Westinghouse

Westinghouse Electric Company
Nuclear Power Plants
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355
USA

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, D.C. 20555

Direct tel: 412-374-6206
Direct fax: 724-940-8505
e-mail: sisk1rb@westinghouse.com

Your ref: Docket No. 52-006
Our ref: DCP_NRC_002630

September 22, 2009

Subject: AP1000 Response to Request for Additional Information (SRP 10)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 10. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-SRP10.2.3-CIB1-01 R2

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Request for Additional Information on SRP Section 10

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cc:	D. Jaffe	-	U.S. NRC	1E
	E. McKenna	-	U.S. NRC	1E
	P. Buckberg	-	U.S. NRC	1E
	T. Spink	-	TVA	1E
	P. Hastings	-	Duke Power	1E
	R. Kitchen	-	Progress Energy	1E
	A. Monroe	-	SCANA	1E
	P. Jacobs	-	Florida Power & Light	1E
	C. Pierce	-	Southern Company	1E
	E. Schmiech	-	Westinghouse	1E
	G. Zinke	-	NuStart/Entergy	1E
	R. Grumbir	-	NuStart	1E
	P. Loza	-	Westinghouse	1E

ENCLOSURE 1

Response to Request for Additional Information on SRP Section 10

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP10.2.3-CIB1-01
Revision: 2

Question:

Section 10.2.3.6 of the AP1000 DCD, Revision 16 states that the maintenance and inspection program for the turbine assembly is based on turbine missile probability calculations. This turbine missile probability analysis was original documented in Westinghouse report WCAP-15783-P, "Analysis of the Probability of the Generation of Missiles from Fully Integral Nuclear Low Pressure Turbines," Revision 2, August 2003. However, Westinghouse Technical Report (TR-86), "Alternate Steam and Power Conversion Design," Revision 1 dated June 2007, provided a revised turbine missile probability analysis in Westinghouse Report WCAP-16650-P, "Analysis of the Probability of the Generation of Missiles from Fully Integral Nuclear Low Pressure Turbines," Revision 0, dated February 2007. It should be noted that Section 3.5.1.3 of the AP1000 DCD states that the potential for a high-trajectory missile to impact safety-related areas of the AP1000 is less than 10^{-7}. However, it is not clear to the NRC staff that WCAP-16650-P addresses high trajectory missiles. Therefore, the NRC staff requests confirmation that WCAP-16650-P includes an analysis for both low and high trajectory missiles. If report WCAP-16650-P does not include the analysis for high-trajectory missiles, provide this analysis which supports the conclusion that the potential of a high-trajectory missile impacting safety-related equipment is less than 10^{-7} to ensure the requirements of GDC 4 concerning missile protection are met.

Westinghouse Response: (Revision 0)

The turbine missile probability analysis in Westinghouse Report WCAP-16650-P replaces the analysis in Westinghouse Report WCAP-15783-P. WCAP-16650-P is for a Toshiba turbine whereas WCAP-15783-P was for a Mitsubishi Heavy Industries turbine. The Mitsubishi Heavy Industries turbine is no longer viable for the Standard AP1000 Nuclear Plant.

The analysis in both WCAPs shows the probability of generating missiles from a burst turbine rotor is less than 10^{-5} per year. This is value P1 as defined in Standard Review Plan (SRP) 3.5.1.3, "Probability of Turbine Failure Resulting in the Ejection of Turbine Rotor Fragments through the Turbine Casing."

P1 is multiplied by the product of P2 and P3 which are defined in the SRP as follows:

P2 = Probability of Ejected Missiles Perforating Intervening Barriers and Striking Structures, Systems, or Components (SSCs) Important to Safety

P3 = Probability of Struck SSCs failing to perform their Safety Function

The SRP states because of inadequate data, controversial assumptions, and modeling difficulties, the staff accepts a product of strike and damage probabilities (P2 x P3) as follows:

For Unfavorably Oriented Turbines: $P2 \times P3 = 10^{-2}$ per year

For Favorably Oriented Turbines: $P2 \times P3 = 10^{-3}$ per year

The product of P1, P2, and P3 results in P4. P4 is defined in the SRP as, "Probability of Unacceptable Damage Resulting from Turbine Missiles." With the above WCAP analysis result for $P1 < 10^{-5}$, and the above SRP products of P2 and P3, the probability of unacceptable damage resulting from high trajectory turbine missiles is:

$P4 = 10^{-5} \times (10^{-2}) \leq 10^{-7}$ per year for unfavorably oriented turbines

$P4 = 10^{-4} \times (10^{-3}) \leq 10^{-7}$ per year for favorably oriented turbines

AP1000 has a favorable turbine orientation with regard to missile strikes to SSCs. This means P1 must be $<10^{-4}$ according to the SRP. However, the value used in DCD Section 10.2.2 and the analysis in the Westinghouse WCAP Reports show that P1 is $<10^{-5}$ which meets the unfavorable orientation criterion. Regardless, the probability of unacceptable damage resulting from turbine missiles of $\leq 10^{-7}$ per year (P4) is still met.

The probability analysis presented in WCAP-16650-P is for high trajectory missiles. Note that Section 3.5.1.3 of the AP1000 DCD states, "Safety-related structures, systems and components are located outside the high-velocity, low-trajectory missile strike zone, as defined by Regulatory Guide 1.115. Thus, postulated low-trajectory missiles cannot directly strike safety-related areas." This statement was not modified for DCD Revision 16.

Additional Westinghouse Response based on NRC comments at 3/18/09 meeting: (Revision 1)

Dual unit sites may result in unfavorably oriented turbines. The probability analysis presented in WCAP-16650-P is also applicable to low trajectory missiles. For the AP1000, $P4 = P1 \times P2 \times P3 = \leq 10^{-7}$ per year regardless of orientation. Thus, a second AP1000 placed next to another AP1000 would not have a P4 value greater than 10^{-7} per year, even when not accounting for the increase in distance between the units and without crediting any possible benefits due to orientation (Reference 1). This meets the criteria of $\leq 10^{-7}$ per year identified in NRC Regulatory Guidance 1.115.

Additional Westinghouse Response to resolve OI-SRP10.2.3-CIB1-01: (Revision 2)

The staff indicated in the Chapter 10 SER that

"The turbine generators at dual-unit sites must be considered unfavorably oriented, because safety-related systems and components are in the low-trajectory missile strike zone. Therefore, to address COL applications for dual-unit sites, the applicant should provide a bounding turbine missile analysis for low-trajectory missiles, or provide a COL Action Item that requires COL applicants to provide a turbine missile analysis for low-trajectory missiles at dual-unit sites. In a letter dated April 13, 2009 [RAI-SRP10.2.3-CIB1-01 R1], Westinghouse stated that WCAP-16650 also applies to low-trajectory turbine missiles for dual unit sites that have unfavorable orientation. However, there is no justification for now applying this analysis for low-trajectory turbine missiles, and whether the analysis is dependent on missile trajectory."

The staff identified this as OI-SRP10.2.3-CIB1-01.

The analysis presented in Westinghouse WCAP-16650-P only determines the probability of generating a missile due to a burst turbine rotor. This is value P1 of 10^{-5} per year. This value is the same, regardless whether the missile is high-trajectory or low-trajectory. The reason only high-trajectory type missiles were referred to in the June 20, 2008 response, is that low-trajectory missiles are not considered for a single unit site, as stated in the AP1000 DCD. If a dual unit site is being considered, it is acceptable to use the P1 result from the WCAP to evaluate low-trajectory missiles. (The WCAP does not address or determine the probability of striking SSCs. The result from the WCAP for P1 was used as an input to determine the probability of striking SSCs, following the guidance in Standard Review Plan 3.5.1.3, which for AP1000 is 10^{-7} as stated in DCD Section 3.5.1.3)

If the unfavorable criterion is applied to account for a dual unit site, the guidelines of Regulatory Guide 1.115 for the probability of striking a SSC of 10^{-7} are still met. The reason is, P1 is 10^{-5} per year for the probability of a missile generated from a burst turbine rotor, which meets the unfavorable orientation criteria (Reference 1).

References:

1. APP-GW-GLR-099, "AP1000 Dual Unit Siting (TR-99)", Rev 0, 6/13/07

Design Control Document (DCD) Revision: None

PRA Revision: None

Technical Report (TR) Revision: None