15.0 Accident Analysis

15.0.3 Radiological Consequences of Design Basis Accidents

15.0.3.1 Introduction

In Chapter 15 of the SSAR submitted by SNC, as part of the ESP application for the VEGP site, the applicant analyzed and provided the radiological consequences of DBAs to demonstrate that a new nuclear unit(s) could be sited at the proposed ESP site without undue risk to the health and safety of the public, in compliance with the requirements of 10 CFR 52.17 and 10 CFR Part 100. The applicant used the Westinghouse AP1000 certified reactor design in its consideration of the proposed ESP site. The applicant used the AP1000 characteristics in conjunction with site characteristics for accident analysis purposes, to assess the suitability of the proposed ESP site. Using the source term developed for this design, the applicant performed and provided radiological consequence analyses for the following DBAs:

- PWR main steamline break
- PWR feedwater system pipe break
- reactor coolant pump shaft seizure (locked rotor)
- reactor coolant pump shaft break
- PWR rod cluster control assembly ejection accident
- failure of small lines carrying primary coolant outside containment
- steam generator tube rupture
- loss-of-coolant accident
- fuel handling accident

The applicant presented the dose consequence assessment results in a series of tables found in SSAR Chapter 15 which provide the postulated radiological consequences of the DBAs identified above at the proposed EAB and the LPZ. The dose consequence assessment results in the tables also demonstrate that any potential doses would be within the radiological consequence evaluation factors set forth in 10 CFR 50.34(a)(1). The applicant provided the accident-specific source terms (release rates of radioactive materials from the ESP footprint to the environment) and resulting site-specific dose consequences for each DBA in Tables 15-2 through 15-22 of the SSAR.

15.0.3.2 Regulatory Basis

In SSAR Table 1-2 and Chapter 15, the applicant identified the following applicable NRC regulations and guidance regarding reactor accident radiological consequence analyses:

- 10 CFR 52.17
- 10 CFR Part 100
- 10 CFR 50.34
- RG 1.145, issued November 1982
- RG 1.183, issued July 2000
- NUREG-0800, Revision 3, issued June 1987

The NRC staff reviewed SSAR Chapter 15 for conformance with the applicable regulations and considered the corresponding guidance, as identified above in addition to RS-002 (May 3, 2004). The regulations at 10 CFR 52.17(a)(1) require that ESP applications contain an analysis and evaluation of the major SSCs of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1). In addition, the ESP site characteristics must comply with the requirements of 10 CFR Part 100. In its evaluation, the NRC staff used the radiological consequence evaluation factors found in 10 CFR 50.34(a)(1) as a factor in determining the acceptability of the site, in accordance with 10 CFR 52.17(a)(1). The radiological consequence evaluation factors for a postulated fission product release based on a major accident (Dose Factors) are:

- An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release would not receive a radiation dose in excess of 25 rem [roentgen equivalent man] TEDE.

- An individual located at any point on the outer boundary of the LPZ who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem TEDE.

The applicant used the AP1000 fission product release values in its assumed release from the ESP footprint to the environment; the NRC staff reviewed the applicant's dose evaluation based on this release.

15.0.3.3 Technical Evaluation

The applicant evaluated the suitability of the site under the Dose Factors using bounding reactor accident source terms and radiological consequences based on the AP1000 design, as well as site-specific atmospheric dispersion factor (χ/Q) values derived from the ESP footprint. The following sections describe the NRC staff's review of each aspect of the applicant's evaluation.

15.0.3.3.1 Selection of Design Basis Accidents

The applicant selected the DBAs listed in Chapter 15 of this SER on the basis of the AP1000 reactor design. The applicant selected the entire set of DBAs that the agency evaluated for the AP1000 reactor design and found to be acceptable in its approval of the AP1000 DCD. The AP1000 is an advanced light-water reactor of the PWR type. The AP1000 advanced design is not substantially different from the designs evaluated by the guidance in Chapter 15 of NUREG-0800 and in RG 1.183. On this basis, the NRC staff used the light-water reactor guidance in NUREG-0800 and RG 1.183 in its review and approval of the AP1000 DCD. The NRC staff finds that the applicant selected DBAs that are consistent with the DBAs listed and analyzed in Chapter 15 of NUREG-0800 and in RG 1.183 for PWRs. Therefore, the NRC staff finds that the applicant provided an acceptable DBA selection for evaluating the compliance of the proposed ESP site with the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1).

15.0.3.3.2 Design-Specific (Assumed) Short-Term Atmospheric Dispersion Factors

Short-term atmospheric dispersion factor values are used in the radiological consequences analyses to characterize the effect of the site-specific meteorological conditions, topography, and distance to either the EAB or LPZ on the radioactivity concentration in the accident release plume. The applicant compared the ESP site-specific short-term χ/Q values to the AP1000 DCD χ/Q values. This comparison ensured that the accident doses calculated in accordance with the AP1000 DCD Chapter 15 results, remain at or below the limiting values of RG 1.183 when taking into consideration the ESP site specific values. In lieu of site-specific meteorological data, the AP1000 DCD provided a set of hypothetical reference short-term χ/Q values for the EAB and LPZ to use in evaluating the AP1000 design. The AP1000 DCD states that the EAB and LPZ χ/Q values were selected to bound the majority of the operating U.S. nuclear power plant sites, but the values were not certified for this specific ESP site. Table 15.0.3-1 of this SER lists the AP1000 χ/Q values:

Table 15.0.3-1 - Design-Specific Short-Term χ/Q Values in s/m^3

Location	Time (hr)	DCD χ/Q (s/m^3)
EAB	0 - 2	0.00051
LPZ	0 - 8	0.00022
LPZ	8 - 24	0.00016
LPZ	24 - 96	0.0001
LPZ	96 - 720	0.00008

15.0.3.3.3 Site-Specific Short-Term Atmospheric Dispersion Factors

The NRC staff reviewed the applicant's site-specific short-term χ/Q values in accordance with the guidance provided in Section 2.3.4 of RS-002 and confirmed the applicants results on atmospheric dispersion. The NRC staff finds the χ/Q values to be acceptable, as described in Section 2.3.4 of this SER. Table 15.0.3-2 of this SER lists the site-specific short-term χ/Q values used by the applicant and reviewed by the NRC staff. Table 15.0.3-2 also includes the ratio of the site-specific values to the DCD values as a comparison. The NRC staff intends to include these site-specific short-term χ/Qs as site characteristics in any ESP that the NRC may issue for the VEGP ESP site.

Table 15.0.3-2 - Site-Specific Short-Term χ/Q Values

Location	Time (hr)	Site χ/Q (s/m^3)	χ/Q Ratio (Site/DCD)
EAB	0 - 2	0.000349	0.684
LPZ	0 - 8	0.0000704	0.32
LPZ	8 - 24	0.0000525	0.328
LPZ	24 - 96	0.0000277	0.277
LPZ	96 - 720	0.0000111	0.139

15.0.3.3.4 Source Terms and Radiological Consequence Evaluations

To evaluate the suitability of the site using the Dose Factors, the applicant provided the reactor accident source terms from the AP1000 design and the site-specific χ/Qs based on the ESP footprint. The source terms are expressed as the timing and release rate of fission products to the environment from the proposed ESP site. The radiological consequences are then derived from the source terms using established methods. The AP1000 accident-specific source term is based on the guidance provided in RG 1.183. The methodologies and assumptions that the AP1000 vendor, Westinghouse, used in its radiological consequence analyses are consistent with the guidance provided in RG 1.183 and were found acceptable to the NRC staff in its review of the AP1000 DCD for certification of the AP1000 design. The resulting doses calculated for the AP1000 design using assumed site parameters meet the Dose Factors.

In determining the potential radiological consequence doses resulting from DBAs at the proposed site, the applicant used the site-specific χ/Q values in conjunction with the DBA radiological consequences and the postulated χ/Q values provided in the certified AP1000 DCD.

The certified AP1000 design met the Dose Factors with the reference χ/Q values in the certified AP1000 DCD. The χ/Q values indicate the atmospheric dilution capability. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. The radiological consequence doses are directly proportional to the χ/Q values. Table 15-11 of the SSAR provides the site-specific χ/Q values the applicant used in its radiological consequence analyses, and Section 2.3.4 of this SER discusses the NRC staff's evaluation of these χ/Q values. The applicant used the atmospheric dispersion computer code PAVAN to derive its site-specific χ/Q values.

The certified AP1000 design met the Dose Factors with its postulated χ/Q values. The estimated site-specific χ/Q values for the proposed site are lower than those postulated in the AP1000 DCD, as summarized in SSAR Table 15-12. The applicant used the ratios of the site-specific χ/Q values to those postulated in the AP1000 DCD to determine and demonstrate that the radiological consequences at the proposed site meet the requirements of 10 CFR 50.34. Accordingly, the resulting DBA radiological consequence doses at the proposed site are lower

than those provided in the AP1000 DCD and, therefore, meet the requirements of 10 CFR 50.34.

The NRC staff evaluated the design-specific source terms the applicant provided and finds them to be consistent with those evaluated as part of the AP1000 design certification review. Furthermore, the NRC staff finds that the references provided by the applicant and the methodology it used to determine timing and release rate of fission product source terms to the environment (and consequent dose consequences) from the proposed ESP site are acceptable. The NRC staff intends to include the site-specific χ/Q values as site characteristics listed in Appendix A to this SER, for use in any ESP that the NRC might issue for the VEGP site.

Based on its evaluation of the applicant's DBA radiological consequences analysis methodology and the inputs to that analysis, the NRC staff finds that the applicant correctly concluded that the radiological consequences for the chosen design comply with the Dose Factors. Table 15.0.3-2 of this SER identifies the site-specific χ/Q values as appropriate for inclusion in any ESP that the NRC might issue for the VEGP ESP site.

The design-related inputs to the applicant's DBA radiological consequence calculation were directly extracted from design documentation previously submitted to and reviewed by the NRC in connection with design certification applications. Because the NRC staff performed this calculation in the DCD review, and the applicant simply used the ratio of the site-specific χ/Q values to the postulated design χ/Q values, the NRC staff did not consider an independent calculation to be useful or necessary and, therefore, did not perform one.

15.0.3.4 Conclusion

As set forth above, the applicant submitted its radiological consequence analyses using the site-specific χ/Q values and AP1000 source-term values and concluded that the proposed site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) for a design such as the AP1000. Based on the reasons set forth above, the NRC staff finds that the applicant's values for source terms included as inputs to the radiological consequence analyses are reasonable. Furthermore, the NRC staff finds that the applicant's site-specific χ/Q values and dose consequence evaluation methodology are acceptable.

Therefore, the NRC staff concludes that the proposed distances to the EAB and the LPZ outer boundary of the proposed ESP site, in conjunction with the fission product release rates to the environment provided by the applicant, are adequate to provide reasonable assurance that the radiological consequences of the postulated DBAs will be within the dose consequence evaluation factors set forth at 10 CFR 50.34(a)(1) for the proposed ESP site.

The NRC staff further concludes that (1) the applicant demonstrated that the proposed ESP site is suitable for power reactors with source term characteristics bounded by those of the AP1000 without undue risk to the health and safety of the public and (2) the applicant complies with the requirements of 10 CFR 52.17 and 10 CFR Part 100.