May 27, 2003

Mr. W. E. Cummins, Director
AP600 & AP1000 Projects
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

Dear Mr. Cummins:

As you are aware, the U. S. Nuclear Regulatory Commission (NRC) staff is preparing the draft safety evaluation report (DSER) for the AP1000 design certification application submitted by Westinghouse Electric Company on March 28, 2002. The staff expects to issue the DSER in June 2003. As of this date, the staff has identified four potential open items for DSER Chapter 10, "Steam and Power Conversion System," which are enclosed for your information. In addition, one open item associated with Chapter 3 is included since resolution of a Chapter 10 issue is associated with the closure of the Chapter 3 item. Please note that the staff's review of the application will continue during preparation of the DSER, which may result in changes to the potential open items identified in the enclosure, or the addition of other open items.

Two of the potential open items in the enclosure are new issues. The other two potential open items have the original request for additional information (RAI) number included for reference. If the staff cannot resolve the potential open items before the issuance of the DSER, these items will be issued as DSER open items and be tracked with a corresponding open item number.

Previously, Westinghouse committed to provide responses to all identified open items within 9 weeks after the issuance of the DSER. The staff will be prepared to review your responses to the open items and have conference calls and meetings with your staff, as appropriate, after the DSER is issued. If Westinghouse chooses to address some or all of these open items before the issuance of the DSER, the staff may not have sufficient time to evaluate every response to the potential open items that Westinghouse submits to the NRC and make changes to the DSER before the scheduled DSER issuance in June 2003.

Please contact one of the following members of the AP1000 project management team if you have any questions or comments concerning this matter: Mr. John Segala (Lead Project Manager) at (301) 415-1858 or jps1@nrc.gov, Mr. Joseph Colaccino at (301) 415-2752 or jxc1@nrc.gov, or Ms. Joelle Starefos at (301) 415-8488 or jls1@nrc.gov.

Sincerely,

/RA/

James E. Lyons, Director
New Reactor Licensing Project Office
Office of Nuclear Reactor Regulation

Docket No. 52-006

Enclosure: As stated

cc: See next page

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Enclosure: As stated
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Westinghouse AP1000
Draft Safety Evaluation Report
Potential Open Items
Chapter 10
Steam and Power Conversion System

Open Item Number: 10.2.8-1

Original RAI(s): 251.023, 251.024

Summary of Issue: Westinghouse stated in Design Control Document (DCD) Tier 2 Section 10.2.3.1, "Materials Selection," that the turbine materials have the lowest fracture appearance transition temperature (FATT) and the highest C_V properties obtainable from water-quenched Ni-Cr-Mo-V material of the size and strength level used, indicating that suitable material toughness is obtained through the use of these types of material. Westinghouse's response to request for additional information (RAI) 251.023 resolved the NRC staff's concern about FATT and the nil ductility temperature (NDT). The response to RAI 251.024 dated March 25, 2003, clarified Westinghouse's fracture toughness requirements. This response indicates that the fracture toughness of the rotor materials will be at least 220 MPa√m (200 ksi√in), and the ratio of fracture toughness to the maximum applied stress intensity factor for rotors at speeds from normal to design overspeed will be at least two. The staff finds these toughness and margin criteria to be acceptable because they are consistent with criteria approved for other applications involving assumed flaws, such as the reactor pressure vessel pressure-temperature limits. However, this criterion is not consistent with what is stated in DCD Tier 2 Section 10.2.3.4. This is DSER Open Item 10.2.8-1.

Open Item Number: 10.2.8-2

Original RAI(s): 251.025, 251.026, 251.027

Summary of Issue: In DCD Tier 2 Section 10.2.3.2, "Fracture Toughness," Westinghouse discusses, in general terms, the maximum initial flaw size and crack growth rates. The staff evaluation of the application of non-destructive examination (NDE), initial flaw size, and crack growth rates, in terms of addressing the probability aspects of turbine missile generation, is discussed in Section 3.5.1.3 of this report. To ensure that the maximum applied stress intensity factor for rotors at various speed was derived appropriately, the NRC staff reviewed DCD Tier 2 Section 10.2.3.2.1, "Brittle Fracture Analysis," and requested additional information in RAIs 251.025, 251.026, and 251.027, for resolving certain concerns about this analysis.

DCD Tier 2 Section 10.2.3.2.1 described a brittle fracture analysis considering the design duty cycle stresses, number of cycles, ultrasonic examination capability and growth rate of potential flaws. In its response to RAI 251.025, regarding the conservative factors of safety that were included in estimating the above-mentioned parameters, Westinghouse referred to the low cycle fatigue (LCF) crack analysis of WCAP-15783. (WCAP-15783 is used to support the NRC staff's review of turbine missiles in DCD Tier 2 Section 3.5.1.3, as well as to support the turbine rotor integrity of DCD Tier 2 Section 10.2.3.) The brittle fracture analysis described in Section 10.2.3.2.1 is completely contained in WCAP-15783. The staff considers this response appropriate because it is clear that the operational stresses in the shaft are much lower than the operational stresses in the disks, making the disks more limiting than the shaft. Hence, the WCAP-15783 analyses for disks are sufficient for assessing overall rotor integrity.

In the revised WCAP-15783, Westinghouse replaced an unreasonable K_{Ic} value used in the LCF analysis, as identified in RAI 251.025, by a reasonable proprietary value. In its response to RAI 251.026 dated March 25, 2003, regarding the vibratory stresses, Westinghouse referred to WCAP-15783 and stated that "(t)he vibratory stress when passing through critical speeds during startups and shutdowns is not included in the evaluation of low cycle fatigue. This is because the bending stress for this condition is greatest on the surface of the rotor and negligibly small on the rotor bore surface, which is the point where maximum stress of low cycle fatigue appears." The NRC staff considers this to be appropriate because the vibratory stress occurred at a different location, not the place where LCF effect is evaluated. However, the response has not provided adequate justification to conclude that rotor resonant stresses resulting from passing through rotor critical speeds are insignificant. This is DSER Open Item 10.2.8-2.

Open Item Number: 3.5.1.3-1

Original RAI(s): 251.002, 251.002(a), 251.027

Summary of Issue: In its response to RAI 251.027 regarding the K_{Ic} value and its associated safety factor and the assumed initial flaw depth that was used in the fatigue crack growth analysis, Westinghouse stated that the requested information can be found in WCAP-15783. Further, Westinghouse addressed the issue regarding the assumed initial crack depth in its response to RAI 251.002(a) on undetected and reported indications. The crack growth analysis and results due to LCF have been evaluated and accepted in the staff's evaluation of DCD Tier 2 Section 3.5.1.3 related to turbine missiles; however, the determination of an initial flaw depth is addressed as RAI 251.002. This is associated with DSER Open Item 3.5.1.3-1.

Open Item Number: 10.2.8-3

Original RAI(s): N/A

Summary of Issue: DCD Tier 2 Section 10.2.3 also states that the maximum tangential stress resulting from centrifugal forces does not exceed 65 percent of the 0.2 percent offset yield strength at design temperature and speed; or the tangential stresses will not cause a flaw, that is twice the corrected ultrasonic examination reportable size, to grow to critical size in the design life of the rotor. The first criterion is not consistent with the stress limit criterion of standard review plan (SRP) 10.2.3, which requires that the combined stresses of a low-pressure turbine disk at design overspeed due to centrifugal forces, interference fit, and thermal gradients not exceed 0.75 of the minimum specified yield strength of the material. This is DSER Open Item 10.2.8-3. The second criterion is not consistent with the margin of two between K_{Ic} and applied K mentioned earlier. This issue of inconsistency in the second design criterion is closely related to DSER Open Item 10.2.8-1 and will be resolved under it.

Open Item Number: 10.5-1

Original RAI(s): N/A

Summary of Issue: The following combined license (COL) Information Item was provided by Westinghouse:

> The Combined License holder will address preparation of an erosion-corrosion monitoring program for carbon steel portions of the steam and power conversion systems that contain water or wet steam. This monitoring program will address industry guidelines and the requirements included in Generic Letter 89-08.

The NRC staff recommends the following changes to this COL Action Item designated as 10.5.1 in the AP1000 DSER:

> The Combined License holder will address preparation of an erosion-corrosion monitoring program for carbon steel portions of the steam and power conversion systems that contain water or wet steam. This monitoring program will address industry guidelines and the provisions of Bulletin 87-01 and Generic Letter 89-08.

This change in the wording of COL Action Item 10.5.1, is identified as DSER Open Item 10.5-1.

AP 1000

cc:

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