CHAPTER 19

PROBABILISTIC RISK ASSESSMENT

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Number	Title
None	

CHAPTER 19

PROBABILISTIC RISK ASSESSMENT

19.1 INTRODUCTION

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19.57 INTERNAL FIRE ANALYSIS

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19.58 WINDS, FLOODS, AND OTHER EXTERNAL EVENTS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

19.58.3 CONCLUSION

Add the following information at the end of DCD Subsection 19.58.3:

HAR SUP 19.58.-1

Table 19.58-201 documents the site-specific external events evaluation that has been performed for HAR 2 and 3. This table provides a general explanation of the evaluation and resultant conclusions and provides a reference to applicable sections of the COL where more detailed supporting information (including data used, methods and key assumptions) regarding the specific event is located. Based upon this evaluation, it is concluded that the HAR 2 and 3 site is bounded by the High Winds, Floods and Other External Events analysis document in DCD Section 19.58 and APP-GW-GLR-101 (Reference 201) and no further evaluations are required at the COL application stage.

19.58.4 REFERENCES

201. Westinghouse Electric Company LLC, “AP1000 Probabilistic Risk Assessment Site-Specific Considerations,” Document Number APP-GW-GLR-101, Revision 1, October 2007.

202. NUREG/CR-4461, “Tornado Climatology of the Contiguous United States,” Revision 2, February 2007.

203. Texas Tech University, Wind Science and Engineering Center, “A Recommendation for an Enhanced Fujita Scale (ER-Scale),” June 2004.

204. ASCE Standard ASCE/SEI 7-05, “Minimum Design Loads for Buildings and Other Structures,” 2006.

205. NUREG/CR-6890, Volume 1, “Reevaluation of Station Blackout Risk at Nuclear Power Plants – Analysis of Loss of Offsite Power Events: 1986-2004.”

Table 19.58-201 (Sheet 1 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
High winds	EF0 Tornado	Notes 1, 3	From the data covering 56.7 years in FSAR Table 2.3.1-204, the number of each type of tornado as recorded by NOAA for the eight counties (total of 4356 mi.^{2}) containing and surrounding the Harris site was identified. For each type of tornado, the event frequency was estimated from the product of the number of tornadoes divided by the number of years and the expected area of a tornado from Table 2-14 of NUREG/CR-4461 (Reference 202) divided by the total area of the counties.	2.66E-06
	EF1 Tornado	Notes 1, 3		2.57E-05
	EF2 Tornado	Notes 1, 3		4.38E-05
	EF3 Tornado	Notes 1, 3		4.34E-05
	EF4 Tornado	Notes 1, 3		2.62E-05
	EF5 Tornado	Notes 1, 3	There being no recorded occurrence of an EF5 tornado in FSAR Table 2.3.1-204 or the NOAA National Climatic Data Center website, the event frequency was estimated to be the same as for an EF4 tornado.	2.62E-05
	Category 1 Hurricane	Notes 1, 3	From data covering 157 years on the NOAA Coastal Services Center website, the number of hurricanes of each category coming within 100 nautical miles of the Harris site was identified. The event frequency was estimated from number of hurricanes divided by the number of years.	5.73E-02
	Category 2 Hurricane	Notes 1, 3		3.82E-02
	Category 3 Hurricane	Notes 1, 3		1.91E-02
	Category 4 Hurricane	Notes 1, 3	There being no recorded occurrence of a Category 4 or Category 5 hurricane within 100 nautical miles of the Harris site in the data covering 157 years on the NOAA Coastal Services Center website, the event frequency was estimated based on the assumed occurrence of one such hurricane during the next 157 years.	3.18E-03
	Category 5 Hurricane	Notes 1, 3		3.18E-03

Table 19.58-201 (Sheet 2 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
	Extratropical Cyclones	Note 3	The risk associated with extratropical cyclones is loss of off-site power (LOSP) due to high winds. Extreme straight-line winds associated with extratropical cyclones are included in the NCDC database (1950 – 2008). The highest recorded wind speed for a thunderstorm in the NCDC database (1950 – 2008) is 87 knots (100 mph) for the eight county area around the HAR 2 and 3 site. The LOSP frequency, due to wind events, is presented in the data reported in NUREG/CR-6890, Volume 1, "Reevaluation of Station Blackout Risk at Nuclear Power Plants - Analysis of Loss of Offsite Power Events: 1986-2004" (Reference 205). That report shows four LOSP events due to high winds (defined in this report as wind speed less than 125 mph) during 1,984.7 reactor-years (Including both Critical and Non-critical conditions for all reactors in the United States). This yields a frequency of 4.0E-03 LOSP events per reactor-year due to high wind events with speeds less than 125 mph (enveloping Extratropical cyclones, Category 1 and Category 2 hurricanes and, EF0 and EF1 tornados). Applying the 4.0E-03 LOSP events per reactor year probability to the "Extratropical Cyclone" subcategory of wind events in DCD Tier 2 Table 19.58-3 evaluation would reduce the CDF in DCD Tier 2 Table 19.58-3. The core damage frequency (CDF) is 3.9E-11 for a conditional core damage probability (CCDP) of 9.81E-09 which is below the 1.0E-08 CDF event screening criteria.	4.0E-03

Table 19.58-201 (Sheet 3 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
External Flood	External Flood	Note 4	At 140 miles from the Atlantic coast and a grade elevation of 261 feet NGVD29 (FSAR Subsection 2.4.5), elimination, by engineering judgment, of the flooding related to storm surges from a Category 5 hurricane (DCD Tier 2 Subsection 19.58.2.2) was considered appropriate for Harris. COL Section 2.4.4 indicates no dams upstream or downstream of the Harris lake that could affect safety-related facilities. The sensitivity analysis in DCD Tier 2 Subsection 19.58.2.2 for flooding-induced failure of the switchyard and non-safety structures was considered bounding for the Harris site based on the resulting conditional core damage probability. For flood-induced failure of safety-related structures and facilities, the evaluation of the applicability of the key site-related assumptions for external flooding comprised the probable maximum flood analysis described in FSAR Table 2.0-201 and confirmation of conformance to site selection criteria.	N/A

Table 19.58-201 (Sheet 4 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
Transpor-tation and Nearby Facility Accidents	Aviation Accident	Notes 2, 3	The probability of small aircraft crashing on Seismic Category I structures (i.e., Containment/Shield Building and Auxiliary Building) is calculated to be 4.783E-06 per year. This crash probability results in a core damage frequency (CDF) of 0.28E-12 per year which is below the 1.0E-08 CDF event screening criteria. Therefore, small aircraft crash probability is acceptable. The probability of large aircraft crashing on Seismic Category I structures is calculated as 0.415E-07 per year. This meets the acceptance criteria of 1.0E-07 per year in Section 19.58.2.3.1 of DCD. Therefore, the probability of crash for large aircraft is acceptable.	4.78E-06 (small aircraft) 4.15E-08 (large aircraft)
	Marine Accident	Note 5	DCD Tier 2 Subsection 19.58.2.3.2 indicates that only sites with large waterways with ship and/or barge traffic that goes through or near the site need to consider marine accidents. FSAR Subsection 2.2.2.4 indicates that the Cape Fear River north of Fayetteville is not navigable by barges or large boats.	N/A
	Pipeline Accident	Note 2	The only fire hazard in the vicinity of the plant site is the potential delayed ignition of flammable vapor clouds associated with the potential for a rupture in the LPG pipeline that passes within approximately 2.5 km (1.6 mi.) of the plant site. The evaluation of the pipeline failure, discussed in FSAR Subsection 2.2.3.1.2, concludes that no damage would result to the HAR 2 and HAR 3 critical facilities that could impede the continued safe operation or prevent safe shutdown of the plant.	<1.0E-07

Table 19.58-201 (Sheet 5 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
	Railroad and Truck Accidents	Notes 2	FSAR Subsection 2.2.3.1.1 concluded that no adverse effects are anticipated due to the transport of explosives via railway or roadway. The annual probabilities provided in FSAR Subsection 2.2.3.1.3.2 for both severe hazardous chemicals from railcar shipments reaching the Harris site and a significant accidental release for an unknown but toxic shipment are bounded by the value in DCD Section 19.58.2.3.4.	<1E-07
Other Events	A number of external events beyond those evaluated in DCD Subsection 19.58 were evaluated for the HAR site. These events are discussed below.		Based on the evaluations below, these events do not pose a credible threat to the safe operation of the station. Thus, these events are not considered to be risk-important and it can be concluded that the HAR 2 and 3 site is within the bounds of the Floods and Other External Events analysis documented in DCD Tier 2 Section 19.58.	

Table 19.58-201 (Sheet 6 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
	External Fires	Note 2	The only fire hazard in the vicinity of the plant site is the potential delayed ignition of flammable vapor clouds associated with the potential for a rupture in the LPG pipeline that passes within approximately 2.5 km (1.6 mi.) of the plant site. The evaluation of the pipeline failure, discussed in FSAR Subsection 2.2.3.1.2, concludes that no damage would result to the HAR 2 and HAR 3 critical facilities that could impede the continued safe operation or prevent safe shutdown of the plant. Therefore, because no risk important consequences were identified, the potential for hazards from external fires are minimal and will not adversely affect the safe operation of HAR 2 and 3.	<1.0E-07
	Toxic Chemical Release	Note 4	Based on the discussion in FSAR Subsection 2.2.2.2, there are no manufacturing facilities in the vicinity that utilize or store products that are considered hazardous. There are no site-specific sources of hazardous materials stored on the site in sufficient quantity to affect control room habitability (FSAR Subsections 2.2.3.1.3 and 6.4.4.2). Thus, these events are not considered risk important.	N/A

Table 19.58-201 (Sheet 7 of 7)
External Event Frequencies for HAR

HAR SUP 19.58.-1

Category	Event	Evaluation Criteria	Explanation of Applicability Evaluation	Event Frequency
	Major Depots and Storage Areas Releases	Note 5	Based on the discussion in FSAR Subsection 2.2.2.2, there are no manufacturing facilities in the vicinity that utilize or store products that are considered hazardous. Per FSAR Subsection 2.2.3.1.6, no storage facilities for corrosive, cryogenic oil or liquids were identified that could be drawn into the intake structures or affect the plant's safe operation. No significant military facilities are located within a 40-km (25-mi.) radius of the plant site. The nearest active military facility is Fort Bragg, located 56 km (35 mi.) to the south.	N/A

Note 1: The initiating event frequency (IEF) is less than the IEF in DCD Tier 2 Section 19.58 or Table 19.58-3 for the event.

Note 2: IEF is less than 1.0E-07.

Note 3: Core damage frequency (CDF) is less than 1.0E-08.

Note 4: A specific event frequency for this event has not been determined. A deterministic quantitative consequence evaluation has been performed that has demonstrated that the event does not adversely impact the safe operation of HAR 2 and 3.

Note 5: The event is not physically possible for the site.

More than one screening note may apply to a given type of event.

19.59 PRA RESULTS AND INSIGHTS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

19.59.10.5 Combined License Information

STD COL 19.59.10-1 A review of the differences between the as-built plant and the design used as the basis for the AP1000 seismic margins analysis will be completed prior to fuel load. A verification walkdown will be performed with the purpose of identifying differences between the as-built plant and the design. Any differences will be evaluated and the seismic margins analysis modified as necessary to account for the plant-specific design, and any design changes or departures from the certified design. A comparison of the as-built SSC high confidence, low probability of failures (HCLPFs) to those assumed in the AP1000 seismic margin evaluation will be performed prior to fuel load. Deviations from the HCLPF values or assumptions in the seismic margin evaluation due to the as-built configuration and final analysis will be evaluated to determine if vulnerabilities have been introduced.

The requirements to which the equipment is to be purchased are included in the equipment specifications. Specifically, the equipment specifications include:

1. Specific minimum seismic requirements consistent with those used to define the Table 19.55-1 HCLPF values. This includes the known frequency range used to define the HCLPF by comparing the required response spectrum (RRS) and test response spectrum (TRS). The range of frequency response that is required for the equipment with its structural support is defined.

2. Hardware enhancements that were determined in previous test programs and/or analysis programs will be implemented.

STD COL 19.59.10-2 A review of the differences between the as-built plant and the design used as the basis for the AP1000 PRA and DCD Table 19.59-18 will be completed prior to fuel load. The plant specific PRA-based insight differences will be evaluated and the plant specific PRA model modified as necessary to account for plant-specific design and any design changes or departures from the design certification PRA.

As discussed in Section 19.58.3, it has been confirmed that the Winds, Floods, and Other External Events analysis documented in DCD Section 19.58 is applicable to the site. The site-specific design has been evaluated and is consistent with the AP1000 PRA assumptions. Therefore, Section 19.58 of the AP1000 DCD is applicable to this design.

STD COL 19.59.10-3 A review of the differences between the as-built plant and the design used as the basis for the AP1000 internal fire and internal flood analysis will be completed prior to fuel load. Plant-specific internal fire and internal flood analysis will be evaluated and the analysis modified as necessary to account for the plant-specific design, and any design changes or departures from the certified design.

STD COL 19.59.10-4 The AP1000 Severe Accident Management Guidance (SAMG) from APP-GW-GLR-070, Reference 1 of DCD Section 19.59, is implemented on a site-specific basis. Key elements of the implementation include:

- SAMG based on APP-GW-GLR-070 is provided to Emergency Response Organization (ERO) personnel in assessing plant damage, planning and prioritizing response actions and implementing strategies that delineate actions inside and outside the control room.
- Severe accident management strategies and guidance are interfaced with the Emergency Operating Procedures (EOP's) and Emergency Plan.
- Responsibilities for authorizing and implementing accident management strategies are delineated as part of the Emergency Plan.
- SAMG training is provided for ERO personnel commensurate with their responsibilities defined in the Emergency Plan.

STD COL 19.59-5 A thermal lag assessment of the as-built equipment required to mitigate severe accidents (hydrogen igniters and containment penetrations) will be performed to provide additional assurance that this equipment can perform its severe accident functions during environmental conditions resulting from hydrogen burns associated with severe accidents. This assessment will be performed prior to fuel load and is required only for equipment used for severe accident mitigation that has not been tested at severe accident conditions. The ability of the as-built equipment to perform during severe accident hydrogen burns will be assessed using the Environment Enveloping method or the Test Based Thermal Analysis method discussed in EPRI NP-4354 (DCD Section 19.59 Reference 3).

Add the following new information after DCD Subsection 10.59.10.5:

STD SUP 19.59.10-1 19.59.10.6 PRA Configuration Controls

PRA configuration controls contain the following key elements:

- A process for monitoring PRA inputs and collecting new information.
- A process that maintains and updates the PRA to be reasonably consistent with the as-built, as operated plant.

- A process that considers the cumulative impact of pending changes when applying the PRA.
- A process that evaluates the impact of changes on currently implemented risk-informed decisions that have used the PRA.
- A process that maintains configuration control of computer codes used to support PRA quantification.
- A process for upgrading the PRA to meet PRA standards that the NRC has endorsed.
- Documentation of the PRA.

PRA configuration controls are consistent with the regulatory positions on maintenance and upgrades in Regulatory Guide 1.200.

Schedule for Maintenance and Upgrades of the PRA

The PRA update process is a means to reasonably reflect the as designed and as operated plant configurations in the PRA models. The PRA upgrade process includes an update of the PRA plus a general review of the entire PRA model, and as applicable the application of new software that implements a different methodology, implementation of new modeling techniques, as well as a comprehensive documentation effort.

- During construction, the PRA is upgraded prior to fuel load to cover those initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year prior to the scheduled date of the initial fuel load for a Level 1 and Level 2 PRA.
- Prior to license renewal, the PRA is upgraded to include all modes of operation.
- During operation, PRA updates are completed as part of the upgrade process at least once every four years.
- A screening process is used to determine whether a PRA update should be performed more frequently based upon the nature of the changes in design or procedures. The screening process considers whether the changes affect the PRA insights. Changes that do not meet the threshold for immediate update are tracked for the next regulatory scheduled update. If the screening process determines that the changes do warrant a PRA update, the update is made as soon as practicable consistent with the required change importance and the applications being used.

PRA upgrades are performed in accordance with 10 CFR 50.71(h).

Process for Maintenance and Upgrades of the PRA

Various information sources are monitored to determine changes or new information that affects the model assumptions or quantification. Plant specific design, procedure, and operational changes are reviewed for risk impact. Information sources include applicable operating experience, plant modifications, engineering calculation revisions, procedure changes, industry studies, and NRC information.

The PRA upgrade includes initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year prior to each required upgrade.

This PRA maintenance and update incorporates the appropriate new information including significant modeling errors discovered during routine use of the PRA.

Once the PRA model elements requiring change are identified, the PRA computer models are modified and appropriate documents revised. Documentation of modifications to the PRA model include the changes as well as the upgraded portions clearly indicating what has been changed. The impact on the risk insights is clearly indicated.

PRA Quality Assurance

Maintenance and upgrades of the PRA are subject to the following quality assurance provisions:

- Procedures identify the qualifications of personnel who perform the maintenance and upgrade of the PRA.

- Procedures provide for the control of PRA documentation, including revisions.

- For updates of the PRA, procedures provide for independent review, or checking of the calculations and information.

- Procedures provide for an independent review of the model after an upgrade is completed. Additionally, after the PRA is upgraded, the PRA is reviewed by outside PRA experts such as industry peer review teams and the comments incorporated to maintain the PRA current with industry practices. Peer review findings are entered into a tracking system. PRA upgrades receive a peer review for those aspects of the PRA that are upgraded.

- PRA models and applications are documented in a manner that facilitates peer review as well as future updates and applications of the PRA by describing the processes that were used, and provide details of the assumptions made and their bases. PRA documentation is developed

such that traceability and reproducibility is maintained. PRA documentation is maintained in accordance with Regulatory Position 1.3 of Regulatory Guide 1.200.

- Procedures provide for appropriate attention or corrective actions if assumptions, analyses, or information used previously are changed or determined to be in error. Potential impacts to the PRA model (i.e., design change notices, calculations, and procedure changes) are tracked. Errors found in the PRA model between periodic updates are tracked using the site tracking system.

PRA-Related Input to Other Programs and Processes

The PRA provides input to various programs and processes, such as the Maintenance Rule implementation, reactor oversight process, the RAP, and the RTNSS program. The use of the PRA in these programs is discussed below, or cross-references to the appropriate FSAR sections are provided.

PRA Input to Design Programs and Processes

The PRA insights identified during the design development are discussed in DCD Subsection 19.59.10.4 and summarized in DCD Table 19.59-18. DCD Section 14.3 summarizes the design material contained in AP1000 that has been incorporated into the Tier 1 information from the PRA. A discussion of the plant features important to reducing risk is provided in DCD Subsection 19.59.9.

PRA Input to the Maintenance Rule Implementation

The PRA is used as an input in determining the safety significance classification and bases of in-scope SSCs. SSCs identified as risk-significant via the Reliability Assurance Program for the design phase (DRAP, Section 17.4) are included within the initial Maintenance Rule scope as high safety significance SSCs.

For risk-significant SSCs identified via DRAP, performance criteria are established, by the Maintenance Rule expert panel using input from the reliability and availability assumptions used in the PRA, to monitor the effectiveness of the maintenance performed on the SSCs.

The Maintenance Rule implementation is discussed in Section 17.6.

PRA Input to the Reactor Oversight Process

The mitigating systems performance indicators (MSPI) are evaluated based on the indicators and methodologies defined in NEI 99-02 (Reference 201).

The Significance Determination Process (SDP) uses risk insights, where appropriate, to determine the safety significance of inspection findings.

PRA Input to the Reliability Assurance Program

The PRA input to the Reliability Assurance Program is discussed in DCD Subsection 19.59.10.1.

PRA Input to the Regulatory Treatment of Nonsafety-Related Systems Programs

The importance of nonsafety-related SSCs in the AP1000 has been evaluated using PRA insights to identify SSCs that are important in protecting the utility's investment and for preventing and mitigating severe accidents. These investment protection systems, structures and components are included in the D-RAP/MR Program (refer to Subsection 17.4), which provides confidence that availability and reliability are designed into the plant and that availability and reliability are maintained throughout plant life through the maintenance rule. Technical Specifications are not required for these SSCs because they do not meet the selection criteria applied to the AP1000 (refer to Subsection 16.1.1).

MOV Program

The MOV Program includes provisions to accommodate the use of risk-informed inservice testing of MOVs (Subsection 3.9.6).

19.59.11 REFERENCES

Add the following text to the end of DCD Subsection 19.59.11:

201. NEI 99-02, Nuclear Energy Institute, "Regulatory Assessment Performance Indicator Guideline," Technical Report NEI 99-02, Revision 5, July 2007.

APPENDIX 19A THERMAL HYDRAULIC ANALYSIS TO SUPPORT SUCCESS CRITERIA

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 19B EX-VESSEL SEVERE ACCIDENT PHENOMENA

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 19C ADDITIONAL ASSESSMENT OF AP1000 DESIGN FEATURES

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 19D EQUIPMENT SURVIVABILITY ASSESSMENT

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 19E SHUTDOWN EVALUATION

This section of the referenced DCD is incorporated by reference with no departures or supplements.

APPENDIX 19F MALEVOLENT AIRCRAFT IMPACT

This section of the referenced DCD is incorporated by reference with no departures or supplements.