ArevaEPRDCPEm Resource

From: DUNCAN Leslie E (AREVA NP INC) [Leslie.Duncan@areva.com]
Sent: Friday, December 05, 2008 6:56 PM
To: Getachew Tesfaye
Cc: John Rycyna; Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 105, FSAR Ch. 11
Attachments: RAI 105 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 105 Response US EPR DC.pdf" provides technically correct and complete responses to 10 of the 11 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 105 Questions 11.03-1, 11.03-2, 11.04-1, 11.04-2, and 11.04-4.

The following table indicates the respective pages in the response document, "RAI 105 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 105 — 11.01-4	2	3
RAI 105 — 11.02-1	4	4
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A complete answer is not provided for one of the 11 questions. The schedule for a technically correct and complete response to this question is provided below.

Question #	Response Date
RAI 105 — 11.02-3	December 19, 2008

Sincerely,

(Les Duncan on behalf of)

Ronda Pederson
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Cc: George Cicotte; Timothy Frye; Joshua Wilson; Stephen Campbell; Surinder Arora; Joseph Colaccino; John Rycyna
Subject: U.S. EPR Design Certification Application RAI No. 105 (1243, 1378,1246, 1379, 1380), FSAR Ch. 11

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 20, 2008, and discussed with your staff on November 4, 2008. Draft RAI Questions 11.03-2, 11.04-1, and 11.04-3 were modified as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 11

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Response to

Request for Additional Information No. 105 (1243, 1378, 1246, 1379, 1380), Revision 0

11/05/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 11.01 - Source Terms
SRP Section: 11.02 - Liquid Waste Management System
SRP Section: 11.03 - Gaseous Waste Management System
SRP Section: 11.04 - Solid Waste Management System
Application Section: FSAR Ch 11

QUESTIONS for Health Physics Branch (CHPB)
QUESTIONS for Balance of Plant Branch 2 (ESBWR/ABWR) (SBPB)

Question 11.01-4:

Section 11.1 of the Tier 2 FSAR states in part:

"The design basis source term is obtained by applying conservative assumptions . . . The realistic source term represents the expected average concentrations of radionuclides in the primary and secondary coolant under normal operating conditions. . . ."

NUREG 0800, "Standard Review Plan," Section 2.4.13 states in part:

"The staff provides, to the organization responsible for review of the effectiveness of radwaste systems and to the organization responsible for review of radiation protection, the locations, dilutions, and travel times corresponding to the bounding set of plausible surface and subsurface pathways for radionuclides in the accident scenarios leading to the most adverse contamination. . . . The staff should, in consultation with the organization responsible for review of solid waste and liquid and gaseous effluents, choose the accident scenarios leading to the most adverse contamination of the groundwater or the surface water."

Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," (July 2000), lists technetium (under "noble metals") as a nuclide which should be considered.

Tc-99 is produced in the reactor core in quantities significantly greater than I-129. This may become an important contributor to dose from groundwater due to the long half life and low retardation in soil by comparison with some of the nuclides already identified in the source term. Pursuant to SRP sections 2.4.13, 11.1, 11.2, and Branch Technical Position (BTP) 11-6, please identify the Tc-99 concentrations in the primary and secondary coolant under design basis and realistic conditions. Please include these concentrations and the associated technical basis in FSAR Section 11.1, or justify their exclusion, and of any other source term nuclides that behave similarly with respect to half-life and interaction with soil.

Response to Question 11.01-4:

For the U.S. EPR, the important technetium (Tc) isotopes (as required by RG 1.183) are considered in accidents involving the release of activity to the environment. In comparison to I-129 (referenced in the question), the concentration of Tc-99 in the primary and secondary coolant is given in Table 11.01-4-1.

Table 11.01-4-1—Concentration of I-129 and TC-99 in Primary and Secondary Coolant

	Primary Coolant µCi/g	Secondary Coolant µCi/g
Design Basis I-129 (Tech Spec)	4.59E-8	4.81E-9
Design Basis Tc-99 (1% failed fuel)	5.56E-9	6.68E-12
Maximum Normal Operation I-129	4.59E-8	4.81E-9
Maximum Normal Operation Tc-99	1.05E-9	1.28E-12

While both of these radionuclides are very long-lived, the ingestion dose conversion factor (DCF) for I-129 is approximately 200 times greater than for Tc-99 (refer to Federal Guidance Report 11). The Federal Guidance Report 11 Annual Limit on Intake (ALI) for Tc-99 is three orders of magnitude greater than for I-129. The difference in uptake for technetium versus iodine does not approach three orders of magnitude. In RG 1.109, Revision 1, the concentration factor for crop uptake (B_{iv}) is approximately 13 times greater for Tc; and the element transfer coefficients, F_{iA}, are approximately 4 and 140 times greater for Tc (for milk and for animal products, respectively) as compared to iodine. For the equilibrium bioaccumulation factor (B_{ip}), both I and Tc have the same values. While uptake may be somewhat greater for Tc than for I, the greater activity concentrations in the coolant and the greater dose impact of I-129 vs. Tc-99 makes I-129 much more important for inclusion in dose analysis. In comparison to I-129, the dose impact of Tc-99 is negligible, and is the justification for its exclusion from the dose analyses.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 11.02-1:

10 CFR 50.34a requires sufficient design information to demonstrate that design objectives for equipment necessary to control releases of radioactive effluents to the environment are met. SRP 11.2 provides guidance related to provisions for standby equipment, alternate processing routes, and/or interconnections to meet anticipated demands imposed by major processing equipment downtime or waste volume surges resulting from anticipated operational occurrences. FSAR Tier 2 Table 11.2-2 (Liquid Waste Management System Component Data; Sheet 2 of 7) states that there is only one Concentrate Pump and one Sludge Pump. The FSAR also states that the LWMS has storage capacity for approximately one week of expected waste and that processing times are such that one week of waste can be processed in less than half of a week. However, any sustained down-time on non-redundant components could have a severe impact on system capacity. Provide information related to system capability with equipment downtime or failure with only one pump in each system.

Response to Question 11.02-1:

Per Section 11.2.2 of the FSAR, the design of the U.S. EPR LWMS is such that it contains two process flow paths; one for the evaporator and one for the demineralizer. The sludge pump and concentrate pump are required only for the evaporator system. The sludge pump removes the sludge from the liquid waste storage tank bottoms and forwards it to the concentrate tanks. Sludge could inhibit operation of the evaporator since there are no pre-filters on the evaporator system. The concentrate pump moves radioactive concentrates from the concentrate tanks to the concentrate buffer tank of the solid waste system. These concentrates include the sludge from the storage tank bottoms and the radioactive concentrates from the evaporator.

Therefore, if the sludge and/or concentrate pump were in any sustained down-time, the waste water would be processed using the demineralizer system. The demineralizer system contains the necessary pre-filters and ultra-filters to remove the suspended solids with the potential to cause flow obstructions (FSAR Section 11.2.2.4.2.3).

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 11.02-2:

10 CFR 52 indicates that significant plant parameters should be included in Tier 1. FSAR Tier 2 Chapter 14, Table 14.3-8, “ITAAC Screening Summary,” (sheet 5 of 7) states that the LWMS is within the scope of Tier 1; however, FSAR Tier 1 Section 2.9.1 states that there are no Tier 1 entries for the liquid waste management system (LWMS).

The LWMS is relied upon to maintain concentrations of radioactive wastes released to the environment below the limits of 10 CFR Part 20 Appendix B (Column 1 to Table 2) and Appendix I. The ability to maintain concentrations below the 10 CFR Part 20 limitations depends upon the basic LWMS process, including the number and sizing of storage tanks, processing equipment, and dilution of release streams.

In view of the above, appropriate Tier 1 entries should be proposed by the applicant for the liquid waste management system (LWMS). The Tier 1 items should include appropriate ITAAC entries for the LWMS to confirm functional arrangements of the system, quality group and seismic classifications, and controls for the release of radioactive materials. Where key system components are not included in Tier 1, appropriate justifications for exclusion should be provided.

Response to Question 11.02-2:

U.S. EPR FSAR Tier 2 material is screened to determine if it is ‘safety significant’ as described in U.S EPR FSAR Tier 2, Section 14.3. This screening process involves two approaches using criteria developed from Standard Review Plan (SRP) 14.3 Appendices A and C. The first screening approach uses discipline checklists that include ITAAC criteria based on guidance in SRP 14.3. For example, the discipline checklist for systems provides guidance to create ITAAC for the following features:

- Major safety-related features.
- Equipment that is seismic, EQ, or 1E.
- Safety-related equipment.
- Design features provided for severe accident mitigation, station blackout, and anticipated transient without scram.
- Significant system features identified in the applicable SRPs for the system.
- Significant safety-related (and non-safety-related) functions derived from those listed in system design requirements documents.

The second screening approach involves an expert review panel that identifies safety significant features based on assumptions and insights from key safety and integrated plant safety analyses in U.S. EPR FSAR Tier 2, where plant performance is dependent on contributions from multiple systems. This second screening approach is based on guidance in SRP 14.3, page 14.3-21. Results of the expert review panel meetings are provided in U.S. EPR FSAR Tier 2, Tables 14.3-1 through 14.3-7.

Specifically:

- The liquid waste management system does not contain any ASME Section III equipment.
- The liquid waste management system does not contain any Seismic Class I equipment.
- The liquid waste management system does not include any category 1E equipment.
- Analyses show that failures of the LWMS do not result in exceeding offsite dose limits as described in U.S. EPR FSAR Tier 2, Chapter 12.

Therefore, using the criteria established, it was determined that while the LWMS is in the scope of screening for Tier 1, it does not have safety significant features that require treatment in U.S. EPR FSAR Tier 1. Detailed discussions of the LWMS are provided in U.S. EPR FSAR Tier 2.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 11.02-3:

RG 1.143 Regulatory Position 1.2.1 specifies that all tanks should have provisions to monitor tank levels. Designated high liquid level conditions should actuate alarms both locally and in the control room. This information was not found in Section 11.2 of the application. Verify in FSAR Section 11.2 that all tanks have the proper Instrumentation based on the guidance in RG 1.143.

Response to Question 11.02-3:

A response to this question will be provided by December 19, 2008.

Question 11.03-1:

Pursuant to 10 CFR 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” criterion 60, “sufficient holdup capacity shall be provided for retention of gaseous . . . effluents containing radioactive materials . . .”

These effluents include noble gases such as krypton and xenon. Final Safety Analysis Report (FSAR) Tier 2, Section 11.3.2.3.9, “Delay Beds,” states in part

“The holdup time for xenon is 27.7 days and the holdup time for krypton is 40 hours.”

However, the level of detail in FSAR Tier 2 Section 11.1, “Source Term,” and in Section 11.3, “Gaseous Waste Management Systems,” (GWMS) was not sufficient for an independent calculation of the holdup times in support of SRP Section 11.3, which specifies evaluation of “Equipment and ventilation system design capacities, expected flows, source terms and radionuclide concentrations, expected decontamination factors or removal efficiencies for radionuclides, and holdup or decay time.”

FSAR Tier 2 Table 11.3-1 contains details of normal operational parameters of the GWMS, but without the input data as to wastes to be processed, the information is not sufficient for staff review. While the staff acknowledges that currently-used computer codes as used by the applicant and approved by NRC are under review at this time, it has also been observed that some of the values contained in FSAR Tier 2 Table 11.3-4, “Gaseous Release (Ci/yr) Calculated by GALE Code,” do not appear to be fully consistent with a comparative calculation of the EPR thermal power capacity stated in FSAR Tier 1 Chapter 1, FSAR Tier 2 Section 11.1 “Source Terms,” and that used in the original GALE code default parameters.

As such, the staff was unable to determine whether effluents will be within release limits and consistent with ALARA principles under 10 CFR 50, Appendix I, without this information. Please provide sufficient details on expected production of fission product gases to be processed by the gaseous waste management system and on the methods used to hold up or otherwise process gaseous wastes, so as to allow independent verification of the adequacy of the systems under normal operational conditions, including anticipated operational occurrences. Please include sufficient information for comparison with NUREG 0017, Rev 1, "Calculation of Releases of Radioactive Material in Gaseous and Liquid Effluents from Pressurized Water Reactors," including comparative values of capacity factor, thermal power, and any variations from the default values used therein.

Response to Question 11.03-1:

The response to this question is provided in three parts:

A. Delay bed residence times,
B. Variations in Input Variables between U.S. EPR FSAR Sections 11.1 and 11.3
C. GALE input parameters for the gaseous waste management system.

A. *Delay Bed Residence Times*

The model employed in the analysis for the delay bed residence (or holdup) times is that described in the PWR GALE computer code (NUREG-0017), along with the Kr and Xe dynamic adsorption coefficients provided therein. Specifically, from Sec. 2.2.13.1 of NUREG-0017, the residence time for a charcoal delay system is given as:

$$t = 0.011\ m\ K / F$$

where

t = residence time (days)

m = mass of charcoal adsorber (klb_m, i.e., 10^3 lb_m)

K = dynamic adsorption coefficient (cm^3/gm), a function of noble gas element, operating temperature and dew point,

F = system flow rate (cfm), and

0.011 = unit conversion factor [1000 (lb_m/klb_m) * 454 (g_m/lb_m) * 3.53E-05 (ft^3/cc) / 1440 (min/day)].

Also needed in the computation of the residence times is the carrier gas density for conversion of the gas flow rate from a mass basis to a volume basis, as follows:

$$\rho = M P' / (10.72\ T')$$

where

ρ = weight density of gas (lb_m/ft^3),

M = gas molecular weight,

P' = gas absolute pressure [psia, or P (psig) + 14.69],

T' = gas temperature [^oR, or T (^oF) + 459.69], and

10.72 = conversion factor (including the individual gas constant).

The associated design input is shown in Table 11.03-1-1.

Table 11.03-1-1—Delay Bed Design Inputs

Description		Nominal Value	Notes
Number of charcoal tanks in delay bed system		3	
Carrier gas		N_2	
Carrier gas molecular weight (M)		28.013	From "Handbook of Chemistry and Physics"
Delay bed operating pressure (P)		116 psig	
Delay bed operating temperature (T)		68°F	Conservative with respect to the temperature of 77°F for the adsorption coefficients listed below
Delay bed operating dew point		-40°F	System requirement
Delay bed mass flow rate		0.079 lb_m/sec	Conservative value based on the design value of 0.0765 lb_m/sec[a]
Delay bed charcoal mass (per tank)		5300 lb_m	About 97% of system requirement (5440 lb_m) [a]
Dynamic adsorption coefficient at 77°F and -40°F	Krypton (K_{Kr})	70 cm^3/g_m	NUREG-0017, PWR-GALE Code (Rev. 1, April 1985), Sec. 2.2.13.1 [a]
	Xenon (K_{Xe})	1160 cm^3/g_m	

NOTE: (a) See also U.S. EPR FSAR Tier 2, Table 11.3-1.

Application of the design input in the calculation of the residence times:

N_2 density at operating conditions -

ρ = M P' / (10.72 T')

= 28.013 (molecular weight)* [{116 + 14.69} (psia)] / [10.72 (constant) * {68 + 459.69} (°R)]

= 0.647 (lb_m/ft^3)

Flow rate through system:

F = 0.079 (lb_m/sec) * 60 (sec/min) / 0.647 (lb_m/ft^3)

= 7.33 cfm

Kr residence time:

t_{Kr} = 0.011 m K_{Kr} / F

= 0.011 * 15.9 (klb_m, 3 tanks) * 70 (cm^3/g_m) / 7.33 (cfm)

= 1.67 days (or 40 hrs)

Xe residence time:

t_{Xe} = 0.011 m K_{Xe} / F

= 0.011 * 15.9 (klb_m, 3 tanks) * 1160 (cm^3/g_m) / 7.33 (cfm)

= 27.7 days (or 664 hours).

B. *Variations in Input Variables between FSAR Sections 11.1 and 11.3*

As observed, there are minor differences between some variables used to define the RCS and secondary coolant concentrations in U.S. EPR FSAR Tier 2, Section 11.1, and those used in U.S. EPR FSAR Tier 2, Section 11.3 for the effluent releases. These variables include the RCS mass, SG mass, steam flow rate, and SG blowdown rate. The effluent analysis uses realistic values, whereas the source term in U.S. EPR FSAR Tier 2, Section 11.1 uses slightly modified values to provide analytical margin while yielding conservative concentrations.

With respect to the capacity factor, it is noted that this variable affects only the effluent releases, and has no impact on the RCS and secondary-side concentrations presented in U.S. EPR FSAR Tier 2, Section 11.1.

With respect to the thermal power level, U.S. EPR FSAR Tier 1, Chapter 1, Section 1.2.5 will be updated to read as follows:

> "The U.S. EPR is designed for a rated reactor core power level of 4590 megawatts thermal (MW_t)."

The GALE analysis was based on the design-basis power level specified in U.S. EPR FSAR Tier 2, Table 15.0-3—Parameters Used to Calculate Design Basis Core Radionuclide Inventory, namely 4612 MW_t, which corresponds to the rated thermal power of 4590 MW_t plus 22 MW_t for heat balance uncertainty.

C. *GALE Input Parameters for Gaseous Waste Management System*

The GALE input variables employed in computation of the gaseous effluent annual releases from the U.S. EPR are provided in U.S. EPR FSAR Tier 2, Table 11.2-3, as identified in U.S. EPR FSAR Tier 2, Section 11.3.3.2. For ease of reference, the contents of this table are reproduced in Table 11.03-1-2, along with the corresponding values in NUREG-0017, Rev. 1, for the reference PWR (from NUREG-0017, Table 2-4 and the sample application).

Included at the end of Table 11.03-1-2, as additional information, are the GALE built-in variables which, by default, were applied to the U.S. EPR. These variables include the capacity factor, which is 80 percent. Incorporation of U.S.EPR-specific values in the analysis would have required modification of the GALE code, and accompanying revalidation, and was not implemented.

Table 11.03-1-2—GALE Input Parameters (3 Sheets)

Item	GALE Input Parameter	Value	
		U.S. EPR	Ref. PWR
1	Thermal power level (MW_t)	4612	3400
2	Mass of coolant in primary system (lb_m)	5.94E+05	5.50E+05
3	Primary system letdown rate (gpm)	226.7	75
4	Letdown cation demineralizer flow rate (gpm)	0	7.5
5	Number of steam generators	4	4
6	Total steam flow (lb_m/hr)	2.17E+07	1.50E+07
7	Mass of liquid in each steam generator (lb_m)	1.70E+05	1.125E+05
8	SG blowdown rate (lb_m/hr, total)	2.18E+05	7.50E+04
9	Blowdown treatment method (Full blowdown flow processed by blowdown system and recycled to condensate system for the U.S. EPR)	0	2
10	Condensate demineralizer regeneration time (days)	0	8.4
11	Condensate demineralizer flow fraction	0.33	0.65
12	Shim bleed flow rate (gpd) (Evaporator and demin. in series for the U.S. EPR)	110	1440
13	Shim bleed DF for iodine	1.0E+04	5.0E+03
14	Shim bleed DF for cesium and rubidium	1.0E+07	2.0E+03
15	Shim bleed DF for other nuclides	1.0E+07	1.0E+05
16	Shim bleed collection time (days)	8.1	22.6
17	Shim bleed processing and discharge times (days)	0.589	0.93
18	Shim bleed average fraction of waste to be discharged	1.0	0.1
19	Equipment drains input (gpd) (Evaporator and demineralizer in series for the U.S. EPR)	1728	330
20	Equipment drains PCA	1.0	0.97
21	Equipment drains DF for iodine	1.0E+04	5.0E+03
22	Equipment drains DF for cesium and rubidium	1.0E+07	2.0E+03
23	Equipment drains DF for other nuclides	1.0E+07	1.0E+05
24	Equipment drains collection time (days)	8.1	22.6
25	Equipment drains processing and discharge time (days)	0.589	0.93
26	Equipment drains average fraction of waste to be discharged	1.0	0.1
27	Clean waste input (gpd) (Clean waste input are included as Group II for U.S. EPR)	9428	980
28	Clean waste PCA	0.001	0.093
29	Clean waste DF for iodine	1.0E+02	5.0E+02
30	Clean waste DF for cesium and rubidium	1.0E+02	1.0E+03
31	Clean waste DF for other nuclides	1.0E+02	1.0E+04
32	Clean waste collection time (days)	1.6	5.7
33	Clean waste processing and discharge times (days)	0.463	0.13
34	Clean waste average fraction of waste to be discharged	1.0	0.1
35	Dirty waste input (gpd)	0	2100
36	Dirty waste PCA	0.1	0.01

Table 11.03-1-2—GALE Input Parameters (3 Sheets)

Item	GALE Input Parameter	Value	
		U.S. EPR	Ref. PWR
37	Dirty waste DF for iodine[(a)]	1.0E+02	5.0E+02
38	Dirty waste DF for cesium and rubidium[(a)]	1.0E+03	1.0E+03
39	Dirty waste DF for other nuclides[(a)]	1.0E+03	1.0E+04
40	Dirty waste collection time (days)	0	3.8
41	Dirty waste processing and discharge times (days)	0	0.19
42	Dirty waste average fraction of waste to be discharged	1.0	1
43	Blowdown fraction processed	1.0	1
44	Blowdown DF for iodine	1.0E+02	1.0E+03
45	Blowdown DF for cesium and rubidium	1.0E+02	1.0E+02
46	Blowdown DF for other nuclides	1.0E+03	1.0E+03
47	Blowdown collection time (days)	0	0
48	Blowdown processing and discharge times (days)	0	0
49	Blowdown average fraction of waste to be discharged	0.0	0
50	Regenerant flow rate (gpd)	0	3400
51	Regenerant DF for iodine (a)	1.0	5.0E+02
52	Regenerant DF for cesium and rubidium	1.0	1.0E+03
53	Regenerant DF for other nuclides	1.0	1.0E+04
54	Regenerant collection time (days)	0	4.7
55	Regenerant processing and discharge times	0	0.37
56	Regenerant average fraction of waste to be discharged	0.0	0.1
57	Is there continuous stripping of full letdown flow?	No	No
58	Holdup time for xenon (days)	27.7	60
59	Holdup time for krypton	1.67	60
60	Fill time of decay tanks for the gas stripper (days)	0	30
61	Waste gas system particulate releases HEPA efficiency	99 %	99 %
62	Fuel Handling Building releases: charcoal efficiency	90 %	90 %
63	Fuel Handling Building releases: HEPA efficiency	99 %	99 %
64	Auxiliary Building releases: charcoal efficiency	90 %	90 %
65	Auxiliary Building releases: HEPA efficiency	99 %	99 %
66	Containment free volume (ft^3)	2.80E+06	2.45E+06
67	Containment internal cleanup system: charcoal efficiency	90 %	
68	Containment internal cleanup system: HEPA efficiency	99 %	
69	Containment internal cleanup system: flow rate	4.10E+03	0
70	Containment high volume purge: charcoal efficiency	90 %	90 %
71	Containment high volume purge: HEPA efficiency	99 %	99 %
72	Containment high volume purges at operation: purges per year (GALE code accounts for 2 purges at cold shutdown)	0	0
73	Containment low volume purge: charcoal efficiency	90 %	90 %
74	Containment low volume purge: HEPA efficiency	99 %	99 %
75	Containment low volume purge: Flow rate	2970	1000
76	Percent of iodine released from blowdown tank vent	0.0 %	0.0 %
77	Percent of iodine removed from air ejector release	0.0 %	0.0 %
78	Detergent waste PF	0.0	N/A

Table 11.03-1-2—GALE Input Parameters (3 Sheets)

Item	GALE Input Parameter	Value	
		U.S. EPR	**Ref. PWR**
79	SG blowdown flash tank gases vented via main condenser air ejector?	No	N/A
80	Condenser air ejector offgas released without treatment?	Yes	N/A
81	Condenser air ejector offgas processed via charcoal adsorbers prior to release?	No	N/A
GALE Built-in Values			
82	Plant capacity factor (%) (GALE pg 1-8)	80	80
83	Primary to secondary leakage (lbm/day) (GALE pg 2-20)	75	75
84	SG partition coefficient for iodines (GALE pg 1-11)	0.01	0.01
85	SG partition coefficient for volatiles (GALE pg 1-11)	0.005	0.005
86	Primary coolant leakage to Auxiliary Building (lbm/day) (GALE pg 2-42)	160	160
87	Steam leakage to Turbine Building (lbm/hr)	1700	1700

NOTE: (a) The dirty waste DF in Items 37, 38 and 39, has no impact on results since dirty waste input is zero.

FSAR Impact:

U.S. EPR FSAR Tier 1, Section 1.2.5 will be revised as described in the response and indicated on the enclosed markup.

Question 11.03-2:

SRP Section 11.3, Acceptance Criteria 3 states “The design should include precautions to stop continuous leakage paths…during normal operation and anticipated operation occurrences.” The FSAR describes several design provisions of the GWMS to reduce or minimize explosive mixtures. However, the FSAR does not describe any provisions for isolation of continuous gaseous leakage paths. Justify in the FSAR that such provisions are included in the design of the GWMS.

Response to Question 11.03-2:

The purge section of the gaseous waste processing system operates at sub-atmospheric pressures, thus preventing leakage from the purge section to the building atmosphere. The positive pressure section of the system is designed to be leak tight, thus limiting the potential for leakage. The leak tightness of the system is verified by pre-operational testing as stated in U.S. EPR FSAR Tier 2, Section 11.3.2.5.2.

The gaseous waste processing system is capable of detecting leaks by monitoring the system operating parameters for abnormalities. For example, if a leak were to exist in the purge section of the system, the upstream O_2 instrument would detect a higher than normal oxygen concentration due to building air ingress. If a leak were to exist in the positive pressure section the system instrumentation would indicate flow rates and pressures outside the normal operating range. Once identified through system instrumentation and controls (I&C), the operator can take appropriate action to isolate the leak.

Per U.S. EPR FSAR Tier 2, Section 11.3.3.6, a bounding analysis was performed for the hypothetical event where an operator error leads to an inadvertent bypass of the delay beds and the exhaust from the coolant degasification system is released directly to the environment. The results of the analysis are in accordance with BTP 11-5. Other possible leaks are bounded by this hypothetical event, and are in accordance with BTP 11-5.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 11.3.3.6 will be revised as described in the response and indicated on the enclosed markup.

Question 11.03-3:

10 CFR 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," indicates that significant plant parameters should be included in Tier 1. FSAR Tier 2 Chapter 14, Table 14.3-8, "ITAAC Screening Summary," (sheet 5 of 7) states that the GWMS is within the Scope of Tier 1; however, FSAR Tier 1 Section 2.9.3 states that there are no Tier 1 entries for the gaseous waste management system (GWMS).

The GWMS is relied upon to maintain releases of gaseous waste radioactive concentrations below the limits of 10 CFR Part 20 Appendix B (Column 1 to Table 2) and Appendix I. The ability to maintain concentrations below the 10 CFR Part 20 limitations depends upon the basic GWMS process, including the design of the delay beds (three pressure vessels connected in series) that provide sufficient hold-up times for decay of noble gases such as krypton and xenon. Furthermore, certain system design features, such as nitrogen purges and upstream and downstream gas analyzers, are critical to prevention of flammable or explosive mixtures of gases.

In view of the above, appropriate Tier 1 entries should be proposed by the applicant for the GWMS. The Tier 1 items should include appropriate ITAAC entries for the GWMS to confirm functional arrangements of the system, quality group and seismic classifications, and controls for the release of radioactive materials. Where key system components (such as the number and connection of delay beds) are not included in Tier 1, appropriate justifications for exclusion should be provided.

Response to Question 11.03-3:

U.S. EPR FSAR Tier 2 material in the scope of Tier 1 is screened to determine if it is 'safety significant' as described in U.S EPR FSAR Tier 2, Section 14.3. This screening process involves two approaches using criteria developed from Standard Review Plan (SRP) 14.3 Appendixes A and C. The first screening approach uses discipline checklists that include ITAAC criteria based on guidance in SRP 14.3. For example, the discipline checklist for systems provides guidance to create ITAAC for the following features:

- Major safety-related features.
- Equipment that is seismic, EQ, or 1E.
- Safety-related equipment.
- Design features provided for severe accident mitigation, station blackout, and anticipated transient without scram.
- Significant system features identified in the applicable SRPs for the system.
- Significant safety-related (and non-safety-related) functions derived from those listed in system design requirements documents.

The second screening approach involves an expert review panel that identifies safety significant features based on assumptions and insights from key safety and integrated plant safety analyses in U.S. EPR FSAR Tier 2, where plant performance is dependent on contributions from multiple systems. This second screening approach is based on guidance in SRP 14.3, page 14.3-21. Results of the expert review panel meetings are provided in U.S. EPR FSAR Tier 2, Tables 14.3-1 through 14.3-7.

Specifically:

- The gaseous waste management system, not including the containment isolation valves, does not contain any ASME Section III equipment.

- The gaseous waste management system, not including the containment isolation valves, does not contain any Seismic Class I equipment.

- The gaseous waste management system, not including the containment isolation valves, does not include any category 1E equipment.

Therefore, using the criteria established, it was determined that the GWMS does not have safety significant features that require treatment in U.S. EPR FSAR Tier 1. Detailed discussions of the GWMS are provided in U.S. EPR FSAR Tier 2.

U.S. EPR FSAR Tier 1 entries for the gaseous waste processing system containment isolation valves described in U.S. EPR FSAR Tier 2, Section 11.3.2.3.18 are provided in U.S. EPR FSAR Tier 1, Section 3.5.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 11.04-1:

10 CFR 50.34a requires the applicant for design approval to submit a description of the equipment for the control of gaseous and liquid effluents and for the maintenance and use of equipment installed in radioactive waste systems. Although general descriptions of the components were provided, the adequacy of the design could not be evaluated because no system P&ID was provided. Provide a system P&ID or additional detail in figure 11.4-1, “Solid Waste Management Flow Diagram,” for the SWMS in the FSAR.

Response to Question 11.04-1:

U.S. EPR FSAR Tier 2, Figure 11.4-1—Solid Waste Management Flow Diagram, has been revised to provide additional detail and clarification for the SWMS. Specifically, a clarification to the processing path for the waste stream wet active waste has been made to show that only one set of three drum drying stations exists in the SWMS. Also, a block for the concentrate recirculation pump was added into the processing path to illustrate the motive force for transferring radioactive concentrates, spent coolant purification resins, spent fuel pool purification resins, and spent radioactive waste demineralizer resins from the concentrate buffer tank to the drum drying stations. U.S. EPR FSAR Tier 2, Figure 11.4-1 illustrates the discussion in U.S. EPR FSAR Tier 2, Section 11.4.2 “System Description”, which identifies the solid waste streams and how they are processed.

FSAR Impact:

U.S. EPR FSAR Tier 2, Figure 11.4-1 will be revised as described in the response and indicated on the enclosed markup.

Question 11.04-2:

10 CFR 50.34a requires the applicant for design approval to submit a description of the equipment for the control of gaseous and liquid effluents and for the maintenance and use of equipment installed in radioactive waste systems. Although general descriptions of the components were provided, the adequacy of the design could not be evaluated because no equipment design parameters were provided. Additionally compliance to RG 1.143 has specific design standards and material requirements. Provide in the FSAR general equipment design parameters such as pump capacity, crane capacity, and tank volume as well as design and material standards for the SWMS components.

Response to Question 11.04-2:

A solid waste management system (SWMS) component data table, Table 11.4-14, will be added to U.S. EPR FSAR Tier 2, Section 11.4. This table lists the major SWMS equipment and the corresponding nominal equipment design parameters.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 11.4-14 will be added as described in the response and indicated on the enclosed markup.

Question 11.04-3:

10 CFR 52 indicates that significant plant parameters should be included in Tier 1. FSAR Tier 2 Chapter 14, Table 14.3-8, “ITAAC Screening Summary,” (sheet 5 of 7) states that solid waste processing is within the Scope of Tier 1; however, FSAR Tier 1 Section 2.9.2 states that there are no Tier 1 entries for the solid waste management system (SWMS).

The SWMS is relied upon to maintain releases of radioactive effluents below the limits of 10 CFR Part 20 Appendix B and Appendix I. The ability to maintain concentrations below the 10 CFR Part 20 limitations depends upon the basic SWMS process, including the design of the radioactive concentrates processing system which treats evaporator concentrates generated in the liquid waste processing and storage system, as well as spent resins generated in the coolant purification system.

In view of the above, appropriate Tier 1 entries should be proposed by the applicant for the SWMS. The Tier 1 items should include appropriate ITAAC entries for the SWMS to confirm functional arrangements of the system, quality group and seismic classifications, and controls for the release of radioactive materials. Where key system components are not included in Tier 1, appropriate justifications for exclusion should be provided.

Response to Question 11.04-3:

U.S. EPR FSAR Tier 2 material in the scope of Tier 1 is screened to determine if it is ‘safety significant’ as described in U.S EPR FSAR Tier 2, Section 14.3. This screening process involves two approaches using criteria developed from Standard Review Plan (SRP) 14.3 Appendixes A and C. The first screening approach uses discipline checklists that include ITAAC criteria based on guidance in SRP 14.3. For example, the discipline checklist for systems provides guidance to create ITAAC for the following features:

- Major safety-related features.
- Equipment that is seismic, EQ, or 1E.
- Safety-related equipment.
- Design features provided for severe accident mitigation, station blackout, and anticipated transient without scram.
- Significant system features identified in the applicable SRPs for the system.
- Significant safety-related (and non-safety-related) functions derived from those listed in system design requirements documents.

The second screening approach involves an expert review panel that identifies safety significant features based on assumptions and insights from key safety and integrated plant safety analyses in U.S. EPR FSAR Tier 2, where plant performance is dependent on contributions from multiple systems. This second screening approach is based on guidance in SRP 14.3, page 14.3-21. Results of the expert review panel meetings are provided in U.S. EPR FSAR Tier 2, Tables 14.3-1 through 14.3-7.

Specifically:

- The solid waste management system does not contain any ASME Section III equipment.
- The solid waste management system does not contain any Seismic Class I equipment.
- The solid waste management system does not include any category 1E equipment.

Therefore, using the criteria established, it was determined that the SWMS does not have safety significant features that require treatment in Tier 1. Detailed discussions of the SWMS are provided in U.S. EPR FSAR Tier 2.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 11.04-4:

GDC 63 requires that radioactive waste systems be able to detect conditions that may result in excessive radiation levels in waste storage locations and to initiate appropriate safety actions. In FSAR Tier 2 Section 11.4.1.2.4 stated area radiation monitors throughout the RWPB detect excessive radiation levels and alert the operators to this condition. FSAR Tier 2 Table 12.3-4 lists the airborne radiation detectors, however, Table 12.3-3 does not list any area radiation monitors for the RWPB. The applicant is requested to incorporate the area radiation monitors for the RWPB in FSAR Table 12.3-3.

Response to Question 11.04-4:

The U.S. EPR design has two area monitors listed as process monitors that monitor area radiation and have the correct instrument range. They are located in the decontamination room and the drumming room.

U.S. EPR FSAR Tier 2, Table 12.3-3 will be revised to add the additional items below:

Monitor Location	**Monitor Provisions**		**Range**
	Continuous	**ACF**	
Post-Accident Monitoring			
Radioactive Waste Processing Building	1 monitor – In the drumming room next to the conveyor	---	1E-4 – 1E+4 rem/hr
	1 monitor - In the decontamination room	---	1E-4 – 1E+1 rem/hr

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 12.3-3 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

1.2.5 Rated Reactor Core Thermal Power

The U.S. EPR is designed for a rated reactor core power level of 4590 megawatts thermal (MW_t). ~~with a bounding secondary heat balance uncertainty of +22 MW_t. The nuclear steam supply system (NSSS) thermal power rating is about 4614 MW_t.~~

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11.3.3.5 Maximum Release Concentrations

Using annual release data generated with the GALE code (Reference 1) and presented in Table 11.3-3, annual average concentrations of radioactive materials released in gaseous effluents to the discharge point have been determined. This analysis was based on an annual average atmospheric dispersion factor of 5.0E-06 sec/m^3. This value represents a conservative value for a distance of 0.5 miles from the reactor centerline, based on a mixed-mode release. For each radionuclide released, the average concentration has been compared to the limiting value for that radionuclide specified in 10 CFR Part 20, Appendix B Table 2. The results of this comparison are presented in Table 11.3-6—Comparison of Annual Average Gaseous Release Concentrations with 10 CFR Part 20 Concentration Limits. Average gaseous effluent concentrations for each radionuclide based on one percent failed fuel fraction have also been determined and compared to the limiting value for that radionuclide specified in 10 CFR Part 20, Appendix B, Table 2. The concentrations for the expected failed fuel case were upwardly adjusted by the ratio of design basis fuel failure primary coolant activity to expected fuel failure primary coolant activity, except for specific radionuclides in which Technical Specifications (TS) limit the maximum primary coolant activity. The results of the design basis case are also presented in Table 11.3-6. For both normal and maximum defined fuel failure cases, individual site boundary concentrations for the U.S. EPR are less than the applicable limits specified in 10 CFR Part 20, Appendix B, Table 2.

11.3.3.6 Radioactive Gaseous Waste System Leak or Failure

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~~In the event of an operator error leading to an inadvertent bypass of the gaseous waste system delay bed, the exhaust from the coolant degasification system is released directly to the environment.~~ The purge system of the gaseous waste processing system operates at sub-atmospheric pressures, thus preventing leakage from the purge section to the building atmosphere. The positive pressure section of the system is designed to be leak tight, thus limiting the potential for leakage. The leak tightness of the system is verified by pre-operational testing as described in Section 11.3.2.5.2.

The gaseous waste processing system is capable of detecting leaks by monitoring the system operating parameters for abnormalities. For example, if a leak were to exist in the purge section of the system. the upstream O_2 instrument would detect a higher than normal oxygen concentration due to building air ingress. If a leak were to exist in the positive pressure section, the system instrumentation would indicate flow rates and pressures outside the normal operating range. Once identified through system instrumentation and controls (I&C), the operator can take appropriate action to isolate the leak.

A bounding analysis was performed for the hypothetical event where an operator error leads to an inadvertent bypass of the delay beds and the exhaust from the coolant

11.03-2

degasification system is released directly to the environment. Based on a one-hour release to the environment, the exposure at the exclusion area boundary is less than 0.1 rem, in accordance with BTP 11-5 (Reference 3).

11.3.3.7 Quality Assurance

The quality assurance program governing design, fabrication, procurement, and installation of the gaseous waste processing system meets the requirements of RG 1.143 as described in Chapter 17. For the containment isolation valves and associated piping, the quality assurance program meets the requirements of Appendix B to 10 CFR Part 50 and Section III-ND of the ASME Boiler and Pressure Vessel Code (Reference 4).

11.3.4 Gaseous Waste Management System Cost-Benefit Analysis

10 CFR Part 50, Appendix I requires that plant designs consider additional items based on a cost-benefit analysis. Specifically, the design must include all items of reasonably demonstrated cleanup technology that, when added to the gaseous waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, reduce the dose to the population reasonably expected to be within 50 miles of the reactor. The cost-benefit analysis presented in this section is for a typical site and results demonstrate that additional cleanup technology is not warranted. Additionally, the U.S. EPR incorporates by reference NEI 07-11, Generic FSAR Template Guidance for Cost-Benefit Analysis for Radwaste Systems for Light-Water Cooled Nuclear Power Reactors (Reference 5). This reference independently demonstrates compliance with 10 CFR Part 50, Appendix I, Section II.D.

The next logical gaseous waste processing component for the U.S. EPR is the addition of a charcoal delay bed to the waste gas holdup subsystem. The original design contains three delay bed vessels, and the augmented design contains four delay bed vessels. All other features and parameters of the system are assumed to remain the same.

11.3.4.1 Calculation of Population Doses

The source term for each equipment equipment configuration option in this analysis was generated using the NUREG-0017 GALE code (Reference 1) and system parameters from Table 11.2.3. All input parameters to the GALE code (Reference 1) are the same for the base and augmented cases except for those parameters affected by the addition of a delay bed. The only GALE (Reference 1) input parameters affected by the design change are the holdup times for krypton and xenon. Holdup times are increased in proportion to the increase in mass of charcoal adsorber.

The GASPAR II code (Reference 2) was used to determine the population doses for both cases. Input parameters are given in Table 11.3-4. GASPAR II (Reference 2)

Wastes are initially classified as combustible, compressible or noncombustible and noncompressible. Compressible waste is compacted to reduce its volume. The wastes are further segregated based on properties, sizes, materials, and activity of the waste material. Waste containing moisture is collected and stored separately to avoid wetting dry active waste and to allow short-term treatment to prevent decomposition and hydrogen formation.

The combustible and compressible wastes are transferred from the storage rooms to the treatment area (e.g., compaction and compression), placed into storage drums, and compacted for temporary storage. The noncombustible and noncompressible wastes (thick metal parts, for example) are transported to the hot workshop, fragmented, and transferred into a drum.

Drums containing low-level radioactive waste are stored in the drum store area of the Radioactive Waste Processing Building until they are ready to be transported to offsite disposal. Drums stored in the drum store area have an activity level low enough that they meet ALARA dose criteria. Tubular shaft storage is provided for higher-level radioactive waste such as filter cartridges and treated resin waste.

11.04-2

The solid waste management processing and storage system is shown in Figure 11.4-1—Solid Waste Management Flow Diagram. Table 11.4-14—Solid Waste Management System Component Data, lists the major equipment and corresponding nominal design parameters. Tables are provided showing the expected and maximum annual activities by nuclide for the noncompressible, compressible, and combustible dry active waste (DAW) in Tables 11.4-2 through 11.4-4. A summary total of the annual activity from dry active wastes is given in Table 11.4-5—Total Dry Active Waste Annual Activity.

11.4.2.2 Radioactive Concentrates Processing System (Wet Solid Wastes)

The radioactive concentrates processing system receives concentrates and sludges from other waste treatment systems and dries these influents to produce a monolithic salt block inside a storage drum. Evaporator concentrates from the concentrate tanks and contaminated sludge from the storage tanks of the liquid waste storage system are transferred to the concentrate buffer tank. These wastes are mixed, sampled, and analyzed for proper pretreatment before leaving the concentrate buffer tank.

Spent resins are stored in the resin waste tanks of the coolant purification system for an extended length of time to allow short-lived activity to decay away. These resins are then transferred into the resin proportioning tank or into a HIC. Depending upon activity levels in the resin in the proportioning tank, a portion of the resin is transferred into the concentrate buffer tank with other liquid waste where it is mixed before leaving the concentrate buffer tank. Spent resin from the demineralizer system, which is part of the liquid waste processing system, may be sent directly to the HICs or

Table 11.4-14—Solid Waste Management System Component Data

Components/Parameters	Nominal Value
Resin Proportioning Tank	
Number	1
Total Volume	150 gallons
Material	Stainless Steel
Concentrate Buffer Tank	
Number	1
Total Volume	3000 gallons
Material	Stainless Steel
Condensate Collection Tank	
Number	1
Total Volume	150 gallons
Material	Stainless Steel
Concentrate Recirculation Pump	
Number	1
Type	Centrifugal
Design Flow Rate	50 gpm
Material	Stainless Steel
Condensate Collection Pump	
Number	1
Type	Centrifugal
Design Flow Rate	15 gpm
Material	Stainless Steel
Drum Drying Stations	
Number	3
Material	Stainless Steel
Condenser Drying Units	
Number	1
Type	Tube Bundle Heat Exchanger
Design Flow Rate (shell/tube)	< 1/5 gpm
Temperature Inlet (shell/tube)	140°F/100°F
Temperature Outlet (shell/tube)	< 110°F/120°F
Material	Stainless Steel

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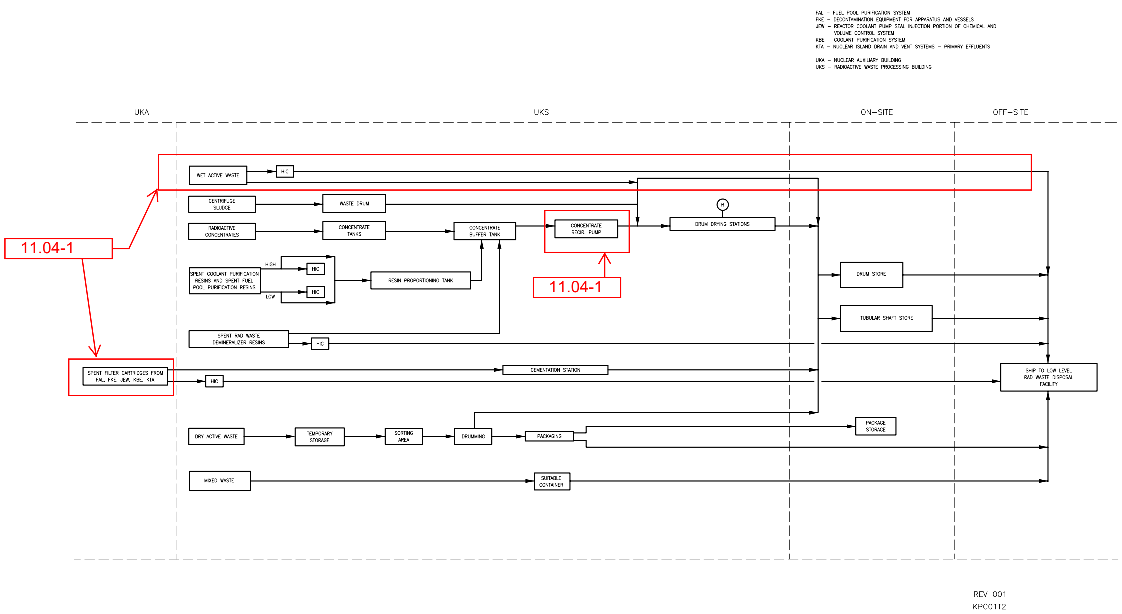
Table 12.3-3—Radiation Monitor Detector Parameters
Sheet 3 of 3

Monitor Location	Monitor Provisions		Range
	Continuous	ACF	
Post Accident Monitoring			
Reactor Building	4 monitors inside containment – Service Compartment	Signals Reactor Building air filtration isolation and RHR valve closure	1E-1 – 1E+7 rad/hr
Radioactive Waste Processing Building	1 monitor – In the drumming room next to conveyor	---	1E-4 – 1E+4 rem/hr
	1 monitor – In the decontamination room	---	1E-4 – 1E+4 rem/hr

11.04-4

Figure 11.4-1—Solid Waste Management Flow Diagram



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