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Your ref: Docket No. 52-006
Our ref: DCP/NRC2175

June 20, 2008

Subject: AP1000 Response to Requests for Additional Information (SRP10.2.3)

Westinghouse is submitting a response to the NRC requests for additional information (RAIs) on SRP Section 10.2.3. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP10.2.3-CIB1-01 and RAI-SRP10.2.3-CIB1-02, as sent in an email from Perry Buckberg to Sam Adams dated May 6, 2008. This response completes all requests received to date for SRP Section 10.2.3.

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
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/Enclosure

1. Response to Requests for Additional Information on SRP Section 10.2.3

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NRO

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ENCLOSURE 1

Response to Requests for Additional Information on SRP Section 10.2.3

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP10.2.3-CIB1-01
Revision: 0

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:

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 turbine missiles causing unacceptable damage 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.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP10.2.3-CIB1-02
Revision: 0

Question:

The staff needs the information listed below in order to complete its review of the reduction in valve testing frequency from quarterly to semi-annually proposed in Section 10.2.3.6 of Rev. 16 of the AP1000 DCD. This information refers to the Westinghouse report submitted to support the semi-annual test interval, WCAP-16651-P, Rev. 0, "Probabilistic Evaluation of Valve Test Frequency," February 2007. The report concludes that a six-month valve test frequency is justified for the turbine generator based on analysis of the operating experience with Toshiba Corporation nuclear steam turbines. A quarterly valve test frequency was approved by the staff in NUREG-1793 for the turbine originally specified in the AP1000 DCD when it was certified. The quarterly valve testing frequency was supported with WCAP-15785, dated April 2002, which is similar to WCAP-16651. The staff needs the information requested below to ensure the proposed DCD reduction in valve test frequency complies with the missile protection requirement of GDC 4.

a) According to SRP Section 3.5.1.3, the probability of generating a turbine missile should be less than 10^{-4} per year for a favorably oriented turbine and 10^{-5} for an unfavorably oriented turbine. It is the staff's understanding that the AP1000 turbine will be favorably oriented. Please explain why WCAP-16651 uses a criterion of 10^{-5} per year.

b) What is the basis for multiplying the probability of system separation, Q_{ss}, by five "in order to make the evaluation conservative"? In WCAP-15785, Q_{ss} was multiplied by a factor of 10 in order to make the evaluation conservative. It is not clear to the staff how these factors are selected, particularly when a smaller (less conservative) factor is being applied to the analysis of fewer operating units (9 units in WCAP-16651 vs. 23 units in WCAP-15785) and fewer operating hours (1.1 million vs. 2.8 million).

c) According to the Conclusions in Section 8, the calculated turbine missile probability was greater than the acceptance criteria of 10^{-5} (i.e., unacceptable) with a 6-month testing interval, but it was below the criteria (i.e., acceptable) if the operating experience through 2004 was extrapolated through 2009 assuming a number of annual operating hours and no failures. What is the basis for making this projection and assuming zero failures over a five-year period?

d) To justify a six-month test frequency on the basis of only the existing operating data, Conclusion 8A indicates a factor of five was applied to Q_{ss} for conservatism, but it also states a factor of three can be applied to result in a six-month test interval with $P < 10^{-5}$. Please explain the basis for applying multiplication factors and for selecting these particular values.

e) According to Conclusion 8B, using the mean value instead of 95% confidence value will also give a 6-month valve test interval with $P < 10^{-5}$, and that this is a reasonable alternative since there has been only one control valve control failure. If the 95% confidence value had been used, what test interval would be justified?

Westinghouse Response:

a. As stated in the response to RAI SRP 10.2.3-CIB1-01, AP1000 has a favorable turbine orientation with regard to turbine missiles causing unacceptable damage to SSCs. This means P1 can be $<10^{-4}$ according to SRP Section 3.5.1.3. However, the value used in DCD Section 10.2.2 and the analysis in both the Westinghouse WCAP Reports for Toshiba and MHI shows that P1 is $<10^{-5}$ which meets the unfavorable orientation criterion and is conservative.

b. At the time WCAP-15785 was written, turbine valves were typically tested quarterly. Since justification could be provided with a factor of 10 on the system separation, it was used in WCAP-15785, with an unfavorable turbine orientation. By the time WCAP-16651 was written for a Toshiba turbine, operating plants in the U.S. were testing the turbine valves once every 6 months as a standard test frequency. Therefore a goal of WCAP-16651 was to show testing could be extended to once every 6 months and still meet the missile probability criteria. Because WCAP-15785 applied a factor of conservatism to the system separation frequency, it was desired to apply some factor of conservatism for WCAP-16651. Since the factor used in WCAP-15785 was somewhat arbitrary, a smaller but still conservative factor of 5 was used which resulted in a missile ejection frequency just slightly above the limit, until further operating experience is gained with the Toshiba valves. Regardless, the factors were provided in both WCAPs to show the magnitude of added conservatism for the respective test intervals.

c. As operating time increases, the probability of a failure decreases to meet the more conservative criterion of $P1 < 10^{-5}$.

d. As stated in the responses to items b) and c) above, the factors show the magnitude of conservatism available with a 6 month valve test frequency.

e. The 95% confidence value for control valve failure is used in the results presented in Table 6-5 in WCAP-16651-P. Making no adjustments to the values used in Table 6-5, a 3 month test interval is justified for an unfavorably oriented turbine and a 12 month test interval is justified for a favorably oriented turbine. As discussed in Section 8 item A, if the conservatism included for the system separation frequency is reduced from 5 times the calculated value to 3 times the calculated value, the 6 month test interval results (including the 95% confidence value for the control valve failure), and would be just below the limit for unfavorably oriented turbines.

In conclusion, AP1000 is designed with a favorable turbine orientation with respect to the probability of generating turbine missiles but the turbine design will meet the more conservative value of $P1 < 10^{-5}$.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None