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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002637

September 25, 2009

Subject: AP1000 Response to Proposed Open Item (Chapter 12)

Westinghouse is submitting the following responses to the NRC open item (OI) on Chapter 12. These proposed open item response are submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in these responses 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 proposed Open Item(s):

OI-SRP12.2-CHPB-02

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 Proposed Open Item (Chapter 12)

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NRO

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ENCLOSURE 1

AP1000 Response to Proposed Open Item (Chapter 12)

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: OI-SRP12.2-CHPB-02
Revision: 0

Question from RAI-SRP12.2-CHPB-02:

In DCD Section 9.1.2.1, Design Basis, the applicant increased the overall capacity of the Spent Fuel Storage from the proposed storage locations for 619 fuel assemblies to storage locations for 884 fuel assemblies. The staff noted that the additional fuel assemblies were not addressed in DCD Section 12.2.1.2.3, "Spent Fuel," nor included in Table 12.2-25, "Fuel Handling Area Airborne Radioactivity Concentrations." The addition of potentially 265 fuel assemblies with 0.25% fuel defects would increase the airborne radioactivity. Moreover, in Table 12.2-25, the applicant did not identify the basis of its parameters included in Table 12.2-24 for the number of Fuel assemblies or burn-up assumptions used in its calculations.
Provide a complete description of the potential radiological effects associated with the addition of 265 additional fuel assemblies in the spent fuel pool and its associated airborne radioactivity. Include this information in the DCD and provide a markup in your response.

Additional NRC Question for OI-SRP12.2-CHPB-02:

Provide results of detailed review of the assumptions in Rev 0 of the RAI and ensure that the values published in the DCD remain conservative as committed to in Rev 0 of RAI.

Westinghouse Response from RAI-SRP12.2-CHPB-02 and OI-SRP12.2-CHPB-02:

The spent fuel discussion in DCD section 12.2.1.2.3 is a general discussion of fuel assembly characteristics, and is not affected by increasing the amount of fuel stored in the spent fuel pool.

The evaluation of the airborne radioactivity concentrations in the fuel handling area, discussed in Table 12.2-24 and with associated concentrations provided in Table 12.2-25, assumed a full core offload, with the offloaded core having 0.25% fuel defects. The newly offloaded fuel with this high fuel defect level dominates the releases to the pool water and therefore the airborne concentration.

Most of the key parameters and assumptions for the evaluation of the fuel handling area are given in DCD table 12.2-24. Other inputs to the evaluation were:

- full core offload. As shown in the DCD table, reactor vessel head removal was assumed at 100 hours after shutdown, and completion of core offload at 10 days (i.e., 340 hours after shutdown),
- spent fuel pool purification rate of 250 gpm.

The evaluation of the concentrations in the spent fuel water conservatively assume instantaneous and complete mixing of the primary coolant activity (at 100 hours after shutdown) with the refueling water and spent fuel pit water. That is, no credit was taken for purification or cleanup of the primary coolant prior to cavity flooding and dilution.

Removal of activity from the spent fuel water by the SFP demineralizers, evaporation from the spent fuel pit, and radioactive decay are considered in arriving at the concentrations throughout the refueling period and during subsequent power operation.

The maximum airborne activity concentrations in the fuel handling area are listed in Table 12.2-25 of the DCD. These values are based on only the fuel from the recent full core offload, and thus that table was not significantly impacted by the increase in number of fuel assemblies to the spent fuel pit.

In general, evaluating only the recent full core offload and ignoring the fuel accumulated from previous outages is a good assumption, because isotopes are either effectively removed by the spent fuel pool demineralizers or have half-lives sufficiently short as to have negligible contribution. The one exception is considered to be the long-lived Kr-85, for which the activity concentrations may build up with subsequent refueling outages, since the dominant removal mechanism is decay rather than demineralization or evaporation. However, for this effect to be significant, it would be necessary to assume long term operation (many fuel cycles) with 0.25% fuel defects. Since this degree of fuel defects challenges the Technical Specification limit, such long-term operation is not considered a reasonable assumption.

Westinghouse has performed a detailed review of the airborne radioactivity concentration values published in the DCD in Table 12.2-25. This review has identified differences in airborne radioactivity concentrations, which can be attributed to an updated method used to calculate these values. A revised response and an updated Table 12.2-25 are provided at this time.

As indicated above, the updated Table 12.2-25 is a result of calculations considering the most current AP1000 design (such as updated fuel transfer tube dimensions, reactor coolant volume, and spent fuel assembly source terms) and a detailed transport model for radionuclides from the primary reactor coolant and other sources. The values shown in Revision 17 of the DCD are based upon airborne concentrations which were calculated for the AP600 using the methods described in Section 12.2.2.4 of the DCD and adjusted to AP1000 values. The adjustment was accomplished using scaling factors taken from primary coolant activity ratios for AP600 and AP1000. The recent calculations for airborne concentrations in the AP1000 use the same methodology that was originally used to calculate airborne concentrations in AP600, only with updated input information. The recent analysis precludes the need to scale results based on reactor coolant activities.

As expected, the recent calculations considering radionuclide transport in the AP1000 result in different calculated radionuclide airborne concentrations than those shown in Revision 17 of the

DCD– some of the noted differences are increases in concentrations, while others are decreases. The updated airborne radioactivity concentrations in the FHA reflecting these recent calculations are included at the end of this response.

To further evaluate the overall effect of updated airborne radioactivity concentrations, Westinghouse performed a health physics assessment of the consequences of worker exposure to such airborne radioactivity concentrations. By evaluating the Derived Airborne Concentration (DAC) values, a relative dose evaluation using radioactivity concentrations from both the current DCD and the Table 12.2-25 markup (shown below) was conducted.

The evaluation shows that, using the listed airborne limits in Appendix B of 10 CFR 20, the airborne radioactivity in the FHA after shutdown, as shown in Revision 17 of the DCD, constitutes a DAC value of 1.4. Using the updated values for airborne radioactivity shown in the DCD markup section below, the maximum airborne radioactivity in the FHA after shutdown corresponds to a DAC value of 0.77. If a more recent biokinetic model, such as the ICRP-66 based model, is used, the calculated DAC values are 1.3, using concentrations shown in the DCD, and, 0.75 using the values from the markup below. The calculated DAC values are tabulated below.

Calculated DAC Values from Airborne Radioactivity in the FHA after Shutdown

Biokinetic Model	Table 12.2-25 of the DCD, Rev. 17	Revised Table 12.2-25, from Updated Calculations
ICRP 30	1.4E+00	7.7E-01
ICRP 66[1]	1.3E+00	7.5E-01

The decreases show that, although some nuclide concentrations may have increased, the overall dose consequence of this airborne radioactivity has decreased. This is attributed to the decrease in concentrations of the two primary contributors to dose – iodine -131 and tritium.

As part of the Westinghouse evaluation of DAC values, the DAC values of the airborne concentrations at 100 hours after shutdown (immediately after head removal) were also calculated. These calculated DAC values are slightly higher than those shown in the table above for radioactivity concentrations 102 hours after shutdown by approximately 4%. That is, although there is a greater amount of radioactivity in a given volume of air at 102 hours after shutdown than at 100 hours after shutdown, the corresponding DAC value is slightly larger at

[1] The application of the ICRP 66 biokinetic models has been permitted by the NRC on a case-by-case basis, as described in reference 3.

100 hours after shutdown. The DAC value at 100 hours after shutdown is still smaller than the DAC value corresponding to the airborne radioactivity concentrations shown in Table 12.2-25 of Revision 17 of the DCD.

In summary, the airborne radioactivity concentrations in the FHA after shutdown have been updated based upon detailed calculations. A Westinghouse evaluation using DAC values shows that, from a Radiation Protection perspective, the airborne radioactivity values shown in Revision 17 of the DCD are conservative and the markup of Table 12.2-25, provided below, communicates changes that do not negatively impact radiological health or safety.

References:

1. APP-GW-N5C-003, Revision 0, “AP1000 Fuel Handling Area Airborne Radioactivity Concentrations”
2. APP-GW-N4C-004, Revision 1, “AP1000 Fuel Handling Area Derived Airborne Concentration Calculations After Shutdown”
3. SECY-99-077, “To Request Commission Approval to Grant Exemptions from Portions of 10 CFR Part 20,” April 1999

Design Control Document (DCD) Revision:

Changes to Table 12.2-25 are shown below.

Table 12.2-25 (Sheet 1 of 2)

FUEL HANDLING AREA AIRBORNE RADIOACTIVITY CONCENTRATIONS[1] ($\mu Ci/cm^3$)

Isotope	Activity[2]
Cr-51	8.7~~3.4~~E-12
Mn-54	4.8~~1.9~~E-12
~~Mn-56~~	~~5.9E-22~~
Fe-55	3.7~~1.5~~E-12
Fe-59	8.7~~3.5~~E-13
Co-58	1.4~~5.3~~E-1~~2~~1
Co-60	1.6~~6.4~~E-1~~3~~2
~~Br-83~~	~~1.3E-23~~
~~Br-84~~	~~4.5E-69~~
~~Kr-83m~~	~~5.1E-26~~
Kr-85m	7.~~9~~6E-16
Kr-85	2.~~3~~2E-10
~~Kr-87~~	~~8.3E-33~~
Kr-88	2.7~~3.1~~E-19
Sr-89	4.2~~3.0~~E-12
Sr-90	~~1.4~~3.7E-13
Sr-91	~~2.9~~2.1E-~~15~~14
~~Sr-92~~	~~5.4E-24~~
Y-90	1.5~~2E~~E-14
Y-91	~~3.8~~1.6E-13
~~Y-92~~	~~2.0E-21~~
Y-93	~~3.4~~1.6E-~~16~~13
Zr-95	~~4.4~~1.2E-~~13~~11

Nb-95	4.38.2E-1312
Mo-99	2.17.1E-1011
Tc-99m	1.44.2E-15
Ru-103	2.23.7E-103
Ag-110m	4.01.2E-112
Te-127m	2.2E9E-128
Te-129m	6.95.4E-12

Table 12.2-25 (Sheet 2 of 2) **FUEL HANDLING AREA AIRBORNE RADIOACTIVITY CONCENTRATIONS (µCi/cm³)**	
Isotope	**Activity**
Te-131m	~~1.8~~4.9E-12
~~Te-131~~	~~1.9E-85~~
Te-132	~~9.3~~2.3E-~~12~~11
~~I-129~~	~~4.3E-16~~
I-130	3.5~~1.0~~E-1~~2~~8
I-131	1.4~~E~~0E-08
~~I-132~~	~~9.4E-22~~
I-133	~~1.3~~1.8E-09
I-135	~~5.0~~2.3E-~~13~~12
Xe-131m	1.7~~8~~E-10
Xe-133m	3.1~~3~~E-10
Xe-133	2.2~~5~~E-08
Xe-135	4.2~~5.3~~E-12
Cs-134	2.~~0E~~2E-~~09~~10
Cs-136	2.4~~E~~3E-~~09~~11
Cs-137	~~1.5~~3.0E-~~09~~10
Ba-140	~~2.4~~3.2E-~~12~~10
La-140	~~1.3~~1.5E-~~12~~10
Ce-141	4.~~1E~~4E-~~13~~12
Ce-143	~~4.8~~1.1E-~~14~~11
Pr-143	~~3.5~~9.0E-~~13~~11
Ce-144	~~3.3~~1.3E-~~13~~10
H-3	~~1~~3.1E-~~05~~06

Total (excluding tritium)	3.74.8E-08
Iodines	1.6E2E-08
Particulates	6.21.7E-09
Noble Gases	2.3E-082.6E-08

[1] The maximum activity concentration is calculated to occur 2 hours after removal of the head, or 102 hours after shutdown in this case.
[2] The following nuclides are expected to exist in the FHA at the time of maximum airborne concentrations with individual nuclide activity concentrations less than 1.0E-20 μCi/cm[3]:
^{56}Mn, ^{83}Br, ^{84}Br, ^{85}Br, ^{83m}Kr, ^{87}Kr, ^{89}Kr, ^{88}Rb, ^{89}Rb, ^{92}Sr, ^{91m}Y, ^{92}Y, ^{129}Te, ^{131}Te ^{134}Te, ^{129}I, ^{132}I, ^{134}I, ^{135m}Xe, ^{137}Xe, ^{138}Xe, ^{138}Cs, ^{137m}Ba, and ^{144}Pr.

PRA Revision:
None

Technical Report (TR) Revision:
None