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Your ref: Docket No. 52-006
Our ref: DCP/NRC2419

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Subject: AP1000 Response to Request for Additional Information (SRP 11)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 11. 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-SRP11.2-CHPB-05 R2
RAI-SRP11.3-CHPB-04
RAI-SRP11.3-CHPB-05

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 11

D063
NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 11

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP11.2-CHPB-05

Revision: 2

Question:

Section 11.2.4, Preoperational Testing, does not address the testing and inspection of ion exchange resin. The initial performance of the liquid radioactive waste systems depends on the existence and performance of ion exchange resin in the ion exchange vessels. Westinghouse based the annual liquid effluent release of radioactivity estimated in section 11.2 on assuming the media provided a specific level of decontamination as listed in Table 11.2-5. What types of preoperational testing and inspection will be performed to ensure that the resin is properly installed and performing to assumed levels at initial start up? Please revise Section 11.2.4 of the DCD to include a description of the preoperational testing of the ion exchangers.

The only tests specified in DCD section 11.2.4 deal with sump level indicators and isolation valve testing. There are no tests specified to determine that the radwaste system will perform as described in the DCD when it pertains to radioactive decontamination of liquid waste. The applicant states how they intend to verify the performance of the gaseous waste delay beds in section 11.3.4 for the gaseous waste management system, a similar description for the liquid system ion exchangers in 11.2.4 would be an acceptable response.

This revision is necessary under 10 CFR 52.63 to provide adequate protection of the public health and safety because the doses from liquid effluents are dependent on the performance of the liquid decontamination system.

Westinghouse Response:

Liquid effluents processed in the liquid radwaste system are routed to monitor tanks prior to discharge. As discussed in DCD section 11.2.2.5.1.3 and 11.2.2.5.2, any fluids routed through the liquid radwaste ion exchangers is collected in these monitor tanks. The contents of the monitor tanks will be sampled routinely prior to discharge in order to ensure that isotopic concentrations are within those required and targeted for discharge. Finally, all liquid effluents en route to discharge are routed through the discharge radiation monitor, which will alarm if radioactivity levels exceed the setpoint. Thus, the arrangement and operation of the liquid radwaste system routinely and intrinsically demonstrates that the performance of the liquid decontamination system is adequate to meet discharge requirements.

Also, each radwaste ion exchange bed is equipped with a differential pressure gauge, and the hypothetical absence of ion exchange media would result in a noticeably lower differential pressure through the vessel. Therefore, the operator is provided with adequate information regarding media loading.

The charcoal used in the gaseous radwaste system discussed in section 11.3.4 does not deplete with use and is anticipated to have a very long life. By contrast, ion exchange media in the liquid radwaste system will be replaced routinely. Thus, pre-operational verification of the liquid media would provide limited benefit.

Therefore, we believe the current DCD commitments are adequate, and anticipated operating procedures properly address the concerns of this RAI.

Additional Question:

DCD Section 11.2.4, Preoperational Testing, should have a statement added indicating that presence of the correct amount of resin will be confirmed in the liquid radwaste system resin containing components

Westinghouse Additional Response:

Section 11.2.4 of the DCD is revised to add a preoperational testing statement indicating that presence of the correct amount of resin will be confirmed in the liquid radwaste system resin containing components.

Design Control Document (DCD) Revision:
~~None~~

Add Section 11.2.4.3 to the DCD as follows:

11.2.4.3 Preoperational Inspection

The performance of the liquid radwaste system has been evaluated based upon using a predetermined quantity and type of ion-exchange media. An inspection will confirm that the proper volume of media, as listed in Table 11.2-2, "Component Data – Liquid Radwaste System," has been installed into the appropriate liquid radwaste system components, MV03 and MV04A/B/C.

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP11.3-CHPB-04
Revision: 0

Question:

In DCD Section 11.3.2.3.3, it is stated that together, the delay beds provide 100 percent of the stated system capacity under design basis conditions. SRP 11.3, Acceptance Criteria 2 provides guidance on gaseous waste management system capacity. Specifically, it states that adequate capacity should be provided to process wastes during periods when major processing equipment may be down for maintenance (single failures) and during periods of excessive waste generation. Provide additional information in the DCD to verify that the GWMS has adequate capacity to meet the anticipated processing requirements of the plant during design basis conditions with a delay bed out of service.

Westinghouse Response:

An evaluation was performed to determine effects of operation with a charcoal delay bed out of service, and the results are provided below. The PWR-GALE code (Ref. 1) was used to determine releases assuming delay times associated with only one bed in service and compliance with 10 CFR 20 and 10 CFR 50 was evaluated. The case of one bed out of service results in half of the normal operation charcoal mass and half of the noble gas delay times. The modified inputs to the PWR-GALE code are as follows:
Card 31 Holdup time for Xe stripped from primary coolant (days): ~~38~~ 19
Card 32 Holdup time for Kr stripped from the primary coolant (days): ~~2~~ 1

This evaluation demonstrates that with one bed out of service, significant margin is preserved:

- The annual average site boundary concentration total fraction per 10 CFR 20 Appendix B is acceptable:

	PWR-GALE Releases[1] % of 10 CFR 20 Limit	Maximum Releases[2] % of 10 CFR 20 Limit
Both delay beds in service	3.0%	33%
One delay bed out of service	3.1%	35%

- Site boundary doses are not significantly increased and are well below 10 CFR 50 Appendix I design objectives as shown below.

The AP1000 charcoal delay beds are passive in nature, and the charcoal adsorption media does not deplete during normal service. The input flow to the WGS is very intermittent and opportunities for maintenance will exist when there is no demand upon the WGS. Thus, operation with one bed out of service will not typically be required. Operating with two beds in series maximizes delay/decay times and minimizes releases, making it the intended mode of

[1] Source terms per ANS-N18.1-1984; site boundary concentration calculated as described in Note b on DCD Table 11.3-4.
[2] Source terms per maximum defined fuel defects and maximum releases calculated as described in Note c on DCD Table 11.3-4.

operation. For this reason, Westinghouse does not intend to add the results of the one bed analysis to the DCD.

The results of the GALE code calculation for one bed in service are provided below. The same format as Table 11.3-3 was used to compare one bed versus two beds. It was determined that only three of the isotopes considered had increased releases when the inputs reflected one bed taken out of service: Kr-85m, Xe-131m, and Xe-133. Only isotopes that increased are shown in the following tables, but the effect on the sum of all releases is also included.

ONE BED IN OPERATION

EXPECTED ANNUAL AVERAGE RELEASE OF AIRBORNE RADIONUCLIDES AS DETERMINED BY THE PWR-GALE CODE, REVISION 1

(RELEASE RATES IN Ci/yr)

Noble Gases[(1)]	Waste Gas System	Building/Area Ventilation			Condenser Air Removal System	Total
		Cont.	Auxiliary Building	Turbine Building		
Kr-85m	6.0E+00	3.0E+01	4.0E+00	0.	2.0E+00	4.2E+01
Xe-131m	4.3E+02	1.6E+03	2.3E+01	0.	1.1E+01	2.1E+03
Xe-133	3.6E+02	4.5E+03	7.6E+01	0.	3.6E+01	5.0E+03
					Total of all isotopes	1.17E+04

Table 11.3-3 (TWO BEDS IN OPERATION)

EXPECTED ANNUAL AVERAGE RELEASE OF AIRBORNE RADIONUCLIDES AS DETERMINED BY THE PWR-GALE CODE, REVISION 1

(RELEASE RATES IN Ci/yr)

Noble Gases[(1)]	Waste Gas System	Building/Area Ventilation			Condenser Air Removal System	Total
		Cont.	Auxiliary Building	Turbine Building		
Kr-85m	0.	3.0E+01	4.0E+00	0.	2.0E+00	3.6E+01
Xe-131m	1.42E+02	1.6E+03	2.3E+01	0.	1.1E+01	1.8E+03
Xe-133	3.0E+01	4.5E+03	7.6E+01	0.	3.6E+01	4.6E+03
					Total of all isotopes	1.10E+04

The GALE results were used to calculate site boundary concentrations and fractions of the allowable limits per 10CFR20 Appendix B, similarly to how DCD Table 11.3-4 was calculated to represent operation with two beds. Only isotopes that increased are shown in the following tables, but the effect on the sum of all releases is also included.

ONE BED IN OPERATION COMPARISON OF CALCULATED OFFSITE AIRBORNE CONCENTRATIONS WITH 10 CFR 20 LIMITS					
Radionuclide	**Effluent Concentration Limit µCi/ml**	**Expected Site Boundary Concentration Limit µCi/ml**	**Fraction of Concentration Limit (expected)**	**Maximum Site Boundary Concentration Limit µCi/ml**	**Fraction of Concentration Limit (maximum)**
Kr-85m	1.0E-07	3.3E-11	3.3E-04	1.4E-10	1.4E-03
Xe-131m	2.0E-06	1.7E-09	8.3E-04	2.0E-09	1.0E-03
Xe-133	5.0E-07	4.0E-09	7.9E-03	1.4E-07	2.7E-01
Total of all isotopes			3.1E-02		3.5E-01

Table 11.3-4 (TWO BEDS IN OPERATION) COMPARISON OF CALCULATED OFFSITE AIRBORNE CONCENTRATIONS WITH 10 CFR 20 LIMITS					
Radionuclide	**Effluent Concentration Limit µCi/ml**	**Expected Site Boundary Concentration Limit µCi/ml**	**Fraction of Concentration Limit (expected)**	**Maximum Site Boundary Concentration Limit µCi/ml**	**Fraction of Concentration Limit (maximum)**
Kr-85m	1.0E-07	2.9E-11	2.9E-04	1.2E-10	1.2E-03
Xe-131m	2.0E-06	1.4E-09	7.1E-04	1.7E-09	8.7E-04
Xe-133	5.0E-07	3.6E-09	7.3E-03	1.3E-07	2.5E-01
Total of all isotopes			3.0E-02		3.3E-01

In addition to the airborne concentrations, the site boundary air doses are also of interest with one bed in operation. Section 11.3.3.4 of the DCD states that "the air doses at ground level at the site boundary are 2.1 mrad for gamma radiation and 10.1 mrad for beta radiation," representing operation with two beds. The air doses were calculated for one bed to be 2.1 mrad/yr for gamma radiation and 10.4/yr mrad for beta radiation. These doses are well below the 10 CFR 50, Appendix I, design objectives of 10 mrad/yr for gamma radiation and 20 mrad/yr for beta radiation as shown in the table below. Also, this case would represent the system operating with only one bed for a year, which is not expected. These doses are based on the annual average atmospheric dispersion factor from Section 2.3 of the DCD (2.0×10^{-5} s/m^3).

	Two Beds	One Bed	10 CFR 50 Appendix I Objective
Gamma Dose (mrad/yr)	2.1	2.1	10.0
Beta Dose (mrad/yr)	10.1	10.4	20.0

References:

1. "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," NUREG-0017, Revision 1, March 1985.

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-SRP11.3-CHPB-05
Revision: 0

Question:

In DCD Table 11.3-1, the applicant removed the dynamic adsorption coefficients and holdup times for Noble gases. By removing this information, the staff can longer justify the holdup times used to calculate the Krypton and Xenon releases in the gaseous effluents. In addition, the staff used these holdup times to conclude that any alteration in system operation will not be necessary due to adverse meteorological conditions. Please explain how the applicant derived the holdup times for Noble gases in the effluent release calculation and explain how the system satisfies GDC 60 as it relates to sufficient holdup capacity for retention of radioactive gaseous effluents.

Westinghouse Response:

No change was made to the physical configuration of the charcoal beds, nor to their operating conditions or modes. The removal of the delay coefficients from Table 11.3-1 was intended to eliminate a source of confusion.

Existing literature reports a wide range of variation on charcoal delay performance. Previous revisions of the DCD included two different assumptions of delay times from two references:

1. More optimistic values, from Reference 1, were reported in Table 11.3-1. These values were not used in any Westinghouse analyses.
2. More conservative values, from NUREG-0017 (Reference 2), were reported in Table 11.2-6 and used in all Westinghouse analyses.

Confusion arose based on the differing values. Although both sets of values are documented in literature, the operating temperature and humidity described in Reference 2 are very similar to those which will be experienced in the AP1000 WGS. Since Reference 1 values were less conservative and had not been used, they were removed and the Reference 2 values were retained.

This change does not affect any analyses or other tables in the DCD. The gaseous releases (Table 11.3-3) and site boundary concentrations (Table 11.3-4) were calculated using the PWR-GALE code and used the more conservative adsorption coefficients given in Reference 2. The PWR-GALE code input, provided in DCD Table 11.2-6 (sheet 3), used 38 days for Xenon and 2 days for Krypton based on Reference 2 (calculation shown below). Since gaseous effluent calculation results provided in the DCD are based on defensible delay times, the previous DCD compliance with GDC 60 is still applicable. It is recognized that the SER cites the now removed values from Reference 1 and the statement of compliance with GDC 60 may need to be reevaluated.

The charcoal adsorption coefficients are given in Ref. 2 for an operating temperature of 77°F and dew point of 45°F:

Kr 18.5 cm^3/g
Xe 330.0 cm^3/g

Using the formula also provided in Ref. 2, the delay times are calculated to be 38 days for xenon and 2 days for krypton.

$T = 0.011\ MK/F$

Where: F – System flow rate, ft^3/min
K – Dynamic adsorption coefficient, cm^3/g
M – Mass of charcoal adsorber, 10^3 lb
T – Holdup time, days

References:

1. Oak Ridge National Lab Report CF-59-6-47, "Removal of Fission Product Gases from Reactor Off-Gas Streams By Adsorption" (Presented at American Nuclear Society Meeting, Detroit, June 11, 1959)

2. NUREG-0017, Rev. 1, "Calculation of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors"

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None