ArevaEPRDCPEm Resource

From: BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
Sent: Wednesday, March 31, 2010 12:11 PM
To: Tesfaye, Getachew
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); WILLIFORD Dennis C (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 299, FSAR Ch. 11, Supplement 1
Attachments: RAI 299 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to the 2 questions in RAI No. 299 on November 5, 2009. This response supersedes the prior response to 11.02-16, Part (j) provided in the original response because it contains the results of revised calculations and FSAR markups as committed to be provided by March 31, 2010. The attached file, “RAI 299 Supplement 1 Response US EPR DC.pdf” provides a technically correct and complete response (including FSAR markups) to the remaining question, as committed.

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 299 Question 11.02-16(j).

The following table indicates the respective pages in the response document, “RAI 299 Supplement 1 Response US EPR DC.pdf,” that contain AREVA NP’s response to the subject question.

Question #	Start Page	End Page
RAI 299—11.02-16(j)	2	8

This concludes the formal AREVA NP response to RAI 299, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Martin (Marty) C. Bryan
Licensing Advisory Engineer
AREVA NP Inc.
Tel: (434) 832-3016
Martin.Bryan.ext@areva.com

From: Pederson Ronda M (AREVA NP INC)
Sent: Thursday, November 05, 2009 8:01 PM
To: 'Tesfaye, Getachew'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); SLIVA Dana (AREVA NP INC); WILLIFORD Dennis C (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 299, FSAR Ch. 11

Getachew,

Attached please find AREVA NP Inc.’s response to the subject request for additional information (RAI). The attached file, “RAI 299 Response US EPR DC.pdf” provides technically correct and complete responses to 2 of the 2 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report (FSAR) in redline-strikeout format which support the response to RAI 299 Questions11.02-16 and 11.03-14.

A complete FSAR markup is not provided for Question 11.02-16(j). As agreed by NRC staff during an FSAR Chapter 11 audit on October 7, 2009, FSAR markups may be submitted after Phase 2 completion to support Staff review to close confirmatory items. Therefore, a complete FSAR markup for this portion of the question will be provided as indicated in the following table:

Question #	**Supplement Date (providing FSAR Markup)**
RAI 299 — 11.02-16 (j)	March 31, 2010

The following table indicates the respective pages in the response document, "RAI 299 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	**Start Page**	**End Page**
RAI 299 — 11.02-16	2	6
RAI 299 — 11.03-14	7	10

This concludes the formal AREVA NP response to RAI 299, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
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Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, October 06, 2009 6:03 PM
To: ZZ-DL-A-USEPR-DL
Cc: Dehmel, Jean-Claude; Frye, Timothy; Jennings, Jason; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 299 (3783,3784),FSAR Ch. 11

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on September 23, 2009, and discussed with your staff on October 6, 2009. No changes were made to the draft RAI as a result of that discussion except for minor typographical error corrections. 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

(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 1271

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Subject: Response to U.S. EPR Design Certification Application RAI No. 299, FSAR Ch. 11, Supplement 1
Sent Date: 3/31/2010 12:11:18 PM
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From: BRYAN Martin (EXT)

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RAI 299 Supplement 1 Response US EPR DC.pdf		136257

Options
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Recipients Received:

Response to

Request for Additional Information No. 299, Supplement 1

10/06/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 11.02 - Liquid Waste Management System
SRP Section: 11.03 - Gaseous Waste Management System

Application Sections: 11.2 and 11.3

QUESTIONS for Health Physics Branch (CHPB)

Question 11.02-16:

While the staff duplicated the estimates of yearly radioactive liquid effluent releases (Ci/yr) and offsite concentrations (uCi/ml), the evaluation identified a number of inconsistencies associated with assumptions and parameters used in calculations. Without such clarifications and corrections, the staff cannot complete its evaluation and conclude, with reasonable assurance, that the design features and supporting analyses demonstrate compliance with Part 20.1301 and 20.1302, effluent concentration limits of Appendix B, Table 2 of Part 20, and design objectives of Appendix I to Part 50. These observations should be evaluated by the applicant and corrected or justified in the next revision of the FSAR. Specifically, the observations include:

a. FSAR Table 11.2-3 – The table should state that the basis of the source term assumes an 80% capacity factor, being the default value in the PWR-GALE code, and provide the expected capacity factor for the U.S. EPR. In qualifying the expected capacity factor for the U.S. EPR, the discussion should acknowledge that the current fleet of operating reactors is operating at factors in excess of 90%, and discuss the rationale as to whether the estimated radioactive liquid effluent releases (Ci/yr) and offsite concentrations (uCi/ml) need to be scaled up in light of an expected higher capacity factor.

b. FSAR Table 11.2-3 – The table should note that the cited mass of primarily coolant does not include the mass of coolant contained in the pressurizer.

c. FSAR Table 11.2-3 – A review of the FSAR indicates that there are three values for the total steam flow rate: 2.07E+07 lbs/hr in Table 11.1-3; 1.9E+07 lbs/hr in Table 11.1-6; and 2.171E+07 lbs/hr in Table 11.2-3. Provide a justification for the use of 2.171E+07 lbs/hr in Table 11.2-3.

d. FSAR Table 11.2-3 – The table applies a value of 2.184E+05 lbs/hr as the SG blowdown rate. Table 11.1-6 lists a value of 1.9E+05 lbs/hr and Table 11.1-3 lists a value of 2.08E+05 lbs/hr. Provide a justification for the use of 2.184E+05 lbs/hr in Table 11.2-3.

e. FSAR Table 11.2-3 – The table applies a value of 0.33 as the fraction of condensate flow going to the condensate demineralizer. In Table 11.1-6, this fraction is listed as zero, and in Table 11.1-3, it is shown as 100% of the condensate. Provide a justification for the use of 0.33 in Table 11.2-3.

f. FSAR Table 11.2-3 – The table applies a value of 110 gpd as the shim bleed flow rate. Table 11.1-6 lists a value of 500 lbs/hr, which is equivalent to a flow rate of 2055 gpd, using the specific volume of Table 11.1-1. Provide a justification for the use of 110 gpd in Table 11.2-3.

g. FSAR Table 11.2-3 – The table applies a value of 1728 gpd for the equipment drain input and 9428 gpd for the clean waste input. However, these input rates could not be inferred from the design values listed in Table 11.2-1 or Group I, II, and III waste streams. Provide the basis and justification for these two input rates.

h. FSAR Table 11.2-3 – The table applies a DF of 10^7 for cesium and other nuclides for the processing of shim bleed and equipment drain. However, these DFs could not be inferred from the values listed in NUREG-0017. Provide the basis and justification for the use of a DF of 10^7.

i. FSAR Table 11.2-3 – The table applies a value of 27.7 days as the holdup time for xenon and 1.67 days for krypton, with the values being imported from FSAR Table 11.3-

1. See staff comments on Table 11.3-1 about holdup times. Update Table 11.2-3 accordingly in light of the resolution of comments generated on this topic for Table 11.3-1.

j. FSAR Table 11.2-3 – The table applies a value of 4100 CFM for the containment internal cleanup rate and 2970 CFM for the containment low volume purge rate. However, these input rates could not be found in FSAR Rev. 1, Section 9.4. Table 12.2-19 provides values of 3210 CFM for the normal operation purge flow rate and 4100 CFM for the equipment area recirculation flow rate, and FSAR Section 6.5.1.3 provides only operational ranges. Provide the basis and justification for the values used in Table 11.2-3.

k. A review of FSAR Rev. 1, Section 11.2.2.1.1 and Table 11.2-4 indicates that the grouping of liquid effluent streams listed in Table 11.2-4 is inconsistent with that of Section 11.2.2.1.1. For example, turbine building floor drain, miscellaneous wastes, and shim bleed waste inputs shown in Table 11.2-4 are not listed in Section 11.2.2.1.1. Similarly, the category of “Misc. Wastes” shown in Table 11-2-4 is not explained as to which waste input streams it includes given the grouping scheme of Section 11.2.2.1.1. Review and revise for consistency the information presented in Section 11.2.2.1.1 and Table 11.2-4. Also, provide in Table 11.2-4 appropriate notations describing how the grouping scheme of Section 11.2.2.1.1 was translated into the one shown in Table 11.2-4.

l. A review of FSAR Rev. 1, Section 11.2.3.5 and Table 11.2-7 indicates that the basis of the adjustment factor applied in estimating releases characterized by maximum fuel defects is not described in Section 11.2.3.5. A review of the results presented in Table 11.2-7 indicates that the scaling factor (max/normal) ranges from 1 to 10^3. For example, the results for corrosion and activation products and tritium are greater than one, which should not be the case since their production is insensitive to the assumed fraction of failed fuel. The scaling factor is presumed to be four, i.e., 1.0% vs 0.25% assumed failed fuel fraction given the information presented in Section 11.1. However, the factors were found to be much higher and variable in many instances. For example, the ratio is 3.8 for H-3, 131 for Mo-99, 1000 for Rh-103m, 69 for Te-129m, 35 for I-131, 1.9 for I-132, 16.7 for I-133, 4.4 for I-135, and 96 for Cs-137, among others. Review and revise the basis of the scaling factor and describe the rationale and application of the scaling factor in FSAR Section 11.2.3.5 and presentation of the results in Table 11.2-7.

Response to Question 11.02-16:

Response to Question 11.02-16(j):

This response supersedes the prior response to 11.02-16(j) provided in the original response to this question on November 5, 2009 because it contains the results of revised calculations. U.S. EPR FSAR Tier 2, Table 11.2-3 contains values of 4100 cfm for the containment internal cleanup rate and 2970 cfm for the containment low volume purge rate. The containment internal cleanup nominal volumetric flow rate is 4120 cfm, and 4100 cfm was conservatively used in the GALE analysis. The containment internal cleanup is for the inner compartment of the two zone containment. The containment low volume exhaust flow rate is 3210 cfm as shown in U.S. EPR FSAR Tier 2, Table 12.2-19. The GALE gaseous analysis incorrectly used the containment low volume purge circuit supply air flow of 2970 cfm instead of the exhaust air flow of 3210 cfm. The gaseous release has been recalculated by the GALE code with the corrected input value for the containment low volume purge exhaust air flow, as shown in Table 11.02-16(j)-1. The resulting dose commitment due to gaseous effluent releases has been revised to reflect this correction and the results are provided in Table 11.02-16(j)-2. The revised results for the annual average gaseous release concentration by nuclide and a comparison with the 10 CFR Part 20 concentration limits are provided in Table 11.02-16(j)-3. U.S. EPR FSAR Tier 2, Table 11.3-3, Table 11.3-5, and Table 11.3-6 will be updated to reflect the revised calculation results.

The change in the containment low flow purge flow rate from 2970 cfm to 3210 cfm results in an insignificant change in the annual gaseous releases from the purge system, with a slight change in the noble gas releases and no change in the total noble gas release of 4.8E+04 curies per year.

FSAR Impact:

U.S EPR FSAR Tier 2, Table 11.3-3, Table 11.3-5, and Table 11.3-6 will be revised as described in the response and indicated on the enclosed markup.

Table 11.02-16(j)-1—Gaseous Release (Ci/yr) Calculated by GALE Code[1]
(2 Sheets)

Nuclide	Gas Stripping (continuous)	Reactor	Auxiliary	Turbine	Air Ejector Exhaust
Kr-85m	0.0E+00	1.5E+02	4.0E+00	0.0E+00	2.0E+00
Kr-85	1.4E+04	1.6E+04	1.4E+02	0.0E+00	6.8E+01
Kr-87	0.0E+00	5.0E+01	4.0E+00	0.0E+00	2.0E+00
Kr-88	0.0E+00	1.8E+02	7.0E+00	0.0E+00	4.0E+00
Xe-131m	4.9E+02	2.8E+03	2.6E+01	0.0E+00	1.2E+01
Xe-133m	0.0E+00	1.9E+02	2.0E+00	0.0E+00	0.0E+00
Xe-133	2.0E+02	8.2E+03	8.0E+01	0.0E+00	3.7E+01
Xe-135m	0.0E+00	1.0E+01	3.0E+00	0.0E+00	2.0E+00
Xe-135	0.0E+00	1.2E+03	2.3E+01	0.0E+00	1.1E+01
Xe-137	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-138	0.0E+00	8.0E+00	3.0E+00	0.0E+00	1.0E+00
Nuclide	**Fuel Building**	**Reactor**	**Auxiliary**	**Turbine**	**Air Ejector Exhaust**
I-131	2.7E-04	1.9E-03	6.6E-03	0.0E+00	0.0E+00
I-133	1.0E-03	5.8E-03	2.5E-02	0.0E+00	0.0E+00
Nuclide	**Waste Gas System**		**Reactor**	**Auxiliary**	**Fuel Handli**
Cr-51	1.4E-07		9.2E-05	3.2E-06	1.8E-06
Mn-54	2.1E-08		5.3E-05	7.8E-07	3.0E-06
Co-57	0.0E+00		8.2E-06	0.0E+00	0.0E+00
Co-58	8.7E-08		2.5E-04	1.9E-05	2.1E-04
Co-60	1.4E-07		2.6E-05	5.1E-06	8.2E-05
Fe-59	1.8E-08		2.7E-05	5.0E-07	0.0E+00
Sr-89	4.4E-07		1.3E-04	7.5E-06	2.1E-05
Sr-90	1.7E-07		5.2E-05	2.9E-06	8.0E-06
Zr-95	4.8E-08		0.0E+00	1.0E-05	3.6E-08
Nb-95	3.7E-08		1.8E-05	3.0E-07	2.4E-05
Ru-103	3.2E-08		1.6E-05	2.3E-07	3.8E-07
Ru-106	2.7E-08		0.0E+00	6.0E-08	6.9E-07

Table 11.02-16(j)-1—Gaseous Release (Ci/yr) Calculated by GALE Code[1]

(2 Sheets)

Nuclide	Waste Gas System	Reactor	Auxiliary	Fuel Handlin
Sb-125	0.0E+00	0.0E+00	3.9E-08	5.7E-07
Cs-134	3.3E-07	2.5E-05	5.4E-06	1.7E-05
Cs-136	5.3E-08	3.2E-05	4.8E-07	0.0E+00
Cs-137	7.7E-07	5.5E-05	7.2E-06	2.7E-05
Ba-140	2.3E-07	0.0E+00	4.0E-06	0.0E+00
Ce-141	2.2E-08	1.3E-05	2.6E-07	4.4E-09
H-3	N/A	N/A	N/A	N/A
C-14	N/A	N/A	N/A	N/A
Ar-41	N/A	N/A	N/A	N/A

Notes:

1. A value of 0.0E+00 in this table indicates that the release is less than 1.0 Ci/yr for noble gases and less thar iodine.

Table 11.02-16(j)-2—Dose Commitment Due to Gaseous Effluent Releases

Type of Dose	U.S. EPR	10 CFR Part 50, Appendix I ALARA Design Objective
Beta Air Dose (mrad/yr)	13.3	20
Gamma Air Dose (mrad/y)	1.65	10
Total Body (mrem/y)	1.05	5
Skin (mrem/y)	9.80	15
Internal Organ (mrem/y)	9.9 (infant thyroid)	15

Table 11.02-16(j)-3—Comparison of Annual Average Gaseous Release Concentrations with 10 CFR Part 20 Concentration Limits

Nuclide	Release Concentration (µCi/ml)[1]		10 CFR Part 20, Appendix B Concentration Limit (µCi/ml)
	Normal Releases	Maximum Fuel Defect	
H-3	2.85E-11	1.14E-10	1.00E-07
C-14	1.16E-12	1.16E-12	3.00E-09
Ar-41	5.39E-12	5.39E-12	1.00E-08
Cr-51	1.54E-17	1.54E-17	3.00E-08
Mn-54	9.04E-18	9.04E-18	1.00E-09
Co-57	1.30E-18	1.30E-18	9.00E-10
Co-58	7.61E-17	7.61E-17	1.00E-09
Co-60	1.74E-17	1.74E-17	5.00E-11
Fe-59	4.44E-18	4.44E-18	5.00E-10
Kr-85m	2.54E-11	7.15E-11	1.00E-07
Kr-85	5.39E-09	4.18E-09	7.00E-07
Kr-87	8.88E-12	1.55E-11	2.00E-08
Kr-88	3.01E-11	8.53E-11	9.00E-09
Sr-89	2.54E-17	2.54E-14	2.00E-10
Sr-90	9.99E-18	9.99E-15	6.00E-12
Zr-95	1.59E-18	1.59E-15	4.00E-10
Nb-95	6.66E-18	6.66E-15	2.00E-09
Ru-103	2.70E-18	2.70E-15	9.00E-10
Ru-106	1.24E-19	1.24E-16	2.00E-11
Sb-125	9.67E-20	9.67E-17	7.00E-10
I-131	1.40E-15	4.99E-14	2.00E-10
I-133	5.07E-15	8.33E-14	1.00E-09
Xe-131m	5.55E-10	5.00E-10	2.00E-06
Xe-133m	3.01E-11	4.50E-10	6.00E-07
Xe-133	1.36E-09	3.45E-08	5.00E-07
Xe-135m	2.38E-12	2.91E-12	4.00E-08
Xe-135	1.90E-10	5.99E-10	7.00E-08
Xe-137	0.00E+00	0.00E+00	1.00E-09
Xe-138	1.90E-12	2.02E-12	2.00E-08
Cs-134	7.61E-18	7.61E-15	2.00E-10
Cs-136	5.23E-18	5.23E-15	9.00E-10
Cs-137	1.43E-17	1.43E-14	2.00E-10
Ba-140	6.66E-19	6.66E-16	2.00E-09
Ce-141	2.06E-18	2.06E-15	8.00E-10

Notes:

1. Release concentrations based on X/Q = 5.0E-06 s/m^3.

U.S. EPR Final Safety Analysis Report Markups

Table 11.3-3—Gaseous Release (Ci/yr) Calculated by GALE Code[1]
Sheet 1 of 2

Nuclide	Gas Stripping (continuous)	Reactor	Auxiliary	Turbine	Air Ejecto Exhaust
Kr-85m	0.0E+00	~~1.4E+02~~1.5E+02	4.0E+00	0.0E+00	2.0E+00
Kr-85	1.4E+04	1.6E+04	1.4E+02	0.0E+00	6.8E+01
Kr-87	0.0E+00	~~4.7E+01~~5.0E+01	4.0E+00	0.0E+00	2.0E+00
Kr-88	0.0E+00	~~1.7E+02~~1.8E+02	7.0E+00	0.0E+00	4.0E+00
Xe-131m	4.9E+02	2.8E+03	2.6E+01	0.0E+00	1.2E+01
Xe-133m	0.0E+00	~~1.8E+02~~1.9E+02	2.0E+00	0.0E+00	0.0E+00
Xe-133	2.0E+02	8.2E+03	8.0E+01	0.0E+00	3.7E+01
Xe-135m	0.0E+00	~~9.0E+00~~1.0E+01	3.0E+00	0.0E+00	2.0E+00
Xe-135	0.0E+00	1.2E+03	2.3E+01	0.0E+00	1.1E+01
Xe-137	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-138	0.0E+00	8.0E+00	3.0E+00	0.0E+00	1.0E+00

Nuclide	Fuel Building	Reactor	Auxiliary	Turbine	Air Ejecto Exhaust
I-131	2.7E-04	1.9E-03	6.6E-03	0.0E+00	0.0E+00
I-133	1.0E-03	5.8E-03	2.5E-02	0.0E+00	0.0E+00

Nuclide	Waste Gas System	Reactor	Auxiliary	Fuel Handl
Cr-51	1.4E-07	9.2E-05	3.2E-06	1.8E-06
Mn-54	2.1E-08	5.3E-05	7.8E-07	3.0E-06

Table 11.3-5—Dose Commitment Due to Gaseous Effluent Releases

Type of Dose	U.S. EPR	10 CFR Part 50, Appendix I ALARA Design Objective
Beta Air Dose (mrad/yr)	13.3	20
Gamma Air Dose (mrad/y)	~~1.62~~1.65	10
Total Body (mrem/y)	~~1.03~~1.05	5
Skin (mrem/y)	~~9.76~~9.80	15
Internal Organ (mrem/y)	9.9 (infant thyroid)	15

11.02-16(j)

Table 11.3-6—Comparison of Annual Average Gaseous Release Concentrations with 10 CFR Part 20 Concentration Limits

Nuclide	Release Concentration (µCi/ml)[1]		10 CFR Part 20, Appendix B Concentration Limit (µCi/ml)
	Normal Releases	Maximum Fuel Defect	
H-3	2.85E-11	1.14E-10	1.00E-07
C-14	1.16E-12	1.16E-12	3.00E-09
Ar-41	5.39E-12	5.39E-12	1.00E-08
Cr-51	1.54E-17	1.54E-17	3.00E-08
Mn-54	9.04E-18	9.04E-18	1.00E-09
Co-57	1.30E-18	1.30E-18	9.00E-10
Co-58	7.61E-17	7.61E-17 11.02-16(j)	1.00E-09
Co-60	1.74E-17	1.74E-17	5.00E-11
Fe-59	4.44E-18	4.44E-18	5.00E-10
Kr-85m	~~2.38E-11~~2.54E-11	~~6.71E-11~~7.15E-11	1.00E-07
Kr-85	5.39E-09	4.18E-09	7.00E-07
Kr-87	~~8.40E-12~~8.88E-12	~~1.47E-11~~1.55E-11	2.00E-08
Kr-88	~~2.85E-11~~3.01E-11	~~8.08E-11~~8.53E-11	9.00E-09
Sr-89	2.54E-17	2.54E-14	2.00E-10
Sr-90	9.99E-18	9.99E-15	6.00E-12
Zr-95	1.59E-18	1.59E-15	4.00E-10
Nb-95	6.66E-18	6.66E-15	2.00E-09
Ru-103	2.70E-18	2.70E-15	9.00E-10
Ru-106	1.24E-19	1.24E-16	2.00E-11
Sb-125	9.67E-20	9.67E-17	7.00E-10
I-131	1.40E-15	4.99E-14	2.00E-10
I-133	5.07E-15	8.33E-14	1.00E-09
Xe-131m	5.55E-10	5.00E-10	2.00E-06
Xe-133m	~~2.85E-11~~3.01E-11	~~4.26E-10~~4.50E-10	6.00E-07
Xe-133	1.36E-09	3.45E-08	5.00E-07
Xe-135m	~~2.22E-12~~2.38E-12	~~2.72E-12~~2.91E-12	4.00E-08
Xe-135	1.90E-10	5.99E-10	7.00E-08
Xe-137	0.00E+00	0.00E+00	1.00E-09
Xe-138	1.90E-12	2.02E-12	2.00E-08
Cs-134	7.61E-18	7.61E-15	2.00E-10
Cs-136	5.23E-18	5.23E-15	9.00E-10
Cs-137	1.43E-17	1.43E-14	2.00E-10
Ba-140	6.66E-19	6.66E-16	2.00E-09
Ce-141	2.06E-18	2.06E-15	8.00E-10