhancing debris coolability.

(27) Refractory-Lined Crucible (E13) — Provide a ceramic-lined crucible and cooling system in the reactor cavity in order to reduce the potential for basemat melt-through.

The NRC staff has reviewed the set of potential design alternatives identified by ABB-CE in the TSD and finds the set to constitute a reasonable range of design alternatives. The list includes all alternatives identified in the NRC containment performance improvement (CPI) program and in the NRC review of SAMDAs for the Limerick Generating Station that would be applicable to System 80+. The NRC notes that the set of design alternatives is not all inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the NRC concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered. On this basis, the NRC concludes that the set of potential design alternatives identified by ABB-CE is acceptable.

3.5 Risk Reduction Potential of Design Alternatives

3.5.1 ABB-CE's Evaluation of Risk Reduction Potential

ABB-CE used the reduction in cumulative risk of accidents occurring during the life of the plant as the basis for estimating the benefit that could be derived from plant improvements. Estimates of risk reduction were developed by determining the approximate effect of each design alternative on the frequency of the various release classes in the PRA. For those design alternatives that were preventative (reduced CDF), ABB-CE assumed that the design alternative would completely eliminate the sequence it addresses. In addition, ABB-CE conservatively assumed that each design alternative when employed worked perfectly (i.e., zero failure rate). A summary of ABB-CE's assessment of risk reduction for the candidate design improvements is provided in Table 1 of this EA.

The NRC staff reviewed ABB-CE's bases for estimating the risk reduction associated with the various design improvements. The NRC staff notes that considerable judgement was exercised in estimating the risk reduction potential, however, the rationale and assumptions on which the risk reductions are based appear to be sound.

3.5.2 NRC Staff Evaluation of Risk Reduction Potential

In view of the small residual risk for the System 80+ (0.17 person-Sv (17 person-rem)), rather than performing an independent assessment of the risk reduction potential of each of the 40 System 80+ design alternatives, the NRC staff used a screening-type approach for identifying the most promising alternatives. The set of potential design alternatives was initially screened by the NRC staff using a bounding assumption that each improvement would eliminate all the risk from internally-initiated events for the System 80+ (0.17 person-Sv (17 person-rem) for a 60-year life). This approach conservatively tends to over-estimate the benefits derived from each design alternative. For those design alternatives whose cost benefit ratio was found to be within a factor of 10 of the $100,000/person-Sv-averted ($1,000/person-rem-averted) criterion in the screening assessment, the NRC staff applied a more design-specific assessment, described below in Section 3.5.3 of this report.

3.5.3 Cost of SAMDAs

ABB-CE determined the approximate costs for each design alternative, using the methodology described in Section 4.3 of the TSD. The cost estimate for each design alternative represents the incremental costs that would be incurred in incorporating that design alternative in a new plant. These costs were intentionally biased on the low side, but all known or reasonably expected costs were accounted for. However, any annual costs associated with operation, testing, maintenance, and training were omitted. For design alternatives that reduced the CDF, ABB-CE reduced the costs of the design alternative by an amount proportional to the averted onsite costs (AOCs).

The NRC staff reviewed the bases for ABB-CE's cost estimates and found them reasonable. For certain design alternatives, the NRC staff also compared ABB-CE's cost estimate with estimates developed elsewhere for similar improvements, even though the bases for some were different. The NRC staff considered cost estimates developed in the evaluation of design improvements for GESSARII (NUREG-0979, Supplement 4), and the review of SAMDAs for Limerick and Comanche Peak (NUREG-9074 and -0775, respectively). The NRC staff noted that cost estimates were lower than expected for a number of SAMDAs, such as 12-hour batteries ($300K) and reactor cavity cooling system ($50K). However, the costs for other improvements were higher than expected, such as alternative concrete composition ($5 million) and refractory-lined crucible ($108 million). Nevertheless, the NRC staff views ABB-CE's approximate cost estimates as adequate, given the uncertainties surrounding the underlying cost estimates, and the level of precision necessary given the greater uncertainty inherent on the benefit side with which these costs were compared.

3.5.4 Cost-Benefit Comparison

ABB-CE performed a cost-benefit comparison to determine whether any of the design alternatives could be justified. The costing methodology and assumptions used by ABB-CE are described in the TSD and in CESSAR-DC Appendix 19A. The benefit of a particular design alternative was evaluated in terms of reduced risk to the general public in units of person-Sv/year (person-rem/year). The cost of a particular design alternative is a one-time initial capital cost in dollars. In order to compare the benefits with the costs, ABB-CE used the former $100,000/person-Sv ($1000/person-rem) criterion and multiplied by 60 years (plant lifetime), to convert the risk reduction into dollars. The cost-benefit ratio for each of the 27 design alternatives are shown in Table 2 of this EA and Table 5-1 of the TSD. As shown in the tables, the costs of the design alternatives range from about $90 billion/person-Sv-averted ($900 million/person-rem-averted) to about $3 million/person-Sv-averted ($30K/person-rem-averted). Consistent with former NRC practice, ABB-CE used a screening criterion of $100,000/person-Sv-averted ($1000/person-rem-averted) to identify whether any of the design alternatives could be cost effective. On this basis ABB-CE concluded that no additional design alternatives are warranted.

Section 4.1 of the TSD describes how AOCs were incorporated into the cost benefit equation. In this section, ABB-CE states that AOCs are included in the cost-benefit analyses of those design alternatives that reduce CDF as reductions in the cost of the design alternatives.

As discussed above in Section 3.5.2 of this report, the NRC staff used a screening-type approach for identifying the most promising design alternatives, and performed a more detailed assessment for only those whose cost-benefit ratio was found to be within a factor of 10 of the $100,000/person-Sv ($1,000/person-rem) criterion. On the basis of initial screening, only two design alternatives were retained for further analysis by the NRC staff:

! Hookup for Portable Generators (C4) — Provide temporary connections so that portable generators could be used to power the turbine-driven EFW pump after the station batteries are depleted; and

- Cavity Cooling (E9) — Modify the reactor cavity configuration and the flow paths between the IRWST and reactor cavity so that heat from the reactor vessel lower head or ex-vessel core debris could be transported passively to the IRWST, thereby reducing the potential for reactor vessel failure, ex-vessel steam explosions, and core-concrete interactions.

The NRC staff notes that for the two design alternatives identified in the screening, the assumption that all residual risk would be eliminated is overly conservative since these improvements will have little impact on the SGTR sequences that dominate risk for the System 80+. ABB-CE's risk reduction estimates, which take into account the actual plant risk profile, are judged by the NRC staff to be more appropriate for these design alternatives. ABB-CE's risk-reduction estimates for the portable generator hookup option (C4) assume complete elimination of all sequences in which EFW is lost after battery depletion, i.e., 0.0000187 person-Sv (0.00187 person-rem) averted per year. ABB-CE's risk-reduction estimates for the cavity flooding option (E9) assume complete elimination of reactor vessel melt-through, basemat attack, and steam explosions, i.e., 0.000307 person-Sv (0.0307 person-rem) averted per year. Furthermore, these SAMDAs are the lowest cost modifications evaluated by ABB-CE ($10,000 and $50,000, respectively), and the cost figures appear somewhat low. Additional costs associated with first-of-a-kind engineering are still to be anticipated for these and many of the other design alternatives. For example, the introduction of a design change would trigger a series of related requirements, such as incremental training, maintenance, procedural changes, and possible licensing requirements. These are all legitimate costs that require consideration in a comprehensive cost estimate. They were, however, conservatively omitted from both the NRC staff's and ABB-CE's cost-benefit analyses. The NRC staff concludes that, using the more realistic risk reduction estimates, and considering the additional cost factors, neither of these design alternatives would be cost effective. Furthermore, they would not substantially reduce overall risk for the System 80+ design since the improvements would not have an impact on the sequences that dominate risk for System 80+.

The cost-benefit ratio of the remaining SAMDAs are approximately one order of magnitude or more greater than for these two, as shown in FSER Table 19.6. Moreover, the risk reduction potential for the more cost beneficial SAMDAs (e.g., B2 and D2) is not significant. Accordingly, the NRC staff concludes that none of the other SAMDAs would be cost beneficial as well.

3.5.5 Further Considerations

The NRC staff has reviewed the assumptions on which this conclusion is based and has considered the effect of uncertainties in estimating CDF, the use of alternative cost-benefit criteria, and the inclusion of external events within the scope of the analysis.

On the basis of uncertainty analyses performed by ABB-CE for the Level 1 PRA (see Section 19.1.3.1.3 of the FSER), the 95th percentile CDF is approximately 5×10^{-6} per reactor year. This is roughly a factor of 3 higher than the mean value on which the cost-benefit analysis is based, but still very low compared to operating plants and also in absolute terms. If the benefits of the various design alternatives were requantified on the basis of this upper bound value and the conservative assumption that each SAMDA eliminates all residual risk was used, only the design alternatives discussed above (C4 and E9) would be cost-beneficial. However, using ABB-CE's calculations of risk reduction potential, which are judged to be more appropriate, no SAMDA was cost-beneficial.

Similarly, if the cost-benefit criteria was increased by a factor of 10, to $1 million/person-Sv-averted ($10,000/person-rem-averted), only the two design alternatives previously discussed (C4 and E9) would become cost effective. Again, using the ABB-CE's estimates of risk-reduction potential, as discussed above, none of the design alternatives become cost-beneficial.

A quantitative assessment of the risk from externally initiated events was not performed for the System 80+ design. Based on experience with probabilistic assessments performed for operating plants, the estimate of the residual risk for the System 80+ design could be one or two orders of magnitude higher than considered if external events are included. (Historically, seismic events dominate external risk.) However, even at two orders of magnitude higher, design alternatives that cost more than $1.7 million would not be cost effective, even if all risk was eliminated. Using ABB-CE's cost estimates, the NRC staff examined the 13 design alternatives that cost less than $2 million, and found that they all have a relatively low risk reduction potential, would eliminate only 10 percent of the residual risk from internal events, and are not expected to be effective in eliminating the added risk from external events (e.g., seismic events). Given the robustness of the seismic design, i.e., a high-confidence-low-probability-of-failure (HCLPF) value of about 0.7 g, the remaining SAMDAs would be unlikely to eliminate a significant portion of the external risk from seismic events. As a result, none of these design alternatives are expected to be cost effective when their actual effectiveness in reducing risk is taken into account.

Since the draft EA was issued in April 1995, the NRC has issued "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058, Revision 2, November 1995). This policy document adopts a $2000 per person-rem conversion factor, subject to present worth considerations and is limited in scope to health effects. Limiting the conversion factor solely to health effects requires that the regulatory analysis include an additional dollar allowance for averted offsite property damage. By adopting the new $2000 per person-rem conversion factor and a $3000 per person-rem supplemental allowance for offsite property (see NUREG/CR-6349, "Cost benefit Considerations in Regulatory Analysis"), and assuming a base case 7% real discount rate as prescribed in NUREG/BR-0058, Revision 2, the present value of the health and safety benefits attributable to an individual SAMDA would increase by a factor of about 1.2. A comparable estimate for the health and safety benefits of the same SAMDA based on a 3% real discount rate, which is recommended for sensitivity analysis purposes, would increase its value by a factor of 2.3. Given that the costs to implement the most cost effective SAMDAs are at least a factor of 10 greater than the value that would make them cost effective, an increase in benefits by factor of 2.3 leaves the total costs well in excess of the total benefits.

In summary, the NRC staff concludes that given the significant margins in the results of the cost-benefit analysis, the findings would be unchanged even considering the factors discussed above.

3.6 Conclusions

As discussed in this report, ABB-CE has made extensive use of the results of PRA to arrive at a final System 80+ design. As a result, the estimated CDF and risk calculated for the System 80+ is very low, both relative to operating plants and in absolute terms. The low CDF and risk for the System 80+ is a reflection of ABB-CE's efforts to systematically minimize the effect of initiators and/or sequences that have been important contributors to CDF as calculated in previous pressurized water reactor PRAs. This has been done largely through the incorporation of a number of hardware improvements in the System 80+ design that both reduce CDF and mitigate the consequences of a core-damage event.

Because the System 80+ design already contains numerous plant features oriented toward reducing CDF and risk, the benefit and risk reduction potential of additional plant improvements is significantly reduced. This is true for both internally and externally initiated events. For example, the System 80+ seismic design basis (0.3 g safe-shutdown earthquake) has been shown to result in significant ability to withstand earthquakes well beyond the design basis, as characterized by a HCLPF value of about 0.7 g. Moreover, with the features already incorporated in the System 80+ design, the ability to estimate CDF and risk approached the limitation of probabilistic techniques. Specifically, when CDFs of 1 in 100,000 or 1,000,000 years are estimated in a PRA, it is the area of the PRA where modeling is least complete, or supporting data is sparse or even non-existent, that could actually be the more important contributors to risk. Areas not modeled or incompletely modeled include human reliability, sabotage, rare initiating events, construction or design errors, and systems interactions. Although improvements in the modeling of these areas may introduce additional contributors to CDF and risk, the NRC staff does not expect that the additional contribution would be significant in absolute terms.

In 10 CFR 50.34(f)(1)(i), the NRC staff requires an applicant to perform a plant or site-specific PRA, the aim of which is to seek such improvements in the reliability of core and containment heat removal systems as are significant and practical and do not impact excessively on the plant. The NRC staff concludes that the System 80+ PRA and ABB-CE's use of the insights from the PRA to improve the design of the System 80+ meet this requirement. The NRC staff concurs with ABB-CE's conclusion that none of the potential design alternatives evaluated are justified based on cost-benefit considerations. It is further concluded that it is unlikely that any other design changes would be justified on the basis of person-rem exposure considerations, because the estimated CDFs would remain very low on an absolute scale.

4.0 THE ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

The issuance of an amendment to 10 CFR Part 52 certifying the System 80+ design would not constitute a significant environmental impact. The amendment would only codify the results of the NRC's review and approval of the System 80+ design as defined in the FSER, dated August 1994 (NUREG-1462). Further, because the action is a rule, there are no resources involved that would have alternative uses.

In Section 3 of this EA, the NRC staff reviewed alternatives to design certification rulemaking and alternative design features related to the prevention and mitigation of severe accidents. Consideration of alternatives under NEPA were necessary for two reasons: (1) to show that the design certification rule is the appropriate course of action, and (2) to ensure that there are no cost-beneficial design changes relating to the prevention and mitigation of severe accidents that were excluded from the design, as codified in the design certification rule. The NRC concludes that the alternatives to design certification did not provide for resolution of issues as did the proposed design certification rulemaking.

This design certification rulemaking is in keeping with the Commission's intent in the Standardization and Severe Accident Policy Statements, and 10 CFR Part 52, to make future plants safer than the current generation plants, to achieve early resolution of licensing issues, and to enhance the safety benefits of standardization. Through its own independent analysis, the NRC also concludes that ABB-CE adequately considered an appropriate set of SAMDAs, and none were found to be cost-beneficial. Although no design changes resulted from the SAMDAs review, ABB-CE did make changes to the System 80+ design based on the results of the PRA. These changes were related to severe accident prevention and mitigation, but were not considered in the SAMDA evaluation because they were already part of the design. See FSER Section 19.1.6, "PRA as a Design Tool."

The certification rule by itself would not authorize the siting, construction, or operation of a System 80+ design nuclear power plant. The issuance of a CP, ESP, COL, or OL for the System 80+ design will require a prospective applicant to address the environmental impacts of construction and operation at a specific site. At that time, the NRC will evaluate the environmental impacts and issue an environmental impact statement (EIS) in accordance with NEPA. The SAMDAs analysis for the System 80+, however, has been completed as part of this EA and will not need to be to be evaluated again as part of an EIS related to siting, construction, or operation.

5.0 AGENCIES AND PERSONS CONSULTED AND SOURCES USED

The NRC concludes that design certification rulemaking does not result in a significant environmental impact because the action does not authorize the construction and operation of a facility at a particular site. Therefore, the NRC staff did not issue this EA for comment by Federal, State, and local agencies. However, the NRC's finding of no significant environmental impact, was published in the Federal Register on April 7, 1995, with the proposed System 80+ design certification rule and there were no comments received related to this EA.

The sources for this draft EA include the "Technical Support Document For Amendments to 10 CFR Part 51 Considering Severe Accidents Under NEPA for Plants of System 80+ Design," Revision 2, dated January 5, 1995; ABB-CE's "Combustion Engineering Standard Safety Analysis Report-Design Certification," through Amendment W; and the NRC staff's "Final Safety Evaluation Report Related to the Certification of the System 80+ Design" (NUREG-1462, Volumes 1 and 2), August 1994.

6.0 FINDING OF NO SIGNIFICANT IMPACT

The Director, Office of Nuclear Reactor Regulation (NRR), has determined under the National Environmental Policy Act of 1969, as amended, and the NRC's regulations in 10 CFR Part 51, Subpart A, that this rule is not a major Federal action significantly affecting the quality of the human environment, and therefore, an environmental impact statement is not required.

The basis for the determination, as documented in this EA, is that the amendment to 10 CFR Part 52 would not authorize the siting, construction, or operation of a facility using the System 80+ design; it would only codify the System 80+ design in a rule. The NRC will evaluate the environmental impacts and issue an EIS as appropriate in accordance with NEPA as part of the application(s) for the siting, construction, or operation of a facility.

In addition, as part of this final EA, the NRC reviewed, pursuant to NEPA, ABB-CE's evaluation of various design alternatives to prevent and mitigate severe accidents that was submitted in ABB-CE's TSD. The Director of NRR finds that ABB-CE's evaluation provides a sufficient basis to conclude that there is reasonable assurance that an amendment to 10 CFR Part 52 certifying the System 80+ design will not exclude a severe accident design alternative for a facility referencing the certified design that would have been cost beneficial had it been considered as part of the original design certification application. The evaluation of these issues under NEPA is considered resolved for the System 80+ design.

Table 1 Summary of ABB-CE's Assessment of Risk Reduction for Candidate Design Improvements

POTENTIAL SYSTEM 80+ DESIGN ALTERNATIVES	ABB-CE's BASIS FOR ESTIMATING RISK REDUCTION	PERSON-SV (PERSON- REM) AVERTED PER YEAR
Increase Primary and Secondary Boundary Integrity		
100% SG Inspection (A2)	Assume all SGTRs are eliminated	0.00249 (0.249)
Secondary Side Guard Pipes (A6)	50% reduction in risk from ISLOCAs and steam line breaks	0.0000076 (0.00076)
Increase Decay Heat Removal Reliability		
Alternative DC Batteries and EFWS (B1)	Assume capability to remove decay heat using batteries and the turbine-driven feedwater pump for whatever time period is required	0.0000187 (0.00187)
12 Hour Batteries (B2)	Decrease probability of failure to restore offsite power by 62%	0.000016 (0.0016)
Alternative Pressurizer Auxiliary Spray (B3)	During SGTR, assume spray always depressurizes primary to allow SCS to operate and SCS always removes decay heat	0.00207 (0.207)
Alternative High Pressure Safety Injection (B4)	Eliminate all sequences with SIS failures	0.00083 (0.083)
Alternative RCS Depressurization (B5)	Eliminate all sequences where SDS of bleed fails	0.000142 (0.0142)
Diesel SI Pumps (B6)	Increase reliability of SIS by factor of 60 and assume SBO is eliminated	0.000834 (0.0834)
Extended RWST Source (B8)	Assume unlimited RWST water supply	0.00182 (0.182)
Improve Electrical Power Reliability		
Third Diesel Generator (C1)	Reduce the risk of release classes for SBO by 24%	0.0000045 (0.00045)
Tornado Protection for Combustion Turbine (C2)	Assume combustion turbine is completely protected and has failure rate of 0.025/d	0.000016 (0.0016)
Fuel Cells (C3)	Assume power for EFW is available for unlimited time during SBO	0.0000187 (0.00187)
Hookup for Portable Generator (C4)	Assume power for EFW is available for unlimited time during SBO	0.0000187 (0.00187)
ATWS and External Events		
Alternative ATWS Pressure Relief Valves (D1)	Eliminate all ATWS core damage sequences	0.0000097 (0.00097)
ATWS Injection System (D2)	Eliminate all ATWS core damage sequences	0.0000097 (0.00097)
Diverse PPS (D3)	Eliminate all ATWS core damage sequences	0.0000097 (0.00097)
Reduce Radioactive Releases		

Alternative Containment Spray (E1)	Prevent all high pressure containment failures caused by slow steam pressurization and eliminate sequences where scrubbing does not occur	0.0000733 (0.00733)
Filtered Vent (Containment) (E2)	Prevent all slow high pressure containment failures	0.0000053 (0.00053)
Alternative Concrete Composition (E3)	Assume ideal concrete composition that prevents basemat melt-through	0.0000487 (0.00487)
Reactor Vessel Exterior Cooling (E4)	Prevent vessel melt-through and subsequent basemat attack or steam explosion	0.000307 (0.0307)
Alternative Hydrogen Igniters (E5)	Prevent release classes associated with containment failures from hydrogen burns or explosions	0.0000093 (0.00093)
Passive Autocatalytic Recombiners (PARS) (E6)	Prevent release classes associated with containment failures from hydrogen burns or explosions	0.0000093 (0.00093)
MSSV and ADV Scrubbing (E7)	Scrub discharges to remove most fission products during SGTR	0.00246 (0.246)
Alternative Containment Monitoring System (E8)	Eliminate release classes where containment bypass is predicted (except for SGTR)	0.0000166 (0.00166)
Cavity Cooling (E9)	Assume existing shutdown cooling system equipment always works - eliminate vessel failure, steam explosions and concrete interactions	0.000307 (0.0307)
Water Cooled Rubble Bed (E12)	Eliminate release classes where basemat melt-through is modeled	0.0000487 (0.00487)
Refractory Lined Crucible (E13)	Eliminate release classes where basemat melt-through is modeled	0.0000487 (0.00487)

Table 2

Potential Design Improvements and Associated Costs (ABB-CE)

Design Alternative		Estimated Cost ($M)	Person-Sv (Person-Rem) Averted Per Year	Cost($M)/ Person-Sv (Person-Rem) Averted Per Year
A2	100% SG inspection	1.0*	0.00249 (0.249)	400 (4.0)
A6	Secondary side pipe guards	1.1	0.0000076 (0.00076)	2,400 (24)
B1	Alternative DC Batteries and EFWS	2.0	0.0000187 (0.00187)	1,800 (18)
B2	12 Hour Batteries	0.3	0.000016 (0.0016)	430 (4.3)
B3	Alternative pressurizer aux. spray	5.0	0.00207 (0.207)	40 (0.40)
B4	Alternative HPSI	2.2	0.00083 (0.083)	43 (0.43)
B5	Alternative RCS Depressurization	0.5	0.000142 (0.0142)	56 (0.56)
B6	Diesel SI Pumps	2.0	0.000834 (0.0834)	39 (0.39)
B8	Extended RWST Source	1.0	0.00182 (0.182)	9.1 (0.091)
C1	Third Diesel Generator	25.0	0.0000045 (0.00045)	93,000 (930)
C2	Tornado Protection for Combustion Turbine	3.0	0.000016 (0.0016)	3,100 (31)
C3	Fuel Cells	2.0	0.0000187 (0.00187)	1,800 (18)
C4	Hookup for Portable Generator	0.01	0.0000187 (0.00187)	8.3 (0.083)
D1	Alternative ATWS Pressure Relief Valves	1.0	0.0000097 (0.00097)	1,700 (17)
D2	ATWS Injection System	0.3	0.0000097 (0.00097)	510 (5.1)
D3	Diverse PPS	3.0	0.0000097 (0.00097)	5,200 (52)
E1	Alternative Containment Spray	1.5	0.0000733 (0.00733)	340 (3.4)
E2	Filtered Vent (Containment)	10.0	0.0000053 (0.00053)	31,000 (310)
E3	Alternative Concrete Composition	5.0	0.0000487 (0.00487)	1,700 (17)
E4	Reactor Vessel Exterior Cooling	2.5	0.000307 (0.0307)	140 (1.4)

E5	Alternative Hydrogen Igniters	1.0	0.0000093 (0.00093)	1,800 (18)
E6	Passive Autocatalytic Recombiners (PARS)	0.76	0.0000093 (0.00093)	1,400 (14)
E7	MSSV and ADV Scrubbing	9.5	0.00246 (0.246)	64 (0.64)
E8	Alternative Containment Monitoring System	1.0	0.0000166 (0.00166)	1,000 (10)
E9	Cavity Cooling	0.05	0.000307 (0.0307)	2.7 (0.027)
E12	Water Cooled Rubble Bed	18.8	0.0000487 (0.00487)	6,400 (64)
E13	Refractory Lined Crucible	108.0	0.0000487 (0.00487)	37,000 (370)

* 100% SG costs are an annual cost and are used directly to calculate $/person-Sv averted