MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

March 4, 2009

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09074

Subject: MHI's Response to US-APWR DCD RAI No. 168-1739 Rev. 1 and 170-1856 Rev. 1

References: 1) "Request for Additional Information No. 168-1739 Revision 1, SRP Section: 12.02 – Radiation Sources, Application Section: 12.2," dated February 3, 2009

2) "Request for Additional Information No. 170-1856 Revision 1, SRP Section: 12.03-12.04 – Radiation Protection Design Features, Application Section: 12.3.1," dated February 3, 2009

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") documents as listed in Enclosures.

Enclosed are the responses to two RAIs contained within References 1 and 2.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittal. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

D081
NRO

Enclosures:

1. Response to Request for Additional Information No.168-1739 Revision 1
2. Response to Request for Additional Information No.170-1856 Revision 1

CC: J. A. Ciocco
C. K. Paulson

Contact Information
C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

UAP-HF-09074
Docket No. 52-021

Response to Request for Additional Information No. 168-1739 Revision 1

March, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 168-1739 REVISION 1**
SRP SECTION:	**12.02 – Radiation Sources**
APPLICATION SECTION:	**12.2**
DATE OF RAI ISSUE:	**2/3/2009**

QUESTION NO.: 12.02-14

10 CFR 20.2001 requires that wastes be disposed of in accordance with 10 CFR 61. 10 CFR 61.55 requires that the concentration of radionuclides contained in waste be identified. Waste Form Technical Position, Revision 1, provides guidance on acceptable methods for demonstrating compliance with the waste form structural stability requirements of 10 CFR Part 61. The guidance contained in Regulatory Guide 1.206 section C.I.12.2.1 notes that the applicant is to provide the models, parameters and bases used to calculate source magnitudes, including isotopic composition and the bases for all values. The application should also describe those sources that are contained in equipment of the radioactive waste management systems.

Question 1:

The APWR DCD contains tables, such as Table 12.2-17 "Chemical and Volume Control System Radiation Sources Mixed Bed Demineralizer Activity (70 ft3 of Resin)", without providing all of the models, assumptions and parameters, need to support the reported activity values. Examples of some information that is needed to complete the analysis include:

- the assumed Resin Decontamination Factors (resin efficiency),
- term of service,
- flow rates (if different than those specified in chapter 9),
- inlet flow stream activity concentration (e.g. Table 12.2-10 provides the inlet activity for the let down flow stream, but there is a filter upstream of the demineralizer and no filtration parameters are specified),
- the assumed source term input resulting from use of the Boron Recycle System.

In accordance with RG 1.206, please revise chapter 12 to provide all of the models, assumptions and parameters used to calculate all of the demineralizer and filter source magnitudes provided as part of Section 12.2.

ANSWER:

1. DEMINERALIZERS

Calculation of the radioactivity concentration contained in the demineralizer resin considers the transfer of nuclides from the demineralizer inflow liquid during operation with due consideration of DF, accumulation and decay during operation, and transfer to daughter nuclides. Table A shows the operation parameters of each demineralizer.

a. Mixed bed demineralizer
In the mixed bed demineralizer, the coolant extracted from the primary system flows in through the regenerative heat exchanger, the letdown heat exchanger, and the mixed bed demineralizer inlet filter. Erring on the conservative side, effects of elimination by the filter of radioactivity in the primary coolant is not accounted for in the shield design of the mixed bed demineralizer. Thus, the concentration of radioactivity in the mixed bed demineralizer inflow liquid is identical to that of the letdown heat exchanger as shown in DCD Table 12.2-13. DF is based on Table 1-4 of NUREG-0017R1, the flow rate is equal to the reactor coolant letdown flow rate, and the time of service is taken as one cycle operation period (two years≒731 days). Please note that these are the same as those in Table 11.1-1 in Chapter 11.

b. Cation-bed demineralizer
Since part of the primary coolant treated by the mixed bed demineralizer flows into the cation-bed demineralizer, the concentration of radioactivity in the cation-bed demineralizer inflow liquid is equal to that of the liquid flowing out of the mixed bed demineralizer (refer to Table a). DF is based on Table 1-4 of NUREG-0017R1, and the time of service is taken as one cycle operation period (two years≒731 days). Please note that these are the same as those in Table 11.1-1 in Chapter 11. However, as actual operation is intermittent, the flow rate considered here differs from the actual flow rate. Assuming that 1/10 of the liquid flowing out of the mixed bed demineralizer flows into the cation-bed demineralizer, the flow rate is taken as 1/10 of the reactor coolant letdown flow rate.

c. Deborating demineralizer
Liquid flowing out of the mixed bed demineralizer or the cation-bed demineralizer flows into the deborating demineralizer. However, shield design takes into account only the liquid flowing out of the mixed bed demineralizer to ensure that the strength of source in the deborating demineralizer will be conservatively evaluated. Although it is not expected that the deborating demineralizer will eliminate radioactive nuclides, DF in the shield design follows NUREG-0017R1, and is set as that for the anion-bed demineralizer, while the flow rate is identical to the reactor coolant letdown flow rate. The deborating demineralizer is used to compensate for fuel burn-up near the end of the core life and the short operation time is obtained by dividing the amount of water by flow rate.

d. B.A. evaporator feed demineralizer
The B.A. evaporator feed demineralizer treats liquid flowing out of the holdup tank. The concentration of radioactivity of liquid phase in the holdup tank is given in DCD Table 12.2-26, while the shield design of US-APWR assumes a decay time somewhat longer, so that the concentration of radioactivity of the liquid flowing into the B.A. evaporator feed demineralizer differs from that in Table 12.2-26 (refer to Table b). DF has the same value as given in Table 1-4 of NUREG-0017R1, while the operation time is obtained by dividing the amount of water treated during one cycle by flow rate.

e. Waste demineralizer (anion-bed)
The waste demineralizer (anion-bed) treats waste liquid of the waste holdup tank that flows through the waste demineralizer inlet filter and the carbon activated filter. Conservatively, shield design of the waste demineralizer (anion-bed) takes no account of the effect of elimination by means of the waste demineralizer inlet filter and the carbon activated filter of radioactivity in the waste liquid. As a result, the concentration of radioactivity of the liquid flowing into the waste demineralizer (anion-bed) is equal to that of the waste liquid storage tank as shown in DCD Table 12.2-37. DF has the same value as given in Table 1-4 of NUREG-0017R1; Operation time is obtained by dividing the amount of waste liquid treated during one cycle by flow rate.

f. Waste demineralizer (cation-bed)
As the waste demineralizer (cation-bed) is installed downstream of the waste demineralizer (anion-bed), the concentration of radioactivity of the liquid flowing into the waste demineralizer

(cation-bed) is equal to that of the liquid flowing out of the waste demineralizer (anion-bed) (refer to Table c). DF has the same value as given in Table 1-4 of NUREG-0017R1; Operation time is obtained by dividing the amount of waste liquid treated during one cycle by flow rate.

g. Waste demineralizer (mixed-bed)
The waste demineralizer (mixed-bed) is installed downstream of the waste demineralizer (cation-bed). However, the waste demineralizer (mixed-bed) has two modes of operations: one to treat the liquid flowing out of the waste demineralizer (cation-bed), and the other to handle distilled water coming from the boron recycle system. Therefore, two types of parameters are set for each calculation, and the overall radioactivity is obtained by summing each value.

i) In case of treating the liquid from the waste demineralizer (cation-bed)
The concentration of radioactivity of the in-flowing liquid is equal to that of the liquid from the waste demineralizer (cation-bed) (refer to Table d). DF has the same value as given in Table 1-4 of NUREG-0017R1; Operation time is obtained by dividing the amount of waste liquid treated during one cycle by flow rate.

ii) In case of treating distilled water from the boron recycle system
The concentration of radioactivity of the in-flowing liquid is equal to that of the distilled water in the boron recycle system (refer to Table e). DF has the same value as given in Table 1-4 of NUREG-0017R1; Operation time is obtained by dividing the amount of waste liquid treated during one cycle by flow rate.

h. Spent fuel pit demineralizer
The spent fuel pit demineralizer treats water in the SFP and the refueling cavity, that is, the liquid flowing into the spent fuel pit demineralizer is SFP water, whose concentration of radioactivity is the same as that shown in DCD Table 12.2-34. DF has the same value (of radwaste demineralizer) as given in Table 1-4 of NUREG-0017R1, while the flow rate is equal to that described in Chapter 9, Subsection 9.1.3.2.1.5, with the operation time being one cycle (731 days).

i. SG blowdown demineralizer
The SG blowdown demineralizer treats the secondary water, that is, the liquid flowing into the SG blowdown demineralizer is the secondary water, having the concentration equal to that described in Chapter 11, Table 11.1-5. DF and the flow rate are the same values as those given in Chapter 11, Table 11.1-4, with the operation time being one cycle (731 days).

Table A Parameters for the US-APWR demineralizers

Name of demineralizer	Parameters				Note
	DF	Flow rate	Term of Service	inlet flow stream activity concentration	
Mixed bed demineralizer	Kr, Xe=1, Br, I=100, Cs, Rb=2 , Others=50	180 gpm	731 days	Table 12.2-13 in the DCD	These values in the left columns are listed in Table 11.1-1.
Cation-bed demineralizer	Kr, Xe=1, Br, I=1, Cs, Rb=10 , Others=10	18 gpm	731 days	Table 12.2-74 in the "Impact on DCD" of this response	
Deborating demineralizer	Anion=100, Cs, Rb=1, Others=1	180 gpm	22 hours	Table 12.2-74 in the "Impact on DCD" of this response	
B.A. evaporator feed demineralizer	Anion=10, Cs, Rb=2, Others=10	30 gpm	780 hours	Table 12.2-75 in the "Impact on DCD" of this response	
Waste demineralizer (Anion-bed)	I=100, Cs, Rb=1, Others=1	90 gpm	280 hours	Table 12.2-37 in the DCD	
Waste demineralizer (Cation-bed)	I=1, Cs, Rb=10, Others=10	90 gpm	280 hours	Table 12.2-76 in the "Impact on DCD" of this response	
Waste demineralizer (Mixed bed) In case of treating HT system	Kr, Xe=1, I=5, Cs, Rb=1 , Others=10	30 gpm	780 hours	Table 12.2-77 in the "Impact on DCD" of this response	Parameters used when treating distilled water in the boron recycle system
Waste demineralizer (Mixed bed) In case of treating WHT system	Kr, Xe=1, I=100, Cs, Rb=2 , Others=100	90 gpm	280 hours	Table 12.2-78 in the "Impact on DCD" of this response	Parameters used when treating waste liquid in the waste liquid storage tank
Spent fuel pit demineralizer	Kr, Xe=1, Br, I=100 Cs, Rb=2 , Others=100	265 gpm	731 days	Table 12.2-34 in the DCD	
SG Blowdown demineralizer	Br, I=100, Cs, Rb=100, Others=1000	1.554E+05 lb/hr	731 days	Table 11.1-5 in the DCD	

2. FILTERS

Filters are installed for removing particulate clad contained in the primary coolant extracted. Particulate clad is captured by filter elements of the filters, whose mechanism is difficult to evaluate by calculation. Regarding water filters, dose rates having sufficient margin in surface dose rate are set based on our plant experience. Concentration of radioactivity and source strength are reverse-counted to provide the given dose rate.

Table B shows designed surface dose rate for each filter. As filter elements are replaced before reaching the set dose rate for clogging, there is no chance for reaching these set dose rates.

Table B Designed upper limit dose rate at the surface of each filter

Name of Filter	Designed upper limit dose rate (rem/h)	Note
Reactor coolant Filter	500	
Mixed bed demineralizer inlet filter	500	Assumed to be same as the Reactor coolant filter
B.A. evaporator feed demineralizer	100	
Boric acid filter	10	
Seal water injection filter	100	
Waste effluent inlet filter	100	
SFP filter	100	
SG blowdown demineralizer inlet filter	10	

Although the shapes of some filters are given in Section 12.2, they are summarized in Table C for ready reference. Sometimes several filter elements are contained in one filter casing, which makes shield calculation difficult as they are actually arranged by restriction of calculation codes. Therefore, a simulation-based calculation is made with a circular ring having the same volume as that of the filter elements.

Table C Radiation sources parameters of the filters

Name of Filter	Source region			filter casing		
	Outer Radius (in.)	Inner Radius (in.)	Height (in.)	Material	Inner Radius (in.)	Material
Reactor coolant Filter	6.4	5.2	19.7	Water: 100%	7.3	Ignored
Mixed bed demineralizer inlet filter	6.4	5.2	19.7	↑	7.3	↑
B.A. evaporator feed demineralizer	3.4	2.7	19.7	↑	3.9	↑
Boric acid filter	6.4	5.2	19.7	↑	7.3	↑
Seal water injection filter	1.7	1.6	19.9	↑	1.8	↑
Waste effluent inlet filter	6.4	5.2	19.7	↑	7.3	↑
SFP filter	6.4	5.2	19.7	↑	7.3	↑
SG blowdown demineralizer inlet filter	6.4	5.2	19.7	↑	7.3	↑

Impact on DCD

For the demineralizers, Table A in the ANSWER section of this RAI will be added as Table 12.2-73, and relating tables will be added as Table 12.2-74 thru Table 12.2-78. Also the geometry of the deborating demineralizer and the B.A. evaporator feed demineralizer will be added in Table 12.2-1. Additionally, activities and source strengths of the deborating demineralizer and the B.A. evaporator feed demineralizer will be added as Table 12.2-62 thru Table 12.2-65.

For the filters, details in Table B and Table C will be added in Table 12.2-1.

Table 12.2-1 Radiation Sources Parameters
(Sheet 1 of ~~5~~ 6)

Components	Assumed Shielding Sources						
	Source Approximate Geometry as Cylinder Volume		Source Characteristics				Quantity
	Radius (in.)	Length (in.)	Type	Material	Density (lb/ft^3)	Equipment Self-Shielding (in.)	
Inside the containment vessel							
Steam generator Plenum Side Shell Side	 66.9 65.9	 63.0 434.2	 Homogeneous Homogeneous	 Source Water Source Water 22 wt%+ Secondary Water 9wt%+ Steel 69wt%	 41.6 69.2	 6.1 3.4	4
Regenerative heat exchanger * Plenum Side Shell Side	8.3	 23.2 140.2	 Homogenous Homogenous	 Water (Charging Line) Water (Letdown Line) 35 wt%+ Water (Charging Line) 6 wt%+ Steel 59 wt%	 62.4 129.2	2.0	3
Letdown heat exchanger Plenum Side Shell Side	17.7	 24.4 189.8	 Homogenous Homogenous	 Source Water Source Water 11 wt%+ Cooling water 61 wt%+ Steel 28 wt%	 62.4 82.5	ignored	1
Excess letdown heat exchanger Plenum Side Shell Side	6.9	 21.7 130.2	 Homogenous Homogenous	 Source Water Source Water 5 wt%+ Cooling water 63 wt%+ Steel 32wt%	 62.4 86.9	 1.8 ignored	1

* The regenerative heat exchanger consists of three shells.

Table 12.2-1 Radiation Sources Parameters
(Sheet 2 of ~~5~~ 6)

Components	Assumed Shielding Sources						
	Source Approximate Geometry as Cylinder Volume		Source Characteristics				Quantity
	Radius (in.)	Length (in.)	Type	Material	Density (lb/ft^3)	Equipment Self-Shielding (in.)	
Outside the containment vessel (Reactor Building)							
Containment spray/residual heat removal heat exchanger	31.5						4
Plenum Side		56.7	Homogenous	Source Water	62.4	1.8	
Shell Side		264.4	Homogenous	Source Water 15 wt%+ Cooling water 48 wt%+ Steel 37 wt%	91.8	1.2	
Seal water heat exchanger	8.4					ignored	1
Plenum Side		22.3	Homogenous	Source Water	62.4		
Shell Side		144.6	Homogenous	Source Water 10 wt%+ Cooling water 49 wt%+ Steel 41 wt%	97.6		
Volume control tank	47.2	179.2				ignored	1
Liquid Phase		107.5	Homogenous	Air	7.6E-02		
Vapor Phase		71.7	Homogenous	Water	62.4		

Table 12.2-1 Radiation Sources Parameters (Sheet 3of 5 6)

Components	Assumed Shielding Sources						
	Source Approximate Geometry as Cylinder Volume		Source Characteristics				Quantity
	Radius (in.)	Length (in.)	Type	Material	Density (lb/ft^3)	Equipment Self-Shielding (in.)	
Auxiliary Building							
Mix bed demineralizer*	23.7	68.9	Homogeneous	Water	62.4	ignored	2
Cation-bed demineralizer*	15.9	65.6	Homogeneous	Water	62.4	ignored	1
Deborating demineralizer*	23.7	68.9	Homogeneous	Water	62.4	ignored	2
Holdup tank Liquid Phase Vapor Phase	147.6	410.0 229.7 180.3	 Homogenous Homogenous	 Water Air	 62.4 7.6E-02	ignored	3
B.A. evaporator feed demineralizer*	23.7	68.9	Homogeneous	Water	62.4	ignored	1
Spent fuel pit demineralizer*	23.7	68.9	Homogeneous	Water	62.4	ignored	2
Steam generator blowdown demineralizer*	44.3	63.4	Homogeneous	Water	62.4	ignored	4
Waste holdup tank	128.0	138.6	Homogeneous	Water	62.4	ignored	4
Waste demineralizer*	23.7	68.9	Homogeneous	Water	62.4	ignored	4
Charcoal bed Charcoal Phase Vapor Phase	23.7	126.0 68.8 57.2	 Homogenous Homogenous	 Charcoal Air	 34.4 7.6E-02	ignored	4
Waste gas surge tank	74.8	167.0	Homogeneous	Air	7.6E-02	1.0	4
Spent resin storage tank	59.1	131.2	Homogeneous	Water	62.4	ignored	2
B.A. evaporator	26.9	188.5	Homogeneous	Water	62.4	ignored	1
B.A. evaporator vent condenser	5.0	78.1	Homogeneous	Air	7.6E-02	ignored	1
Boric acid tank	118.1	361.5	Homogeneous	Water	62.4	ignored	2

* Parameters for the US-APWR demineralizers are tabulated in Table 12.2-73.

Table 12.2-1 Radiation Sources Parameters
(Sheet 3 4 of 5 6)

Components	Assumed Shielding Sources						
	Source Approximate Geometry as Cylinder Volume		Source Characteristics				Quantity
	Radius (in.)	Length (in.)	Type	Material	Density (lb/ft^3)	Equipment Self-Shielding (in.)	
Plant Yard Area (Outside the Power Block)							
Refueling water storage auxiliary tank	236.2	536.6	Homogeneous	Water	62.4	ignored	1
Primary makeup water tank	183.1	316.9	Homogeneous	Water	62.4	ignored	2

Table 12.2-1 Radiation Sources Parameters (Sheet 4 5 of 5 6)

Components	Assumed Shielding Sources							
	Source Approximate Geometry as rectangular parallelepiped Volume			Source Characteristics				Quantity
	Width (in.)	Depth (in.)	Length (in.)	Type	Material	Density (lb/ft^3)	Equipment Self-Shielding (in.)	
Outside the Containment Vessel (Reactor Building)								
Spent fuel pit heat exchanger *	29.5	47.7	88.6	Homogeneous	Source Water 25.5 wt%+ Cooling water 25.5 wt%+ Steel 49 wt%	109.3	ignored	2

* Spent fuel pit exchanger is a plate heat exchanger.

Table 12.2-1 Radiation Sources Parameters (Sheet 6 of 6)

Components	Assumed Shielding Sources								
	Source Approximate Geometry as Annular Cylinder Volume			Source Characteristics					Quantity
	Outer Radius (in.)	Inner Radius (in.)	Height (in.)	Type	Material	Density (lb/ft^3)	Equipment Self-Shielding (in.)	Designed Upper limit dose rate (mrem/h)	
Auxiliary Building									
Reactor coolant Filter	6.4	5.2	19.7	Homogeneous	Water	62.4	Ignored	500	2
Mixed bed demineralizer inlet filter	6.4	5.2	19.7	Homogeneous	Water	62.4	Ignored	500	3
B.A. evaporator feed demineralizer	3.4	2.7	19.7	Homogeneous	Water	62.4	Ignored	100	1
Boric acid filter	6.4	5.2	19.7	Homogeneous	Water	62.4	Ignored	10	1
Seal water injection filter	1.7	1.6	19.9	Homogeneous	Water	62.4	Ignored	100	2
Waste effluent inlet filter	6.4	5.2	19.7	Homogeneous	Water	62.4	Ignored	100	2
SFP filter	6.4	5.2	19.7	Homogeneous	Water	62.4	Ignored	100	2
SG blowdown demineralizer inlet filter	6.4	5.2	19.7	Homogeneous	Water	62.4	Ignored	10	2

Table 12.2-62 Chemical and Volume Control System Radiation Sources Deborating Demineralizer Activity (70 ft^3 of Resin)

Nuclide	Activity ($\mu Ci/cm^3$)
Br-82	1.5E-02
Br-83	2.6E-02
Br-84	3.1E-03
I-130	1.4E-01
I-131	3.4E+00
I-132	2.1E+00
I-133	4.3E+00
I-134	7.4E-02
I-135	1.5E+00

Table 12.2-63 Chemical and Volume Control System Radiation Sources Deborating Demineralizer Source Strength (70 ft^3 of Resin)

Gamma Ray Energy (MeV)	Source Strength ($MeV/cm^3/sec$)
0.015	1.3E+01
0.03	2.6E+02
0.08	2.6E+02
0.1	9.0E-01
0.15	6.7E+01
0.2	3.7E+02
0.3	4.0E+03
0.4	4.4E+04
0.5	8.4E+04
0.6	7.0E+04
0.8	8.1E+04
1.0	4.9E+04
1.5	7.1E+04
2.0	1.9E+04
3.0	1.6E+02
4.0	3.3E+01

Table 12.2-64 Chemical and Volume Control System Radiation Sources B.A. Evaporator Feed Demineralizer Activity (70 ft^3 of Resin)

Nuclide	Activity (µCi/cm^3)	Nuclide	Activity (µCi/cm^3)
Br-82	1.2E-02	Te-129m	2.0E-01
Br-83	3.0E-03	Te-129	1.5E-04
Br-84	8.5E-05	Te-131m	3.7E-02
Rb-86	2.9E+00	Te-131	2.1E-05
Rb-88	1.1E+00	Te-132	1.1E+00
Rb-89	1.3E-03	Te-133m	2.0E-04
Sr-89	9.3E-02	Te-134	2.1E-04
Sr-90	5.9E-03	I-130	1.5E+00
Sr-91	7.9E-04	I-131	1.3E+01
Sr-92	6.7E-05	I-132	1.3E+00
Y-90	1.3E-01	I-133	2.2E+00
Y-91m	5.3E-04	I-134	3.8E-03
Y-91	1.3E-02	I-135	3.4E-01
Y-92	2.8E-04	Cs-132	5.5E-01
Y-93	1.6E-04	Cs-134	5.0E+02
Zr-95	1.5E-02	Cs-135m	1.4E-03
Nb-95	4.0E-02	Cs-136	6.3E+01
Mo-99	2.5E+00	Cs-137	2.9E+02
Mo-101	1.7E-05	Cs-138	9.1E-02
Tc-99m	3.5E+00	Ba-137m	2.5E+02
Ru-103	1.1E-02	Ba-140	5.2E-02
Ru-106	5.0E-03	La-140	1.0E-01
Ag-110m	4.5E-05	Ce-141	1.2E-02
Te-125m	1.7E-02	Ce-143	8.0E-04
Te-127m	7.5E-02	Ce-144	1.2E-02
		Pr-144	1.7E-02
		Pm-147	1.4E-03
		Eu-154	1.3E-04
		Na-24	4.2E-02
		Cr-51	1.2E-01
		Mn-54	1.2E-01
		Mn-56	1.1E-02
		Fe-55	1.2E-01
		Fe-59	1.6E-02
		Co-58	2.5E-01
		Co-60	4.2E-02
		Zn-65	3.3E-02

Table 12.2-65 Chemical and Volume Control System Radiation Sources B.A. Evaporator Feed Demineralizer Source Strength (70 ft^3 of Resin)

Gamma Ray Energy (MeV)	Source Strength (MeV/cm^3/sec)
0.015	2.6E+03
0.02	2.7E+02
0.03	3.3E+04
0.04	9.8E+03
0.05	3.0E+02
0.06	1.8E+04
0.08	1.3E+04
0.1	1.1E+03
0.15	6.3E+04
0.2	7.7E+04
0.3	4.3E+05
0.4	1.6E+05
0.5	2.2E+05
0.6	1.9E+07
0.8	1.6E+07
1.0	2.9E+06
1.5	8.9E+05
2.0	2.5E+04
3.0	9.2E+03
4.0	4.3E+01
5.0	3.0E+02

Table 12.2-73 Parameters for the US-APWR demineralizers

Component	Parameters				Note
	DF	Flow rate	Term of Service	inlet flow stream activity concentration	
Mixed bed demineralizer	Kr, Xe=1, Br, I=100, Cs, Rb=2 , Others=50	180 gpm	731 days	Table 12.2-13	These values in the left columns are listed in Table 11.1-1.
Cation-bed demineralizer	Kr, Xe=1, Br, I=1, Cs, Rb=10 , Others=10	18 gpm	731 days	Table 12.2-74	
Deborating demineralizer	Anion=100, Cs, Rb=1, Others=1	180 gpm	22 hours	Table 12.2-74	
B.A. evaporator feed demineralizer	Anion=10, Cs, Rb=2, Others=10	30 gpm	780 hours	Table 12.2-75	
Waste demineralizer (Anion-bed)	I=100, Cs, Rb=1, Others=1	90 gpm	280 hours	Table 12.2-37	
Waste demineralizer (Cation-bed)	I=1, Cs, Rb=10, Others=10	90 gpm	280 hours	Table 12.2-76	
Waste demineralizer (Mixed bed) In case of treating HT system	Kr, Xe=1, I=5, Cs, Rb=1 , Others=10	30 gpm	780 hours	Table 12.2-77	Parameters used when treating distilled water in the boron recycle system
Waste demineralizer (Mixed bed) In case of treating WHT system	Kr, Xe=1, I=100, Cs, Rb=2 , Others=100	90 gpm	280 hours	Table 12.2-78	Parameters used when treating waste liquid in the waste liquid storage tank
Spent fuel pit demineralizer	Kr, Xe=1, Br, I=100 Cs, Rb=2 , Others=100	265 gpm	731 days	Table 12.2-34	
SG Blowdown demineralizer	Br, I=100, Cs, Rb=100, Others=1000	1.554E+05 lb/hr	731 days	Table 11.1-5	

Table 12.2-74 Inlet Flow Stream Activity of Cation-bed demineralizer and Deborating demineralizer

Nuclide	Activity ($\mu Ci/cm^3$)	Nuclide	Activity ($\mu Ci/cm^3$)
Kr-83m	5.5E-01	Te-129m	1.2E-04
Kr-85m	1.8E+00	Te-129	1.5E-04
Kr-85	9.2E+01	Te-131m	3.1E-04
Kr-87	1.2E+00	Te-131	1.7E-04
Kr-88	3.3E+00	Te-132	3.4E-03
Xe-131m	4.1E+00	Te-133m	3.2E-04
Xe-133m	4.2E+00	Te-134	5.8E-04
Xe-133	3.1E+02	I-130	6.2E-04
Xe-135m	7.9E+00	I-131	1.6E-02
Xe-135	1.2E+01	I-132	6.5E-02
Xe-138	6.7E-01	I-133	2.7E-02
		I-134	6.1E-03
Br-82	8.6E-05	I-135	1.8E-02
Br-83	7.8E-04	Cs-132	4.1E-04
Br-84	4.2E-04	Cs-134	3.8E-01
Rb-86	3.7E-03	Cs-135m	4.5E-03
Rb-88	2.1E+00	Cs-136	1.0E-01
Rb-89	4.9E-02	Cs-137	2.2E-01
Sr-89	3.8E-05	Cs-138	4.9E-01
Sr-90	2.4E-06	Ba-137m	1.1E+03
Sr-91	2.5E-05	Ba-140	4.6E-05
Sr-92	1.4E-05	La-140	3.5E-04
Y-90	4.4E-04	Ce-141	7.1E-06
Y-91m	1.8E-04	Ce-143	6.0E-06
Y-91	6.1E-06	Ce-144	5.3E-06
Y-92	2.2E-05	Pr-144	1.0E-01
Y-93	4.8E-06	Pm-147	6.0E-07
Zr-95	7.3E-06	Eu-154	5.6E-08
Nb-95	2.0E-05		
Mo-99	8.9E-03	Na-24	7.7E-04
Mo-101	3.9E-04	Cr-51	7.5E-05
Tc-99m	8.7E-02	Mn-54	5.1E-05
Ru-103	6.0E-06	Mn-56	2.6E-03
Ru-106	2.1E-06	Fe-55	5.0E-05
Ag-110m	1.9E-08	Fe-59	8.7E-06
Te-125m	8.7E-06	Co-58	1.2E-04
Te-127m	3.4E-05	Co-60	1.8E-05
		Zn-65	1.4E-05

Table 12.2-75 Inlet Flow Stream Activity of B.A. evaporator feed demineralizer

Nuclide	Activity ($\mu Ci/cm^3$)	Nuclide	Activity ($\mu Ci/cm^3$)
Kr-83m	1.6E-01	Te-129m	1.2E-04
Kr-85m	9.7E-01	Te-129	2.8E-05
Kr-85	9.2E+01	Te-131m	2.8E-04
Kr-87	2.4E-01	Te-131	1.1E-05
Kr-88	1.4E+00	Te-132	3.3E-03
Xe-131m	4.1E+00	Te-133m	4.8E-05
Xe-133m	4.0E+00	Te-134	6.6E-05
Xe-133	3.1E+02	I-130	6.2E-04
Xe-135m	3.3E-01	I-131	1.6E-02
Xe-135	8.4E+00	I-132	2.5E-02
Xe-138	2.6E-02	I-133	2.4E-02
		I-134	9.3E-04
Br-82	7.9E-05	I-135	1.2E-02
Br-83	2.8E-04	Cs-132	4.1E-04
Br-84	3.6E-05	Cs-134	3.8E-01
Rb-86	3.7E-03	Cs-135m	6.4E-04
Rb-88	1.4E+00	Cs-136	9.9E-02
Rb-89	2.0E-03	Cs-137	2.2E-01
Sr-89	4.8E-05	Cs-138	6.9E-02
Sr-90	2.4E-06	Ba-137m	8.1E+00
Sr-91	1.9E-05	Ba-140	4.6E-05
Sr-92	5.6E-06	La-140	3.3E-04
Y-90	4.2E-04	Ce-141	7.1E-06
Y-91m	3.4E-05	Ce-143	5.5E-06
Y-91	6.2E-06	Ce-144	5.3E-06
Y-92	1.4E-05	Pr-144	4.8E-03
Y-93	3.6E-06	Pm-147	6.0E-07
Zr-95	7.3E-06	Eu-154	5.6E-08
Nb-95	2.0E-05		
Mo-99	8.5E-03	Na-24	6.3E-04
Mo-101	1.6E-05	Cr-51	7.5E-05
Tc-99m	5.7E-02	Mn-54	5.1E-05
Ru-103	6.0E-06	Mn-56	9.8E-04
Ru-106	2.1E-06	Fe-55	4.9E-05
Ag-110m	1.9E-08	Fe-59	8.7E-06
Te-125m	8.6E-06	Co-58	1.2E-04
Te-127m	3.4E-05	Co-60	1.8E-05
		Zn-65	1.4E-05

Table 12.2-76 Inlet Flow Stream Activity of Waste Demineralizer (Cation Bed)

Nuclide	Activity ($\mu Ci/cm^3$)	Nuclide	Activity ($\mu Ci/cm^3$)
Xe-131m	3.1E-03	Te-129m	2.5E-03
Xe-133m	1.2E-02	Te-129	2.0E-03
Xe-133	1.8E-01	Te-131m	6.3E-03
Xe-135m	2.5E+00	Te-131	2.2E-03
Xe-135	4.6E-01	Te-132	7.0E-02
		Te-133m	4.3E-03
Br-82	3.5E-03	Te-134	7.6E-03
Br-83	2.4E-02	I-130	2.7E-04
Br-84	1.1E-02	I-131	6.7E-03
Rb-86	1.1E-02	I-132	2.9E-03
Rb-88	1.4E+00	I-133	1.1E-02
Rb-89	2.5E-02	I-134	1.5E-03
Sr-89	8.3E-04	I-135	6.4E-03
Sr-90	5.4E-05	Cs-132	2.2E-03
Sr-91	4.7E-04	Cs-134	2.0E+00
Sr-92	2.2E-04	Cs-135m	2.4E-03
Y-90	1.8E-04	Cs-136	2.5E-01
Y-91m	2.7E-04	Cs-137	1.2E+00
Y-91	1.3E-04	Cs-138	2.6E-01
Y-92	2.1E-04	Ba-137m	8.0E+00
Y-93	9.0E-05	Ba-140	9.8E-04
Zr-95	1.6E-04	La-140	4.2E-04
Nb-95	1.8E-04	Ce-141	1.5E-04
Mo-99	1.8E-01	Ce-143	1.2E-04
Mo-101	5.0E-03	Ce-144	1.2E-04
Tc-99m	1.1E-01	Pr-144	2.9E-03
Ru-103	1.3E-04	Pm-147	1.3E-05
Ru-106	4.7E-05	Eu-154	1.2E-06
Ag-110m	4.3E-07		
Te-125m	1.9E-04	Na-24	1.5E-02
Te-127m	7.5E-04	Cr-51	1.6E-03
		Mn-54	1.1E-03
		Mn-56	4.0E-02
		Fe-55	1.1E-03
		Fe-59	1.9E-04
		Co-58	2.6E-03
		Co-60	3.9E-04
		Zn-65	3.2E-04

Table 12.2-77 Inlet Flow Stream Activity of Waste Demineralizer (Mixed bed)*

Nuclide	Activity (μCi/cm³)	Nuclide	Activity (μCi/cm³)
Kr-83m	1.6E-04	Te-129m	1.2E-08
Kr-85m	9.7E-04	Te-129	2.9E-09
Kr-85	9.2E-02	Te-131m	2.8E-08
Kr-87	2.4E-04	Te-131	1.2E-09
Kr-88	1.4E-03	Te-132	3.3E-07
Xe-131m	4.1E-03	Te-133m	4.8E-09
Xe-133m	4.0E-03	Te-134	6.6E-09
Xe-133	3.1E-01	I-130	6.2E-07
Xe-135m	3.7E-04	I-131	1.6E-05
Xe-135	8.4E-03	I-132	1.2E-04
Xe-138	2.6E-05	I-133	2.4E-05
		I-134	9.8E-07
Br-82	7.9E-09	I-135	1.2E-05
Br-83	2.8E-08	Cs-132	2.1E-07
Br-84	3.6E-09	Cs-134	1.9E-04
Rb-86	1.9E-06	Cs-135m	3.2E-07
Rb-88	7.2E-04	Cs-136	5.0E-05
Rb-89	1.0E-06	Cs-137	1.1E-04
Sr-89	4.8E-09	Cs-138	3.4E-05
Sr-90	2.4E-10	Ba-137m	1.3E-01
Sr-91	1.9E-09	Ba-140	4.6E-09
Sr-92	5.6E-10	La-140	5.9E-08
Y-90	4.4E-08	Ce-141	7.1E-10
Y-91m	1.4E-08	Ce-143	5.5E-10
Y-91	6.3E-10	Ce-144	5.3E-10
Y-92	1.8E-09	Pr-144	1.4E-06
Y-93	3.6E-10	Pm-147	6.0E-11
Zr-95	7.3E-10	Eu-154	5.6E-12
Nb-95	2.4E-09		
Mo-99	8.5E-07	Na-24	6.3E-08
Mo-101	1.6E-09	Cr-51	7.5E-09
Tc-99m	1.3E-05	Mn-54	5.1E-09
Ru-103	6.0E-10	Mn-56	9.8E-08
Ru-106	2.1E-10	Fe-55	4.9E-09
Ag-110m	1.9E-12	Fe-59	8.7E-10
Te-125m	8.6E-10	Co-58	1.2E-08
Te-127m	3.4E-09	Co-60	1.8E-09
		Zn-65	1.4E-09

*: These activities are used when this demineralizer processes the distilled water from the boron recycle system.

Table 12.2-78 Inlet Flow Stream Activity of Waste Demineralizer (Mixed bed)*

Nuclide	Activity (μCi/cm³)	Nuclide	Activity (μCi/cm³)
Kr-83m	2.8E-02	Te-129m	2.5E-04
Xe-131m	3.1E-03	Te-129	2.0E-04
Xe-133m	1.2E-02	Te-131m	6.3E-04
Xe-133	1.8E-01	Te-131	2.2E-04
Xe-135m	2.5E+00	Te-132	7.0E-03
Xe-135	4.6E-01	Te-133m	4.3E-04
		Te-134	7.6E-04
Br-82	3.5E-04	I-130	2.7E-04
Br-83	2.4E-03	I-131	6.7E-03
Br-84	1.1E-03	I-132	2.0E+00
Rb-86	1.1E-03	I-133	1.1E-02
Rb-88	1.4E-01	I-134	7.0E-03
Rb-89	2.5E-03	I-135	6.4E-03
Sr-89	8.3E-05	Cs-132	2.2E-04
Sr-90	5.4E-06	Cs-134	2.0E-01
Sr-91	4.7E-05	Cs-135m	2.4E-04
Sr-92	2.2E-05	Cs-136	2.5E-02
Y-90	3.3E-05	Cs-137	1.2E-01
Y-91m	3.1E-04	Cs-138	2.6E-02
Y-91	1.3E-05	Ba-137m	4.6E+02
Y-92	3.7E-05	Ba-140	9.8E-05
Y-93	9.0E-06	La-140	3.6E-04
Zr-95	1.6E-05	Ce-141	1.5E-05
Nb-95	2.1E-05	Ce-143	1.2E-05
Mo-99	1.8E-02	Ce-144	1.2E-05
Mo-101	5.0E-04	Pr-144	7.3E-03
Tc-99m	1.6E-01	Pm-147	1.3E-06
Ru-103	1.3E-05	Eu-154	1.2E-07
Ru-106	4.7E-06		
Ag-110m	4.3E-08	Na-24	1.5E-03
Te-125m	1.9E-05	Cr-51	1.6E-04
Te-127m	7.5E-05	Mn-54	1.1E-04
		Mn-56	4.0E-03
		Fe-55	1.1E-04
		Fe-59	1.9E-05
		Co-58	2.6E-04
		Co-60	3.9E-05
		Zn-65	3.2E-05

*: These activities are used when this demineralizer processes the liquid effluent from the waste holdup tank.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

Enclosure 2

UAP-HF-09074
Docket No. 52-021

Response to Request for Additional Information No. 170-1856 Revision 1

March, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 170-1856 REVISION 1**

SRP SECTION: **12.03-12.04 – Radiation Protection Design Features**

APPLICATION SECTION: **12.3.1**

DATE OF RAI ISSUE: **2/3/2009**

QUESTION NO.: 12.03-12.04-6

10 CFR 20.1101(b), 1201and 1202 require licensees to control internal and external occupational exposure, and to ensure that engineering controls are used to keep occupational doses ALARA. In 10 CFR 20 the definition for ALARA includes guidance to make every reasonable effort to maintain exposures below regulatory limits, taking into account the state of technology. Regulatory Guide 1.206 section C.I.12.3.1 "Facility Design Features" notes that the Applicant should identify features that reduce the potential for exposure by minimizing the time in the area, reducing source build up, providing remote operation and reducing activation product generation.

APWR DCD Section 12.3.1.1.1.2 does not discuss any filter media specifications. DCD Section 9.3.4.2.6, discusses nuclear plant filters, but does not provide any performance specifications for these filters. Industry standard documents note that experience in Westinghouse plants shows that using 0.1 micron seal injection filters improves seal life. For an operating plant, the result of improved seal life would be less work and dose associated with seal maintenance and replacement. This method of material specification is a known, proven, cost effective and documented dose reduction technique. DCD Section 12.3.1.1.1.1 "Nuclear Steam Supply System Equipment", or Section 12.3.1.1.2.A "Balance of Plant Equipment - Filters" fail to note this aspect as part of the design bases for the equipment.

In accordance with RG 1.206, please revise chapter 12.3.1.1.1 to include the information that describes the ALARA related design specifications for the material selection of filters, or. revise chapter 12.3.1.1.1 to provide justification for not specifying a known and proven exposure reduction method and material as part of the design features discussed in section 12.3.1.1.1.

ANSWER:

Operational experience of MHI plants also shows that using the submicron filters (e.g. 0.01 micron) for the seal injection filter provides the improvement of seal leak characteristics and the effective prevention of the introduction of particulates. Meanwhile, using the small mesh filter may cause the increase of filter replacements and associated increases of dosage and radioactive waste. Improved seal life can be obtained by adopting smaller filter media and also improvement of the seal itself. The filter media is changeable and filters with feasible mesh size can be adopted during actual operation taking into account the filter replacement frequency.

Impact on DCD

There is no impact on the DCD

Impact on COLA

There is no impact on the COLA

Impact on PRA

There is no impact on the PRA