7.3 Severe Accident Mitigation Alternatives

As described in ER Section 7.2, GE performed a generic severe accident analysis for the ABWR as part of the design certification process (Reference 7.3-1). ER Section 7.2 extends the GE generic severe accident analysis to examine STP 3 & 4 and determined that the generic conclusions remain valid for STP 3 & 4. GE also submitted an analysis of severe accident mitigation design alternatives (SAMDAs) and determined that no potential mitigating design alternatives are cost-effective, that is, appropriate mitigating measures are already incorporated into the ABWR design (Reference 7.3-2). This section addresses whether there are cost-beneficial severe accident procedural modifications that would need to be implemented for STP 3 & 4 to mitigate the impacts from severe accidents.

7.3.1 SAMA Analysis Process

Design or procedural modifications that could mitigate the consequences of a severe accident are known as severe accident mitigation alternatives (SAMAs). SAMAs are somewhat broader than SAMDAs, which primarily focus on design changes and do not consider procedural modifications. The GE analysis is a SAMDA analysis in which one of the stated purposes is to support a conclusion that:

> No further evaluation of severe accidents for the ABWR design, including SAMDAs to the design, is required in any environmental report, environmental assessment, environmental impact statement, or other environmental analysis prepared in connection with issuance of a combined license for a nuclear power plant referencing a certified ABWR design (Reference 7.3-2).

For an existing plant with a well-defined design and established procedural controls, the normal evaluation process for identifying potential SAMAs includes four steps:

(1) Define the base case —The base case is the dose-risk and cost-risk of a severe accident before implementation of any SAMAs. A plant's probabilistic risk assessment is the primary source of data in calculating the base case. The base case risks are converted to a monetary value to use for screening SAMAs. ER Section 7.2 presents the base case for a single ABWR unit at the STP site, without the monetary valuation step(which is discussed in Section 7.3.3 below).

(2) Identify and screen potential SAMAs —Potential SAMAs can be identified from the plant's Individual Plant Examination, the plant's probabilistic risk assessment, and the results of other plants' SAMA analyses. This list of potential SAMAs is assigned a conservatively low implementation cost based on historical costs, similar design changes and/or engineering judgment, then compared to the base case monetary screening value. SAMAs with higher implementation cost than the base case are not evaluated further.

(3) Determine the cost and net value of each SAMA — Each SAMA remaining after Step 2 has a detailed engineering cost estimate developed using current plant engineering processes. If the SAMA does not exceed the base case screening value, Step 4 is performed.

(4) Determine the benefit associated with each remaining SAMA — Each SAMA that passes the screening in Step 3 is evaluated using the probabilistic risk assessment model to determine the reduction in risk associated with implementation of the proposed SAMA. The reduction in risk benefit is then converted to a monetary value and compared to the detailed cost estimate developed in Step 3. Those SAMAs with reasonable cost-benefit ratios are considered for implementation.

Since the GE analysis has shown that there are no additional cost-beneficial design modifications, no further assessment of design modifications is required. In the absence of an existing plant with established procedural controls, the STP SAMA analysis thus is limited to determining the magnitude of plant-specific procedural modifications that would be cost-effective. Determining the magnitude of cost-effective procedural modifications is the same as “1. Define base case” for existing nuclear units. The monetary value of the base case benefit is calculated by assuming the current dose-risk of the unit could be reduced to zero and assigning a defined dollar value for this reduction in risk. Any procedural change with a cost that exceeds the benefit value would not be considered cost-effective.

The dose-risk and cost-risk results from the ER Section 7.2 analyses are converted to monetary value in accordance with methods established in NUREG/BR-0184 (Reference 7.3-3). NUREG/BR-0184 presents methods for determining the value of decreases in risk using four types of attributes: public health, occupational health, offsite property, and onsite property. Any SAMAs in which the conservatively low implementation cost exceeds the base case monetary value would not pass the screening in Step 2. If the STP baseline analysis produces a monetary value of the benefit that is below the cost expected for implementation of any SAMA, the remaining steps of the SAMA analysis are not necessary.

7.3.2 ABWR SAMA Analysis

In the certification process, only design alternatives were of interest. The GE SAMDA analysis is presented in the Technical Support Document for the ABWR (Reference 7.3-2). The monetary valuation of the averted cost-risk (defined as the monetary valuation of reducing the base case core damage frequency to zero) was based solely on the cumulative dose-risk over the 60-year life of the plant, assuming the NRC-generated value of $1000 per person-rem. The resulting dose-risk was determined to be 0.269 person-rem (4.48 × 10-3 person-rem per reactor year), so the averted cost-risk was calculated to be $269. GE determined that no design change would be cost-effective with this low value of averted cost-risk.

7.3.3 Monetary Valuation of the STP 3 & 4 Cost-Risk

The principal inputs to the base case calculations are as follows:

Dose-risk	4.3×10^{-3} person-rem per reactor year (reported in Table 7.2-1)
Cost-risk	2.6 dollars per reactor year (reported in Table 7.2-1)
Dollars per person-rem	$2000 (provided in NUREG/BR-0184)
Licensing period	40 years
Economic discount rate	7% and 3% (recommended in NUREG/BR-0184)

With these inputs, the monetary valuation of reducing the base case core damage frequency to zero is presented in Table 7.3-1. The monetary valuation, known as the maximum averted cost-risk, is conservative because no SAMA can reduce the core damage frequency to zero.

The maximum averted cost-risk for a single ABWR at the proposed STP site is $6,900. Even with a conservative 3% discount rate, the valuation of the averted risk is only approximately $12,500.

These values are higher than the GE generic analysis result of $269. However, the GE analysis (Reference 7.3-2) used a different methodology that did not calculate a cost-risk for each accident sequence, did not calculate net present value, and used $1000 per person-rem instead of $2000. If STPNOC were to perform the analysis described in ER Section 7.2 using the GE methodology (Reference 7.3-2), the resulting dose-risk value would be $258. This $258 value is approximately the same as the GE value. Even using the STPNOC values, the results of the SAMDA analysis performed by GE for the ABWR would not be affected; i.e., there still would be no cost-effective design alternatives.

Due to the costs associated with processing administrative changes (including training costs), administrative changes are likely to cost more than the maximum averted cost-risk of $6,900 (or even $12,500). Furthermore, since administrative changes would likely have a small impact on risk, the reduction in risk benefit of administrative changes will likely be substantially less than the cost of the administrative changes. Therefore, it may be concluded that administrative changes are not reasonable SAMAs.

Evaluation of specific administrative controls will occur when the STP 3 & 4 design is finalized and plant administrative processes and procedures are being developed. At that time, appropriate administrative controls on plant operations would be incorporated into the management systems for STP 3 & 4.

7.3.4 References

7.3-1 "Probabilistic Evaluations," Chapter 19D, ABWR Standard Safety Analysis Report, Amendment 35, General Electric.

7.3-2 “Technical Support Document for the ABWR,” Revision 1, MPL No. A90-3230, General Electric, San Jose, California, November 18, 1994.

7.3-3 "Regulatory Analysis Technical Evaluation Handbook," NUREG/BR-0184, January 1997.

Table 7.3-1 STP Maximum Averted Cost-Risk for one ABWR Net Present Value (2007 dollars)

	7% Discount Rate	3% Discount Rate
Offsite exposure cost	$66	$158
Offsite economic cost	$20	$48
Onsite exposure cost	$68	$140
Onsite cleanup cost	$2,300	$4,700
Replacement power cost	$4,400	$7,400
Approximate Total	**$6,900**	**$12,500**