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12 January 2017

US Nuclear Regulatory Commission
Document Control Desk
Washington, DC

Re: Technical Specifications Amendment
License No. R-120
Docket No. 50-297

Attached please find the response to the Request for Additional Information (RAI) from 1 March 2016 (Accession no. ML 13085A400 TAC No. MF5778). As a result of the RAI responses, the amendment and the supporting analysis have been revised and are enclosed.

If you have questions regarding this amendment or require additional information, please contact Gerald Wicks at 919-515-4601 or wicks@ncsu.edu .

I declare under penalty of perjury that the forgoing is true and correct. Executed on 12 January 2017.

Sincerely,

Ayman Hawari

Ayman I. Hawari, Ph.D.
Director, Nuclear Reactor Program
North Carolina State University

Enclosures: Response to Request for Additional Information
R-120 License Change
Technical Specification Amendment 19
Attachment 1: Fueled Experiment Analysis

cc: Duane Hardesty, US NRC

Summary

An amendment to the Technical Specifications (TS) is requested regarding TS 3.8 for fueled experiments. TS 3.8 regarding fueled experiments has been modified for conducting experiments using several specific fissionable materials. Radiation doses from an experiment failure are calculated to be 10 percent or less of the applicable limits given in 10 CFR Part 20. The amount of fissionable allowed by the license and the experiment are calculated to be within the activity limits given in Category 2 in 10 CFR Part 37.

Up to 10 percent of the applicable radiation dose limits is used as a limit based on regulatory requirements for monitoring of occupational personnel and reporting of radiation doses in excess of the constraint dose for members of the public. This limitation meets guidance given in Regulatory Guide 2.2 "Development of Technical Specifications for Experiments in Research Reactors". TS definition 1.2.24b states that reportable events include a release of radioactivity from the site above allowed limits. The limit of 10 percent of the annual public dose is below the radiation dose associated with the "Notification of Unusual Event" emergency declaration. Therefore, failure of a fueled experiment would not require an emergency declaration or result in a reportable event.

Revision of TS 3.8 was based on the analysis provided in Attachment 1. Attachment 1 provides details on the use, production, and release of radioactive material from several specific fissionable materials in a fueled experiment. Release of radioactive materials into the reactor building air space and subsequent venting to the environment are analyzed for radiation dose from inhalation and submersion dose pathways to occupants inside the reactor building and in public areas outside the reactor building. Continuous irradiation times up to 1 year followed by decay times up to 1 year were evaluated. Removal of fissionable material and ingrowth of other fissionable material were accounted for in Attachment 1.

To allow fueled experiments to be conducted, changes are proposed to the facility license conditions for possession of fissionable material. Potential radiation dose from a fueled experiment failure is related to the mass, fluence rate, and time used. Mass limits listed for fluence rates at specific times are given in TS 3.8 and shall not be exceed. If a mixture of fissionable materials is present, then the sum of the fractions of the masses to the respective limits for the planned fluence rate and time may not exceed a value of one. Possession limits are based on being within 10 CFR Part 37 Category 2 limits. Limits for radionuclides listed in 10 CFR Part 37 Category 2 are not exceeded and the facility security plan is not revised. The definition of fueled experiments is changed in TS based on the mass of fissionable materials that are consistent with not exceeding the public constraint dose or use of self-encapsulated items.

TS 3.8 as proposed meets 10 CFR Part 20, other TS requirements on experiments, the facility emergency plan and security plan. Conditions do not exceed those for a reportable event, emergency action level, or Category 2 limits given in 10 CFR Part 37.

RAI Question 1:

The requested amendment to the NCSU License (ADAMS Accession No. ML13085A400) requests changes to the technical specifications (TSs) for conducting experiments using any fissionable material. NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the licensing of Non-Power Reactors, Format and Content," Part 1,Section 9.5, "Possession and Use of Byproduct, Source, and Special Nuclear Material," provides guidance that licensees should "clearly state the materials and areas of the facility requested to be authorized by the reactor license. The reactor license and TSs also will include regulatory conditions that apply to the management of such materials." The LAR does not provide any additional information related to the request regarding the types or quantities of additional materials regarding the receipt, storage, or use of these additional materials. Provide responses for the following:

a. Describe any reviews and assessments of the NCSU licensed possession limits for the reactor license and indicate if the current possession limits and license conditions are adequate for the scope of the NCSU LAR, propose needed changes to the possession limits, or justify why no review is needed.

b. Provide a description, which includes all of the additional licensed materials (as referenced in the NCSU LAR), the locations where the listed materials are to be stored or used, or justify why no description is needed.

c. Discuss how radiation protection and any material control or security requirements will be met for the planned materials to be stored and used. Any information related to security requirements should be submitted in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 73.21, "Protection of Safeguards Information: Performance Requirements."

d. Describe any reviews and assessments of the NCSU facility broad scope license and reactor license and indicate if any additional license conditions need to be modified or incorporated within the scope of the NCSU Reactor License, R-120, or justify why no review is needed.

RAI Question 1 Response:

a. Possession limits for fissionable materials that may be used in fueled experiments have been analyzed in Attachment 1 Section E. The possession limits listed are based on keeping the total inventory below those given in 10 CFR Part 37 for Category 2 quantities of concern.

   The fissionable material and associated fission product inventory were evaluated in determining the possession limits. Possession quantities listed are also based on anticipated experimental needs. Since inventory may vary over time, the sum of the ratios of the amount of material possessed to the respective limit given shall not exceed a value of one.

b. Storage shall be within the reactor building controlled access area in a facility that meets requirements given in TS 5.3, 10 CFR Part 20, and the facility Security Plan and Radiation Protection Program. Prior NRC approval is required if a license amendment is needed for changes to the facility license or result in a decrease of effectiveness of the security or emergency plan.

   TS 3.8 requires a documented review for the experiment, including storage. Reviews of experiments and associated changes, such as storage facilities or experimental facilities or facility structures, are documented using facility procedures to meet 10 CFR Part 50.59, 10 CFR Part 50.54, the facility security plan, emergency plan, and radiation protection program. These reviews require approval by the Reactor Safety and Audit Committee. License amendments and changes affecting radioactive releases are additionally approved by the NCSU Radiation Safety Committee. The review process given in TS 6.2.3 is followed for any changes made.

c. The security plan, emergency plan, and radiation protection program requirements have to be reviewed and met. All facility changes, such as experiments, storage or handling facilities, design changes, experiments, and procedure changes, are documented and reviewed and approved by the Reactor Safety and Audit Committee.

   License amendments and changes affecting radioactive releases are additionally reviewed and approved by the NCSU Radiation Safety Committee. The review process given in TS 6.2.3 is followed for any changes made. Materials for fueled experiments are to be stored within the facility controlled access area as defined in the facility security plan. The radiation protection program limits access, use, storage, disposal, and radiation levels from materials.

d. Changes for possession limits of materials to be used in fueled experiments are proposed based on the analysis given in Attachment 1 Section E. The changes proposed to the R-120 facility license keep the materials in possession within 10 CFR Part 37 Category 2 activity limits and therefore no revision of the facility security plan is required.

RAI Question 2.

The following questions pertain to the "Assumptions and Data Sources" section on (page 3), of Attachment 1 to the NCSU LAR:

a. The seventh assumption in the list states "Initially pure fissionable material is exposed, i.e., there is no initial inventory of fission products." Are all fueled experiments performed at the NCSU done so with initially pure fissionable material? Provide additional information/explanation for why fueled experiments, using previously irradiated material, were not considered for the accident analysis scenario for fueled experiments. Alternatively, provide a technical specification that limits fueled experiments to initially pure fissionable material.

b. The eighth assumption states "Exposure times to personnel in the reactor building and to the public are estimated as 0.25 h and 24 h, respectively based on evacuation time from the reactor building and reactor building exhaust rates in the confinement mode." This assumption forms the basis for the accident analysis dose calculation and subsequent limiting fission rates.
   i. Provide documentation regarding the evacuation times at the NCSU reactor for personnel.
   ii. Provide documentation regarding the reactor building exhaust rates in the confinement mode.

c. The fourteenth assumption in the list states "Buildup and fissions of transuranics is neglected," and assumption 15 states "Depletion by transmutation of fission products and fissionable materials (i.e., burnup) is neglected." Irradiation of a fueled experiment will result in higher dose calculation results when accounting for burned up material in the experiment. This may lead to a situation in which the limiting fission yields calculated for the accident analysis calculations actually varies as a function of operating time/burnup. Provide additional information/basis for why buildup of the fission products and transuranics in the fueled experiment was not considered in the accident analysis dose calculations. For example, plutonium produced in the irradiation of U-238 and U-232 produced in the irradiation of thorium.

RAI Question 2 Response:

2.a. The analysis made in Attachment 1 applies to initial quantities of materials present, e.g. fissionable material and those that buildup from decay prior to being used in an experiment and those that are produced by the experiment are included. Each fissionable material present is evaluated separately in Attachment 1, e.g. U-235, U-238, U-234, etc.

Mass limits determined for each are based on radiation dose from all radioactive materials present from a given fissionable material are determined in Attachment 1. From these results, mixtures of materials are addressed by limiting the sum of the ratios of the experimental mass to the respective calculated mass limit for all fissionable materials initially present to a value of one. Additionally, the possession limits shall not be exceeded in any fueled experiment. Attachment 1 Sections B, D,E,G, and H provide details. Examples are provided in Attachment 1 Section I.

2.b.i. Evacuation times from the reactor building were measured and estimated by calculation as described in Attachment 1 Section C. Time to evacuate the reactor building was measured for several individuals from several locations following initiation of the evacuation alarm. The exposure time was then increased to account for detector response and operator action, e.g. announcing an evacuation as needed.

The public exposure time is associated with complete venting of the reactor building since 24 hours provides more than 10 air changes in confinement mode. No emergency action level is anticipated or expected as determined by the analysis made and therefore public evacuation is not required.

Prior to receiving the evacuation alarm, the radiation monitoring system provides annunciation at a lower radiation and radioactivity level. This alerts the reactor operator and requires notification to be made to the Designated Senior Reactor Operator (DSRO) and Reactor Health Physicist (RHP) as stated in facility procedures. If the release is increasing slowly, the reactor staff may have time to respond and either halt or reduce the release. Either the DSRO or RHP may order evacuation or reactor shutdown in such an event.

2.b.ii. Reactor building exhaust rates are continuously monitored by differential pressure (dP). In the confinement mode used for fueled experiments, a dP of 0.1 inches of water is maintained.

The dP and flow rate in confinement mode is measured to be within specifications annually using facility surveillance procedures. Additionally, every week the reactor is operated the confinement dP is checked using the reactor start-up checklist and operating procedures.

In confinement, any loss of dP for situations other than opening of doors or indication that the confinement fan is off would not meet conditions for reactor operation and the reactor would be shutdown.

2.c. Transmutation of fissionable materials is now included in Attachment 1. The assumption and condition made for irradiation in this analysis is that the fissionable material was chemical pure at some time within the previous 50 years. If not, then fissionable materials is treated as a mixture. For mixtures, the sum of the mass to mass limits must be less than one.

Pu-239 and U-232 may arise from other fissionable materials either by decay or activation. These were included in the analysis made in Attachment 1. The activation reaction used was (n,γ).

U-238 with production of Pu-239 is included with the U-238 analysis. U-232 production in included with the analysis of Pa-231. Details are given in Attachment 1 Sections B, G, and H for several materials.

Pu-239 production from the activation of U-238 with subsequent decay by U-239 and Np-239 is calculated. The amount of U-238 and Pu-239 present after a given irradiation time are used to calculate radiation doses. Total dose for all radionuclides are calculated to determine the limiting mass.

In the case of Th/U-232, it is noted that the process leading to U-232 production comes from many possible series of activation and decay. Mass limits are established for Th-232, Pa-231, U-233, and U-234 in Attachment 1.

U-232 from U-233 pathway is given an as example :

- U-233 has a mass limit for 1 year of irradiation at 1E-3 g
- 1 g of U-233 produces 2.2E-4 g of Th-229 by decay after 50 years
- 1 g of Th-229 activates to 3.92E-1 g of Th-230 after 1 year of irradiation
- 1 g of Th-230 activates to Th-231 and decays to produce 1.13E-3 g of Pa-231
- 1 g of Pa-231 activates to Pa-232 and decays to produce 1.86E-1 g of U-232

This gives the following mass for U-232:

1.8E-11 g = (1E-3)(2.2E-4)(0.392)(1.13E-3)(0.186) g

Following the mass limits given in the TS 3.8 Table 3.8-1 and Attachment 1, the following amount of U-232 is conservatively estimated as follows:

Nuclide	Mass, g		Nuclide	Mass, g
U233	9.0E-04		Th232	3.3E-02
Th229	2.0E-07		U233	8.0E-04
Th230	7.7E-08		Th229	1.7E-07
Pa231	8.7E-11		Th230	6.9E-08
U232	1.6E-11		Pa231	7.7E-09
			U232	1.4E-09
U234	8.8E-03		U234	8.8E-03
Th230	1.2E-06		U235	1.8E-03
Pa231	1.4E-09		Pa231	8.6E-11
U232	2.6E-10		U232	1.6E-11
U235	1.8E-03		U233	9.00E-04
Pa231	8.8E-11		U234	3.9E-04
U232	1.6E-11		Th230	5.5E-08
			Pa231	6.2E-11
U233	9.0E-04		U232	1.2E-11
U234	3.9E-04			
U235	7.9E-05		Th232	3.3E-02
Pa231	3.9E-12		Pa231	1.1E-12
U232	7.2E-13		U232	2.0E-13

The Th232(n,2n)Th231 reaction was also evaluated. Details are as follows:

- Th-232 mass is limited to 0.033 g for 1 year of irradiation at the peak experimental fluence rate. Maximum fissions occur at the peak fluence rate. The fission rate is 6.6E7 f/s.
- The threshold for the reaction is at approximately 6.75 MeV and a peak cross section of approximately 2 barns at 12 MeV. Average cross section is estimated as 1 barn from 6.75 to 14 MeV.
- From prompt neutron fission spectra, the yield is 0.04 neutrons per fission from 6.75 to 14 MeV using calculated distributions of fission neutrons.
- This gives a reaction rate of 2.2E2 per second: (6.6E7f/s)(0.04n/f)(1E-24cm2)(0.033g/232g*6.022E23atoms)
- From the Th-232 analysis, maximum Pa-231 activation by the (n,2n) reaction would occur with 1 year of irradiation. The estimated mass of Pa-231 produced is approximately 1E-12 g of Pa-231.
- Production of U-232 is estimated as being 2E-13 g following methods used in this analysis for the activation of Pa-231 to Pa-232 with decay to U-232.

For U-232, the mass limit is 1E-4 g. All pathways leading to U-232 are well below 1E-4 g.

Data for Th232(n,2n)Th231 taken from the National Nuclear Data Center. Data from "Sigma Plot" was retrieved as follows:

MeV	b
6.80E+00	7.70E-02
7.00E+00	2.50E-01
7.25E+00	5.50E-01
7.50E+00	8.50E-01
7.75E+00	1.15E+00
8.00E+00	1.38E+00
8.50E+00	1.73E+00
9.00E+00	1.94E+00
9.50E+00	2.06E+00
1.00E+01	2.18E+00
1.05E+01	2.16E+00
1.10E+01	2.22E+00
1.18E+01	2.22E+00
1.20E+01	2.23E+00
1.22E+01	2.22E+00
1.26E+01	2.17E+00
1.30E+01	2.06E+00
1.36E+01	1.77E+00
1.41E+01	1.49E+00

Fission neutron spectra from the Engineering Compendium on Radiation Shielding Volume I, International Atomic Energy Agency, R. Jaeger et al ed, Springer-Verlag pub, 1968:

Prompt Fission Neutron Spectrum									
dE (Mev)=	**Watt Eqn**		**Cranberg Eqn**				**Maxwellian Eqn**		
0.25	**Fraction**				**Fraction**			**Fraction**	
E (MeV)	**per Interval**	**N(E)dE**	**[kE]-1/2**	**X(E)**	**per Interval**	**N(E)dE**	**X(E)**	**per Interval**	**N(E)dE**
6.75			3.93E+00	1.06E-02	2.69E-03	6.54E-03	1.07E-02	2.72E-03	6.62E-03
7	5.31E-03	1.29E-02	4.00E+00	8.77E-03	2.23E-03	5.42E-03	8.96E-03	2.29E-03	5.55E-03
7.25			4.07E+00	7.27E-03	1.85E-03	4.49E-03	7.51E-03	1.92E-03	4.66E-03
7.5	3.66E-03	8.89E-03	4.14E+00	6.01E-03	1.53E-03	3.72E-03	6.30E-03	1.61E-03	3.90E-03
7.75			4.21E+00	4.97E-03	1.26E-03	3.07E-03	5.27E-03	1.34E-03	3.27E-03
8	2.50E-03	6.08E-03	4.28E+00	4.10E-03	1.04E-03	2.54E-03	4.41E-03	1.13E-03	2.73E-03
8.25			4.35E+00	3.38E-03	8.61E-04	2.09E-03	3.69E-03	9.42E-04	2.29E-03
8.5	1.70E-03	4.13E-03	4.41E+00	2.79E-03	7.10E-04	1.72E-03	3.09E-03	7.87E-04	1.91E-03
8.75			4.48E+00	2.30E-03	5.84E-04	1.42E-03	2.58E-03	6.58E-04	1.60E-03
9	1.16E-03	2.81E-03	4.54E+00	1.89E-03	4.80E-04	1.17E-03	2.16E-03	5.50E-04	1.34E-03
9.25			4.60E+00	1.55E-03	3.95E-04	9.59E-04	1.80E-03	4.59E-04	1.12E-03
9.5	7.81E-04	1.90E-03	4.66E+00	1.27E-03	3.24E-04	7.87E-04	1.50E-03	3.83E-04	9.32E-04
9.75			4.73E+00	1.04E-03	2.66E-04	6.46E-04	1.25E-03	3.20E-04	7.78E-04
10	5.25E-04	1.28E-03	4.79E+00	8.56E-04	2.18E-04	5.29E-04	1.05E-03	2.67E-04	6.49E-04
10.25			4.84E+00	7.01E-04	1.78E-04	4.34E-04	8.73E-04	2.23E-04	5.41E-04
10.5	3.53E-04	8.58E-04	4.90E+00	5.74E-04	1.46E-04	3.55E-04	7.28E-04	1.86E-04	4.51E-04
10.75			4.96E+00	4.69E-04	1.19E-04	2.90E-04	6.07E-04	1.55E-04	3.76E-04
11	2.36E-04	5.74E-04	5.02E+00	3.84E-04	9.76E-05	2.37E-04	5.06E-04	1.29E-04	3.13E-04
11.25			5.08E+00	3.13E-04	7.97E-05	1.94E-04	4.21E-04	1.07E-04	2.61E-04
11.5	1.58E-04	3.83E-04	5.13E+00	2.56E-04	6.51E-05	1.58E-04	3.51E-04	8.95E-05	2.17E-04
11.75			5.19E+00	2.09E-04	5.31E-05	1.29E-04	2.92E-04	7.45E-05	1.81E-04
12	1.05E-04	2.55E-04	5.24E+00	1.70E-04	4.33E-05	1.05E-04	2.43E-04	6.20E-05	1.51E-04
12.25			5.30E+00	1.39E-04	3.53E-05	8.57E-05	2.03E-04	5.16E-05	1.25E-04
12.5			5.35E+00	1.13E-04	2.87E-05	6.98E-05	1.69E-04	4.30E-05	1.04E-04
12.75			5.40E+00	9.19E-05	2.34E-05	5.68E-05	1.40E-04	3.58E-05	8.69E-05
13	1.16E-04	2.82E-04	5.46E+00	7.48E-05	1.90E-05	4.62E-05	1.17E-04	2.97E-05	7.23E-05
13.25			5.51E+00	6.08E-05	1.55E-05	3.76E-05	9.70E-05	2.47E-05	6.01E-05
13.5			5.56E+00	4.94E-05	1.26E-05	3.06E-05	8.07E-05	2.06E-05	5.00E-05
13.75			5.61E+00	4.01E-05	1.02E-05	2.48E-05	6.71E-05	1.71E-05	4.16E-05
14	5.09E-05	1.24E-04	5.66E+00	3.26E-05	8.29E-06	2.02E-05	5.58E-05	1.42E-05	3.46E-05
Total =		4.05E-02				3.08E-02			3.38E-02

Average cross section = $\Sigma N(E)dE * \sigma / \Sigma N(E)dE = 0.04 / 0.039$ or 1.0 barn

	(n, 2n)		
MeV	b	N[E]dE	N[E]dE*b
6.80E+00	7.70E-02	6.6E-03	5.1E-04
7.00E+00	2.50E-01	5.5E-03	1.4E-03
7.25E+00	5.50E-01	4.6E-03	2.5E-03
7.50E+00	8.50E-01	3.8E-03	3.2E-03
7.75E+00	1.15E+00	3.2E-03	3.6E-03
8.00E+00	1.38E+00	2.6E-03	3.6E-03
8.50E+00	1.73E+00	4.0E-03	6.9E-03
9.00E+00	1.94E+00	2.8E-03	5.4E-03
9.50E+00	2.06E+00	1.9E-03	3.9E-03
1.00E+01	2.18E+00	1.3E-03	2.8E-03
1.05E+01	2.16E+00	8.9E-04	1.9E-03
1.10E+01	2.22E+00	6.1E-04	1.4E-03
1.18E+01	2.22E+00	4.2E-04	9.2E-04
1.20E+01	2.23E+00	2.8E-04	6.3E-04
1.22E+01	2.22E+00	1.1E-04	2.3E-04
1.26E+01	2.17E+00	1.9E-04	4.2E-04
1.30E+01	2.06E+00	1.3E-04	2.7E-04
1.36E+01	1.77E+00	8.9E-05	1.6E-04
1.41E+01	1.49E+00	6.1E-05	9.0E-05
	Sum =	3.9E-02	4.0E-02
	Ave b =	1.0E+00	

RAI Question 3:

The "Source Term" section of Attachment 1 to the NCSU LAR provides equations for Ni0, Nn(t), and N2(t) (page 7). Provide a reference for the equations listed on page 7 of Attachment 1.

RAI Question 3 Response:

Equations given in references 1 and 2 were used in Attachment 1 for the terminology and conditions of the fueled experiment to give Ni(0), Nn(t), and N2(t). The equations were re-written for clarification and indicate that references1 and 2 were used.

RAI Question 4:

The following questions pertain to possible typographical errors in the "Source Term" section of Attachment 1 to the NCSU LAR.

a. On page 7, in equation Nn(t) should the symbol "pi" be replaced on the denominator of the summation of the Production Pi (1-e-kjt) term with a Product symbol (Π) (kp-kj). Explain whether this was an editing error, or if it affects the calculated results.

b. On page 9 see equation N4(t) and note that a "+" may be missing at the end of the 2nd decay product, k2. Explain whether this was an editing error, or affects the calculated results.

c. On page 9, 7th line of equation, N4(t), the first term of P2B2k2B3mK3mB3k3[…] equation may have a mistake in the denominator. Should the "k1" located in the denominator of the 1st equation be changed to "k2?" Explain whether this was an editing error, or affects the calculated results.

RAI Question 4 Response:

Typographic errors were made and are corrected. These equations were typed incorrectly and were not copied or imported from the spreadsheet calculation. The spreadsheet equations were checked to be correct. Comparison of the calculated atom population was made to the program "Nuclear Analysis" for several nuclides with general agreement. The comparison is documented in Attachment 1 Section J.

RAI Question 5:

The "Source Term" section of Attachment 1 to the NCSU LAR provides equations for N3(t) and N4(t) (page 9 and page 10 respectively). Provide additional information regarding the solutions to the decay chain equations (e.g., N3(t) and N4(t)). If taken from a reference, provide the reference.

RAI Question 5 Response:

Equations for N3(t) and N4(t) were given as examples of the solution for the equation for Nn(t). In Attachment 1 Section B, the equation for N3(t) was removed since the equation for N4(t) adequately serves as an example to solution for Nn(t). The equation for N4(t) was re-written with additional information provided to clarify which decay paths are included. It is noted that redundant paths are excluded to avoid accounting for the same pathway more than once.

RAI Question 6:

The "Source Term" section of Attachment 1 to the NCSU LAR (page 14), states "Values of N for fission product decay chains for atomic masses from A = 66 to A =167 from the thermal and fast fission of various materials were determined as described above. The number of radionuclides evaluated was approximately 500." Provide a basis for the fission products that were analyzed in Attachment 1 including supporting analyses and references.

RAI Question 6 Response:

A correction is made to dose calculations using the symbol "Z" for missing fission yields data. This is explained in Attachment 1 Section B on fission yield data and Section D on dose assessment. Correction for the dose from fission products is made if the sum of the fission yield is less than 2 as follows:

$D_{reference}$ = f Z (Time-Integrated Exposure) (DCF)

where, $Z = 2 / \Sigma Y$ with ΣY = sum of the fission yields for each fission product
$f = 0.1$ for noble gas fission products inside the reactor building
$f = 1$ for noble gas fission products outside the reactor building
$f = 1$ for all other radionuclides
$D_{reference}$ is the dose calculated for the reference mass and fluence rate

Fission product yields atomic masses from 66 to 167 were analyzed. The number of radionuclides evaluated was approximately 500. The fission yields analyzed ranged from 1.86 to 1.91, with an average of 1.89 per fission. The calculated dose is increased by a factor of $(2 / \Sigma Yi)$ to account for missing fission products; e.g. $Z = 2/1.89 = 1.058$.

The dose from missing fission products is assumed to give a similar dose as those were analyzed and therefore assumes an average dose for the missing fission products is applicable. Z is applied only to fission product activity and dose calculations.

RAI Question 7:

The "RELEASED (Dispersed) ACTIVITY" section of Attachment 1 to the NCSU LAR (page 20), states "Activity at end of time of production, A(t), is given by: $A(t) = \lambda N(t)$, where, t = time of production Decayed Activity, $A(t + T)$ is given by: $A(t + T) = \lambda N(t + T)$." Provide units for the activity and the delayed activity equations on page 20.

RAI Question 7 Response:

> Activity as used has generic units for radioactive decay rate. In Attachment 1 Section C, "dps" units were added as calculated with a decay constant in s^{-1} and N in atoms. dps units are converted to other activity units, e.g. uCi, as necessary.

RAI Question 8:

The "External Dose Rates" section of Attachment 1 to the NCSU LAR (page 23), states "External dose rates from gamma radiation release from fissionable materials is a function of mass, fluence rate, and time. For radiological control purposes, external dose rates from gamma radiation is limited by facility procedures consistent with experimental limitations and conditions and 10 CFR 20 requirements including ALARA practices." Provide additional supporting analyses, procedures, and data to provide a more defensible basis for why external dose rates from gamma radiation are ignored. The use of all types of fissionable materials in the reactor during planned experiments may result in varied source terms of gamma radiation that may not have been accounted for in the existing shielding analysis. Provide additional analysis/basis for the external dose rates. Also, address non-gamma dose rates from fueled experiments, including radon released from uranium and thorium.

RAI Question 8 Response:

> External dose rates and other experiment hazards are controlled by several programs, procedures, and TS. Refer to Attachment 1 Section D and the answer for RAI 2a.
>
> A simple, conservative evaluation of the external dose rates inside the reactor pool is made in Attachment 1 Section D. This analysis indicates external dose rates originating from within the reactor pool are negligible. External dose rates are controlled by other programs and processes; e.g. shielding, access control, experiment restrictions that are included in the experiment review process.
>
> The objective of TS 3.8 states "The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure."
> In addition to TS 3.8, other applicable controls are observed for any operation or experiment conducted at the reactor facility. TS 3.8 is not all inclusive. Adherence to all applicable controls is required.

A radiation authorization/protocol approved by the NCSU Radiation Safety Committee and procedures approved by the Reactor Safety and Audit Committee are used in all experiments and include radiation safety requirements. TS 3.7, 6.2, 6.4 and 6.5 all apply for any experiment at the reactor facility. These TS state the need to have approved experiment controls, health physics procedures, that the reactor facility and NCSU campus radiation protection programs are to be met.

All materials, including fissionable materials, decay products (including radon and thoron), activation products present and other material used in the experiment have to be known and assessed to comply with TS 3.7. TS 3.8 states TS 3.7 applies. Activity and dose rate estimates, activity releases, materials used, irradiation conditions, and other details for every experiment are required for the review to be conducted per TS 6.5 and facility procedures and as described in TS 6.2. TS 3.8 requires a documented review.

Dose rates are reviewed, controlled, and managed by the limitations and conditions established by these reviews and approved procedures. If an experiment of any type produces a high radiation area, then appropriate controls are established controlling access. Radiation monitoring using fixed and portable instruments are used as stated in the TS and facility procedures. Radiation shielding is added as necessary for experimental conditions, e.g. radiation beams, to reduce radiation levels in occupied areas following applicable programs and procedures. Reviews are performed under 10 CFR Part 50.59 as necessary to determine if the proposed change is consistent with the FSAR or requires a license amendment.

Attachment 1 includes analysis radiation hazards from fissionable materials and associated decay and activation products, e.g. bone surface dose and effective dose-equivalent, in the determination of experiment limits should a release occur.

RAI Question 9:

The "Experiment Limits" section of Attachment 1 to the NCSU LAR (page 24), provides a chart for the calculated dry and wet sample limiting fission rates versus irradiation time in black and white with similar types of symbols representing each data series. It is difficult to differentiate between the data series. Use a different symbol for the "All others" series of data in the calculated dry and wet sample limiting fission rates versus irradiation time in the graph or provide a colored graph.

RAI Question 9 Response:

A table is used rather than a graph. The table provides specific mass limits for a given fissionable material at specific times which are used to determine if a fueled experiment is allowed. Interpolation of data on the table is used for times not listed as the mass limits are reasonably close. Tabular data is now used since the dose from fissionable materials is included and the dose, especially bone surface dose, varies significantly with the fissionable material being evaluated. As a result, a generic curve cannot be used for all fissionable materials as it was for the fission product dose alone.

RAI Question 10:

The "Mass Limits" section of Attachment 1 to the NCSU LAR (page 26), states "For an incident uniform neutron fluence rate, the mass of the target may be determined from the limiting fission rate as follows:" Provide the value for the uniform fluence rate selected for the postulated accident analyses and a basis for the value selected.

RAI Question 10 Response:

> Fission rates are no longer used as a limit. Mass limits are derived from a reference mass and fluence rate at a specific time. Total dose from all irradiated materials and the design dose limits are used to determine the mass limits. The reference mass was1 g and is typical for experiments. The peak fluence rate for experiment facilities is approximately 1E13 $cm^{-2}s^{-1}$.
>
> The effect of fluence rate on the mass of fissionable material was evaluated to determine if target burnup would decrease or increase the reference dose. Dose from fissionable material is related to mass and the mass of fissionable material is dependent on fluence; as fluence increases the target mass decreases. Fission and activation product activity and dose increase or decrease with the mass and fluence rate proportionately. Fission and activation products are included in dose calculations with the dose from fissionable material based on the mass and fluence rate for specified irradiation times. For fluence rates less than 1 E10 $cm^{-2}s^{-1}$, the effect on mass limits for the experiments was negligible.

RAI Question 11:

The "Energy Release" section of Attachment 1 to the NCSU LAR (page 27), states "The energy release rate (RE) is calculated as follows:

> RE = (200 MeV per fission)($\sigma\varphi N$) in MeV per second
> RE = (200 MeV per fission)($\sigma\varphi N$) (1 watt / 6.243 E12 MeV per s), in watts
> Total energy release in Joules, J = (RE in watts)(Irradiation time in seconds)."

Provide additional information regarding the calculation of the energy release rate (RE) such as the units for the fission rate (assumed to be fissions/sec). In addition, discuss whether the conversion from MeV/sec should be changed to show that 1 W-s = 6.243E12 MeV.

RAI Question 11 Response:

> The energy release calculation was deleted since it was used as a reference to prior analysis. It is not currently and is not proposed for use as limit. If used, it is noted that 1 Watt-s = 6.243E12 MeV is equivalent to 1 Watt = 6.243E13 MeV/s. Fission rate is in fissions per second.

RAI Question 12:

The "Example Calculations" section of Attachment 1 to the NCSU LAR (page 30), states "N(t) evaluated at a production time, t, of 1.73 E5 seconds (or 2 days) gives:

N(1.73E5s) = 4.30 E10 atoms of Sn-133
N(1.73E5s) = 2.81E14 + 3.19E14 = 6.00 E14 atoms of Te-133
N(1.73E5s) = 2.45 E16 + 3.59 E16 + 4.04 E16 = 1.01 E17 atoms of 1-133

a. The explanation of the number of atoms of Te-133 on page 30 does not match the results provided in the table on page 31. Provide the additional information, correction, or explanation for this apparent discrepancy.

b. Provide an additional explanation for how the resulting atom populations are calculated.

RAI Question 12 Response:

12a The Te-133 calculation is re-written indicating the atom populations summed. The sum is 6.0E14 for all pathways leading to Te-133. This was done also for I-133 giving a sum of 1.01E17 atoms.

N(t) evaluated at a production time, t, of 1.73 E5 seconds (or 2 days) gives:

N(1.73E5s) = 6.72E11+1.1E13+8.42E13 + 1.85E14+1.84E13+3.01E14
= 2.81E14+3.19E14 = 6.00 E14 atoms of Te-133

N(1.73E5s) = 5.32E13+8.71E14+6.66E15+1.48E16+2.13E15+2.51E14+4.11E15+
3.15E16+1.47E15+2.41E16+1.48E16
= 2.45E16+3.59E16+4.04E16
= 1.01 E17 atoms of I-133

12b The atom populations were calculated using the kinetic and decay equations given in Attachment 1. Atoms produced by redundant pathways are excluded. In the examples given, direct production of Te-133 calculated in the 5th pathway at 1.85E14 atoms is excluded a second time since this was included in the first pathway. Similarly, direct production of I-133 is only considered once in the first pathway and not in any others A more detailed explanation of the example calculation was added in Attachment 1.

RAI Question 13:

The regulation in 10 CFR Part 20, Appendix B, Table 1, "Occupational Values," states that the value for Tellerium-133 is 9E-6 uCi/ml. The "Dry Sample (example)" section of Attachment 1 to the NCSU LAR (page 37), states "Te-133: Rem = [9.48E-4 uCi/ml *(1 – e-0 966) * 5 rem] / [3.86 per h* 2000 h * 3E-5 uCi/ml] = 1.52 E-2 rem (effective)." The Table 1 DAC value for Tellerium-133 in 10 CFR Part 20, Appendix B, is 9E-6 uCi/ml which is much less than the 3E-5 uCi/ml value that is listed on page 37 of Attachment 1. Provide an explanation for this difference.

RAI Question 13 Response:

Following 10 CFR Part 20 Appendix B directions, the correct value was used for CEDE and CDE calculations. For the case of Te-133, the following data applies for Class D or Class W Te-133:

ALI (µCi)	**DAC (uCi/ml)**
2E+4	9E-6
Thyroid (6E+4)	-

Airborne concentrations are derived from the ALI:

ALI = 2E4 uCi for the 50 rem CDE limit to the thyroid.
This gives a DAC of 2E4 uCi / 2.4E9 ml = 9E-6 uCi/ml for the thyroid

ALI = 6E4 uCi for the 5 rem CEDE limit.
This gives a DAC or 6E4 uCi / 2.4E9 ml = 3E-5 uCi/ml for the CEDE

The lower DAC is listed in 10 CFR 20 Appendix B and applies to the thyroid.

The public EC = 3E-5 uCi/ml / 300 = 8E-8 uCi, or (6E4 uCi/2.4E9 ml /300). The public EC is associated with a CEDE of 0.05 rem to an adult and 0.1 rem to a child. The factor of 300 is used based on a dose factor of 50 (5 / 0.1), a factor of 2 for other age groups, and a factor of 3 for time and inhalation rate adjustments between occupational workers and members of the public.

Refer to Attachment 1 Section D. Calculations were made following 10 CFR Part 20 Appendix B directions. 10 CFR Part 20 Appendix B was used correctly to determine the DCF for the CEDE and thyroid CDE.

RAI Question 14:

The "Example Calculations" section of Attachment 1 to the NCSU LAR (page 40), states "For the fission of 1 g of U-235 by thermal neutrons at a fluence rate of 1 E13 cm-2s-1, doses and f/s are calculated for times from t = 10s to t = 3E7s.:" Were the total fissions in the 8th column of the table on page 40 calculated or assumed values? Provide additional information for the selection or calculation of these values.

RAI Question 14 Response:

> The total fissions were calculated assuming a constant mass and fluence rate for the irradiation time. Fission rates are no longer used for experiment limits. Mass limits as a function of fluence rate and irradiation time are now used. In Attachment 1, adjustements for mass at each irradiation time are used to determine total dose. Mass limits are then calculated using the design dose limits vs the total dose.
>
> Previously the times selected were for graphing purposes and also because most experiments are relatively short in duration. The same times are kept in Attachment 1. It is noted that mass limits vary slowly over time.

RAI Question 15:

The "Detailed Calculation Results for the Thermal Fission of U-235" section of Attachment 1 to the NCSU LAR (page 42), shows a "Dry Rem Bay Thy" result of 1.55E+00 and on page 41, t=100 s, to T=0 s shows a "Dry Environment THY Rem" result of 1.43E+00. The value "Dry Rem Bay Thy" listed in the table on page 41 is not the same value as that listed on page 40 of the 3rd set of example calculations (t=0 to t=100 s). Provide an explanation for this difference and if this difference affects the calculated results.

RAI Question 15 Response:

> The value of 1.55 rem for the thyroid listed on page 40 was the peak dose determined for the decay times between 0 seconds and 1 year considered in the analysis, which occurred at 300 s. Sample unloading within 1 year is considered as being normal and likely. Sample unloading at 0 seconds of decay is associated with an experiment in an open beam. Iodine activities may increase after irradiation due to the decay of other radionuclides. The value of 1.43 rem was calculated at 0 seconds of decay (T) while the value of 1.55 rem was calculated at 300 s decay (T) for production time of 100 s (t). The peak value of 1.55 rem was used to determine experiment limits based on thyroid dose.

Corrections made in Attachment 1 for particulate release of 0.01 for Sb and Te radionuclides, reactor building volume of 2.4 E9 ml, evacuation time of 0.05 h, and adding one-tenth of the DDE from noble gas have changed these to TODE values of 0.312 rem at 300 s decay and 1.21 rem at 0 s decay:

300 s decay: CDE for the thyroid is 0.293 rem (0.312-0.1*0.187 = 0.293)

Fission Products Conditions	Bay Effective Dose in Rem	Bay Organ* Dose in Rem
All Noble Gas	1.87E-01	
All Bromines	2.45E-01	
All Iodines	5.32E-03	3.12E-01
All Particulates	1.24E-01	*Thyroid
All fission products	**5.62E-01**	**3.12E-01**

0 s decay: CDE for the thyroid is 1.1 rem (1.21- 0.1*1.11= 1.1)

Fission Products Conditions	Bay Effective Dose in Rem	Bay Organ* Dose in Rem
All Noble Gas	1.11E+00	
All Bromines	3.26E+00	
All Iodines	4.40E-03	1.21E+00
All Particulates	8.47E-01	*Thyroid
All fission products	**5.22E+00**	**1.21E+00**

As a result, the maximum dose occurs at 0 s decay in with the changes made.

RAI Question 16:

Attachment 1 to the NCSU LAR (page 44), gives calculated dose results for an example based on the 100 sec irradiation of 1 gram of U-235 material followed by 300 sec decay time. The dose conversion factors used to produce the calculated dose values are not provided anywhere in Attachment 1. Provide the dose conversion factors used to obtain these results.

RAI Question 16 Response:

The dose results given are for the reference conditions. Dose Conversion Factors (DCF) were taken from 10 CFR Part 20 Appendix B. The doses shown are determined as described on page 22 of the previous analysis:

Dose = (Time-Integrated Exposure) (DCF)

With the changes made to Attachment 1, the doses calculated are given in Section H for the reference conditions as described in Section D (page 45 of the revised analysis):

$D_{reference}$ = f Z (Time-Integrated Exposure) (DCF)

where, Z = 2 / ΣY with ΣY = sum of the fission yields for each fission product
f = 0.1 for noble gas fission products inside the reactor building
f = 1 for noble gas fission products outside the reactor building
f = 1 for all other radionuclides
$Dose_{reference}$ is the dose calculated for the reference mass and fluence rate

Fueled experiments may have multiple fissionable materials present. The activity, concentration, and dose were calculated for a reference mass of 1 gram and reference fluence rate of 1E13 $cm^{-2}s^{-1}$. Adjustments to the reference doses calculated at a constant mass of 1 gram and fluence rate of 1E13 $cm^{-2}s^{-1}$ are made as indicated below:

For fission products from the fissionable material initially present: $$D_{FP} = \frac{M_{average}(t)\varphi}{(1g)(1E13)} D_{reference}$$

For fission products from fissionable material produced by activation or decay:

$$D_{FP}^{j} = \frac{M_{average}^{j}(t)\varphi}{(1g)(1E13)} D_{reference}$$

For fissionable material initially present:

$$D_{FM} = \frac{M(t)}{(1g)} D_{reference}$$

For fissionable material produced by activation or decay:

$$D_{FM}^{j} = \frac{M^{j}(t)}{(1g)} D_{reference}$$

where,

- D is dose
- FP is fission product, FM is fissionable material
- j refers to fissionable material produced by activation or decay of the initial fissionable material
- φ is the fluence rate in $cm^{-2}s^{-1}$
- Reference mass is 1 g and reference fluence rate is 1E13 $cm^{-2}s^{-1}$
- Reference doses are given in Section H
- M(t) and average mass for different fluence rates are given in Section H. Mass values are calculated from EQ9, 10, 11, and 12 for EQ27, 28, 25, and 26, respectively.

RAI Question 17:

As stated in the Regulatory Position section (page 2.2-3), of NRC Regulatory Guide 2.2, "Development of Technical Specifications for Experiments in Research Reactors," "The safety-oriented considerations from which technical specifications for experiments should be developed include (1) the physical conditions of the design and conduct of experiments, (2) the materials content of experiments, and (3) the administrative controls employed to evaluate, authorize, and carry out experiments."

a. Provide or describe the procedure that specifies to researchers how the incident neutron flux in which the fueled experiment is to be irradiated is determined for input to the fission rate calculation.

b. Provide an example calculation, in the form that it would be reviewed for approval by the NCSU review committee for each of the following, using the methodology in proposed amendment.
   i. U-238/U-235 sample with no previous irradiation.
   ii. Thorium/U-233 sample with no previous irradiation.
   iii. If samples with previous irradiation history are permitted, provide sample calculations for each of the above with previous irradiation assumed.

c. Provide or describe the procedure by which either:
   i. the actual irradiation history of the fueled experiment is determined to validate that limits were not exceeded during the irradiation, or
   ii. the fueled experiment is analyzed after irradiation to determine that limits were not exceeded.

RAI Question 17 Response:

17a Neutron fluence rates in experimental facilities is measured by the reactor staff and shared with the experimenter in planning an experiment. These measurements are made following standard ASTM E261 "Standard Methods for Determining Neutron Fluence, Fluence Rate, and and Spectra by Radioactivation Techniques" and NIST traceable materials. These measurements are made periodically, as experimental facilities change, or for specific experimental needs.

17b Experiments are reviewed and approved by the reactor staff, Reactor Safety and Audit Committee (RSAC), and NCSU Radiation Safety Committee (RSC) as stated in TS 6.2 and 6.5. Reviews meet 10 CFR Part 50.59 and 10 CFR Parts 50.54(p) and 50.54(q). Additionally, experiments shall meet reactor license conditions and TS, including those given in the reactor and NCSU Radiation Protection Programs (RPP).

RPP requirements include the following:

- Experiment purpose
- Personnel and their qualifications, experience, and training
- Laboratory location, facilities, and equipment
- Experiment procedure (handling, precautions, safety, monitoring, location, equipment)
- Radioactive materials / radiation devices used, activity, form
- Radiation monitoring, surveys
- Storage, security of materials and devices
- Waste handling and disposal

TS 3.8 compliance would be provided with the experiment procedures. TS 3.8 requires a review of each type of fueled experiment to include the following:

- Meeting license requirements for the receipt, use, storage, and security of fissionable material.
- Meeting conditions given in Specification 3.8a through 3.8f
- Irradiation and unloading of irradiated fissionable materials within the reactor building
- Initiation of the reactor building evacuation alarm.

The reactor staff and experimenter work together to determine how best to do the experiment. The reactor staff determines compliance with TS and the reactor license prior to forwarding materials to RSAC and RSC.

TS 3.8 criteria for mass are addressed in the examples using methodology as provided in Attachment 1 for the examples requested.

17b.i It is noted that U-236 production from U-235 and Pu-239 production from U-238 are included in Attachment 1 Section H.

Example:

Sample of 20% U-235 enrichment and 80% U-238 enrichment up to a maximum irradiation of 1 year (3.15E7 s) at fluence rates up to 1E13 $cm^{-2}s^{-1}$is planned in an approved experimental facility.

Using Table TS 3.8-1and the license possession limits the mass limits on the samples for the planned experiments are calculated for irradiation times up to 1 year.

Table 3.8-1:

U235	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.1E+00	1.1E+01	2.3E+01	2.3E+01
3.0E+01	2.1E-01	2.1E+00	9.6E+00	9.6E+00
1.0E+02	8.9E-02	8.9E-01	4.5E+00	4.5E+00
3.0E+02	5.6E-02	5.6E-01	2.8E+00	2.8E+00
1.0E+03	4.5E-02	4.5E-01	2.1E+00	2.1E+00
3.0E+03	4.0E-02	4.0E-01	2.0E+00	2.0E+00
1.0E+04	3.5E-02	3.5E-01	2.0E+00	2.0E+00
3.0E+04	3.0E-01	3.0E-01	1.9E+00	1.9E+00
1.0E+05	2.5E-02	2.5E-01	1.9E+00	1.9E+00
3.0E+05	1.4E-02	1.4E-01	1.4E+00	1.7E+00
1.0E+06	7.1E-03	7.1E-02	7.1E-01	1.0E+00
3.0E+06	2.4E-03	2.3E-02	2.3E-01	4.6E-01
1.0E+07	1.7E-03	1.7E-02	1.7E-01	3.5E-01
3.2E+07	1.8E-03	1.7E-02	1.6E-01	3.4E-01

U238	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E+10
1.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
1.0E+03	5.2E+01	9.4E+01	1.0E+02	1.0E+02
3.0E+03	1.6E+01	1.9E+01	1.9E+01	1.9E+01
1.0E+04	5.5E+00	5.9E+00	5.9E+00	5.9E+00
3.0E+04	4.4E+00	4.7E+00	4.7E+00	4.7E+00
1.0E+05	4.1E+00	4.6E+00	4.6E+00	4.7E+00
3.0E+05	3.4E+00	4.5E+00	4.6E+00	4.6E+00
1.0E+06	1.4E+00	4.0E+00	4.6E+00	4.6E+00
3.0E+06	1.6E-01	1.6E+00	4.2E+00	4.5E+00
1.0E+07	3.6E-02	3.5E-01	3.4E+00	4.1E+00
3.2E+07	1.1E-02	1.1E-01	1.1E+00	3.2E+00

License limits are 26 g of U-235 and 100 g of U-238.

Possession is limited to 63.7 g of sample:

63.7 g = 1 / [0.2/26g + 0.8/100g]
Mass of U-235 is limited to 0.2*63.7 g = 12.7 g
Mass of U-238 is limited to 0.8*63.7 g = 51 g
1 = (12.7g / 26g) + (51g / 100g)

Using Table 3.8-1 the following table for the sample to be irradiated indicates the mass of sample at the beginning of irradiation that will satisfy TS limits:

Fluence rate, cm-2s-1:	1.E+13	1.E+12	1.E+11	≤1E10
Time,s	Mass, g	Mass, g	Mass, g	Mass, g
1.0E+01	63.700	63.700	63.700	63.700
3.0E+01	63.700	63.700	63.700	63.700
1.0E+02	63.700	63.700	63.700	63.700
3.0E+02	63.700	63.700	63.700	63.700
1.0E+03	40.984	63.700	63.700	63.700
3.0E+03	12.668	15.098	15.701	15.730
1.0E+04	4.426	4.787	5.143	5.146
3.0E+04	3.536	3.784	4.136	4.139
1.0E+05	3.258	3.737	4.089	4.092
3.0E+05	2.741	3.701	3.997	4.069
1.0E+06	1.174	3.612	3.829	3.898
3.0E+06	0.131	3.364	3.647	3.701
1.0E+07	0.029	2.589	3.349	3.401
3.2E+07	0.009	0.846	2.710	2.793

Example: Mass limit at a fluence rate of 1E12 for 1E5 s = (0.2) (0.25g) + (0.8) (4.6 g) = 3.7 g

To meet license limits on possession, the total mass of U-235, U-238, U-236, Pu-239, and U-234 for this experiment for the irradiation times and experiment mass limits is estimated based on the experimental mass limits calculated above and data given in Section H of the attachment to the fueled experiment amendment. Results are as follows for the maximum fluence rate and maximum allowed target mass:

Fluence rate, cm-2s-1:	*1.0E+13*						
Irradiation Time "t" s	Mass at Time "t" g U238	Mass at Time "t" g Pu239	Mass at Time "t" g U234	Mass at Time "t" g U235	Mass at Time "t" g U236	Mass at Time "t" g Pa231	Fraction of Licensed Limit
1.0E+01	5.1E+01	0.0E+00	4.0E-07	1.3E+01	1.3E-07	6.2E-07	99.96%
3.0E+01	5.1E+01	0.0E+00	4.0E-07	1.3E+01	3.8E-07	6.2E-07	99.96%
1.0E+02	5.1E+01	0.0E+00	4.0E-07	1.3E+01	1.3E-06	6.2E-07	99.96%
3.0E+02	5.1E+01	0.0E+00	4.0E-07	1.3E+01	3.8E-06	6.2E-07	99.96%
1.0E+03	3.3E+01	3.9E-08	2.5E-07	8.2E+00	8.1E-06	4.0E-07	64.31%
3.0E+03	1.0E+01	4.0E-07	7.9E-08	2.5E+00	7.5E-06	1.2E-07	19.88%
1.0E+04	3.5E+00	2.7E-06	2.7E-08	8.9E-01	8.8E-06	4.3E-08	6.94%
3.0E+04	2.8E+00	1.8E-04	2.2E-08	7.1E-01	2.1E-05	3.4E-08	5.55%
1.0E+05	2.6E+00	6.7E-04	2.0E-08	6.5E-01	6.5E-05	3.2E-08	5.12%
3.0E+05	2.2E+00	1.8E-03	1.7E-08	5.5E-01	1.6E-04	2.7E-08	4.31%
1.0E+06	9.4E-01	2.6E-03	7.3E-09	2.3E-01	2.3E-04	1.1E-08	1.86%
3.0E+06	1.0E-01	8.7E-04	8.2E-10	2.6E-02	7.8E-05	1.3E-09	0.21%
1.0E+07	2.2E-02	6.3E-04	1.8E-10	5.4E-03	5.7E-05	2.8E-10	0.05%
3.2E+07	6.9E-03	6.5E-04	5.8E-11	1.5E-03	5.8E-05	9.2E-11	0.02%
License Limit, g	1.0E+02	1.1E+01	1.0E+02	2.6E+01	1.0E+02	1.0E+02	

Inventory does not exceed 100%of licensed limits at any time from 10s to 1 year.
Current inventory of these materials is maintained by health physics procedures.

17b.ii It is noted that U-233 production from Th-232 is included as described in Attachment 1 with results given in Section H.

Example:

Sample of Th-232 up to a maximum irradiation of 1 year (3.15E7 s) at a constant fluence rate of 5E7 $cm^{-2}s^{-1}$is planned in an approved experimental facility.

Using Table TS 3.8-1and the license possession limits the mass limits on the samples for the planned experiments are calculated for irradiation times up to 1 year.

Table 3.8-1:

Th232	**Mass Limits (g) at fluence rates**			
Time,s	**1.0E+13**	**1.0E+12**	**1.0E+11**	**≤ 1.E10**
1.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+01	9.2E+01	1.0E+02	1.0E+02	1.0E+02
1.0E+02	2.9E+01	3.3E+01	3.3E+01	3.4E+01
3.0E+02	1.1E+01	1.2E+01	1.2E+01	1.2E+01
1.0E+03	4.1E+00	4.2E+00	4.2E+00	4.2E+00
3.0E+03	2.1E+00	2.1E+00	2.2E+00	2.2E+00
1.0E+04	1.7E+00	1.7E+00	1.7E+00	1.7E+00
3.0E+04	1.7E+00	1.7E+00	1.7E+00	1.7E+00
1.0E+05	1.6E+00	1.7E+00	1.7E+00	1.7E+00
3.0E+05	1.6E+00	1.6E+00	1.6E+00	1.6E+00
1.0E+06	1.4E+00	1.5E+00	1.5E+00	1.5E+00
3.0E+06	1.1E+00	1.3E+00	1.3E+00	1.3E+00
1.0E+07	1.4E-01	1.1E+00	1.1E+00	1.1E+00
3.2E+07	3.3E-02	1.0E+00	1.1E+00	1.1E+00

License limit is 100 g of Th-232 and 18 g of U-233. Table TS 3.8-1 includes the buildup of Th-233 and U-233 in the sample. Th-232 mass irradiated at a fluence rate of 5E7 $cm^{-2}s^{-1}$ is limited to those given at < 1E10 $cm^{-2}s^{-1}$.

Total mass of Th-232and U-233 for this experiment is estimated for the irradiation times, planned fluence rate, and experiment mass limits to be the following:

Irradiation Time "t" s	Mass at Time "t" g Th232	Mass at Time "t" g Th233	Mass at Time "t" g U233	Fraction of Licensed Limit
1.0E+01	1.0E+02	8.6E-07	0.0E+00	100.0%
3.0E+01	1.0E+02	2.6E-06	0.0E+00	100.0%
1.0E+02	3.4E+01	2.8E-06	0.0E+00	33.5%
3.0E+02	1.2E+01	3.5E-06	0.0E+00	11.8%
1.0E+03	4.2E+00	2.8E-06	0.0E+00	4.2%
3.0E+03	2.2E+00	2.8E-06	0.0E+00	2.2%
1.0E+04	1.7E+00	2.8E-06	1.5E-08	1.7%
3.0E+04	1.7E+00	2.8E-06	1.7E-07	1.7%
1.0E+05	1.7E+00	2.8E-06	2.0E-06	1.7%
3.0E+05	1.6E+00	2.7E-06	1.8E-05	1.6%
1.0E+06	1.5E+00	2.5E-06	1.7E-04	1.5%
3.0E+06	1.3E+00	2.2E-06	1.1E-03	1.3%
1.0E+07	1.1E+00	1.9E-06	6.6E-03	1.2%
3.2E+07	1.1E+00	1.8E-06	2.7E-02	1.2%
License Limit, g	1.0E+02	N/A Short half life	1.8E+01	

Th-233 has a half-life of 22.3 minutes. License limit is 100 g of Th-232 and 18 g of U-233. License limits are met at all times. Current inventory of these materials is maintained by health physics procedures.

17b.iii All samples in experiments need to specify the materials present. For samples with a previous irradiation history, documentation and data are needed to determine if the sample is allowed to be used.

Documentation is typically provided by the experimenter. If no documentation is available, then the sample history may be estimated from dose rate and radioisotopic measurements (e.g. gamma spectroscopy). The presence of fission and activation products and the associated activities may be used to determine if the sample was previously used in a fueled experiment. For example, the presence of I-131, Cs-137, and other fission products would indicate prior use and may be used to estimate the past history of the sample.

If the history is known or concluded from radioassay data, then the sample history relative to TS 3.8 Table 3.8-1 is made. If no documentation, history, or conclusions can be made from sample measurements, then the sample is an unknown and not allowed for use.

For the case of U-238 and U-235 mixture with previous irradiation history, U-236 and Pu-239 would be present. To account for the fission product inventory, the entry time on TS Table 3.8-1 must be determined. If the fission product inventory is not detectable, then the U-236 and Pu-239 can be evaluated as a separate fissionable material in a mixed sample.

For example, a 3 g 20% U-235 enriched sample with a known history of 1E6 s irradiation at 1E7 s of decay at a fluence rate of 1E8 $cm^{-2}s^{-1}$ and 0.05 uCi of Cs-137 is to be used for an experiment at a fluence rate of 1E11 $cm^{-2}s^{-1}$ for 24 hours.

Data: U-235 mass is 0.6g
U-236 mass is 3 E-4 g
U-238 mass is 2.4 g
Pu-239 mass is 1 E-3 g
Pa-231 and U-234 mass is negligible

The data matches the history. TS Table 3.8-1 is entered at a starting time of 1E6 s. From the response given for RAI 17bi at the planned fluence rate a 3 g of sample may be irradiated for another 1.9E6 s (2E7-1E6s) as estimated by interpolation. Alternately, 2.7 g may be irradiated for the remaining time of 3.05E7 s (3.15E7s-1E6s).

Fluence rate, cm-2s-1:		1.E+13	1.E+12	1.E+11	≤1E10
Time,s		Mass, g	Mass, g	Mass, g	Mass, g
1.0E+06		1.174	3.612	3.829	3.898
3.0E+06		0.131	3.364	3.647	3.701
1.0E+07		0.029	2.589	3.349	3.401
3.2E+07		0.009	0.846	2.710	2.793

For the case of Th-232/U-233 considered in RAI 17b.ii with previous irradiation, the presence of fission, activation, and decay products, e.g. U-233, Ra-228, Th-228, U-234, Cs-137, etc. could be used to estimate the sample irradiation history if the irradiation history is not known.

For example, assume the mass of Th-232 is 10 g and U-233 mass is 0.5 g with no detectable fission products. Expected masses are shown below as given in Section H of the attachment to the fueled experiment amendment for an initial mass of 1 g Th-232 irradiated at a fluence rate of 1E13 $cm^{-2}s^{-1}$:

Irradiation Time, s	Mass, g Th232	Mass, g Th233	Mass, g U233
1.0E+02	1.00E+00	8.57E-09	0.00E+00
1.0E+02	1.00E+00	2.56E-08	0.00E+00
3.4E+01	1.00E+00	8.38E-08	0.00E+00
1.2E+01	1.00E+00	2.97E-07	0.00E+00
4.2E+00	1.00E+00	6.71E-07	0.00E+00
2.2E+00	1.00E+00	1.31E-06	0.00E+00
1.7E+00	1.00E+00	1.65E-06	8.80E-09
1.7E+00	1.00E+00	1.66E-06	1.01E-07
1.7E+00	1.00E+00	1.66E-06	1.22E-06
1.6E+00	1.00E+00	1.66E-06	1.10E-05
1.5E+00	9.99E-01	1.66E-06	1.16E-04
1.3E+00	9.97E-01	1.66E-06	8.71E-04
1.1E+00	9.91E-01	1.66E-06	5.83E-03
1.1E+00	9.73E-01	1.66E-06	2.42E-02

In this example a 10 g of Th-232 at the peak experiment fluence rate for 1 y would produce 0.24 g of U-233. The 0.5 g of U-233 indicates a mixture rather than a Th-232 sample with prior history. The sample is therefore treated as a mixture with 10 g of Th-232 and 0.5 g of U-233.

License Limits:

For the planned experiment license limits on fissionable are met at all times. Maximum fraction is 10% of the licensed possession limit. This includes 10 g of Th-232, 0.5 g of U-233 and approximately 4 E-7 g of U-234. License limits are 100 g for Th-232, 100 g for U-234, and 18 g for U-233.

TS 3.8 Compliance:

Results of irradiation for this mixture are as follows for a fueled experiment per TS 3.8:

Time	Th232	U233	Fraction at	Th232	U233	Fraction at	Th232	U233	Fraction at
s	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10	≤ 1.E+10
1.0E+01	1.0E+02	1.0E+00	5.8E-01	1.0E+02	1.0E+00	5.8E-02	1.0E+02	1.0E+00	5.0E-02
3.0E+01	1.0E+02	1.0E+00	5.9E-01	1.0E+02	1.0E+00	5.9E-02	1.0E+02	1.0E+00	5.0E-02
1.0E+02	3.4E+01	1.0E+00	7.9E-01	3.4E+01	1.0E+00	7.9E-02	3.4E+01	1.0E+00	6.7E-02
3.0E+02	1.2E+01	1.0E+00	1.3E+00	1.2E+01	1.0E+00	1.3E-01	1.2E+01	1.0E+00	1.1E-01
1.0E+03	4.2E+00	1.0E+00	2.9E+00	4.2E+00	1.0E+00	2.9E-01	4.2E+00	1.0E+00	2.5E-01
3.0E+03	2.2E+00	1.0E+00	5.2E+00	2.2E+00	1.0E+00	5.2E-01	2.2E+00	1.0E+00	4.4E-01
1.0E+04	1.7E+00	9.9E-01	6.4E+00	1.7E+00	9.9E-01	6.4E-01	1.7E+00	9.9E-01	5.4E-01
3.0E+04	1.7E+00	9.9E-01	6.4E+00	1.7E+00	9.9E-01	6.4E-01	1.7E+00	9.9E-01	5.5E-01
1.0E+05	1.7E+00	9.8E-01	6.5E+00	1.7E+00	9.8E-01	6.5E-01	1.7E+00	9.8E-01	5.5E-01
3.0E+05	1.6E+00	9.6E-01	6.7E+00	1.6E+00	9.6E-01	6.7E-01	1.6E+00	9.6E-01	5.7E-01
1.0E+06	1.5E+00	5.9E-01	7.5E+00	1.5E+00	5.9E-01	7.5E-01	1.5E+00	5.9E-01	6.4E-01
3.0E+06	1.3E+00	2.4E-01	9.8E+00	1.3E+00	2.4E-01	9.8E-01	1.3E+00	2.4E-01	8.3E-01
1.0E+07	1.1E+00	1.8E-01	1.2E+01	1.1E+00	1.8E-01	1.2E+00	1.1E+00	1.8E-01	9.9E-01
3.2E+07	1.1E+00	1.8E-01	1.2E+01	1.1E+00	1.8E-01	1.2E+00	1.1E+00	1.8E-01	1.0E+00
U233	**5.0E-01**	**g**		**5.0E-02**	**g**		**4.3E-02**	**g**	
Th232	**1.0E+01**	**g**		**1.0E+00**	**g**		**8.5E-01**	**g**	

At the planned fluence rate of 5E7 $cm^{-2}s^{-1}$ (< 1E10 $cm^{-2}s^{-1}$) the following mass limits may be irradiated without exceeding the TS 3.8 Table 3.8-1 limits:

- 10 g Th232 and 0.5 g U-233 may be irradiated to 100 s
- 1 g Th232 and 0.05 g U-233 may be irradiated to 3E6 s
- 0.85 g Th232 and 0.043 g U-233 may be irradiated for 1 year

17c. Irradiation history and sample contents (masses, activities, chemical and physical form and properties) are to be known for any sample prior to any experiment as required by TS and facility procedures. The reactor staff then determines if the experiment is permitted by the NCSU radioactive/radiation authorization, reactor radiation protection program, and is a tried or untried experiment as described in TS 3.8 and TS 6.5. Once the materials are known and the experiment is shown to meet all applicable requirements, it may be scheduled.

Additional controls, such as wire or foils to measure fluence or fluence rates may be included with the experiement to validate the irradiation conditions (refer to the response for RAI 17a). These measurements may be performed before or during the fueled experiment. The fluence rate and initial material mass would then be used to confirm compliance with TS 3.8.

17.c.i

To determine the history and contents, the experimenter provides necessary documentation or performs an analysis. In the case of fueled experiments, prior irradiation history may be estimated from the measurement of longer lived fission products, such as I-131, Cs-137, and other fission products, or other fissionable material produced by activation.

17.c.ii

Compliance with TS 3.8 is determined by limiting the amount and type of materials allowed in the experiment and radiation monitoring during and after the irradiation is performed.

If radiation levels measured during the experiment exceed those expected, then the experiment is stopped until the discrepancy is resolved. If the discrepancy was caused by a violation, appropriate action is taken as stated in TS and facility procedures.

All samples are surveyed for radiation dose rates upon removal or being handled as required by the radiation protection program and radioactive/radiation authorization. If the measured dose rate exceeds that estimated, an investigation is performed to determine if there was a violation of TS, license conditions, or procedures.

Radioisotopes produced may be assessed to determine if TS 3.8 limits were exceeded by radiation surveys and gamma spectroscopy upon sample removal. If the discrepancy was caused by a violation, appropriate action is taken as stated in TS and facility procedures.

RAI Question 18:

The "Comparison of Atom and Activity Calculations to Nuclear Analysis 1.0" section of Attachment 1 to the NCSU LAR (page 55), provides a comparison of the results between the equations used in this calculation for the 4 and 6 pathway and the 4 pathway Nuclear Analysis 1.0 decay branching fractions for two cases. The section states "all of the above are in good agreement with the exception of Xe-133m and Xe-133. Nuclear Analysis 1.0 does not list a IT decay branching fraction for Xe-133m, which affects the atom calculations for both Xe-133m and Xe-133." For both Case 1 and Case 2 data, it appears that calculated I-133 results when compared to the I-133 results for Nuclear Analysis 1.0 do not closely agree. Provide an explanation of the disparity or provide a revision to the conclusions for this section.

RAI Question 18 Response:

This example is moved to Attachment 1 Section J. This specific example was provided to indicate that Nuclear Analysis uses different library data which gives different values from those calculated. The calculation was changed using the Nuclear Analysis library data so that a direct comparison may be made.

It is noted that Nuclear Analysis uses similar equations to those used in Attachment 1 but the solution is different. Both Nuclear Analysis and Attachment 1 are based on the Bateman equations. Nuclear Analysis uses an iterative process for user specified time intervals that are evenly divided over the elapsed time (irradiation plus decay times). Time intervals from 100 to 500 were used for comparison to the analytic equations used in Attachment 1.

The IT and B-,m branching fractions and values used in Nuclear Analysis are different than the values used in the calculation. Specifically, Nuclear Analysis does not list a B-,m decay branching fraction for Sb-133 or I-133 and the B- and IT decay branching fractions for Te-133m are different.. Fission yields used in both Nuclear Analysis and by the calculation in Attachment 1 were the same.

It is noted the IT branching fraction was previously listed as a B- branching fraction for Xe-133m. With the decay branch correction to Xe-133m made, the 4 and 6 pathway models have been re-written. The 6 model pathway used in the calculation was correct and not affected by this change. The 4 pathway model used for comparison is changed.

From the JEFF Report 20 decay branching fractions, there are 6 decay pathways:

1. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133m to Xe-133
2. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133
3. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133 m to Xe-133
4. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133
5. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133m to Xe-133
6. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133

From the Nuclear Analysis 1.0 decay branching fractions, there are 4 decay pathways:

1. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133
2. Te-133m to Te-133 to I-133 to Xe-133
3. Te-133m to I-133 T0 Xe-133
4. Xe-133m to Xe-133

With the Nuclear Analysis 4 pathway model used in the calculations, the values of the nuclide atom populations agree better. Xe-133m and Xe-133 have the largest difference since there are 3 pathways leading to Xe-133m in the 6 pathway model rather than 1 for the 4 pathway model.

4 and 6 pathway model results are changed to the following:

Case A: t = 1.73E5 s, T = 0 s

	Calculated Atoms		Nuclear Analysis 1.0 Atoms
Nuclide	6 pathway	4 pathway	4 pathway
Sn-133	4.3E10	4.3E10	4.29E10
Sb-133	7.78E13	7.77E13	7.75E13
Te-133m	2.45E15	2.15E15	2.14E15
Te-133	6.0E14	6.52E14	6.63E14
I-133	1.01E17	1.03E17	8.79E16
Xe-133m	2.41E15	3.62E13	3.61E13
Xe-133	9.23E16	9.45E16	7.98E16

Case B: t = 1.000 E3 s, T = 1.000 E3 s

	Calculated Atoms		Nuclear Analysis 1.0 Atoms
Nuclide	6 pathway	4 pathway	4 pathway
Sn-133	0	0	0
Sb-133	7.59E11	7.57E11	7.57E11
Te-133m	3.76E14	3.28E14	3.28E14
Te-133	1.2E14	1.61E14	1.68E14
I-133	4.29E14	5.18E14	5.05E14
Xe-133m	4.06E11	2.81E11	2.81E11
Xe-133	1.24E12	5.07E12	4.3E12

With the revised 4 pathway model for comparison, the calculation and Nuclear Analysis results indicate good agreement. I-133 has a difference of 17% (high) for Case A and

2.6 % (high) for Case B.

4 Pathway Model	% Difference	% Difference
Nuclide	Case A	Case B
Sn-133	2.33E-01	
Sb-133	2.58E-01	0.00E+00
Te-133m	4.67E-01	0.00E+00
Te-133	-1.66E+00	-4.17E+00
I-133	1.72E+01	2.57E+00
Xe-133m	2.77E-01	0.00E+00
Xe-133	1.84E+01	1.79E+01

Previously for the 4 pathway model, the result in Case A for I-133 was 15% high and the result in Case B for I-133 was 9% low.

RAI Question 19:

Attachment 1 to the NCSU LAR (page 59), provides a comparison of fission rate limits between the current amendment request and amendment 17 to the NCSU technical specifications in a figure with similar symbols for each data series. Update the graph using a more easily discernible symbol for each series in the graph or provide a colored graph to make it easier to see the differences between the three sets of data.

RAI Question 19 Response:

This comparison was removed since the analysis for TS amendment17 and this amendment were performed differently. As a result there are differences attributable to the fission yield used (chain yield vs cumulative), consideration for the fissionable materials present, activation, and bone surface dose.

The methods used in this amendment request are more rigorous, thorough, and realistic than those used in TS amendment 17. e.g by considering the fissionable material and associated decay and activation products along with the fission products, i.e. the methods are not consistent. As a result of these differences the calculated data is different making the comparison inappropriate.

R-120 License Change:

2 B. (2) Pursuant to the Act and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," to receive, possess, and use in connection with operation of the reactor up to 25 kilograms of contained uranium-235 enriched to less than 20 percent in the isotope uramium-235 in the form of reactor fuel; up to 20 grams of contained uranium-235 of any enrichment in the form of fission chambers; up to 2 grams of contained uranium-235 of any enrichment in the form of foils; up to 200 grams of plutonium-239 in the form of plutonium-beryllium neutron sources; as listed in the table below for fissionable materials in liquid or solid form of any enrichment for fueled experiments; and to possess, but not separate, such special nuclear material as may be produced by operation of the facility or by performance of fueled experiments.

FUELED EXPERIMENT POSSESSION LIMITS

Fissionable Material	Mass (g)	Activity (Ci)	SUM OF FRACTIONS
Am241	1.9E+00	6.43E+00	
Cf252	7.0E-03	3.78E+00	**SUM**
Cm244	1.2E-01	9.64E+00	
Pu238	6.7E-01	1.13E+01	**OF**
Pu239	1.1E+01	6.51E-01	
Am243	1.1E-01	2.10E-02	**FRACTIONS**
Cf249	7.0E+00	2.87E+01	
Cf251	1.1E-02	1.68E-02	**NOT**
Cm242	7.0E-01	2.31E+03	
Cm243	8.8E-01	4.55E+01	**TO**
Cm245	7.7E+00	1.31E+00	
Cm246	1.0E+02	3.10E+01	**EXCEED**
Cm248	1.0E+02	4.20E-01	
Np237	3.2E+00	2.24E-03	**VALUE**
Pa231	1.0E+02	4.70E+00	
Pu240	4.6E+00	1.05E+00	**OF**
Pu241	2.5E+00	2.45E+02	
Pu242	5.6E-01	2.18E-03	**1.0**
Th232	1.0E+02	1.10E-05	
U232	2.7E+01	6.01E+03	**FOR**
U233	1.8E+01	1.77E-01	
U234	1.0E+02	6.20E-01	**ALL**
U235	2.6E+01	5.70E-05	
U236	1.0E+02	6.50E-03	**FISSIONABLE**
U238	1.0E+02	3.40E-05	**MATERIALS**

TS Changes:

1.2.9

e. Fueled Experiment is an experiment that involves the use of fissionable material within the reactor building meeting Specification 3.8 criteria.

Fueled experiments exclude:

(i) self-encapsulated materials, such as detectors and foils and wires and sealed sources that contain fissionable material, and

(ii) fissionable material in amounts less than the values listed in Specification 3.8 Table 3.8-2.

5.2. Reactor Building

a. The reactor shall be housed in the Reactor Building, designed for confinement. The minimum free volume in the Reactor Building shall be 2.4×10^9 cm^3.

3.8 Operations with Fueled Experiments

Applicability

This specification applies to the operation of the reactor with any fueled experiment.

Objective

The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specifications

Fueled experiments which use fissionable materials in excess of Table 3.8-2 shall meet the following conditions and limitations:

a. Physical forms of fissionable materials shall be non-volatile liquid, powder, and/or solid

b. Fissionable materials are limited to those isotopes listed in Table 3.8-1

c. Limits in Table 3.8-1 shall not be exceeded.

d. The reactor shall not be operated with a fueled experiment unless the ventilation system is operated in the confinement mode.

e. Specifications 3.2, 3.5, 3.6, and 3.7 pertaining to limiting conditions shall be met.

f. Specification 5.3 pertaining to storage shall be met.

g. Specifications 6.2.3 and 6.5 pertaining to the review of experiments shall be met.

   Each type of fueled experiment shall be classified as a new (untried) experiment with a documented review. The documented review shall include the following items:

   i. Meeting license requirements for the receipt, use, storage, and security of fissionable material.

   ii. Meeting conditions given in Specification 3.8a through 3.8f

   iii. Irradiation and unloading of irradiated fissionable materials within the reactor building

   iv. Initiation of the reactor building evacuation alarm.

h. Credible failure of any fueled experiment shall not result in releases or exposures in excess of 10 percent of the annual limits established in 10 CFR Part 20.

Table 3.8-1 Mass Limits

Am241	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.0E+01	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.0E+02	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.0E+02	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.0E+03	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.0E+03	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.0E+04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
3.0E+04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
1.0E+05	8.3E-04	8.3E-04	8.3E-04	8.3E-04
3.0E+05	8.3E-04	8.2E-04	8.2E-04	8.2E-04
1.0E+06	8.3E-04	8.2E-04	8.2E-04	8.2E-04
3.0E+06	8.3E-04	8.2E-04	8.2E-04	8.2E-04
1.0E+07	8.3E-04	8.2E-04	8.2E-04	8.1E-04
3.2E+07	8.3E-04	8.2E-04	8.0E-04	8.0E-04

Cf249	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.0E+01	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.0E+02	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.0E+02	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.0E+03	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.0E+03	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.0E+04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.0E+04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.0E+05	3.9E-04	4.7E-04	4.7E-04	4.7E-04
3.0E+05	3.4E-04	4.6E-04	4.6E-04	4.6E-04
1.0E+06	3.3E-04	4.3E-04	4.3E-04	4.3E-04
3.0E+06	3.0E-04	3.7E-04	3.7E-04	3.7E-04
1.0E+07	2.6E-04	2.5E-04	2.5E-04	2.5E-04

Am243	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.0E+01	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.0E+02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.0E+02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.0E+03	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.0E+03	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.0E+04	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.0E+04	1.3E-02	1.3E-02	1.3E-02	1.3E-02
1.0E+05	1.0E-02	1.0E-02	1.0E-02	1.0E-02
3.0E+05	6.3E-03	6.3E-03	6.3E-03	6.3E-03
1.0E+06	2.7E-03	2.7E-03	2.7E-03	2.7E-03
3.0E+06	1.1E-03	1.0E-03	1.0E-03	1.0E-03
1.0E+07	3.9E-04	3.3E-04	3.3E-04	3.3E-04
3.2E+07	1.9E-04	1.1E-04	1.1E-04	1.1E-04

Cf251	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.0E+01	1.2E-03	1.2E-03	1.2E-03	1.2E-03
1.0E+02	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.0E+02	1.2E-03	1.2E-03	1.2E-03	1.2E-03
1.0E+03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.0E+03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
1.0E+04	8.1E-04	1.2E-03	1.2E-03	1.2E-03
3.0E+04	4.9E-04	1.1E-03	1.1E-03	1.1E-03
1.0E+05	3.0E-04	9.6E-04	9.8E-04	9.8E-04
3.0E+05	1.4E-04	5.0E-04	6.8E-04	7.0E-04
1.0E+06	1.7E-04	3.4E-04	3.6E-04	3.6E-04
3.0E+06	9.1E-05	1.4E-04	1.5E-04	1.5E-04
1.0E+07	3.7E-05	5.0E-05	5.0E-05	5.0E-05

Np237	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	2.8E+00	2.8E+00	2.8E+00	2.8E+00
3.0E+01	2.7E+00	2.7E+00	2.7E+00	2.7E+00
1.0E+02	2.7E+00	2.7E+00	2.7E+00	2.7E+00
3.0E+02	2.6E+00	2.6E+00	2.6E+00	2.6E+00
1.0E+03	2.4E+00	2.4E+00	2.4E+00	2.4E+00
3.0E+03	1.9E+00	1.9E+00	1.9E+00	1.9E+00
1.0E+04	1.1E+00	1.1E+00	1.1E+00	1.1E+00
3.0E+04	4.8E-01	4.8E-01	4.8E-01	4.8E-01
1.0E+05	1.7E-01	1.7E-01	1.7E-01	1.7E-01
3.0E+05	6.4E-02	6.4E-02	6.4E-02	6.4E-02
1.0E+06	2.3E-02	2.2E-02	2.2E-02	2.2E-02
3.0E+06	8.3E-03	8.2E-03	8.2E-03	8.2E-03
1.0E+07	2.7E-03	2.5E-03	2.5E-03	2.5E-03
3.2E+07	1.0E-03	8.3E-04	8.1E-04	8.1E-04

Pa231	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+01	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+02	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+02	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+04	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+04	3.5E-03	3.5E-03	3.5E-03	3.5E-03
1.0E+05	3.4E-03	3.4E-03	3.4E-03	3.4E-03
3.0E+05	3.2E-03	3.2E-03	3.2E-03	3.2E-03
1.0E+06	3.1E-03	3.1E-03	3.1E-03	3.1E-03
3.0E+06	3.1E-03	3.0E-03	3.0E-03	3.0E-03
1.0E+07	1.7E-03	1.6E-03	1.6E-03	1.6E-03
3.2E+07	7.0E-04	6.1E-04	6.0E-04	5.9E-04

Notation in Table 3.8-1 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the limiting mass for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Limit}} \leq 1$

Table 3.8-1 Mass Limits

Cm242	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+01	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+02	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+02	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+03	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+03	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+04	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+04	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+06	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+06	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+07	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.2E+07	2.7E-05	2.7E-05	2.7E-05	2.7E-05

Cm243	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+01	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+02	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+02	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+03	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+03	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+04	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+04	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+06	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+06	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+07	7.9E-05	7.9E-05	7.8E-05	7.8E-05
3.2E+07	7.9E-05	7.9E-05	7.5E-05	7.5E-05

Cm244	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+01	5.5E-05	5.5E-05	5.5E-05	5.5E-05
1.0E+02	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+02	5.5E-05	5.5E-05	5.5E-05	5.5E-05
1.0E+03	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+03	5.5E-05	5.5E-05	5.5E-05	5.5E-05
1.0E+04	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+04	5.5E-05	5.5E-05	5.5E-05	5.5E-05
1.0E+05	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+05	5.5E-05	5.5E-05	5.5E-05	5.5E-05
1.0E+06	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+06	5.5E-05	5.5E-05	5.5E-05	5.5E-05
1.0E+07	5.5E-05	5.4E-05	5.4E-05	5.4E-05
3.2E+07	4.9E-05	4.4E-05	4.4E-05	4.3E-05

Cm245	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.6E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+01	1.5E-02	1.6E-02	1.6E-02	1.6E-02
1.0E+02	1.3E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+02	1.1E-02	1.5E-02	1.6E-02	1.6E-02
1.0E+03	9.0E-03	1.5E-02	1.6E-02	1.6E-02
3.0E+03	6.9E-03	1.4E-02	1.6E-02	1.6E-02
1.0E+04	4.3E-03	1.3E-02	1.6E-02	1.6E-02
3.0E+04	2.5E-03	1.0E-02	1.5E-02	1.6E-02
1.0E+05	1.5E-03	8.2E-03	1.5E-02	1.6E-02
3.0E+05	1.2E-03	7.1E-03	1.4E-02	1.5E-02
1.0E+06	1.1E-03	6.7E-03	1.4E-02	1.5E-02
3.0E+06	6.2E-04	6.0E-03	1.4E-02	1.4E-02
1.0E+07	4.7E-04	4.2E-03	1.3E-02	1.3E-02
3.2E+07	4.7E-04	4.2E-03	1.2E-02	1.2E-02

Cm246	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+01	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+02	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+02	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+04	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+04	9.4E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+05	9.4E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+05	9.4E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+06	9.3E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+06	9.3E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+07	9.2E-03	9.5E-03	9.5E-03	9.5E-03
3.2E+07	8.9E-03	9.5E-03	9.5E-03	9.5E-03

Cm248	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+02	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+02	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+03	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+03	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+04	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+04	1.5E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+05	1.3E-01	1.5E-01	1.5E-01	1.5E-01
3.0E+05	1.1E-01	1.2E-01	1.2E-01	1.2E-01
1.0E+06	8.0E-02	8.0E-02	8.0E-02	8.0E-02
3.0E+06	4.0E-02	4.0E-02	4.0E-02	4.0E-02
1.0E+07	1.4E-02	1.5E-02	1.5E-02	1.5E-02
3.2E+07	3.0E-03	4.8E-03	5.0E-03	5.1E-03

Notation in Table 3.8-1 is read as follows: 1.2 E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the limiting mass for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Limit}} \leq 1$

Table 3.8-1 Mass Limits

Th232	Mass Limits (g) at fluence rates				Pu240	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+01	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+01	9.2E+01	1.0E+02	1.0E+02	1.0E+02	3.0E+01	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+02	2.9E+01	3.3E+01	3.3E+01	3.4E+01	1.0E+02	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+02	1.1E+01	1.2E+01	1.2E+01	1.2E+01	3.0E+02	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+03	4.1E+00	4.2E+00	4.2E+00	4.2E+00	1.0E+03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+03	2.1E+00	2.1E+00	2.2E+00	2.2E+00	3.0E+03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+04	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.0E+04	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+04	1.7E+00	1.7E+00	1.7E+00	1.7E+00	3.0E+04	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+05	1.6E+00	1.7E+00	1.7E+00	1.7E+00	1.0E+05	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+05	1.6E+00	1.6E+00	1.6E+00	1.6E+00	3.0E+05	2.2E-03	2.2E-03	2.2E-03	2.2E-03
1.0E+06	1.4E+00	1.5E+00	1.5E+00	1.5E+00	1.0E+06	2.2E-03	2.2E-03	2.2E-03	2.2E-03
3.0E+06	1.1E+00	1.3E+00	1.3E+00	1.3E+00	3.0E+06	2.0E-03	2.0E-03	2.0E-03	2.0E-03
1.0E+07	1.4E-01	1.1E+00	1.1E+00	1.1E+00	1.0E+07	1.7E-03	1.6E-03	1.6E-03	1.6E-03
3.2E+07	3.3E-02	1.0E+00	1.1E+00	1.1E+00	3.2E+07	1.1E-03	1.0E-03	1.0E-03	1.0E-03

Pu238	Mass Limits (g) at fluence rates				Pu241	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+01	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+01	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.0E+01	6.1E-04	6.1E-04	6.1E-04	6.1E-04
1.0E+02	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+02	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+02	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.0E+02	6.1E-04	6.1E-04	6.1E-04	6.1E-04
1.0E+03	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+03	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+03	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.0E+03	6.1E-04	6.1E-04	6.1E-04	6.1E-04
1.0E+04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.0E+04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
1.0E+05	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+05	6.0E-04	6.0E-04	6.0E-04	6.0E-04
3.0E+05	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.0E+05	6.0E-04	6.0E-04	6.0E-04	6.0E-04
1.0E+06	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+06	6.0E-04	6.0E-04	6.0E-04	6.0E-04
3.0E+06	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.0E+06	6.0E-04	6.0E-04	6.0E-04	6.0E-04
1.0E+07	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.0E+07	6.0E-04	6.0E-04	6.0E-04	6.0E-04
3.2E+07	1.7E-04	1.7E-04	1.7E-04	1.7E-04	3.2E+07	6.0E-04	6.0E-04	6.0E-04	6.0E-04

Pu239	Mass Limits (g) at fluence rates				Pu242	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	4.7E-02	4.7E-02	4.7E-02	4.7E-02	1.0E+01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+01	4.7E-02	4.7E-02	4.7E-02	4.7E-02	3.0E+01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
1.0E+02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	1.0E+02	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	3.0E+02	7.4E-01	7.4E-01	7.4E-01	7.4E-01
1.0E+03	3.9E-02	4.6E-02	4.6E-02	4.6E-02	1.0E+03	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+03	3.4E-02	4.6E-02	4.6E-02	4.6E-02	3.0E+03	7.4E-01	7.4E-01	7.4E-01	7.4E-01
1.0E+04	2.8E-02	4.6E-02	4.6E-02	4.6E-02	1.0E+04	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+04	2.3E-02	4.6E-02	4.6E-02	4.6E-02	3.0E+04	7.3E-01	7.3E-01	7.3E-01	7.3E-01
1.0E+05	1.7E-02	4.6E-02	4.6E-02	4.6E-02	1.0E+05	7.0E-01	7.1E-01	7.1E-01	7.1E-01
3.0E+05	9.2E-03	4.6E-02	4.6E-02	4.6E-02	3.0E+05	5.4E-01	6.2E-01	6.3E-01	6.4E-01
1.0E+06	3.8E-03	3.8E-02	4.4E-02	4.4E-02	1.0E+06	1.8E-01	4.1E-01	4.7E-01	4.7E-01
3.0E+06	1.2E-03	1.2E-02	3.9E-02	3.9E-02	3.0E+06	2.9E-02	1.5E-01	2.5E-01	2.7E-01
1.0E+07	8.6E-04	8.2E-03	3.3E-02	3.5E-02	1.0E+07	2.9E-03	2.3E-02	8.0E-02	1.1E-01
3.2E+07	7.3E-04	6.0E-03	2.1E-02	2.8E-02	3.2E+07	3.0E-04	2.8E-03	1.7E-02	3.4E-02

Notation in Table 3.8-1 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the limiting mass for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Limit}} \leq 1$

Table 3.8-1 Mass Limits

U232	Mass Limits (g) at fluence rates				U235	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+01	1.1E+00	1.1E+01	2.3E+01	2.3E+01
3.0E+01	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.0E+01	2.1E-01	2.1E+00	9.6E+00	9.6E+00
1.0E+02	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+02	8.9E-02	8.9E-01	4.5E+00	4.5E+00
3.0E+02	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.0E+02	5.6E-02	5.6E-01	2.8E+00	2.8E+00
1.0E+03	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+03	4.5E-02	4.5E-01	2.1E+00	2.1E+00
3.0E+03	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.0E+03	4.0E-02	4.0E-01	2.0E+00	2.0E+00
1.0E+04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+04	3.5E-02	3.5E-01	2.0E+00	2.0E+00
3.0E+04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.0E+04	3.0E-01	3.0E-01	1.9E+00	1.9E+00
1.0E+05	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+05	2.5E-02	2.5E-01	1.9E+00	1.9E+00
3.0E+05	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.0E+05	1.4E-02	1.4E-01	1.4E+00	1.7E+00
1.0E+06	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+06	7.1E-03	7.1E-02	7.1E-01	1.0E+00
3.0E+06	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.0E+06	2.4E-03	2.3E-02	2.3E-01	4.6E-01
1.0E+07	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E+07	1.7E-03	1.7E-02	1.7E-01	3.5E-01
3.2E+07	1.0E-04	1.0E-04	1.0E-04	1.0E-04	3.2E+07	1.8E-03	1.7E-02	1.6E-01	3.4E-01

U233	Mass Limits (g) at fluence rates				U236	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	4.3E-01	9.1E-01	1.0E+00	1.0E+00	1.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+01	1.4E-01	6.4E-01	9.8E-01	1.0E+00	3.0E+01	2.6E+01	1.0E+02	1.0E+02	1.0E+02
1.0E+02	6.2E-02	4.0E-01	9.0E-01	1.0E+00	1.0E+02	1.2E+01	8.6E+01	1.0E+02	1.0E+02
3.0E+02	3.8E-02	2.9E-01	8.2E-01	1.0E+00	3.0E+02	7.3E+00	6.0E+01	1.0E+02	1.0E+02
1.0E+03	3.0E-02	2.4E-01	7.8E-01	1.0E+00	1.0E+03	6.0E+00	5.9E+01	1.0E+02	1.0E+02
3.0E+03	2.7E-02	2.2E-01	7.6E-01	1.0E+00	3.0E+03	5.2E+00	4.3E+01	1.0E+02	1.0E+02
1.0E+04	2.4E-02	2.0E-01	7.3E-01	9.9E-01	1.0E+04	4.5E+00	3.4E+01	9.7E+01	1.0E+02
3.0E+04	2.1E-02	1.8E-01	7.0E-01	9.9E-01	3.0E+04	3.8E+00	2.4E+01	5.0E+01	5.6E+01
1.0E+05	1.7E-02	1.5E-01	6.5E-01	9.8E-01	1.0E+05	2.9E+00	1.3E+01	1.9E+01	2.0E+01
3.0E+05	1.0E-02	1.0E-01	5.9E-01	9.6E-01	3.0E+05	2.0E+00	6.2E+00	7.7E+00	7.9E+00
1.0E+06	3.8E-03	3.7E-02	3.7E-01	5.9E-01	1.0E+06	1.1E+00	3.0E+00	3.4E+00	3.5E+00
3.0E+06	1.2E-03	1.2E-02	1.2E-01	2.4E-01	3.0E+06	3.5E-01	2.2E+00	2.5E+00	2.5E+00
1.0E+07	8.6E-04	8.2E-03	8.2E-02	1.8E-01	1.0E+07	2.5E-01	2.0E+00	2.4E+00	2.4E+00
3.2E+07	9.0E-04	7.9E-03	7.8E-02	1.8E-01	3.2E+07	2.5E-01	2.0E+00	2.4E+00	2.4E+00

U234	Mass Limits (g) at fluence rates				U238	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	3.1E+00	3.1E+00	3.1E+00	3.1E+00	1.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+01	3.0E+00	3.1E+00	3.1E+00	3.1E+00	3.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
1.0E+02	2.9E+00	3.1E+00	3.1E+00	3.1E+00	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+02	2.8E+00	3.1E+00	3.1E+00	3.1E+00	3.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
1.0E+03	2.7E+00	3.1E+00	3.1E+00	3.1E+00	1.0E+03	5.1E+01	9.4E+01	1.0E+02	1.0E+02
3.0E+03	2.6E+00	3.1E+00	3.1E+00	3.1E+00	3.0E+03	1.6E+01	1.9E+01	1.9E+01	1.9E+01
1.0E+04	2.6E+00	3.1E+00	3.1E+00	3.1E+00	1.0E+04	5.5E+00	5.9E+00	5.9E+00	5.9E+00
3.0E+04	2.5E+00	3.1E+00	3.1E+00	3.1E+00	3.0E+04	4.3E+00	4.7E+00	4.7E+00	4.7E+00
1.0E+05	2.3E+00	3.0E+00	3.1E+00	3.1E+00	1.0E+05	4.1E+00	4.6E+00	4.6E+00	4.7E+00
3.0E+05	1.9E+00	3.0E+00	3.1E+00	3.1E+00	3.0E+05	3.4E+00	4.6E+00	4.6E+00	4.7E+00
1.0E+06	7.9E-01	2.9E+00	3.1E+00	3.1E+00	1.0E+06	1.5E+00	4.5E+00	4.6E+00	4.6E+00
3.0E+06	1.1E-01	2.8E+00	3.1E+00	3.1E+00	3.0E+06	1.6E-01	4.2E+00	4.5E+00	4.5E+00
1.0E+07	2.6E-02	1.8E+00	3.1E+00	3.1E+00	1.0E+07	3.5E-02	3.2E+00	4.1E+00	4.2E+00
3.2E+07	8.8E-03	7.1E-01	3.0E+00	3.1E+00	3.2E+07	1.1E-02	1.1E+00	3.3E+00	3.4E+00

Notation in Table 3.8-1 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the limiting mass for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Limit}} \leq 1$

Table 3.8-2 Fueled Experiment Mass Thresholds

Am241	Non-fueled Experiment Mass Limits (g) at fluence rates					Cf249	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10		Time,s	1.0E+13	1.0E+12	1.0E+11	
1.0E+01	1.5E-06	1.5E-06	1.5E-06	1.5E-06		1.0E+01	9.4E-07	9.4E-07	9.4E-07	9.4E-07
3.0E+01	1.5E-06	1.5E-06	1.5E-06	1.5E-06		3.0E+01	9.4E-07	9.4E-07	9.4E-07	9.4E-07
1.0E+02	1.5E-06	1.5E-06	1.5E-06	1.5E-06		1.0E+02	9.3E-07	9.4E-07	9.4E-07	9.4E-07
3.0E+02	1.5E-06	1.5E-06	1.5E-06	1.5E-06		3.0E+02	9.2E-07	9.4E-07	9.4E-07	9.4E-07
1.0E+03	1.5E-06	1.5E-06	1.5E-06	1.5E-06		1.0E+03	9.1E-07	9.4E-07	9.4E-07	9.4E-07
3.0E+03	1.5E-06	1.5E-06	1.5E-06	1.5E-06		3.0E+03	8.7E-07	9.4E-07	9.4E-07	9.4E-07
1.0E+04	1.5E-06	1.5E-06	1.5E-06	1.5E-06		1.0E+04	7.8E-07	9.2E-07	9.4E-07	9.4E-07
3.0E+04	1.5E-06	1.5E-06	1.5E-06	1.5E-06		3.0E+04	6.4E-07	9.0E-07	9.4E-07	9.4E-07
1.0E+05	1.5E-06	1.5E-06	1.5E-06	1.5E-06		1.0E+05	5.2E-07	8.7E-07	9.3E-07	9.4E-07
3.0E+05	1.4E-06	1.4E-06	1.4E-06	1.4E-06		3.0E+05	4.6E-07	8.4E-07	9.1E-07	9.2E-07
1.0E+06	1.4E-06	1.4E-06	1.4E-06	1.4E-06		1.0E+06	4.3E-07	8.0E-07	8.7E-07	8.8E-07
3.0E+06	1.4E-06	1.4E-06	1.4E-06	1.4E-06		3.0E+06	4.1E-07	7.1E-07	7.7E-07	7.8E-07
1.0E+07	1.4E-06	1.4E-06	1.4E-06	1.4E-06		1.0E+07	3.8E-07	5.3E-07	5.6E-07	5.6E-07
3.2E+07	1.4E-06	1.4E-06	1.4E-06	1.4E-06						

Am243	Non-fueled Experiment Mass Limits (g) at fluence rates					Cf251	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10		Time,s	1.0E+13	1.0E+12	1.0E+11	
1.0E+01	2.6E-05	2.6E-05	2.6E-05	2.6E-05		1.0E+01	2.4E-06	2.4E-06	2.4E-06	2.4E-06
3.0E+01	2.6E-05	2.6E-05	2.6E-05	2.6E-05		3.0E+01	2.4E-06	2.4E-06	2.4E-06	2.4E-06
1.0E+02	2.6E-05	2.6E-05	2.6E-05	2.6E-05		1.0E+02	2.3E-06	2.4E-06	2.4E-06	2.4E-06
3.0E+02	2.6E-05	2.6E-05	2.6E-05	2.6E-05		3.0E+02	2.2E-06	2.4E-06	2.4E-06	2.4E-06
1.0E+03	2.6E-05	2.6E-05	2.6E-05	2.6E-05		1.0E+03	2.0E-06	2.4E-06	2.4E-06	2.4E-06
3.0E+03	2.5E-05	2.5E-05	2.5E-05	2.5E-05		3.0E+03	1.6E-06	2.3E-06	2.4E-06	2.4E-06
1.0E+04	2.5E-05	2.5E-05	2.5E-05	2.5E-05		1.0E+04	1.1E-06	2.1E-06	2.3E-06	2.4E-06
3.0E+04	2.2E-05	2.2E-05	2.2E-05	2.2E-05		3.0E+04	6.5E-07	1.8E-06	2.1E-06	2.2E-06
1.0E+05	1.7E-05	1.7E-05	1.7E-05	1.7E-05		1.0E+05	4.0E-07	1.3E-06	1.7E-06	1.8E-06
3.0E+05	9.5E-06	9.6E-06	9.6E-06	9.6E-06		3.0E+05	3.0E-07	9.0E-07	1.1E-06	1.2E-06
1.0E+06	3.8E-06	3.8E-06	3.8E-06	3.8E-06		1.0E+06	2.3E-07	4.7E-07	5.2E-07	5.3E-07
3.0E+06	1.5E-06	1.4E-06	1.4E-06	1.4E-06		3.0E+06	1.6E-07	2.0E-07	2.1E-07	2.1E-07
1.0E+07	5.2E-07	4.4E-07	4.4E-07	4.3E-07		1.0E+07	1.2E-07	7.3E-08	6.9E-08	6.8E-08
3.2E+07	2.5E-07	1.5E-07	1.4E-07	1.4E-07						

Np237	Non-fueled Experiment Mass Limits (g) at fluence rates					Pa231	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10		Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	5.4E-03	5.5E-03	5.5E-03	5.5E-03		1.0E+01	5.4E-03	5.4E-03	5.4E-03	5.4E-03
3.0E+01	5.3E-03	5.4E-03	5.5E-03	5.5E-03		3.0E+01	5.3E-03	5.3E-03	5.3E-03	5.3E-03
1.0E+02	5.1E-03	5.4E-03	5.4E-03	5.4E-03		1.0E+02	5.1E-03	5.1E-03	5.1E-03	5.1E-03
3.0E+02	4.7E-03	5.2E-03	5.3E-03	5.3E-03		3.0E+02	4.7E-03	4.7E-03	4.7E-03	4.7E-03
1.0E+03	4.3E-03	4.8E-03	4.9E-03	4.9E-03		1.0E+03	4.3E-03	4.3E-03	4.3E-03	4.3E-03
3.0E+03	3.5E-03	4.0E-03	4.0E-03	4.0E-03		3.0E+03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+04	2.3E-03	2.5E-03	2.5E-03	2.5E-03		1.0E+04	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+04	1.1E-03	1.2E-03	1.2E-03	1.2E-03		3.0E+04	1.1E-03	1.1E-03	1.1E-03	1.1E-03
1.0E+05	4.3E-04	4.5E-04	4.5E-04	4.5E-04		1.0E+05	4.3E-04	4.3E-04	4.3E-04	4.3E-04
3.0E+05	1.7E-04	1.8E-04	1.8E-04	1.8E-04		3.0E+05	1.8E-04	1.8E-04	1.8E-04	1.8E-04
1.0E+06	6.8E-05	7.1E-05	7.1E-05	7.1E-05		1.0E+06	6.9E-05	6.9E-05	6.9E-05	6.9E-05
3.0E+06	2.6E-05	2.8E-05	2.8E-05	2.8E-05		3.0E+06	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+07	8.7E-06	8.9E-06	8.9E-06	8.8E-06		1.0E+07	9.1E-06	9.1E-06	9.1E-06	9.1E-06
3.2E+07	3.1E-06	2.9E-06	2.9E-06	2.9E-06		3.2E+07	3.2E-06	3.2E-06	3.2E-06	3.2E-06

Notation in Table 3.8-2 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the mass threshold for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Threshold}} \leq 1$

If the sum of the fractions from Table TS 3.8-2 exceeds 1, then the experiment is fueled and Table 3.8-1 shall be met.

Table 3.8-2 Fueled Experiment Mass Thresholds

Cm242	Non-fueled Experiment Mass Limits (g) at fluence rates				Cm245	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+01	2.1E-05	2.1E-05	2.2E-05	2.2E-05
3.0E+01	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.0E+01	1.9E-05	2.1E-05	2.2E-05	2.2E-05
1.0E+02	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+02	1.7E-05	2.1E-05	2.2E-05	2.2E-05
3.0E+02	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.0E+02	1.4E-05	2.1E-05	2.1E-05	2.2E-05
1.0E+03	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+03	1.2E-05	2.0E-05	2.1E-05	2.2E-05
3.0E+03	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.0E+03	9.2E-06	1.9E-05	2.1E-05	2.2E-05
1.0E+04	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+04	5.7E-06	1.7E-05	2.1E-05	2.2E-05
3.0E+04	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.0E+04	3.3E-06	1.4E-05	2.0E-05	2.1E-05
1.0E+05	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+05	2.0E-06	1.1E-05	2.0E-05	2.1E-05
3.0E+05	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.0E+05	1.6E-06	9.5E-06	1.9E-05	2.1E-05
1.0E+06	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+06	1.4E-06	8.9E-06	1.9E-05	2.1E-05
3.0E+06	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.0E+06	1.3E-06	8.3E-06	1.8E-05	2.1E-05
1.0E+07	3.8E-08	3.8E-08	3.8E-08	3.8E-08	1.0E+07	1.3E-06	7.8E-06	1.7E-05	2.0E-05
3.2E+07	3.8E-08	3.8E-08	3.8E-08	3.8E-08	3.2E+07	1.5E-06	7.1E-06	1.6E-05	1.8E-05

Cm243	Non-fueled Experiment Mass Limits (g) at fluence rates				Cm246	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.6E-07	1.6E-07	1.6E-07	1.6E-07	1.0E+01	1.3E-05	1.3E-05	1.3E-05	1.3E-05
3.0E+01	1.6E-07	1.6E-07	1.6E-07	1.6E-07	3.0E+01	1.3E-05	1.3E-05	1.3E-05	1.3E-05
1.0E+02	1.6E-07	1.6E-07	1.6E-07	1.6E-07	1.0E+02	1.3E-05	1.3E-05	1.3E-05	1.3E-05
3.0E+02	1.6E-07	1.6E-07	1.6E-07	1.6E-07	3.0E+02	1.3E-05	1.3E-05	1.3E-05	1.3E-05
1.0E+03	1.6E-07	1.6E-07	1.6E-07	1.6E-07	1.0E+03	1.3E-05	1.3E-05	1.3E-05	1.3E-05
3.0E+03	1.6E-07	1.6E-07	1.6E-07	1.6E-07	3.0E+03	1.3E-05	1.3E-05	1.3E-05	1.3E-05
1.0E+04	1.6E-07	1.6E-07	1.6E-07	1.6E-07	1.0E+04	1.3E-05	1.3E-05	1.3E-05	1.3E-05
3.0E+04	1.6E-07	1.6E-07	1.6E-07	1.6E-07	3.0E+04	1.3E-05	1.3E-05	1.3E-05	1.3E-05
1.0E+05	1.5E-07	1.6E-07	1.6E-07	1.6E-07	1.0E+05	1.2E-05	1.3E-05	1.3E-05	1.3E-05
3.0E+05	1.5E-07	1.6E-07	1.6E-07	1.6E-07	3.0E+05	1.2E-05	1.3E-05	1.3E-05	1.3E-05
1.0E+06	1.5E-07	1.6E-07	1.6E-07	1.6E-07	1.0E+06	1.2E-05	1.3E-05	1.3E-05	1.3E-05
3.0E+06	1.5E-07	1.6E-07	1.6E-07	1.6E-07	3.0E+06	1.2E-05	1.3E-05	1.3E-05	1.3E-05
1.0E+07	1.5E-07	1.5E-07	1.5E-07	1.5E-07	1.0E+07	1.2E-05	1.3E-05	1.3E-05	1.3E-05
3.2E+07	1.5E-07	1.5E-07	1.4E-07	1.4E-07	3.2E+07	1.2E-05	1.3E-05	1.3E-05	1.3E-05

Cm244	Non-fueled Experiment Mass Limits (g) at fluence rates				Cm248	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+01	3.0E-04	3.0E-04	3.0E-04	3.0E-04
3.0E+01	7.3E-08	7.3E-08	7.3E-08	7.3E-08	3.0E+01	3.0E-04	3.0E-04	3.0E-04	3.0E-04
1.0E+02	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+02	3.0E-04	3.0E-04	3.0E-04	3.0E-04
3.0E+02	7.3E-08	7.3E-08	7.3E-08	7.3E-08	3.0E+02	2.9E-04	3.0E-04	3.0E-04	3.0E-04
1.0E+03	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+03	2.9E-04	3.0E-04	3.0E-04	3.0E-04
3.0E+03	7.3E-08	7.3E-08	7.3E-08	7.3E-08	3.0E+03	2.8E-04	3.0E-04	3.0E-04	3.0E-04
1.0E+04	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+04	2.5E-04	3.0E-04	3.0E-04	3.0E-04
3.0E+04	7.3E-08	7.3E-08	7.3E-08	7.3E-08	3.0E+04	2.1E-04	2.9E-04	3.0E-04	3.0E-04
1.0E+05	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+05	1.7E-04	2.7E-04	2.9E-04	2.9E-04
3.0E+05	7.3E-08	7.3E-08	7.3E-08	7.3E-08	3.0E+05	1.4E-04	2.4E-04	2.6E-04	2.6E-04
1.0E+06	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+06	1.2E-04	1.9E-04	2.0E-04	2.0E-04
3.0E+06	7.3E-08	7.3E-08	7.3E-08	7.3E-08	3.0E+06	8.1E-05	1.1E-04	1.2E-04	1.2E-04
1.0E+07	7.3E-08	7.3E-08	7.3E-08	7.3E-08	1.0E+07	3.3E-05	4.6E-05	4.7E-05	4.7E-05
3.2E+07	7.3E-08	7.2E-08	7.1E-08	7.0E-08	3.2E+07	6.2E-06	1.4E-05	1.5E-05	1.5E-05

Notation in Table 3.8-2 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the mass threshold for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Threshold}} \leq 1$

If the sum of the fractions from Table TS 3.8-2 exceeds 1, then the experiment is fueled and Table 3.8-1 shall be met.

Table 3.8-2 Fueled Experiment Mass Thresholds

Th232	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	3.5E-01	4.1E-01	4.2E-01	4.2E-01
3.0E+01	1.2E-01	1.4E-01	1.4E-01	1.4E-01
1.0E+02	3.9E-02	4.4E-02	4.5E-02	4.5E-02
3.0E+02	1.5E-02	1.6E-02	1.6E-02	1.6E-02
1.0E+03	5.4E-03	5.6E-03	5.6E-03	5.6E-03
3.0E+03	2.8E-03	2.9E-03	2.9E-03	2.9E-03
1.0E+04	2.2E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+04	2.2E-03	2.2E-03	2.2E-03	2.2E-03
1.0E+05	2.2E-03	2.2E-03	2.2E-03	2.2E-03
3.0E+05	2.1E-03	2.2E-03	2.2E-03	2.2E-03
1.0E+06	1.9E-03	2.0E-03	2.0E-03	2.0E-03
3.0E+06	1.4E-03	1.7E-03	1.7E-03	1.7E-03
1.0E+07	6.4E-04	1.5E-03	1.5E-03	1.5E-03
3.2E+07	1.7E-04	1.4E-03	1.5E-03	1.5E-03

Pu240	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	4.0E-06	4.0E-06	4.0E-06	4.0E-06
3.0E+01	4.0E-06	4.0E-06	4.0E-06	4.0E-06
1.0E+02	4.0E-06	4.0E-06	4.0E-06	4.0E-06
3.0E+02	4.0E-06	4.0E-06	4.0E-06	4.0E-06
1.0E+03	4.0E-06	4.0E-06	4.0E-06	4.0E-06
3.0E+03	4.0E-06	4.0E-06	4.0E-06	4.0E-06
1.0E+04	4.0E-06	4.0E-06	4.0E-06	4.0E-06
3.0E+04	4.0E-06	4.0E-06	4.0E-06	4.0E-06
1.0E+05	4.0E-06	4.0E-06	4.0E-06	4.0E-06
3.0E+05	4.0E-06	4.0E-06	4.0E-06	4.0E-06
1.0E+06	3.9E-06	3.9E-06	3.9E-06	3.9E-06
3.0E+06	3.8E-06	3.8E-06	3.8E-06	3.8E-06
1.0E+07	3.3E-06	3.3E-06	3.3E-06	3.3E-06
3.2E+07	2.5E-06	2.4E-06	2.4E-06	2.4E-06

Pu238	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	6.0E-07	6.0E-07	6.0E-07	6.0E-07
3.0E+01	6.0E-07	6.0E-07	6.0E-07	6.0E-07
1.0E+02	6.0E-07	6.0E-07	6.0E-07	6.0E-07
3.0E+02	6.0E-07	6.0E-07	6.0E-07	6.0E-07
1.0E+03	6.0E-07	6.0E-07	6.0E-07	6.0E-07
3.0E+03	6.0E-07	6.0E-07	6.0E-07	6.0E-07
1.0E+04	6.0E-07	6.0E-07	6.0E-07	6.0E-07
3.0E+04	6.0E-07	6.0E-07	6.0E-07	6.0E-07
1.0E+05	6.0E-07	6.0E-07	6.0E-07	6.0E-07
3.0E+05	6.0E-07	6.0E-07	6.0E-07	6.0E-07
1.0E+06	6.1E-07	6.0E-07	6.0E-07	6.0E-07
3.0E+06	6.1E-07	6.1E-07	6.1E-07	6.1E-07
1.0E+07	6.4E-07	6.1E-07	6.1E-07	6.1E-07
3.2E+07	7.1E-07	6.2E-07	6.1E-07	6.1E-07

Pu241	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.7E-06	1.7E-06	1.7E-06	1.7E-06
3.0E+01	1.7E-06	1.7E-06	1.7E-06	1.7E-06
1.0E+02	1.7E-06	1.7E-06	1.7E-06	1.7E-06
3.0E+02	1.6E-06	1.7E-06	1.7E-06	1.7E-06
1.0E+03	1.6E-06	1.7E-06	1.7E-06	1.7E-06
3.0E+03	1.6E-06	1.7E-06	1.7E-06	1.7E-06
1.0E+04	1.6E-06	1.7E-06	1.7E-06	1.7E-06
3.0E+04	1.6E-06	1.7E-06	1.7E-06	1.7E-06
1.0E+05	1.5E-06	1.6E-06	1.7E-06	1.7E-06
3.0E+05	1.5E-06	1.6E-06	1.6E-06	1.6E-06
1.0E+06	1.4E-06	1.6E-06	1.6E-06	1.6E-06
3.0E+06	1.4E-06	1.6E-06	1.6E-06	1.6E-06
1.0E+07	1.4E-06	1.6E-06	1.6E-06	1.6E-06
3.2E+07	1.7E-06	1.6E-06	1.6E-06	1.6E-06

Pu239	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.3E-04	1.4E-04	1.5E-04	1.5E-04
3.0E+01	1.1E-04	1.4E-04	1.5E-04	1.5E-04
1.0E+02	8.1E-05	1.3E-04	1.4E-04	1.5E-04
3.0E+02	6.2E-05	1.3E-04	1.4E-04	1.5E-04
1.0E+03	5.2E-05	1.2E-04	1.4E-04	1.5E-04
3.0E+03	4.5E-05	1.2E-04	1.4E-04	1.5E-04
1.0E+04	3.8E-05	1.1E-04	1.4E-04	1.5E-04
3.0E+04	3.0E-05	1.1E-04	1.4E-04	1.5E-04
1.0E+05	2.2E-05	9.4E-05	1.4E-04	1.4E-04
3.0E+05	1.7E-05	8.3E-05	1.3E-04	1.4E-04
1.0E+06	1.2E-05	6.8E-05	1.3E-04	1.4E-04
3.0E+06	8.1E-06	5.3E-05	1.2E-04	1.4E-04
1.0E+07	5.4E-06	3.8E-05	1.1E-04	1.3E-04
3.2E+07	1.7E-06	1.4E-05	6.5E-05	1.0E-04

Pu242	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+01	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+02	2.2E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+02	2.2E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+03	2.2E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+03	2.1E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+04	2.1E-03	2.2E-03	2.2E-03	2.2E-03
3.0E+04	1.9E-03	2.1E-03	2.2E-03	2.2E-03
1.0E+05	1.7E-03	2.0E-03	2.0E-03	2.0E-03
3.0E+05	1.1E-03	1.6E-03	1.7E-03	1.7E-03
1.0E+06	2.8E-04	8.7E-04	1.1E-03	1.1E-03
3.0E+06	4.0E-05	2.5E-04	5.0E-04	5.6E-04
1.0E+07	3.9E-06	3.3E-05	1.4E-04	2.0E-04
3.2E+07	4.0E-07	3.8E-06	2.5E-05	6.0E-05

Notation in Table 3.8-2 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the mass threshold for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Threshold}} \leq 1$

If the sum of the fractions from Table TS 3.8-2 exceeds 1, then the experiment is fueled and Table 3.8-1 shall be met.

Table 3.8-2 Fueled Experiment Mass Thresholds

U232	Non-fueled Experiment Mass Limits (g) at fluence rates				U235	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+01	1.5E-03	1.5E-02	1.5E-01	1.3E+00
3.0E+01	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.0E+01	2.9E-04	2.8E-03	2.8E-02	2.8E-01
1.0E+02	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+02	1.2E-04	1.2E-03	1.2E-02	1.2E-01
3.0E+02	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.0E+02	7.4E-05	7.4E-04	7.4E-03	7.3E-02
1.0E+03	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+03	6.0E-05	6.0E-04	6.0E-03	5.9E-02
3.0E+03	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.0E+03	5.3E-05	5.3E-04	5.3E-03	5.3E-02
1.0E+04	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+04	4.6E-05	4.6E-04	4.6E-03	4.6E-02
3.0E+04	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.0E+04	4.0E-05	4.0E-04	4.0E-03	4.0E-02
1.0E+05	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+05	3.3E-05	3.3E-04	3.3E-03	3.2E-02
3.0E+05	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.0E+05	2.6E-05	2.6E-04	2.6E-03	2.6E-02
1.0E+06	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+06	2.0E-05	2.0E-04	2.0E-03	2.0E-02
3.0E+06	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.0E+06	1.5E-05	1.5E-04	1.5E-03	1.5E-02
1.0E+07	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.0E+07	1.2E-05	1.2E-04	1.2E-03	1.2E-02
3.2E+07	1.4E-07	1.4E-07	1.4E-07	1.4E-07	3.2E+07	1.1E-05	9.7E-05	9.6E-04	9.6E-03

U233	Non-fueled Experiment Mass Limits (g) at fluence rates				U236	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	5.7E-04	1.2E-03	1.4E-03	1.4E-03	1.0E+01	1.4E-01	3.4E-01	4.0E-01	4.0E-01
3.0E+01	1.9E-04	8.5E-04	1.3E-03	1.4E-03	3.0E+01	3.5E-02	2.0E-01	3.6E-01	4.0E-01
1.0E+02	8.3E-05	5.4E-04	1.2E-03	1.4E-03	1.0E+02	1.5E-02	1.1E-01	3.2E-01	3.9E-01
3.0E+02	5.1E-05	3.8E-04	1.1E-03	1.3E-03	3.0E+02	9.7E-03	7.9E-02	2.8E-01	3.7E-01
1.0E+03	4.0E-05	3.2E-04	1.0E-03	1.3E-03	1.0E+03	8.0E-03	7.8E-02	6.5E-01	2.4E+00
3.0E+03	3.6E-05	2.9E-04	1.0E-03	1.3E-03	3.0E+03	6.9E-03	5.7E-02	2.0E-01	2.7E-01
1.0E+04	3.2E-05	2.6E-04	9.7E-04	1.3E-03	1.0E+04	5.9E-03	4.5E-02	1.3E-01	1.6E-01
3.0E+04	2.8E-05	2.4E-04	9.3E-04	1.3E-03	3.0E+04	5.1E-03	3.2E-02	6.7E-02	7.5E-02
1.0E+05	2.3E-05	2.0E-04	8.6E-04	1.3E-03	1.0E+05	3.8E-03	1.7E-02	2.6E-02	2.7E-02
3.0E+05	1.8E-05	1.6E-04	7.8E-04	1.3E-03	3.0E+05	2.7E-03	8.2E-03	1.0E-02	1.1E-02
1.0E+06	1.2E-05	1.2E-04	6.6E-04	1.2E-03	1.0E+06	1.7E-03	4.0E-03	4.6E-03	4.6E-03
3.0E+06	8.5E-06	8.0E-05	5.2E-04	1.2E-03	3.0E+06	1.3E-03	2.9E-03	3.3E-03	3.3E-03
1.0E+07	6.7E-06	6.2E-05	4.4E-04	1.1E-03	1.0E+07	1.1E-03	2.7E-03	3.2E-03	3.2E-03
3.2E+07	5.3E-06	4.6E-05	3.5E-04	1.0E-03	3.2E+07	9.7E-04	2.6E-03	3.2E-03	3.2E-03

U234	Non-fueled Experiment Mass Limits (g) at fluence rates				U238	Non-fueled Experiment Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10	Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	4.1E-03	4.2E-03	4.2E-03	4.2E-03	1.0E+01	3.4E+00	1.9E+01	3.6E+01	3.9E+01
3.0E+01	4.0E-03	4.1E-03	4.2E-03	4.2E-03	3.0E+01	5.9E-01	4.6E+00	1.4E+01	1.8E+01
1.0E+02	3.9E-03	4.1E-03	4.2E-03	4.2E-03	1.0E+02	2.5E-01	1.7E+00	4.2E+00	4.8E+00
3.0E+02	3.7E-03	4.1E-03	4.2E-03	4.2E-03	3.0E+02	1.4E-01	6.3E-01	9.4E-01	9.9E-01
1.0E+03	3.6E-03	4.1E-03	4.1E-03	4.2E-03	1.0E+03	6.8E-02	1.2E-01	1.4E-01	1.4E-01
3.0E+03	3.5E-03	4.1E-03	4.1E-03	4.2E-03	3.0E+03	2.1E-02	2.5E-02	2.5E-02	2.5E-02
1.0E+04	3.4E-03	4.1E-03	4.1E-03	4.2E-03	1.0E+04	7.3E-03	7.8E-03	7.9E-03	7.9E-03
3.0E+04	3.3E-03	4.1E-03	4.1E-03	4.2E-03	3.0E+04	5.8E-03	6.2E-03	6.2E-03	6.2E-03
1.0E+05	3.0E-03	4.0E-03	4.1E-03	4.2E-03	1.0E+05	5.4E-03	6.1E-03	6.2E-03	6.2E-03
3.0E+05	2.5E-03	4.0E-03	4.1E-03	4.2E-03	3.0E+05	4.6E-03	6.1E-03	6.2E-03	6.2E-03
1.0E+06	1.5E-03	3.9E-03	4.1E-03	4.2E-03	1.0E+06	2.6E-03	6.0E-03	6.1E-03	6.1E-03
3.0E+06	5.9E-04	3.7E-03	4.1E-03	4.2E-03	3.0E+06	8.9E-04	5.6E-03	6.0E-03	6.0E-03
1.0E+07	1.8E-04	3.2E-03	4.1E-03	4.1E-03	1.0E+07	2.4E-04	4.4E-03	5.5E-03	5.5E-03
3.2E+07	5.2E-05	2.1E-03	4.0E-03	4.1E-03	3.2E+07	6.1E-05	2.4E-03	4.5E-03	4.5E-03

Notation in Table 3.8-2 is read as follows: 1.2E-03 = 1.2×10^{-3}

For mixtures, the sum of the fractions of the initial experiment mass to the mass threshold for each i^{th} fissionable material shall not exceed a value of 1: $\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Threshold}} \leq 1$

If the sum of the fractions from Table TS 3.8-2 exceeds 1, then the experiment is fueled and Table 3.8-1 shall be met.

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ATTACHMENT 1

FUELED EXPERIMENT ANALYSIS

TECHNICAL SPECIFICATIONS AMENDMENT 18

TABLE OF CONTENTS

Attachment 1 Revision Summary:

1. Analysis is rewritten and reformatted. References, symbols and abbreviations are given. Sections on activity and mass estimates for fissionable materials and bone surface dose and possession limits were added. The TS definition for fueled experiments was revised based on radiation dose. Specific fissionable materials are listed for fueled experiments in TS 3.8.

2. Radioactive materials are encapsulated until the time of failure. Release of radioactive materials from an encapsulation failure are based on NUREG 1400 (Ref 8), ANSI/ANS 15.7 (Ref 33), and US NRC Regulatory Guide 2.2 (Ref 11). Dispersion factor for particulates is reported as 0.01 in NUREG 1400 and was used. Previous analysis used a factor of 1.

3. Correction to the fissionable material mass is made as a result of activation and fission reactions during the irradiation time. The average mass of each fissionable material present during the irradiation time was used to determine the activity present in the sample prior to release. Previous analysis did not account for burnup or decay of fissionable material.

4. Single-mode nonviolent failure of the encapsulation boundary was the failure mode considered in the release of radioactive material into the reactor building free air volume. (Ref 11). The reactor building free air volume is approximated at 2.4 E9 ml based on reported (Ref 22) and measured data. TS 5.2a was revised to list the reactor building volume as 2.4E9 ml.

5. Exposure times to personnel in the reactor building is 0.05 hours (3 minutes) based on measured and estimated evacuation time from the reactor building.

6. A correction factor of 0.1 is used for submersion dose within the reactor building for photons emitted by noble gases based on dimensions and geometry. A sphere rather than hemisphere is assumed. (Ref 27, 28, 29)

7. Fissionable materials are a radiation dose hazard to the bone surfaces. The bone surface dose was evaluated. In many cases, the bone surface dose was the limiting consideration in setting experiment fission rates.

8. 10 CFR Part 37 Category 2 Quantities of Concern were evaluated to establish license possession limits. This included the fissionable materials present or produced during irradiation and the fission products produced. By staying below these limits, the facility security plan does not require a revision. A license change to possession limits is proposed.

9. TS 1.2.9 regarding the definition of a fueled experiment was changed based on the mass of fissionable materials that are consistent with not exceeding the public constraint dose or use of self-encapsulated items. Adjustments for normal ventilation mode and exposure time for at least 5 air changes were made following an accidental release.

10. TS 3.8 was revised to address storage of fissionable material and only allow specific fissionable materials to be used in fueled experiments.

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A. INTRODUCTION

An amendment to the Technical Specifications (TS) is requested regarding TS 3.8 for fueled experiments. TS 3.8 on fueled experiments currently provides limits for fueled experiments only for U-235. Several specific fissionable materials are included in this analysis in support of this TS amendment. TS 3.8 as proposed provides limiting conditions which will allow fueled experiments to be conducted using these specific fissionable materials individually or as mixtures.

Limitations for a fueled experiment are based on potential radiation dose and other experimental limitations, e.g. reactivity, heat, pressure, and encapsulation. This analysis is concerned only with potential radiation doses to occupants inside the reactor building and members of the public outside the reactor building following an accidental release of fission products from a failed fueled experiment. Additionally, this analysis limits the amount of fissionable material that may be possessed or used for fueled experiments to Category 2 limits given in 10 CFR Part 37. All conditions for fueled experiments must be met as stated in TS 3.8 for the experiment to be conducted, including those for general experiment limitations on reactivity, heat, pressure, hazardous material properties, and encapsulation.

TS 3.8 has been modified based on limiting radiation doses to less than 10 percent of the applicable limits given in Title 10 of the Code of Federal Regulations (CFR) Part 20. Up to 10 percent of the applicable dose limits is based on regulatory requirements for monitoring of occupational personnel and reporting doses in excess of the constraint dose for members of the public. This limitation meets guidance given in Regulatory Guide 2.2 "Development of Technical Specifications for Experiments in Research Reactors". TS definition 1.2.24b states that reportable events include a release of radioactivity from the site above allowed limits. The limit of 10 percent of the annual public dose is below the radiation dose associated with the "Notification of Unusual Event" emergency declaration. Therefore, failure of a fueled experiment would not require an emergency declaration or result in a reportable event.

The accident scenario considered for fueled experiments is the release of radioactive material into the reactor building. Production periods from 10 seconds to 1 year with no decay and with decay periods up to an additional 1 year were analyzed. Release of materials in a wet, or pool, environment is lower than those in a dry, or external beam, environment. Therefore, the dry environment is more restrictive and was used in the analysis.

The radioactive material inventory released is assumed to be instantaneously and uniformly distributed throughout the entire reactor bay air space initially and then exhausted to the environment by the reactor building ventilation system which includes filters and an elevated exhaust stack. Concentration inside the reactor building, filter retention, exhaust ventilation rate, and atmospheric dispersion are considered in the analysis. Release of materials in a wet, or pool, environment are lower than those in a dry, or external beam, environment. Therefore, the dry environment is more restrictive and was analyzed.

Fueled experiments were previously defined in TS as experiments that contain fissionable material. To allow fueled experiments to be conducted, changes are proposed to the facility license conditions for use of fissionable material. The definition of fueled experiment is changed based the fission rate associated with a potential radiation dose from a failure of an experiment that may exceed 10 percent of the applicable regulatory radiation dose limits. The definition assumes the experiment is conducted in normal, rather confinement, ventilation mode with no exhaust filtration and that the release is not immediately detected. Credit for atmospheric dispersion is taken.

Revision of TS 3.8 was based on the analysis provided in Attachment 1. Attachment 1 provides details on the use, production, and release of radioactive material from several specific fissionable materials in a fueled experiment. Release of radioactive materials into the reactor building air space and subsequent venting to the environment are analyzed for radiation dose from inhalation and submersion dose pathways to occupants inside the reactor building and in public areas outside the reactor building. Continuous irradiation times up to 1 year followed by decay times up to 1 year were evaluated. Credit is taken for filtration and atmospheric dispersion in calculating the TEDE to members of the public.

Total Effective Dose-Equivalent (TEDE) and Total Organ Dose-Equivalent (TODE) to the thyroid and bone surfaces are calculated for occupants inside the reactor building. TEDE is calculated for members of the public. Committed Dose-Equivalent (CDE) and Deep Dose-Equivalent (DDE) are summed to give the TODE to the thyroid and bone surfaces. Thyroid CDE is associated with fission products (primarily radioiodine) and bone surface CDE is associated with fissionable materials. Total effective dose-equivalent (TEDE) for members of the public is limited to 0.01 rem. TEDE and TODE to occupants inside the reactor building are limited to 0.5 rem and 5 rem, respectively. DDE and CEDE are summed to give TEDE. DDE and CDE are summed to give TODE. DDE from submersion is adjusted based on the experimental area dimensions for the reactor building.

Removal (or burnup) of fissionable material and ingrowth of other fissionable material were accounted for in Attachment 1. The activity calculations made in Attachment 1 were compared to those estimated by the Nuclear Analysis 1.0 program for fission products and activated fissionable materials.

As a result of the need for filtered ventilation, an exhaust stack, and radiation monitoring of the ventilation system, fueled experiments are excluded from being performed in experimental facilities located outside the reactor building.

In Attachment 1, radiation dose calculated using a reference fluence rate and mass. The results for the reference conditions were adjusted for consumption, in-growth, and decay of all radioactive material. Limits and conditions for TS 3.8 are based on the adjusted doses and most restrictive dose; TEDE or TODE vs the TS dose limits (10 percent of regulatory limits).

Dose is considered in determination of fueled experiment fission rate limits in TS 3.8. Also, the mass of the fissionable material allowed in a fueled experiment is a reviewed as a condition of the experiment in TS 3.8.

For mixtures of fissionable materials, the sum of the fractions of the material fission rates to the fission rate limits shall not exceed a value of one. In addition, the mass of fissionable material may not exceed license possession limits.

The mass of the fissionable material allowed for possession by the facility license is revised to be less than those given for Category 2 radionuclides listed in 10 CFR Part 37. 10 CFR Part 37 defines quantities of concern based on activity for select radionuclides, including fission products and fissionable material. Activity may be converted to mass using the specific activity given in 10 CFR Part 71. License condition.2B(2) is revised to allow possession of fissionable materials up to 10 CFR Part 37 Category 2 limits. With this license condition, radioactive materials in excess of 10 CFR Part 37 limits are not permitted. Therefore, revision of the existing security plan is not needed. Analysis for possession limits is given in Attachment 1 Section E.

The definition of a fueled experiment is based on the mass associated with the public constraint dose of 0.01 rem for personnel inside the reactor building in normal ventilation mode for an experiment lasting up to 1 year. This analysis is provided in Attachment 1 Section E. Limits, or mass thresholds, vary with the material irradiated, irradiation time, and fluence rate. Results are summarized in table TS 3.8-2. Values in excess of table TS 3.8-2 are considered fueled experiments, which are bounded by the limits given in table TS 3.8-1. Values below table TS 3.8-2 are not fueled experiment but must meet TS 3.7 conditions for experiments.

TS 3.8 as proposed meets 10 CFR Part 20, other TS requirements on experiments, the facility emergency plan and security plan. Conditions do not exceed those for a reportable event, emergency action level, or limits given in 10 CFR Part 37.

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ANALYSIS OVERVIEW

This analysis is performed following regulations, license requirements, and guidance as described in References 11 and 13. The following major steps were performed in this analysis to determine the limitations on fueled experiments:

1. The radioactive material source term was calculated using the following:
   a. Equations reported References 1 and 2 were used to determine fission product inventory, activation products and subsequent decay, and fissionable material consumption (burnup) and subsequent decay
   b. Decay products and radioactive half-life data was taken from Reference 6
   c. Fission yield data was taken from References 3,4,5
   d. Cross-section data for activation and fission was taken from Reference 7
   e. Comparison to results from Reference 21 for some irradiation and decay conditions to confirm the calculation method.

2. The source term was released to the reactor air space as described in Reference 11. Release fractions and airborne concentrations were calculated. Release fractions were taken from References 8 and 14.

3. Total effective dose-equivalent (TEDE) and Total organ dose-equivalent (TODE) were calculated to personnel inside the reactor building. These dose calculations were based on the following:
   a. Reference mass of 1 gram of fissionable material with (i) buildup of decay products prior to being irradiated and (ii) production of activation products with subsequent decay during irradiation
   b. Reference fluence rate of 1E13 $cm^{-2}s^{-1}$
   c. Dose conversion factors (DCF), in the units of annual dose per unit concentration, were taken or determined from Reference 13
   d. Credit for room dimensions were taken as described in References 27, 28, and 29
   e. Exposure time was taken based on References 11, 25, and 26
   f. Dose calculations were performed consistent with methods given in Reference 12

4. TEDE was calculated to personnel outside the reactor building. These dose calculations were based on the following:
   a. Reference mass of 1 gram of fissionable material with buildup of decay products prior to being irradiated
   b. Reference fluence rate of 1E13 $cm^{-2}s^{-1}$
   c. DCF, in the units of annual dose per unit concentration, were taken or determined from Reference 13
   d. Credit for filtration and atmospheric dispersion were taken as described in References 11, 22, and 24
   e. Exposure time was taken as 24 hours based on ventilation exhaust rates and References 11, 22, and 24
   f. Dose calculations were performed consistent with methods given in Reference 12

5. TEDE and TODE from fissionable material and fission products included:
   a. Removal (burnup) of the initial fissionable material mass
   b. Mass of other fissionable materials initially present or produced by activation and subsequent decay
   c. Room dimensions for fission product noble gases (Ref 27, 32)
   d. Fission products from fissionable materials initially present and produced during irradiation.
   e. Fission yield data that was incomplete was multiplied by the ratio of $2/\Sigma Y$.
   f. Room dimensions for fission product noble gases (Ref 27, 32)

6. Experimental limits and license limits for mass of fissionable material are calculated to
   a. Meet the TEDE and TODE design dose limits
   b. Keep the activity within Category 2 limits given in 10 CFR Part 37. This includes fissionable material and fission product activity. Conversion to mass is made by using the specific activities given in 10 CFR Part 71 (Ref 31).

7. The TS definition for fueled experiments was changed based on the constraint dose of 0.01 rem to personnel inside the reactor building in normal ventilation and excludes self-encapsulated items.

8. License conditions for a fueled experiment were changed to keep the mass of fissionable material used in fueled experiments within 10 CFR Part 37 Category 2 limits or the mass associated for the limiting radiation dose, whichever is lower. Table TS 3.8-1 is used to establish limits for individual experiments. Mass used is a reviewed condition in TS 3.8.

ASSUMPTIONS

Assumed conditions for fueled experiments are as follows:

1. Radioactive materials are encapsulated until the time of failure. Release of radioactive materials from an encapsulation failure are based on NUREG 1400 (Ref 8), ANSI/ANS 15.7 (Ref 33), and US NRC Regulatory Guide 2.2 (Ref 11).
2. Neutron flux density is constant over time and for the entire mass of the fissionable material present during the experiment irradiation time. Corrections to the mass is made as a result of activation and fission reactions during the irradiation time.
3. No loss from the encapsulation occurs until the time of failure.
4. Single-mode nonviolent failure of the encapsulation boundary results in release of radioactive material into the reactor building free air volume. (Ref 11)
5. Reactor ventilation system is in the confinement mode (Ref 22)
6. Initially pure fissionable material is exposed, i.e. there is no initial inventory of fission products
7. Exposure times to personnel in the reactor building is 0.05 hours (3 minutes) based on measured and estimated evacuation time from the reactor building for fueled experiments. For non-fueled experiments using lesser masses of fissionable materials, the exposure time is taken as that required for 5 air changes of the reactor building free volume in normal ventilation, or 3.767 hours.
8. Exposure times to the public is 24 hours based on evacuation time from the reactor building and reactor building exhaust rates in the confinement mode (Ref 24, 35)
9. No credit for respiratory protection is assumed
10. The release is assumed to occur instantaneously and to mixed within the reactor building air space (Ref 11, 33)
11. A correction factor of 0.1 is used for submersion dose within the reactor building for photons emitted by noble gases based on dimensions and geometry. A sphere rather than hemisphere is assumed. (Ref 27, 28, 29)
12. The reactor building free air volume is approximated at 2.4 E9 ml based on reported and measured data. (Ref 22)
13. Confinement filter removal efficiency, or retention, is 99.97% for particulates and 90% for halogens (Ref 22). Halogen (charcoal filter) retention is listed as 99%. For conservatism, 90% is the assumed charcoal retention.
14. Atmospheric dispersion parameter, X/Q at 1 m/s for Class F weather stability and a release time of up to 24 hours is assumed to be less than or equal to 0.0076 s m^{-3} for the PULSTAR reactor based on ANSI/ANS 15-7 (Ref 33) methodology for accidental releases were assumed:
    - Class F weather stability
    - 1 m/s (2.24 mph) wind speed
    - No wind direction change (i.e. no cross wind averaging or sector averaging)
    - Stack height of 30 m (i.e. actual and effective stack height approximately the same)

NOTES

Notes on references and the reactor facility applicable to fueled experiments are as follows:

- Chapter 5 of the SAR describes the ventilation system. The confinement system flow rate and filters are described. HEPA retention of 99.97% is stated. Charcoal filters are mentioned, but no retention is given. Confinement would be placed into operation manually for fueled experiments to meet TS 3.8. Operating procedures were revised to include this requirement for fueled experiments.

- Chapter 13 of the SAR states the HEPA and charcoal retention are 99.97% and 99% respectively (section 13.2.1.4). In the amendment we claimed 90% for the charcoal retention for conservatism.

- For operation and fuel movement, the ventilation system is required under TS 3.6 in either normal or confinement mode. If normal mode is used, then the confinement system must be operable - confinement automatically starts for certain conditions or by manual initiation. For fueled experiments, TS 3.8 requires the confinement system to be operated during the experiment.

- Testing is performed per TS 4.5 on the ventilation system, including filter testing. Maintenance and surveillance is in place for this testing. Acceptance criteria are 99.97% for HEPA tested and 99% for charcoal tested. Testing methods follow ASME N510-1989 "Testing of Nuclear Air Treatment Systems". Testing and maintenance are documented in facility surveillance files as required by TS 6.4 and 6.8.

- Normal ventilation exhaust rate is 1870 cfm and is not filtered prior to release to the environment. Normal ventilation stops and confinement ventilation starts if set points are exceeded or if changed manually. Normal ventilation is the standard ventilation mode for reactor operations.

- Radiation monitoring of the reactor building and exhaust stack is required for reactor operations under TS 3.5. These include detectors for external radiation levels, radioactive gases, and radioactive particulates. Set points for these monitors meet TS 3.5. For fueled experiments, monitoring for released activity is required as part of the experiment review in the proposed TS 3.8. Set points may be adjusted as needed for experiments and other conditions in accordance with facility procedures. Radiation monitoring is required for reactor operation for both normal or confinement ventilation modes.

- To meet reactor operation requirements, the confinement system and radiation monitoring system must be operable. This includes satisfactory surveillance and testing of the filters, radiation monitors, building differential pressure (dP).

- Reactor systems, structures, components, plans, and procedures that are in place for fuel handling accidents are applicable for handling of a failed fueled experiment.

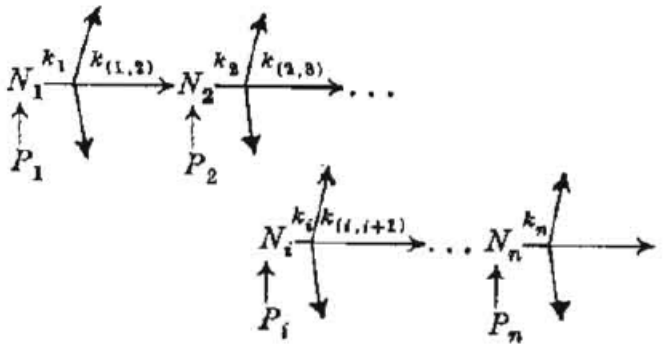
SYMBOLS and ABBREVIATIONS

A	atomic mass number or atomic weight in grams per mole
A	radioactivity, units are specified in the analysis
ARF	airborne release fraction
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
b	cross section in barns
B	branching radioactive decay factor
B	gamma photon buildup factor
B	beta particle
C	concentration, units are specified in the analysis
CDE	Committed Dose-Equivalent
CEDE	Committed Effective Dose-Equivalent
D	dispersal factor of radioactive material entering the air space
$D_{reference}$	Reference dose
DAC	Derived Air Concentration
DDE	Deep Dose-Equivalent
EC	Effluent Concentration
f	submersion gamma photon dose correction factor
F	flow rate
f/s	fission rate
k	total removal rate constant
M or m	mass, units are specified in the analysis
Maverage	average mass
m	metastable radionuclide
N	number of atoms
NA	Avogadro's number equal to 6.022E23 atoms per mole
Naverage	average number of atoms
P	production rate
Q	10 CFR Part 37 Category 2 fraction
RF	respirable fraction
S	storage time prior to irradiation time
T	decay time after irradiation time
T	radiological (physical) half-life
t	irradiation time
TEDE	Total Effective Dose-Equivalent
TODE	Total Organ Dose-Equivalent
v	ventilation removal rate constant
V	volume
X/Q	atmospheric dispersion parameter
Z	fission yield correction
τ	exposure time to the airborne activity released
σ	microscropic (atomic) cross-section
λ	radiological decay constant

B. **PRODUCTION AND DECAY KINETICS**

The number of atoms, N, for a given radionuclide in a serial transformation, such as a fission product decay chain, is calculated using the following equation during the time of production, "t" (Ref . 1,2):

For a serial transformation by any linear first order process of each member in the series, the following model is used:



where

N_i = quantity of the i^{th} species present at a particular time, t,

k_i = total removal constant for the i^{th} species (i.e. the instantaneous fraction of the i^{th} speeies destroyed per unit time by all linear first order removal processes),

$k_{(i,i+1)}$ = partial removal constant for the i^{th} species (i.e. thc instantaneous fraction of the i^{th} species transformed per unit time to the $(i+1)^{th}$ species), and related to the branching fraction, $f_{(i,i+1)}$:

$$k_{(i,i+1)} = f_{(i,i+1)} k_i,$$

and

P_i = constant independent rate of production of the i^{th} speeies.

The differential equations for the instantaneous time rate of change in the quantities for each member of the chain are:

$$\frac{dN_1}{dt} = P_1 - k_1 N_1$$

$$\frac{dN_2}{dt} = P_2 + k_{(1,2)} N_1 - k_2 N_2$$

$$\vdots$$

$$\frac{dN_i}{dt} = P_i + k_{(i-1,i)} N_{(i-1)} - k_i N_i,$$

$$\vdots$$

$$\frac{dN_n}{dt} = P_n + k_{(n-1,n)} N_{(n-1)} - k_n N_n.$$

These equations may be solved by standard methods to obtain the quantity of any member of the series. The general quantity for the n^{th} member of the series is given by:

$$N_n(t) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} k_{j,\,j+1} \sum_{j=i}^{n} \frac{N_i(0) e^{-k_j t}}{\prod_{p=i, p\neq j}^{n} (k_p - k_j)} + \frac{P_i (1 - e^{-kjt})}{k_j \prod_{p=i, p\neq j}^{n} (k_p - k_j)} \qquad \text{EQ 1}$$

where,

- $N_i(0)$ = quantity of i^{th} species present at some arbitrary reference time zero
- t = generation or elapsed time
- If a given quantity in a series is produced by a first order process from some branching chain, then by application of EQ1 over all applicable chains, it is possible to obtain the total value of this quantity by simple addition of values calculated from the various chains.
- However, in calculating the quantity of the n^{th} species from various contributing chains, the last term in the major summation, which is calculated for i = n, should not be added more than once since it represents contribution of the n^{th} species to itself. Similar considerations apply to any species following the n^{th} species.
- Convergent and divergent branches can be treated independently to yield quantities of interest.

In applying the equations, it is noted that the total removal rate constants must be distinctly different. For cases in which the rate constants of two or more species are exactly equal, the equation reduces to an indeterminate form since certain factors in the product would reduce to zero, i.e. the term $(k_p - k_j)$. If $(k_p - k_j)$ is changed to be non-zero, then approximate solutions may be obtained from the EQ1 directly. This is rarely the case, but when it occurred a change of less than 0.1% was made.

If $N_i(0)$ is initially zero for all fission product atom populations, as would be the case for the assumption of initially pure fissionable materials, then the above equation is simplified to the following:

$$N_n(t) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} k_{j,\,j+1} \sum_{j=i}^{n} \frac{P_i(1-e^{-kjt})}{k_j \prod_{p=i,\,p\neq j}^{n} (k_p - k_j)} \qquad \text{EQ 2}$$

where,

- i ranges from 1 to n to account for all members of the decay chain leading to the formation of the n^{th} atom population
- j and p are used as indices for i to account for the number of n^{th} atoms originating from the i^{th} atom population
- k is the total removal rate constant
- B is the decay branch fraction and Bk is the partial rate constant
- If radioactive decay is the only removal mechanism, then $k = \lambda$
- P_i from fission is given by the following:

$$\boldsymbol{P_i = \sigma_f \varphi N_{fm} Y_i}$$

- σ_f is the fission microscopic cross section for the fissionable material in cm^2
- φ is the neutron fluence rate, which is assumed to be constant and uniform, in $cm^{-2}s^{-1}$
- N_{fm} is the number of fissionable material atoms available to undergo fission
- Y_i is the fission yield for nuclide "i"

Both thermal and non-thermal fluence rates may be present for a given experiment, and therefore both cases are evaluated. The more restrictive of these cases was used to determine experimental limits.

Values of N for fission product decay chains for atomic masses from A = 66 to A =167 from the thermal and fast fission of various materials were determined as described above. The number of radionuclides evaluated was approximately 500.

The fission yields analyzed ranged from 1.86 to 1.91, with an average of 1.89 per fission. Values of Nn(t+T) were increased by a factor of $(2 / \Sigma Yi)$ to account for missing fission products, e.g. 2/1.89 = 1.058.

If the following substitutions are made to EQ 2:

- λ is the radioactive decay constant equivalent to the total removal rate constant k
- B is the decay branch fraction leading to the succeeding radionuclide
- $B_j\lambda_j$ is the partial rate constant leading to the next member of the decay chain equivalent to the parameter $k_{j, j+1}$ (i.e. $k_{j, j+1} = \lambda_j * f_{j, j+1}$)

then EQ 2 becomes:

$$N_n(t) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} B_j \lambda_j \sum_{j=i}^{n} \frac{P_i(1-e^{-\lambda j t})}{\lambda_j \prod_{p=i, p\neq j}^{n} (\lambda_p - \lambda_j)} \qquad \text{EQ 3}$$

where P_i is given previously for EQ 2

If n = 2, then EQ3 gives the following:

$$N_2(t) = B_1\lambda_1[\frac{P_1(1-e^{-\lambda 1 t})}{\lambda_1(\lambda_2 - \lambda_1)} + \frac{P_1(1-e^{-\lambda 2 t})}{\lambda_2(\lambda_1 - \lambda_2)}] + [\frac{P_2(1-e^{-\lambda 2 t})}{\lambda_2}]$$

$$N_1(t) = \frac{P_1(1-e^{-\lambda 1 t})}{\lambda_1}$$

Rewriting gives the following:

$$N_2(t) = P_1B_1\lambda_1[\frac{(1-e^{-\lambda 1 t})}{\lambda_1(\lambda_2 - \lambda_1)} + \frac{(1-e^{-\lambda 2 t})}{\lambda_2(\lambda_1 - \lambda_2)}] + P_2[\frac{(1-e^{-\lambda 2 t})}{\lambda_2}]$$

$$N_1(t) = P_1[\frac{(1-e^{-\lambda 1 t})}{\lambda_1}]$$

DECAY BRANCHING FRACTIONS

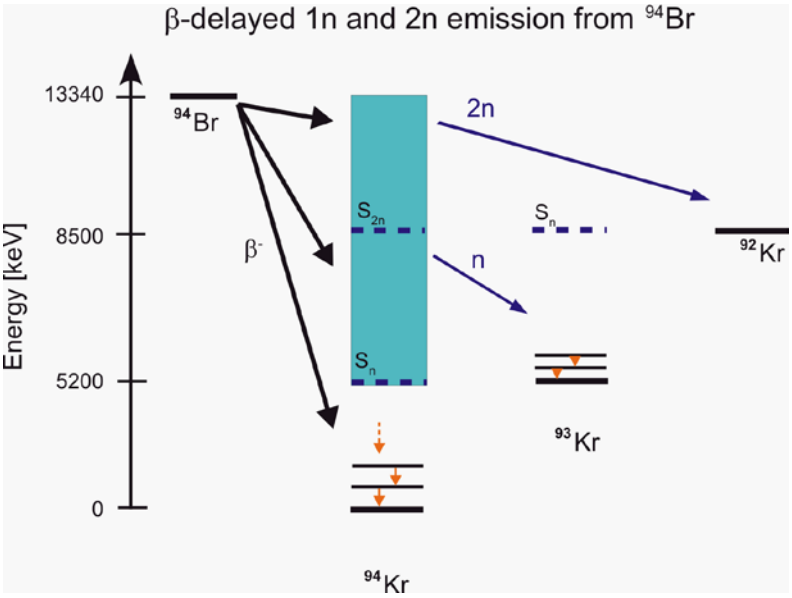
Altered radioactive decay pathways occur frequently with metastable nuclides and delayed neutron emitting nuclides.

Data from Reference 6 was used for the various decay branching fractions. These include the alpha decay, beta decay, and isomeric transition.

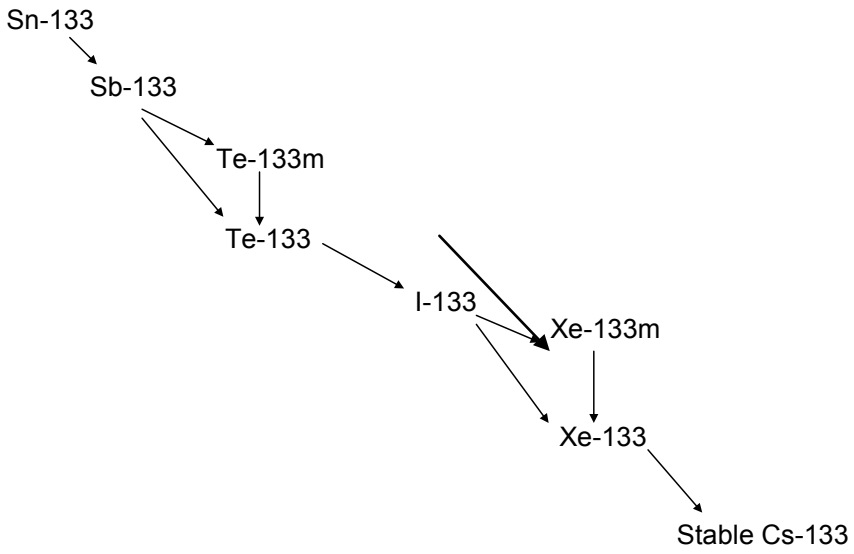
B-	Beta minus decay
B-m	Beta minus decay leading to 1st level metastable decay product
B-,n	Beta minus decay with delayed neutron
B-,nm	Beta minus decay with delayed neutron leading to metastable decay product
IT	Isomeric transition with gamma photon emission
α	Alpha decay

Many of the fission products undergo beta minus decay and delayed neutron emission.

For example the B-, B-,n and B-, 2n decay of Br-94 is shown below:



Example decay chain: A = 133



Decay Chains for A = 133

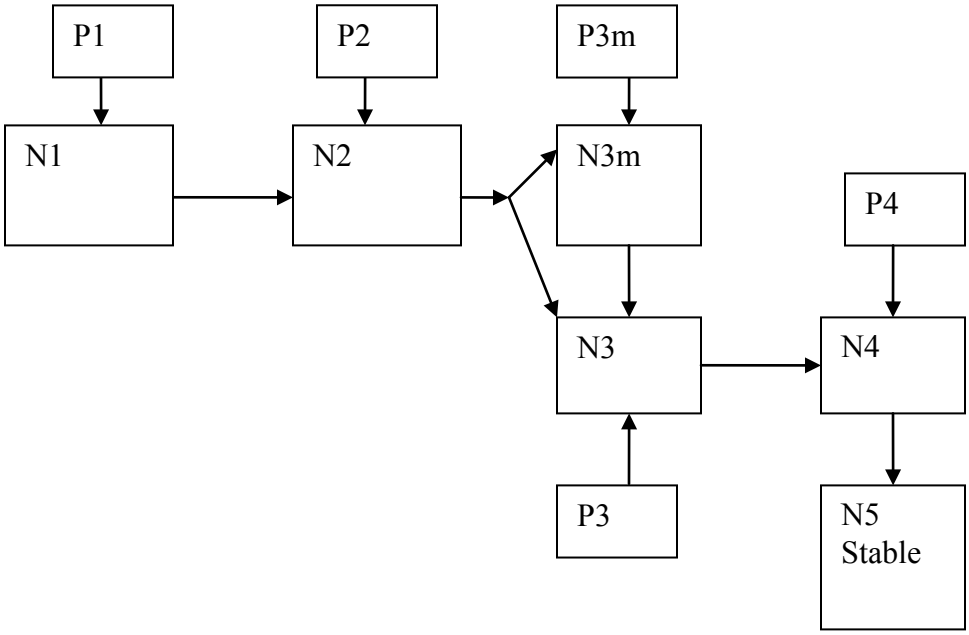
1. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133m to Xe-133
2. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133
3. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133m to Xe-133
4. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133
5. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133m to Xe-133
6. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133

Decay Chains and Data for A = 133

Nuclide	Half-life (s)	Yield per 100 fissions for U-235	Decay Constant (1/s)	Branching Decay Fraction
Sn133	1.44E+00	1.38E-01	4.81E-01	1 (B)
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729 (B,m)
Te133m	3.32E+03	2.99E+00	2.09E-04	0.175 (IT)
Te133	7.44E+02	1.15E+00	9.32E-04	1 (B)
I133	7.49E+04	1.65E-01	9.26E-06	0.0285 (B,m)
Xe133m	1.89E+05	1.89E-03	3.66E-06	1 (IT)
Xe133	4.53E+05	6.66E-04	1.53E-06	1 (B)
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729
Te133m	3.32E+03	2.99E+00	2.09E-04	0.175
Te133	7.44E+02	1.15E+00	9.32E-04	1
I133	7.49E+04	1.65E-01	9.26E-06	0.9715 (B)
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729
Te133m	3.32E+03	2.99E+00	2.09E-04	0.825 (B)
I133	7.49E+04	1.65E-01	9.26E-06	0.0285
Xe133m	1.89E+05	1.89E-03	3.66E-06	1
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729
Te133m	3.32E+03	2.99E+00	2.09E-04	0.825
I133	7.49E+04	1.65E-01	9.26E-06	0.9715
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.8271 (B)
Te133	7.44E+02	1.15E+00	9.32E-04	1
I133	7.49E+04	1.65E-01	9.26E-06	0.0285
Xe133m	1.89E+05	1.89E-03	3.66E-06	1
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.8271
Te133	7.44E+02	1.15E+00	9.32E-04	1
I133	7.49E+04	1.65E-01	9.26E-06	0.9715
Xe133	4.53E+05	6.66E-04	1.53E-06	1

Where, (B) is beta minus decay, (B,m) is beta minus decay to isomer, (IT) is isomeric transition

For example consider the decay series producing N4(t) with no initial radioactive inventory, (i.e. $N_n(0)$ is 0):



For the example given above and the previous discussion, accounting for branching decay gives the following pathways from N_1 leading to $N_4(t)$:

(1) N1→N2→N3→N4→N5
(2) N1→N2→N3m→N3→N4→N5

For N4 it is noted that decay branching occurs. The pathways leading to N4 are as follows:

For pathway (1): N1→N2→N3→N4→
N2→N3→N4→
N3→N4→
N4→

For pathway (2) N1→N2→N3m→N3→N4→
N2→N3m→N3→N4→
N3m→N3→N4→
Redundant production and decay from pathway (1) are excluded,
i.e. N3→N4→ and N4 →

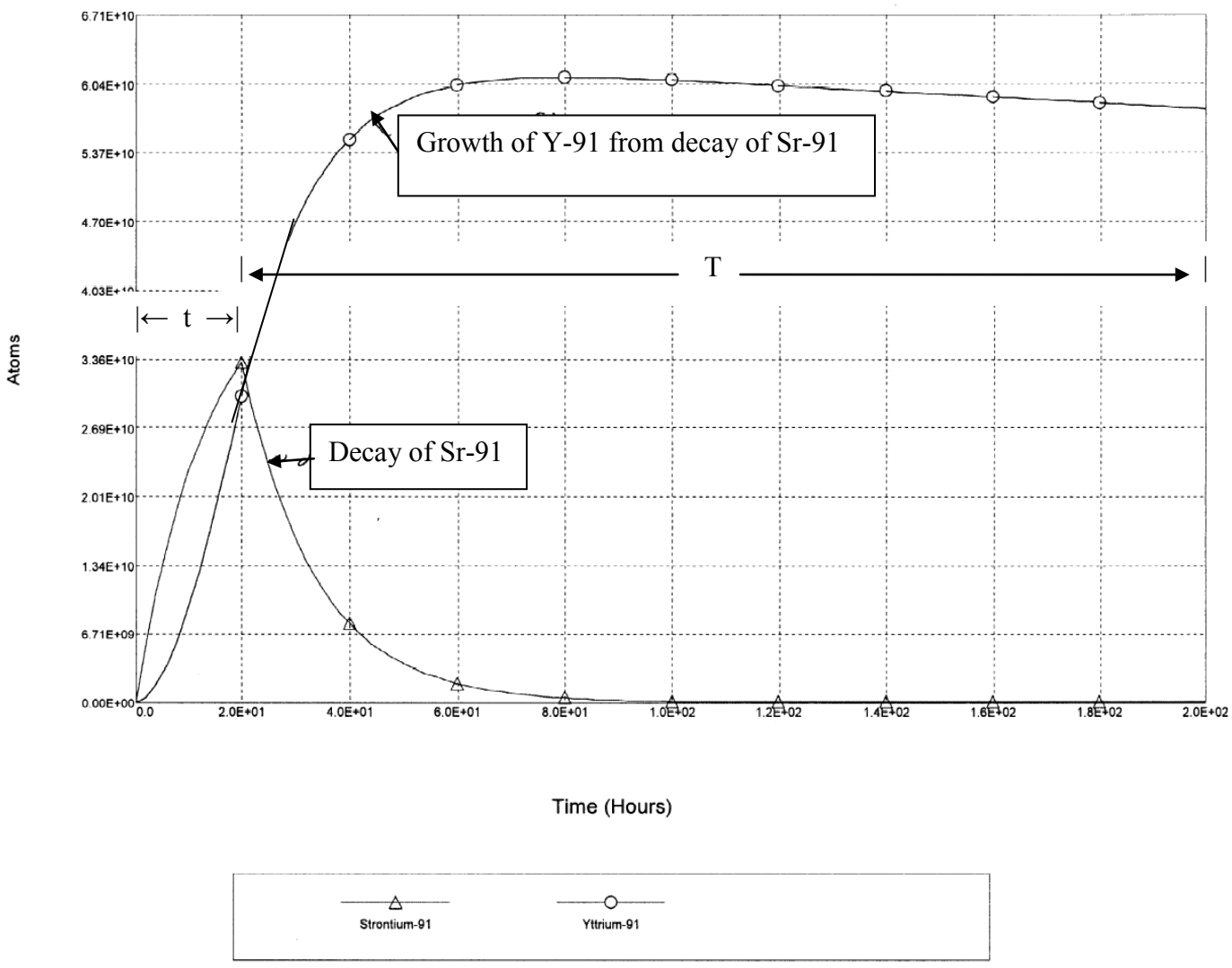
Using EQ3, the solution for $N_4(t)$ is given by the following:

$$N_4(t) = P_1 B_1 k_1 B_2 k_2 B_3 k_3 \left[\frac{1-e^{(-k_1 t)}}{k_1(k_2-k_1)(k_3-k_1)(k_4-k_1)} + \frac{1-e^{(-k_2 t)}}{k_2(k_1-k_2)(k_3-k_2)(k_4-k_2)} + \right.$$
$$\left. \frac{1-e^{(-k_3 t)}}{k_3(k_1-k_3)(k_2-k_3)(k_4-k_3)} + \frac{1-e^{(-k_4 t)}}{k_4(k_1-k_4)(k_2-k_4)(k_3-k_4)} \right]$$
$$+ P_2 B_2 k_2 B_3 k_3 \left[\frac{1-e^{(-k_2 t)}}{k_2(k_3-k_2)(k_4-k_2)} + \frac{1-e^{(-k_3 t)}}{k_3(k_2-k_3)(k_4-k_3)} + \frac{1-e^{(-k_4 t)}}{k_4(k_2-k_4)(k_3-k_4)} \right]$$
$$+ P_3 B_3 k_3 \left[\frac{1-e^{(-k_3 t)}}{k_3(k_4-k_3)} + \frac{1-e^{(-k_4 t)}}{k_4(k_3-k_4)} \right] + P_4 \left[\frac{1-e^{(-k_4 t)}}{k_4} \right] + P_1 B_1 k_1 B_2 k_2 B_{3m} k_{3m} B_3 k_3$$
$$\left[\frac{1-e^{(-k_1 t)}}{k_1(k_2-k_1)(k_{3m}-k_1)(k_3-k_1)(k_4-k_1)} + \frac{1-e^{(-k_2 t)}}{k_2(k_1-k_2)(k_{3m}-k_2)(k_3-k_2)(k_4-k_2)} \right.$$
$$+ \frac{1-e^{(-k_{3m} t)}}{k_{3m}(k_1-k_{3m})(k_2-k_{3m})(k_3-k_{3m})(k_4-k_{3m})} + \frac{1-e^{(-k_3 t)}}{k_3(k_1-k_3)(k_2-k_3)(k_{3m}-k_3)(k_4-k_3)}$$
$$\left. + \frac{1-e^{(-k_4 t)}}{k_4(k_1-k_4)(k_2-k_4)(k_{3m}-k_4)(k_3-k_4)} \right] + P_2 B_2 k_2 B_{3m} k_{3m} B_3 k_3 \left[\frac{1-e^{(-k_2 t)}}{k_2(k_{3m}-k_2)(k_3-k_2)(k_4-k_2)} \right.$$
$$+ \frac{1-e^{(-k_{3m} t)}}{k_{3m}(k_2-k_{3m})(k_3-k_{3m})(k_4-k_{3m})} + \frac{1-e^{(-k_3 t)}}{k_3(k_2-k_3)(k_{3m}-k_3)(k_4-k_3)}$$
$$\left. + \frac{1-e^{(-k_4 t)}}{k_4(k_2-k_4)(k_{3m}-k_4)(k_3-k_4)} \right] + \quad P_{3m} B_{3m} k_{3m} B_3 k_3 \left[\frac{1-e^{(-k3mt)}}{k_{3m}(k_3-k_{3m})(k_4-k_{3m})} \right.$$
$$\left. + \frac{1-e^{(-k_3 t)}}{k_3(k_{3m}-k_3)(k_4-k_3)} + \frac{1-e^{(-k_4 t)}}{k_4(k_{3m}-k_4)(k_3-k_4)} \right]$$

ACTIVITY IN-GROWTH FROM DECAY

The above equations apply to "t", the time of production, and account for the number of atoms produced directly from fission and by decay of precursors during "t". Atoms continue to be produced by the decay of precursors following production, or during decay time "T". The graph below indicates buildup and decay of radioactive material during production time "t" with decay following production during time "T". With the decay of precursors, the activity of a given nuclide may continue to increase during "T".

e.g. Sr-91 and Y-91 atoms populations are shown below for a production time (t) of 20 h (fission irradiation time). The atom population of Y-91 continues to increase during the decay time (T) from the decay of Sr-91 following production.



DECAY FOLLOWING PRODUCTION

After the production time 't" is over, a decay period "T" follows. During "T" no production occurs, i.e. P = 0 in EQ1. EQ1 then becomes the following:

$$N_n(t) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} k_{j,\,j+1} \sum_{j=i}^{n} \frac{N_i(0) e^{-kjt}}{\prod_{p=i,\,p\neq j}^{n} (k_p - k_j)} \qquad \text{EQ 4}$$

In EQ1 and EQ4, time "t" is the generation or production time in this analysis. To account for decay during post-production time "T", removal occurs by radioactive decay only. Decay branching fractions, or convergent and divergent decay pathways are taken into account.

The following substitutions are noted regarding EQ4 for this analysis:

- λ is the radioactive decay constant equivalent to the total removal rate constant k
- B is the decay branch fraction leading to the succeeding radionuclide
- $B_j\lambda_j$ is the partial rate constant leading to the next member of the decay chain equivalent to the parameter $k_{j,\,j+1}$ (i.e. $k_{j,\,j+1} = \lambda_j * f_{j,\,j+1}$)
- The end of the production period is defined as "t" and the decay time is defined as "T"
- Elapsed time is the sum of "t+T". The atom population at elapsed time "t+T" is needed, i.e. $N_n(t+T)$.
- $N_i(0)$ in EQ 1 and EQ 4 is the initial atom population that undergoes radioactive decay. In this analysis $N_n(t)$ from EQ3 is $N_i(0)$ in EQ4.
    - Alternately this is evident by noting that at the start of the decay period, T = 0 and the elapsed time (t+T) = t+0 = t, which makes Ni(0) in EQ 4 = Ni(t), i.e. the initial activity that undergoes decay during time T.
    - This then gives $N_i(0)$ in EQ4 = $N_i(t)$ during the elapsed time scale (t+T), or $N_i(0)$ in EQ4 = $N_n(t)$ from EQ3
- At the end of the decay period, elapsed time is t+T giving $Ni(t)e^{(-\lambda jT)}$

Making these substitutions to EQ4 gives:

$$N_n(t+T) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} B_j\lambda_j \sum_{j=i}^{n} \frac{N_i(t) e^{-\lambda jT}}{\prod_{p=i,\,p\neq j}^{n} (\lambda_p - \lambda_j)} \qquad \text{EQ 5}$$

where, $N_n(t+T)$ is the atom population after production time t and decay time T
Elapsed time is t+T
$N_i(t)$ is the atom population after production time t and is calculated as $N_n(t)$ from EQ3

For calculation of $N_n(t+T)$ for fission products, EQ3 and EQ5 are used.

For example, if n=2 then EQ5 gives the following:

$$N_2(t+T) = B_1\lambda_1[\frac{N_1(t)e^{(-\lambda_1 T)}}{(\lambda_2-\lambda_1)} + \frac{N_1(t)e^{(-\lambda_2 T)}}{(\lambda_1-\lambda_2)}] + [N_2(t)e^{(-\lambda_2 T)}]$$

$$N_1(t+T) = N_1(t)e^{-\lambda_1 T}$$

Rewriting gives the following:

$$N_2(t=T) = N_1(t)B_1\lambda_1[\frac{e^{(-\lambda_1 T)}}{(\lambda_2-\lambda_1)} + \frac{e^{(-\lambda_2 T)}}{(\lambda_1-\lambda_2)}] + N_2(t)[e^{(-\lambda_2 T)}]$$

$$N_1(t+T) = N_1(t)e^{-\lambda_1 T}$$

Each decay pathway leading to N must be analyzed, i.e. divergent and convergent pathways are analyzed as previously described.

ACTIVATION OF FISSIONABLE MATERIAL

In addition to fission products, fissionable material may activate and subsequently decay to produce radioactive material, some of which may be fissionable, e.g. Pu-239 is produced from the activation U-238 and decay of U-239 and Np-239. Activation and decay chains are summarized in Section G.

Atom populations from the activation of fissionable material and decay products are calculated as described using EQ3 except that the activation cross section is used rather than the fission cross section in the production rate term, P. P is considered for activation during the irradiation time "t".

In this analysis only the initial fissionable material is considered, i.e. P_i, for i > 1 is set to "0" so no direct production is considered other than the initial activation product. As a result, only P_1 was used; e.g. for fission of U-238 the activation of U-238 is considered while activation of Pu-239 was not. However, activation of Pu-239 was considered in its own set of calculations and these were added to the U-238 experimental limit calculations as described later.

$$N_n(t) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} B_j \lambda_j \sum_{j=i}^{n} \frac{P_1(1 - e^{-\lambda j t})}{\lambda_j \prod_{p=i, p\neq j}^{n} (\lambda_p - \lambda_j)} \qquad \text{EQ6}$$

where $\boldsymbol{P_1 = \sigma_a \, \varphi \, N_1}$

- σ_a is the (n,γ) activation cross section for the target atom, in cm^2
- φ is the neutron fluence rate, which is assumed to be constant and uniform, in $cm^{-2}s^{-1}$
- N_1 is the number of the first fissionable material atoms available to undergo activation
- P_1 in conventional units is the production rate, atoms per second

Decay products of the activated fissionable material are evaluated by EQ6 during the irradiation time, t. Activated fissionable material and associated decay products are evaluated using EQ5 during the decay time, T.

In this analysis the production time "t" and decay time "T" have a maximum of 1 year each, or "t+T" period ranges up to 2 years. The decay chain effectively ends once a radionuclide with a long half- life compared to the "t+T" time of 2 years is reached. This is achieved if the decay fraction is small, e.g. 0.01, or the survival fraction is large, e.g. 0.99. For a decay period of 2y this gives a half-life of 138 years.

Decay fraction = [1 – exp(-k)] = 0.01; or Survival fraction = exp(-k) = 0.99

Solving for $T_{1/2}$; ln(0.99) = -[ln(2)/ $T_{1/2}$] *2y; $T_{1/2}$ = -1.386 /-0.01 = 138 years

DECAY OF FISSIONABLE MATERIAL

Also of concern is the fissionable material that has not been irradiated. These radionuclides are typically longer lived radioactive materials with their own decay products. The initial fissionable material is assumed to be of high purity. Decay products grow in over a decay (storage) time, S, prior to irradiation time, t, e.g. Pa-231 from the decay of U-235. Decay chains used are given in Section G. The atom population from the decay of fissionable material prior to irradiation is calculated as described previously in EQ5 except that only the initial fissionable material is considered to be initially present. EQ5 is then re-written as EQ7:

$$N_n(S) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} B_j \lambda_j \sum_{j=i}^{n} \frac{N_1(0) e^{-\lambda_j S}}{\prod_{p=i, p\neq j}^{n} (\lambda_p - \lambda_j)} \qquad \text{EQ 7}$$

where,

- Only $N_1(0)$ is present at the beginning of the storage time S and is equal to the initial atom population of the fissionable material. $N_i(0)$ for i > 1 are set at "0"
- S is set at 50 years if the half-life if 50 years or longer
- S is set at the half-life if the half-life is less than 50 years

The fissionable material and decay products at time "S", $N_n(S)$, are present at the beginning of production time, t, and continue to decay during production time, t, and the post-production decay time, T. $N_n(S)$ is the initial inventory of atoms present at the beginning of "t", or:

$N_n(S) = N_i(0)$ in EQ4 and $N_n(S)e^{(-\lambda nt)} = N_i(t)$ in EQ5

With these changes noted to EQ5, EQ8 is written to account for the decay of the initially present fissionable material and associated decay products during the period "t+T":

$$N_n(t+T) = \sum_{i=1}^{n} \prod_{j=i}^{n-1} B_j \lambda_j \sum_{j=i}^{n} \frac{N_i(S) e^{-\lambda j (t+T)}}{\prod_{p=i, p\neq j}^{n} (\lambda_p - \lambda_j)} \qquad \text{EQ 8}$$

Production time "t" and decay time "T", which have a maximum of 1 year each. The decay chain effectively ends once a radionuclide with a long half-life compared to the smaller of 50 years or the radionuclide half-life. This is achieved if the decay fraction is small, e.g. 0.01, or the survival fraction is large, e.g. 0.99. For 50 years, this gives a half-life of 3465 years.

Decay fraction = [1 – exp(-k)] = 0.01; or Survival fraction = exp(-k) = 0.99

Solving for $T_{1/2}$; ln(0.99) = -[ln(2)/ $T_{1/2}$] *50y; $T_{1/2}$ = -34.65 /-0.01 = 3465 years

ATOM POPULATION AND MASS

Fueled experiments may include multiple fissionable materials, either as a mixture of initially present fissionable materials or as a result of decay and activation of initially present fissionable material.

Initially pure fissionable was allowed to decay for the lesser of the half-life or 50 years to allow for the in-growth of decay products, some of which may also be fissionable material prior to irradiation.

During the irradiation time activation products are produced, some of which may also be fissionable material or decay to fissionable material. Mixtures are evaluated as a group of individual fissionable materials.

Radiation dose is directly related to activity. Depending on the type of radionuclide, removal rate constant, and irradiation time, the activity from the reference calculations are affected. The associated radiation dose calculated from the reference calculations was adjusted based on mass and fluence rate.

Activity present includes the following:

- Fission products produced by fissionable materials
- Fissionable materials initially present
- Fissionable materials produced by decay of the initial fissionable material
- Fissionable materials produced by activation and subsequent decay

The number of atoms present was calculated for each irradiation time. Mass is calculated from the number of atoms. Mass is a function of fluence rate. Activity produced by fission or activation depends directly on fluence rate.

Mass of fissionable material initially present

In the reference calculations, the mass of the initial fissionable material was kept constant at 1 gram. Adjustments to the reference mass were made to account for removal by fission, activation, and decay of the fissionable material. The mass at time "t" was calculated as follows:

$$N(t) = N(0)e^{-kt}$$

where,

- N(t) is the number of initial atoms remaining at time "t" as given by: (Ref 2, 36)
- N(0) for the initial fissionable material was calculated by converting the reference mass of 1 g, or M(0), to N(0):

$$N(0) = \frac{N_a M(0)}{A}$$

- N_a is Avogadro's number of 6.022E23 atoms per mole
- A is the atomic mass number in grams per mole
- kis the total removal rate constant = $\lambda + (\sigma_a + \sigma_f)\varphi$, to account for removal by decay, activation, and fission
  - $(\sigma_a + \sigma_f)$ is the reaction cross-section in cm^2
  - λ is radiological decay constant in s^{-1}
  - φ is the fluence rate. Reference fluence rate was 1E13 $cm^{-2}s^{-1}$
- t is the irradiation time, in seconds

N(t) is converted to M(t):

$$M(t) = \frac{AN(t)}{N_a}$$

Combining and re-writing these equations gives:

$$M(t) = M(0)e^{-kt} \qquad \text{EQ 9}$$

Mass of fissionable material produced by decay or activation

N(t) was calculated using equations EQ6 and EQ5 for fissionable material produced by activation with subsequent decay. N(t) for fissionable material produced by the decay of the initial fissionable material was calculated from EQ 7 and EQ 8 with T set at "0". N(t) was converted to M(t) for each j^{th} fissionable material produced by decay or activation:

$$M^j(t) = \frac{AN(t)}{N_a} \qquad \text{EQ10}$$

Average mass of fissionable material initially present

For the fissionable material initially present, the average of N(t) over the irradiation time "t" was calculated as follows:

$$N_{average}(t) = \frac{\int_0^t N(t)dt}{\int_0^t dt} = \frac{\int_0^t N(0)e^{(-kt)}dt}{\int_0^t dt}$$

Solving gives:

$$N_{average}(t) = \frac{N(0)[1-e^{(-kt)}]}{kt}$$

Converting to mass gives:

$$M_{average}(t) = \frac{M(0)[1-e^{(-kt)}]}{kt} \qquad \text{EQ 11}$$

Average mass of fissionable material produced by decay or activation

For each j^{th} fissionable material produced by activation or decay of the fissionable material initially present, the average mass is approximated by the relationship between the j^{th} fissionable material $M^j(t)$ and the reference mass, M(0), of the fissionable material initially present scaled to the average mass of the initial fissionable material at a given irradiation time, $M_{average}(t)$, and as follows:

$$M^j_{average}(t) = \frac{M^j(t)}{M(0)} M_{average}(t) \qquad \text{EQ 12}$$

$M^j(t)$ was calculated using EQ6 and EQ5 or EQ7 and EQ8, as applicable for the fissionable material produced by activation or decay of the fissionable material initially present. EQ 12 is based on the reference mass M(0) producing or decaying to $M^j(t)$ with M(0) being held constant. $M_{average}(t)$ is relative to M(0), which allows a simple ratio to be used to determine the adjusted value $M^j_{average}(t)$.

M(t) and average masses for the reference conditions are given in Section H of this analysis.

Fluence Rate Adjustments

Mass at the end of the irradiation time was used to assess dose from fissionable materials. This mass varies with the fluence rate since reaction rates are dependent on fluence rate. The fluence rate directly affects fissionable materials produced by activation.

Fission product activity production depends on the fission reaction rate ($\sigma\varphi N$), and therefore is dependent on the fluence rate (φ) and number of fissional material atoms (N). N changes over time from the fission and activation reactions. In the calculations made, N was held constant. To account for the fission product activity as the initial value of N changes, the average value of N for fissionable materials was used. Fluence rate adjustment is also made by comparing the experiment fluence rate to the reference fluence rate.

In summary, M(t) and average mass are a function of fluence rate and activity produced by fission or activation depends directly on fluence rate. For fluence rate below 1E10 $cm^{-2}s^{-1}$ the changes on mass were minimal for the fissionable materials evaluated. Results on mass as a function of fluence rate are given in Section H.

Mass and fluence rate affect dose. Dose assessment for reference conditions and adjustments made for mass and fluence rate are described in detail in Section D. Reference doses are given in Section H.

FISSION YIELD DATA

Individual thermal neutron fission yields for the following materials were evaluated:

Th-227, 229
U-232, 233, 235
Np-237
Pu-239, 240, 242
Am-241.242
Cm-245
Cf-249, 251, 252

Individual fast neutron fission yields for the following materials were evaluated:

Pa-231, 232
Th-230, 232, 233
U-233, 234, 235, 236, 237, 238
Np-238
Pu-238, 239, 240, 241, 242, 243
Am-241, 243
Cm-242, 243, 244, 246, 248

Th-227, Th-230, Am-242, U-237, Np-238. Pu-243, and Cf-252 were not considered as individual targets in the analysis due to the short half-lives or uncommon use as a primary target. These nuclides were included as activation and decay products of other fissionable materials, e.g. Am-242 from activation of Am-241.

Cf-252, Pa-232, Th-230, and Th-233 are produced by activation of another fissionable material, e.g. Cf-252 from activation of Cf-251. Fission yields were assumed to be the same as the initially irradiated fissionable material for these fissionable materials, e.g Cf-251 fission yields were used for Cf-252.

Fission yields were taken from data given in "Evaluation and Compilation of Fission Product Yields, T.R. England and B.F. Rider, Los Alamos National Laboratory, October, 1994, LA-UR 94-3106 ENDF 349" (Ref 3) and in the JAEA Nuclear Data Center Tables of Nuclear Data (Ref 5). If available, JAEA data for fission yields was used for data not given in ENDF 349.

The fission yields analyzed ranged from 1.86 to 1.91, with an average of 1.89 per fission. Values of $Nn(t+T)$ were increased by a factor of $(2 / \Sigma Yi)$ to account for missing fission products, e.g. 2/1.89 = 1.058. Fission yield is converted from percent to atoms per fission. Total fission yield is taken at 2, or 200 percent.

CROSS-SECTION DATA

Cross-section data was taken from Reference 7 for fission and activation, OECD NEA Joint Evaluated Fission and Fusion Project Report 21 (Ref 7).

Cross sections were taken at 0.025 eV for the thermal neutron energy.

Cross sections were taken at the higher of the following for non-thermal neutron energies:

- Average from 1E-5 eV to 10 eV
- Average resonance integral from 0.5 eV to 1E5 eV
- Average over fission neutron spectrum from 1E3 eV to 2E7 eV

Other references reviewed for cross section data included:

- National Nuclear Data Center, Brookhaven National Laboratory, Evaluated Nuclear Data Files (ENDF libraries) (Ref 4)
- Japan Atomic Energy Agency Nuclear Data Center Tables of Nuclear Data (JENDL data) (Ref 5)

This review indicated general agreement with Reference 7.

CROSS-SECTION DATA (Ref 7)

Nuclide	Thermal Fission Cross Section (b)	Non-thermal Fission Cross section (b)	Thermal Activation Cross-Section (b)	Non-thermal Activation Cross-Section (b)
Pa232	1.52E+03	1.57E+03	2.12E+02	2.24E+02
Th230		1.80E-01	2.31E+01	8.51E+02
Th234		3.63E-02	1.75E+00	9.35E+01
Cm247	8.18E+01	6.01E+02	5.72E+01	5.34E+02
Cf250	4.09E+00	1.94E+01	1.78E+03	8.42E+03
Bk249	3.97E+00	6.49E+00	7.11E+02	1.12E+03
Np239		1.45E+00	7.70E+01	4.56E+02
Pu243	1.81E+02	5.53E+02	8.81E+01	2.74E+02
Cm249	1.02E+01	1.55E+02	1.76E+00	6.23E+01
Am244	2.30E+03	2.37E+03	6.00E+02	6.14E+02
Pu244	0.00E+00	9.92E-01	1.83E+00	1.05E+02

CROSS-SECTION DATA (Ref 7)

Nuclide	Thermal Fission Cross Section (b)	Non-thermal Fission Cross section (b)	Thermal Activation Cross-Section (b)	Non-thermal Activation Cross-Section (b)
Pa-231	1.04E-02	9.82E-01	2.27E+02	5.95E+02
Th-227	2.02E+02	2.06E+02	1.54E+03	1.54E+03
Th-229	3.08E+01	4.40E+02	6.34E+01	1.24E+03
Th-232	0.00E+00	7.80E-02	7.40E+00	8.56E+01
Th233	1.50E+01	1.51E+01	1.45E+03	1.45E+03
U-232	7.71E+01	4.16E+02	7.26E+01	3.16E+02
U-233	5.31E+02	7.62E+02	4.53E+01	1.38E+02
U-234	6.70E-02	1.17E+00	9.98E+01	6.31E+02
U-235	5.85E+02	5.71E+02	9.87E+01	1.40E+02
U-236	6.13E-02	4.34E+00	5.30E+00	3.45E+02
U-237	1.70E+00	4.44E+01	4.52E+02	1.08E+03
U-238	2.65E-05	3.01E-01	2.68E+00	2.75E+02
Np-237	2.04E-02	1.33E+00	1.62E+02	6.61E+02
Np-238	2.03E+03	2.01E+03	2.03E+02	2.01E+02
Pu-238	1.79E+01	2.75E+01	5.40E+02	5.17E+02
Pu-239	7.48E+02	7.89E+02	2.71E+02	3.10E+02
Pu-240	5.92E-02	3.36E+00	2.86E+02	8.48E+03
Pu-241	1.01E+03	1.06E+03	3.63E+02	3.74E+02
Pu-242	2.56E-03	1.15E+00	1.88E+01	1.13E+03
Am-241	3.15E+00	1.08E+01	6.47E+02	1.52E+03
Am-242	2.09E+03	2.20E+03	2.19E+02	2.29E+02
Am-243	8.13E-02	2.20E+00	7.67E+01	1.79E+03
Cm-242	5.06E+00	1.11E+01	1.59E+01	1.08E+02
Cm-243	6.18E+02	1.55E+03	1.30E+02	1.98E+02
Cm-244	6.04E-01	1.08E+01	1.04E+01	5.93E+02
Cm-245	2.14E+03	2.03E+03	3.59E+02	3.37E+02
Cm-246	1.44E-01	4.72E+00	1.31E+00	1.14E+02
Cm-248	3.70E-01	1.13E+01	2.57E+00	2.60E+02
Cf-249	1.67E+03	2.21E+03	5.04E+02	6.94E+02
Cf-251	5.32E+03	5.31E+03	2.86E+03	2.84E+03
Cf-252	3.22E+01	1.11E+02	2.05E+01	4.71E+01

C. RELEASED ACTIVITY

Activity at end of time of production, A(t), is given by:

$$A(t) = \lambda N(t)$$

where, t = time of production

Decayed Activity, A(t + T) is given by:

$$A(t + T) = \lambda N(t + T)$$

Source dispersal fractions, D, are applied based on US NRC Regulatory Guide 2.2 and data given 10 CFR Part 30.72 Schedule C to estimate released (dispersed) activity into the reactor bay:

Form	Accident or Environment	Dispersal Fraction, D
Gas	Dry	1
Halogen		1
Particulate		0.01
Gas	Wet, i.e.	1
Halogen	in-pool	0.25
Particulate		0

The dispersed and decayed activity, $A_D(t+T)$ is given by the following:

$$A_D(t+T) = A(t + T)\ D \qquad \text{EQ 13}$$

In the above equations:

- λ = decay constant, typically in 1/s
- A(time) is in decays per second, dps, i.e. Bq and may then be converted to other activity units, uCi or Ci, using the conversion factor of 3.7E4 dps = 1 uCi
- D is taken from the release fraction in NUREG 1400 Table 1.1 for materials in the form of powders, liquids, or solids. Fissionable material in the form of a gas or volatile or combustible material is not allowed.

The dispersal fraction, D, for wet environments is the same as of lower than that for dry environments. As a result, dry environments would have a higher associated dose and therefore dose from wet environments do not need to be evaluated.

Dispersion Fraction, D

The Dispersion Fractions, D, used in this analysis are based on release fractions given in various references. Failure of the encapsulation by non-violent means is the credible scenario considered in this analysis. Many of the references address violent accidents involving large quantities of materials. Data relevant to expected failure modes that are not violent were reviewed as described below:

References:

- Regulatory Guide 2.2 states radiation doses associated with single mode non-violent failures are to be considered in experiment failures and that credit may be taken for consequence limiting features.

  Precautions are taken to limit intake from inhalation. Normal precautions for fueled experiments would include having the sample encapsulated and shielded for radiation safety. The encapsulation is assumed to fail in this analysis by non-violent means. Shielding, which is normally used, would offer some reduction in release of particulates. It is also normal practice to allow irradiated samples to decay prior to being handled and for personnel not to be continuously present at the experiment location during irradiation.

  Technical Specification 3.7 requires encapsulation of materials used in experiments. Fueled experiments may generate gaseous and volatile (halogen) materials making double encapsulation necessary.

- NUREG 1400 (Ref 8) Table 1.1 gives a value of 0.01 for non-volatile powders and liquids, 0.001 for solids, and 1 for gases or volatile materials. The release fractions are considered suitable for releases to air in the workplace and are a simplified version of 10 CFR 30.72 Schedule C.

- 10 CFR 30.72 Schedule C (Ref 14) 10 CFR 30.72 Schedule C is used specifically to determine the need for emergency planning in response to a release. 10 CFR 30.72 Schedule C gives a value of 0.01 for mixed fission products and a value of 0.001 for Am, Ac, Ra, and other alpha emitters.

- NUREG 1140 (Ref 9) Section 2.3 (By-product Material Facilities). Values for release fractions for particulates are 0.01 for fires from radiopharmaceutical manufacturing, sealed source manufacturing, and university research laboratories. The values given are for particles of respirable size, which are up to 10 microns. For materials of unknown form, but not generally volatile or combustible, the release fraction of 0.01 is assumed. Release fraction for gases is 1 and 0.5 for volatiles materials or combustible materials. Combustible materials include isotopes of H, S, P, Br, I, and Cl. For isotopes of U, Pu, Am, and Cm a release fraction of 0.001 is assumed.

- DOE Handbook DOE-HDBK-3010-94 "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" Volume 1, December 1994 (Ref 10) provides summaries of experimental data for airborne release fractions and respirable fractions for numerous accident conditions, physical forms, and chemical forms. The product of the airborne release fraction (ARF) and respirable fraction (RF) and other factors give the released source term that is respirable are shown below.

  The average of the median product of the ARF and RF is approximately 4 E-4 with a range from 0 to 2 E-3. Other factors may also apply, such as the damage ratio and leak path factor in determining the activity released. No credit is taken for the damage ratio or leak path factor in this analysis.

DOE Handbook 3010-94 Material and Accident	**Bounding ARF**	**Bounding RF**	**Product ARF*RF**
LIQUIDS - Section 3.1			
Heating of solution, not continuous boiling	3.E-05	1.E+00	3.E-05
Venting, low pressure < 50 psig, explosion	5.E-05	8.E-01	4.E-05
Venting, high pressure, heavy solution, explosion	1.E-03	4.E-01	4.E-04
Spill, aqueous solution	2.E-04	5.E-01	1.E-04
Spill, slurries, < 40% solids	5.E-05	8.E-01	4.E-05
Spill, heavy metal solution	2.E-05	1.E+00	2.E-05
Average for liquids			**1.E-04**
SOLIDS - Sections 4.1, 4.3.3, and 5.1			
Oxidation (not ignited)	3.E-05	4.E-02	1.E-06
Self sustained oxidation with ignition of molten metal with natural convection	5.E-04	5.E-01	3.E-04
Powder under thermal stress	6.E-03	1.E-02	6.E-05
Venting of powder, deflagration, < 25 psig	5.E-03	4.E-01	2.E-03
Heating small specimens (air)	3.E-05	3.E-01	9.E-06
Free fall of solids (a)			0.E+00
Free fall with brittle fracture from 1m (Section 4.3.3)			2.E-06
Powder free fall < 3m, normal air flow	2.E-03	3.E-01	6.E-04
Powder free fall with no brittle fracture (b), release from shock vibration, or suspension from shock vibration	1.E-03	1.E+00	1.E-03
Average for solids			**4.E-04**
Median for liquids and solids			**4.E-05**
Maxium for liquids and solids			**2.E-03**

Notes:
(a) For materials with high surface area to mass ratios, no significant suspension is expected for free fall spill from typical working heights (~ 1 - 1.5 m).
(b) For low-energy stresses, powders do not tend to significantly fragment.

- Safety Analysis Working Group Workshop 2000 preprint publication INEEL/CON 2000-00099 provides airborne release fractions (ARF) for transuranics. The ARF increases with the surface area to bulk weight parameter, Sa. For Sa > 1, the ARF is listed as 1E-3. A Sa parameter > 1 is expected for samples used in fueled experiments.

- Release fractions for fuel failures are used for gases and halogens (volatile material) in wet environments are based on NUREG 1400 and ANSI/ANS 15-7. Particulates are assumed to be retained in the water.

From the above discussion and data given in references, the Dispersal Fraction, D, used in this analysis are as follows:

- In dry environments, D of 0.01 is used for fission product particulates and for fissionable material and in-grown transuranic nuclides in the form of non-volatile and non-combustible powders, solids, and liquids. The value of 0.01 is a maximum value given in the references and considers only the particulates released that are respirable. It is noted that this value of 0.01 is typically used as a screening level for evaluation of airborne hazards. Also there would most likely be intervening materials (encapsulation materials, shielding) limiting the activity of particulates released. For gases and volatile materials (halogens) a D value of 1 is used.

  In wet environments the values for D are as follows; 1 for gases, 0.25 for volatile materials (halogens), and 0 for particulates (Ref 33).

  The dispersion fraction, D, for wet environments is the same as or lower than that for dry environments. As a result, dry environments would have a higher associated dose and therefore dose from wet environments do not need to be evaluated.

CONCENTRATION and TIME INTEGRATED EXPOSURE

After the source is produced and decayed, the source is assumed to be removed from the experiment with all of the remaining activity instantaneously released to the reactor bay resulting in uniform airborne activity distribution throughout the entire reactor bay. The instantaneously released concentration, C(t+T), in the reactor bay is given by the following:

$$C(t+T) = \frac{A_D(t+T)}{V} = \frac{A_D(t+T)}{2.4\ E9\ ml} \qquad \text{EQ 14}$$

where, V of 2.4E9 ml is the reactor bay free air volume in the experimental facility area reported in Reference 22.

The time-integrated exposure and removal by radioactive decay and the ventilation system are taken into account as follows:

$$\int_0^{\tau} C(t+T)e^{(-k\tau')}d\tau' = \frac{C(t+T)}{k}\left[1-e^{(-k\tau)}\right] \qquad \text{EQ 15}$$

where,

- $k = \lambda + v$ in h^{-1}
- v is the confinement ventilation mode air removal rate constant in h^{-1}
- v = 1.18 E-4 s^{-1} or 0.425 h^{-1} at a 600 cfm exhaust rate
- τ is exposure time, ranging from 0 to τ, in hours

Time-integrated exposure in public areas is further reduced by removal of halogens and particulates by the confinement filters and by atmospheric dispersion. This gives the following equation for time-integrated exposure:

$$\frac{\mu Ci\ h}{ml} = \frac{C(t+T)}{k}(1-e^{-k\tau})(1-R)(7.6\times10^{-3})\ \ F \qquad \text{EQ 16}$$

where,

- C(t+T) is in uCi/ml
- k is in h^{-1}
- τ is exposure time in hours
- R = 0.9 for halogens, R = 0.9997 for particulates, and R = 0 for noble gases
- F is the volumetric stack exhaust rate in confinement = 0.283 m^3/s, converted from 600 cfm
- 7.6 E-3 s/m^3 is the most limiting atmospheric dispersion parameter (i.e. X/Q) which was evaluated at a stack height of 30 m and a distance of 150 m and a receptor height of 30 m for Class F weather stability at a wind speed of 1 m/s. This X/Q value is associated with meeting emergency action levels given in the facility emergency plan.

US NRC Regulatory Guide 2.2 states that evacuation time is to be considered in the analysis for experiment failure. Evacuation time was measured from various locations inside the reactor building to the evacuation exit point for several individuals to be 1 minute or less following initiation of the reactor building evacuation signal. Evacuation exit was at the northwest basement door as specified in the facility emergency plan and procedures. Also, an evacuation time of approximately 1 minute is calculated for an average walking pace of 3 mph for 250 feet, which is the distance from the furthest location in the reactor building to the assembly point outside the reactor building. Measured times are in good agreement with estimated walking times.

REACTOR BUILDING EVACUATION TIMES

Location	**Exit Point**	**Evacuation Time, s** (measured)	**Distance**	**Walking Time, s**
Control Room	North West Door	58	250	57
Reactor pool top	North West Door	55	250	57
Mechanical Equipment Room	North West Door	45	200	45
Primary Piping Vault	North West Door	36	150	34
Loading dock	North West Door	54	225	51
Experiment/beam tubes (east)	North West Door	48	200	45
Experiment/beam tubes (west)	North West Door	25	100	23
Experiment/beam tubes (south)	North West Door	10	40	9
Experiment/beam tubes (north)	North West Door	38	175	40
Ventilation room	North West Door	10	40	9
Date:	19-May-16			

For personnel in the reactor building, an exposure time (τ) of 0.05 hours (3 minutes) is used based on the time needed for operator or detector action to activate building evacuation alarm and for personnel to physically exit the reactor building. Detector response time may take from 10 to 60 seconds. Reactor Operator response may take from 5 to 30 seconds. Total is less than 3 minutes.

Exposure time (τ) is taken as 24 hours for members of the public. 24 hours is sufficient time for the entire released activity to be vented from the reactor building (in excess of 10 air changes). A public exposure time of 24 hours is associated with meeting emergency action levels given in the facility emergency plan.

Example calculations are given in Section I.

D. DOSE ASSESSMENT

EXTERNAL DOSE (other than submersion)

For radiological control purposes, external dose rates from beta, gamma, and neutron radiation is limited by facility procedures consistent with experimental limitations and conditions and 10 CFR Part 20 requirements including ALARA (As Low As Reasonably Achievable) practices.

All experiments require a radioactive materials authorization approved by the Reactor Safety and Audit Committee (RSAC) and the NCSU Radiation Safety Committee (RSC). Activity limits, handling conditions, and experimental uses by personnel are established in the radioactive material authorizations.

Prior to conducting the irradiation, external dose rates and source activities are estimated, along with other required information, in the experiment request. Other information includes giving the materials and quantities present in the sample and indicating if any fissionable materials or materials with high cross-sections are present. The experiment request is reviewed and approved by reactor staff prior to conducting the irradiation. Fueled experiments are controlled as stated in TS 3.8 to include documented reviews, committee reviews by RSAC and RSC, and radiation monitoring.

The peak fission rate expected from fueled experiments is less than 1E13 f/s (8.9E12 f/s for U-235) as compared to 3.1E16 f/s at 1 MW from the reactor. For fueled experiments near the reactor core, this gives an increase of 0.03% to the measured radiation levels of approximately 1 mrem/h outside the reactor shield or top of the pool.

Estimated activities and dose-equivalent rates may be determined using various texts, regulations, and technical reports listed as references in this calculation. Reactor shielding includes 7m of water over the top of the reactor to the top of the reactor pool and 1 m of water and 1.98 m (6.5 feet) of barytes concrete at the level of the reactor core and experimental beam tubes.

Using data from References 17, 18, 19, and 20, the source term with a fission rate of 1E13 f/s has an unshielded gamma dose rate of 1E7 mrem/h at 30 cm:

Gamma MeV	Estimated photon/s	Estimated MeV/photon	Unshielded at 30 cm, mR/h
0-1	5.4E+13	0.5	4.70E+06
1-2	1.4E+13	1.5	3.04E+06
2-3	3.3E+12	2.5	1.06E+06
3-4	8.8E+11	3.5	3.51E+05
4-5	3.7E+11	4.5	1.75E+05
5-7.5	1.8E+11	6	1.04E+05
Total =	7.3E+13		9.44E+06

If all radiation dose is assumed to come from 8 MeV gamma photons, the barytes concrete and water shielding in place at the reactor pool are evaluated to give dose rates less than 0.01 mrem/h to areas outside the reactor pool using point source geometry:

		Distance	u/p	Mass Thickness		Buildup		
Shield	**MeV**	**cm**	**cm2/g**	**g/cm2**	**MFP**	**B**	**B exp(-ux)**	**mrem/h**
Barytes Concrete	8	198	2.95E-02	6.93E+02	2.04E+01	1.43E+01	1.89E-08	8.69E-03
Water	8	700	2.42E-02	7.00E+02	1.69E+01	6.00E+00	2.64E-07	9.69E-03

Notes:

- 1E7 mrem/h * B exp(-ux) * $(30/d)^2$ *2 =1.8E10 * B exp(-ux) / d^2
- The factor of 2 accounts for prompt gamma photons from fission and neutron capture and fission product gamma photons (Ref 17, 18)
- Barytes concrete density is 3.5 g/cm^3 (Ref 37)

Experimental beam tubes may be filled with various shielding materials (e.g. concrete, polyethylene, water, lead) to reduce external dose rates. Additional shielding may be placed outside the experimental beam tube, and within the reactor building, such as steel, concrete, and lead to reduce external dose rates. Appropriate access controls and monitoring as required by 10 CFR Part 20, the radiation protection program, and the radioactive/radiation authorization for the experiment are used to control personnel dose.

Radiation surveys are performed to verify that external dose rates, airborne activity, and contamination levels are within acceptable levels for new experiments, new experimental facilities or altered shielding. If needed, a power accession or short irradiation is performed to estimate dose rates at higher power and longer durations.

Occupationally exposed personnel at the reactor facility are monitored as provided for in the facility radiation protection program. Doses to occupational personnel are limited administratively as provided for in the facility radiation protection program. Currently, administrative limits are 10% of the annual limits for all dose quantities, e.g. 0.5 rem TEDE, 5 rem TODE. Authorization is required to exceed the administrative dose limits as provided for in the facility radiation protection program. Radiation monitoring with local alarms and Control Room notification, shielding, limitation of access/ stay times, boundary controls/distance (e.g. for High Radiation Area), alarming dosimeters, and use of approved procedures and Radiation Work Permits are included as needed to keep personnel dose ALARA.

All samples are surveyed at the time of removal from an experiment. Remote radiation monitoring may be used to measure and indicate the sample dose rate. Upon removal samples may be shielded or returned to storage for further decay as necessary. Samples removed are labeled and stored and used in areas which are posted as required by the facility radiation protection program. As is the case with all experiments, and as directed by the facility radiation protection program, experiments producing an abnormal, unexpected, or unacceptably high radiation levels are stopped. Radioactive material is shipped or disposed of as provided for in the facility radiation protection program. Members of the public and are not allowed into areas exceeding 2 mrem per hour or 100 mrem per year and also are not allowed to handle sources of radiation or radioactivity regardless of dose rate.

DOSE FROM RELEASED MATERIALS

Dose to occupational workers and members of the public is determined as follows for radioactive materials released:

$$D_{reference} = (Time\text{-}Integrated\ Exposure)\ (DCF) \qquad \text{EQ 17}$$

where,

- $D_{reference}$ is dose, in rem = Time Integrated Exposure (uCi-h/ml) * DCF (rem/h per uCi/ml) calculated for a reference mass of 1 gram
- DCF = Dose Conversion Factor in rem/h per uCi/ml taken from 10CFR20 Appendix B Table 1 and Table 2 (Ref 13)

DCF are determined from 10 CFR Part 20 Appendix B using the listed Derived Air Concentration (DAC), Annual Limit on Intake (ALI), or Effluent Concentration (EC). DCF were based on limiting values given in 10 CFR Part 20 Appendix B, i.e. using the lower value listed for the different inhalation classes.

The following are noted in 10 CFR Part 20 Appendix B regarding DAC, EC, and ALI:

10 CFR Part 20 Appendix B, Table 1, Occupational Values

When an ALI is defined by the stochastic dose limit, this value alone, is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses. (Abbreviated organ or tissue designations are used: e.g Thyroid, Bone Surf for bone surface).

10 CFR Part 20 Appendix B, Table 2, Effluent Concentrations

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to occur at the dose levels established for individual members of the public.

The air concentration values listed in Table 2, Column 1, were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by 2.4 E9 ml, relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 5 rem annual occupational dose limit to the 0.1rem limit for members of the public, a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values (derived for adults) so that they are applicable to other age groups.

For those radionuclides for which submersion (external dose) is limiting, the occupational DAC in Table 1, Column 3, was divided by 219. The factor of 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2000 hours per year to full-time exposure (8760 hours per year). Note that an additional factor of 2 for age considerations is not warranted in the submersion case.

The Committed Effective Dose-Equivalent (internal dose quantity) used to assess stochastic effects may be calculated using the stochastic based Annual Limit on Intake (ALI). In Table 1, if an organ is listed, then listed Derived Air Concentration (DAC) is based on non-stochastic effects and the stochastic based ALI is listed in parentheses. To assess the CEDE the stochastic based concentration limit is determined by dividing the stochastic based ALI value in parentheses in uCi by 2.4E9 ml. Alternately, the Effluent Concentration listed in Table 2 may be multiplied by 300.

The DAC is calculated as directed in 10 CFR Part 20 Appendix B. This value applies to the Organ DCF if the organ is listed or to the Effective DCF if no organ is listed:

$$DAC = ALI / 2.4E9\ ml$$

When an organ is listed, the stochastic based ALI listed in parentheses is used to determine the air concentration associated with the Effective DCF as follows:

$$DAC\ (effective\ dose) = ALI(\ in\ parentheses) / 2.4E9\ ml$$

Alternately the EC given in Table 2 may be multiplied by 300 for evaluation of CEDE. DCF for CEDE are then determined as specified in EQ 18.

The radioactive materials present in a fueled experiment include the fissionable material, fission products, and activation products. Activation of the fissionable material produces other radionuclides which may also be fissionable. Decay of these materials leads to other radionuclides being present.

Associated radiation dose from the submersion and inhalation pathways for these radioactive materials include the following, as defined in 10 CFR Part 20:

- Total effective dose-equivalent (TEDE) from inhalation and submersion given by the sum of the deep dose-equivalent (DDE) and the committed effective dose-equivalent (CEDE)

- Total organ dose-equivalent (TODE) given by the sum of the DDE and committed dose-equivalent (CDE) to the organ of concern

CEDE and CDE are associated with inhalation. CDE for the thyroid and bone surfaces were analyzed. Thyroid CDE is primarily associated with fission products (I and Te). Bone surface CDE is primarily associated with fissionable materials and its activation products.

DDE is associated with external exposure to a radiation source. In this analysis only submersion dose from a cloud of radioactive noble gases is analyzed.

As described in US NRC Regulatory Guide 8.34 (Ref 12), use of values given in 10 CFR Part 20 Appendix B may be used to estimate internal dose quantities and submersion dose.

Dose Conversion Factors (DCF)

For CEDE:

$$\textit{Effective DCF for workers} = \frac{\textit{(5 rem / 2000 h)}}{\textit{[10CFR20 Appendix B Table 1 DAC in uCi/ml]}} \qquad \text{EQ 18}$$

$$\textit{Effective DCF for public} = \frac{\textit{(0.05 rem / 8760 h)(2)}}{\textit{[10CFR20 Appendix B Table 2 EC in uCi/ml]}} \qquad \text{EQ 19}$$

For DDE from submersion dose:

$$\textit{Effective DCF for workers} = \frac{\textit{(5 rem / 2000 h)(0.1)}}{\textit{[10CFR20 Appendix B Table 1 DAC in uCi/ml]}} \qquad \text{EQ 20}$$

$$\textit{Effective DCF for public} = \frac{\textit{(0.1 rem / 8760 h)}}{\textit{[10CFR20 Appendix B Table 2 EC in uCi/ml]}} \qquad \text{EQ 21}$$

For CDE to the thyroid and bone surfaces:

$$\textit{Organ DCF for workers} = \frac{\textit{(50 rem / 2000 h)}}{\textit{[10CFR20 Appendix B Table 1 DAC in uCi/ml]}} \qquad \text{EQ 22}$$

Corrections to Dose Calculations

Correction for dose from fission products are made based on fission product yields, submersion dose from fission product noble gases based on room dimensions, concentration based on volume, and mass of the fissionable material present during the irradiation.

Submersion Dose Correction

Reduction of submersion dose from photons emitted by radioactive noble gas fission products inside the reactor building is made using the following (Ref 27, 28, 29):

$$D_{refernece} = f\,(Time\text{-}Integrated\ Exposure)\,(DCF) \qquad \text{EQ 23}$$

where, $$f = f'Gk = u_{en}\,RGk$$

$$f = (4.92E\text{-}5/cm)(944\ cm)(2)(1.1) = 1.0E\text{-}1$$

Alternately, $f = 2k[1-exp(-u_{en}\,R)] = 2(1.1)[1- exp(-4.92E\text{-}5*944)] \sim 0.1$

- f' is the ratio of dose from a finite cloud to dose from a semi-infinite cloud given by the product of $u_{en}\,R$
- u_{en} = energy absorption coefficient in air for photons, for photons above 50 keV this value is < 4.92E-5 per cm from Reference 32
- R = effective radius of 944 cm based on the reactor building volume of 3.5E9 ml
- G = geometry correction factor of 2 for a sphere (4π geometry for personnel at an elevated location) vs. hemisphere (2π geometry for semi-infinite cloud affecting personnel on a lower level surface)
- k = ratio of mass energy absorption coefficients for tissue to air to convert to tissue dose having a value of ~ 1.1 for photon energies from 50 keV to several MeV
- f has a value of ~ 0.1 or less and is applied to the submersion dose inside the reactor building

Volume

V of 2.4 E9 ml is reported in the facility FSAR (Reference 22) for the free volume in the reactor bay. V is estimated for the reactor building experimental area (bay) by using the dimensions and a free volume fraction of 70 percent:

V = (39 ft x 53 ft x 60 ft) (28,317 ml/cubic foot)(0.7) = (3.5E9 ml) (0.7) = 2.5 E9 ml

Measurements of the reactor building experimental area were made and give a total volume of 3.4 E9 ml. Free volume was measured to be 3.1 E9 ml by accounting for existing equipment and experiments:

MEASURED REACTOR BUILDING VOLUME

Location	Cubic feet	Cubic cm
Reactor Bay	1.24E+05	3.52E+09
Loading Dock	7.38E+03	2.09E+08
Imaging and Positron	3.14E+03	8.90E+07
Reactor Shield Level 1	3.16E+03	8.94E+07
Pool level 1	5.87E+02	1.66E+07
Reactor Shield Level 2	1.95E+03	5.53E+07
Pool level 2	9.71E+02	2.75E+07
Reactor Shield Level 3	2.13E+02	6.04E+06
Pool level 3	3.31E+02	9.36E+06
Gross Free Volume	1.21E+05	3.43E+09
Misc Volume	1.21E+04	3.43E+08
Net Free Volume	1.09E+05	3.09E+09

The estimated and measured free volumes are both above the FSAR value. Additional equipment, modifications, or experiments in the reactor building significantly affecting free air volume are not expected. Therefore, the FSAR value of 2.4 E9 ml is acceptable for use in this calculation.

DATA FOR f VALUE

	DRY AIR	1 - exp(-uenR)	f value
Energy	μen		
(MeV)	(1/cm)		
5.00E-02	4.92E-05	4.53E-02	9.97E-02
6.00E-02	3.65E-05	3.38E-02	7.44E-02
8.00E-02	2.89E-05	2.69E-02	5.91E-02
1.00E-01	2.79E-05	2.60E-02	5.71E-02
1.50E-01	3.00E-05	2.79E-02	6.13E-02
2.00E-01	3.21E-05	2.98E-02	6.55E-02
3.00E-01	3.45E-05	3.20E-02	7.04E-02
4.00E-01	3.54E-05	3.28E-02	7.22E-02
5.00E-01	3.56E-05	3.30E-02	7.26E-02
6.00E-01	3.54E-05	3.29E-02	7.23E-02
8.00E-01	3.46E-05	3.21E-02	7.06E-02
1.00E+00	3.35E-05	3.11E-02	6.84E-02
1.25E+00	3.20E-05	2.97E-02	6.54E-02
1.50E+00	3.06E-05	2.84E-02	6.25E-02
2.00E+00	2.81E-05	2.62E-02	5.76E-02
3.00E+00	2.47E-05	2.30E-02	5.06E-02
4.00E+00	2.24E-05	2.09E-02	4.61E-02
5.00E+00	2.09E-05	1.95E-02	4.29E-02
6.00E+00	1.98E-05	1.85E-02	4.06E-02
8.00E+00	1.83E-05	1.71E-02	3.76E-02
1.00E+01	1.74E-05	1.63E-02	3.58E-02
1.50E+01	1.62E-05	1.52E-02	3.34E-02
2.00E+01	1.57E-05	1.47E-02	3.24E-02

Fission Yield Correction

Correction for the dose from fission products is made if the sum of the fission yield is less than 2 as follows:

$$D_{reference} = f\,Z\,(\text{Time-Integrated Exposure})\,(DCF) \qquad \text{EQ 24}$$

where, $Z = 2 / \Sigma Y$ with ΣY = sum of the fission yields for each fission product
f = 0.1 for noble gas fission products inside the reactor building
f = 1 for noble gas fission products outside the reactor building
f = 1 for all other radionuclides

Fission product yields atomic masses from 66 to 167 were analyzed. The number of radionuclides evaluated was approximately 500. The fission yields analyzed ranged from 1.86 to 1.91, with an average of 1.89 per fission. The calculated dose is increased by a factor of (2 / ΣYi) to account for missing fission products; e.g. Z = 2/1.89 = 1.058.

The dose from missing fission products is assumed to give a similar dose as those analyzed and therefore assumes an average dose for the missing fission products is applicable. Z is not applied to the fissionable material or its activation products.

Mass and Fluence Rate Corrections

Fueled experiments may have result multiple fissionable materials present. The activity, concentration, and dose were calculated for a reference mass of 1 gram and reference fluence rate of 1E13 $cm^{-2}s^{-1}$. Adjustments to the reference doses calculated at a constant mass of 1 gram and fluence rate of 1E13 $cm^{-2}s^{-1}$ are made as indicated below:

For fission products from the fissionable material initially present:

$$D_{FP} = \frac{M_{average}(t)\varphi}{(1g)(1E13)} D_{reference} \qquad \text{EQ 25}$$

For fission products from fissionable material produced by activation or decay:

$$D_{FP}^{j} = \frac{M^{j}_{average}(t)\varphi}{(1g)(1E13)} D_{reference} \qquad \text{EQ 26}$$

For fissionable material initially present:

$$D_{FM} = \frac{M(t)}{(1g)} D_{reference} \qquad \text{EQ 27}$$

For fissionable material produced by activation or decay:

$$D_{FM}^{j} = \frac{M^{j}(t)}{(1g)} D_{reference} \qquad \text{EQ 28}$$

where,

- D is dose
- FP is fission product, FM is fissionable material
- j refers to fissionable material produced by activation or decay of the initial fissionable material
- φ is the fluence rate in $cm^{-2}s^{-1}$
- Reference mass is 1 g and reference fluence rate is 1E13 $cm^{-2}s^{-1}$
- Reference doses are given in Section H
- M(t) and average mass for different fluence rates are given in Section H. Mass values are calculated from EQ9, 10, 11, and 12 for EQ27, 28, 25, and 26, respectively.

DOSE RESULTS

In summary:

- Maximum TEDE and TODE for a reference mass of fissionable material at a uniform fluence rate were determined for each listed fissionable material for various irradiation times "t" with and without decay during "T" and for the assumed irradiation, decay, and exposure conditions. Irradiation and decay times varied up to 1 year each.

- Maximum doses may or may not correspond to maximum radioactive material inventories since dose conversion factors vary with the radionuclide radiation decay characteristics, biological and metabolic characteristics, and physical half-life, i.e. dose varies as the radioactive material distribution changes over time. A decay period up to 1 year is realistic and accounts for the buildup and decay of radioactive material inventory from the decay of precursors.

- The maximum doses for the TEDE and TODE were determined. The TODE to the bone surfaces is associated with the fissionable material, activated fissionable material, and associated decay products. The TODE to the thyroid is associated with fission products.

- Corrections are made for the mass and fluence rate for fissionable materials, fission yield for incomplete fission yield data, and submersion dose for the personnel inside the reactor building based on dimensions of the experimental area.

TEDE and TODE dose results for the reference conditions and adjusted doses with noted corrections are given in Section H of this analysis.

Example calculations are given in Section I.

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E. EXPERIMENT LIMITS

The postulated accident dose depends on the activity present. Calculations were performed for specific fissionable materials for a reference fluence rate and reference mass for continuous irradiation times up to 1 year followed by decay times up to 1 year. As a result of activation of the fissionable material, other fissionable material is produced which in turn undergoes fission. The mass of the produced fissionable material and potential radiation doses are calculated at each irradiation time, t. Reference fluence rate was 1E13 $cm^{-2}s^{-1}$ and reference mass was 1 gram throughout irradiation time, t. The reference fluence rate is the peak experimental fluence rate at the reactor facility

The design dose limits are 0.01 rem TEDE for members of the public outside the reactor building and 0.5 rem TEDE and 5 rem TODE to the thyroid or bone surfaces for occupational personnel inside the reactor building. TODE to the thyroid is associated with fission products and not the fissionable material or activated fissionable material. TODE to the bone surfaces is associated with the fissionable material and its decay products and activated fissionable material and its decay products, not the fission products.

To account for all fissionable materials involved in the irradiation, including those initially present and those that are produced by activation and all fission products from the fissionable material, the radiation doses from EQ 25, 26, 27, and 28 are summed at each fluence rate to give the Total Dose per initial gram of fissionable material for a specified fluence rate and irradiation time.

$$\textit{Total Dose}(\varphi,t)\ \textit{per g} = D_{FP} + D_{FM} + \Sigma_j\,[D^j_{FP} + D^j_{FM}] \qquad \text{EQ 27}$$

where, Total dose is either the TEDE inside the reactor building, TEDE outside the reactor building, thyroid TODE inside the reactor building, or bone surface TODE inside the reactor building

The mass limit, M^{Limit} at the specified fluence rate and irradiation time was calculated as follows:

$$M^{Limit} = \frac{Dose\ \ Limit}{Total\ \ Dose(\varphi,t)\,per\ \ g} \qquad \text{EQ 28}$$

where, Dose limits are:

- ☐ 0.5 rem for TEDE inside the reactor facility
- ☐ 0.01 rem TEDE in unrestricted areas (public areas outside the reactor facility)
- ☐ 5 rem TODE to the thyroid or bone surfaces inside the reactor facility

Total dose is calculated from EQ 27

- ☐ Total dose for the TEDE includes dose from all radionuclides present
- ☐ Total dose for the TODE is the higher of the thyroid TODE or bone surface TODE. Fission products give thyroid TODE. Fissionable materials give bone surface TODE.

Corrections were made to calculated reference doses as described in Section D. Results are given in Section H based on the limiting mass for different fluence rates and irradiation times.

EQ 28 is used to determine the associated mass for a fueled experiment for a single fissionable material. For mixtures of fissionable materials, the ratio of the experiment fission rate for each i^{th} fissionable material to the respective limiting fission rate shall not be greater than a value of 1 and the mass determined shall not exceed the possession limit:

$$\sum_i \frac{M_i^{Experiment}}{M_i^{Limit}} \leq 1 \qquad \text{EQ 29}$$

POSSESSION LIMITS

Possession limits given in the proposed facility license for fueled experiments are changed to be within 10 CFR Part 37 Category 2 limits while meeting experiment needs. 10 CFR Part 37 security requirements apply if the activity limits for the listed radionuclides are exceeded either individually or collectively (i.e. if the sum of the activity fractions exceeds 1).

10 CFR Part 37 Category 2 lists specific radionuclides and activity limits which include fissionable materials and fission products. Mass limits for these nuclides are calculated using the activity limits given in 10 CFR Part 37 and the specific activity given in 10 CFR Part 71 (Ref 31).

10 CFR Part 37 Category 2 nuclides, activity limits, and associated mass limits are as follows:

Radionuclide	10CFR37 Category 2 Activity Limit, Ci	10CFR37 Category 2 Mass Limit, g
Pu238	1.62E+01	9.53E-01
Pu239	1.62E+01	2.61E+02
Am241	1.62E+01	4.76E+00
Cm244	1.35E+01	1.67E-01
Cf252	5.40E+00	1.00E-02
Radionuclide	**10CFR37 Category 2 Activity Limit, Ci**	**10CFR37 Category 2 Mass Limit, g**
Sr90	3.70E+02	2.64E+00
Cs137	2.70E+01	3.10E-01
Pm147	1.08E+04	1.16E+01
Gd153	2.70E+02	7.71E-02
Tm170	5.40E+03	9.00E-01
Yb169	8.10E+01	3.38E-03
Ir192	2.16E+01	2.35E-03
Ra226	1.08E+01	1.08E+01
Se75	5.40E+01	3.60E-03

Fueled experiments were evaluated for the activity of radionuclides listed in 10 CFR Part 37. To determine the mass of fissionable material that gives the 10 CFR Part 37 limits, the reference data was used and adjusted using the mass of each fissionable material present.

The maximum for the fission products and fissionable material produced by activation occur at the reference fluence rate at an irradiation time of 1 year. The mass used for fission products was the average at the end of 1 year of irradiation. The mass at the end of the year was used for the fissionable material fissionable materials produced by activation. For the fissionable material initially present, the reference mass of 1 g at the beginning of the irradiation time was used. For fissionable materials produced by decay, the mass at the end of the storage period was used. Mass was converted to activity for comparison to the 10 CFR Part 37 limits.

The activity fraction of 10 CFR Part 37 radionuclides, Q, was calculated as follows:

$$Q = \sum_i \frac{(A_i \; per \; g)(M_i)}{A_i^{Limit}}$$

where,

- A_i is the activity for material "i" listed in 10 CFR Part 37 for reference conditions
- A_i^{Limit} is the activity limit of material "i" listed in 10 CFR Part 37
- M_i is the maximum mass fraction for material "i" for reference conditions with an initial mass of 1 g
  - M(0) is used for the fissionable material initially present divided by 1g
  - M(0) at the end of the storage time is used for fissionable material produced by decay of the fissionable material initially present divided by 1 g
  - M(t) is used for fissionable material produced by activation divided by 1g

10 CFR Part 37 security requirements apply if the activity limits for the listed radionuclides are exceeded either individually or collectively (i.e. if the sum of the activity fractions, or Q, exceeds 1). The mass (M) of fissionable material producing the 10 CFR Part 37 Category 2 limit was then calculated as follows:

$$M = \frac{1}{Q} \qquad \text{EQ 30}$$

Maximum results for the 10 CFR Part 37 activity fraction, Q, for the fissionable material considered in this analysis are shown below. Total Q includes other fissionable materials present during irradiation.

Fissionable Material	Q Reference Fraction	Total Q Fraction	Experiment Mass Limit, g
Pa231	5.2E-05	4.65E-03	2.1E+02
U232	2.4E-02	2.5E-02	4.0E+01
U233	3.8E-02	3.8E-02	2.6E+01
U234	5.1E-05	5.2E-03	1.9E+02
U235	2.6E-02	2.7E-02	3.7E+01
U236	1.8E-04	5.1E-12	2.0E+11
U238	1.2E-05	2.8E-03	3.5E+02
Pu238	1.8E-03	7.1E-03	1.4E+02
Pu239	3.2E-02	6.0E-02	1.7E+01
Pu240	1.4E-04	1.5E-01	6.5E+00
Pu241	1.5E-01	2.6E-01	3.8E+00
Pu242	4.3E-05	1.2E+00	8.4E-01
Np237	2.2E-01	2.2E-01	4.6E+00
Am241	2.1E-01	3.7E-01	2.7E+00
Am243	3.4E+00	6.7E+00	1.5E-01
Cm242	9.3E-01	9.4E-01	1.1E+00
Cm243	4.4E-01	8.0E-01	1.2E+00
Cm244	6.0E+00	6.0E+00	1.7E-01
Cm245	8.8E-02	8.9E-02	1.1E+01
Cm246	1.0E-03	1.8E-03	5.5E+02
Cm248	4.0E-04	4.0E-04	2.5E+03
Cf249	7.2E-02	8.0E-02	1.2E+01
Cf251	2.8E+01	5.5E+01	1.8E-02
Th232	3.5E-06	9.2E-04	1.1E+03

Possession limits are established based experimental needs and 10 CFR Part 37 limits. Possession limits for individual materials were calculated as being the lesser or the following:

- 70% of the limit given for Category 2 in 10 CFR Part 37
- 70% of the mass estimated by EQ 30
- 100 g

Possession limits were calculated to be:

Fissionable Material	Mass (g)	Activity (Ci)	SUM OF FRACTIONS
Am241	1.9E+00	6.43E+00	
Cf252	7.0E-03	3.78E+00	**SUM**
Cm244	1.2E-01	9.64E+00	
Pu238	6.7E-01	1.13E+01	**OF**
Pu239	1.1E+01	6.51E-01	
Am243	1.1E-01	2.10E-02	**FRACTIONS**
Cf249	7.0E+00	2.87E+01	
Cf251	1.1E-02	1.68E-02	**NOT**
Cm242	7.0E-01	2.31E+03	
Cm243	8.8E-01	4.55E+01	**TO**
Cm245	7.7E+00	1.31E+00	
Cm246	1.0E+02	3.10E+01	**EXCEED**
Cm248	1.0E+02	4.20E-01	
Np237	3.2E+00	2.24E-03	**VALUE**
Pa231	1.0E+02	4.70E+00	
Pu240	4.6E+00	1.05E+00	**OF**
Pu241	2.5E+00	2.45E+02	
Pu242	5.6E-01	2.18E-03	**1.0**
Th232	1.0E+02	1.10E-05	
U232	2.7E+01	6.01E+03	**FOR**
U233	1.8E+01	1.77E-01	
U234	1.0E+02	6.20E-01	**ALL**
U235	2.6E+01	5.70E-05	
U236	1.0E+02	6.50E-03	**FISSIONABLE**
U238	1.0E+02	3.40E-05	**MATERIALS**

TS 5.3 requirements for fueled experiments in storage shall be met, as applicable. Calculations and measurements made for reactor fuel are used for fueled experiment storage. These are documented using facility procedures to verify fueled experiments are stored in a configuration to keep k_{eff} no greater than 0.9.

Storage facilities are reviewed under TS 3.8, 10 CFR Part 50.59 for design changes, 10 CFR 50.54(p) for security, 10 CFR 50.54(q) for emergency planning, and 10 CFR Part 20 for radiation protection. If a storage facility requires a license amendment, then approval by the NRC is needed prior to implementing the change.

Fueled experiment materials shall be inventoried and accounted for as required by 10 CFR Part 70, as applicable, the university broad scope license, and facility procedures.

FUELED EXPERIMENT DEFINITION

Radiation dose inside and outside the reactor building was estimated in this analysis and was used to derive the mass limits for fueled experiments. The basis for the definition of fueled experiments is an experiment failure that may exceed 10 percent of the annual dose limits given in 10 CFR Part 20. The non-fueled experiment definition is based on an experiment failure that does not exceed the public TEDE constraint of 0.01 rem. It is noted that public TEDE outside the reactor building is lower than that inside the reactor building due to atmospheric dilution (Atmospheric dilution is over a factor of 100 while the noble gas cloud correction is a factor of 10.)

To meet this definition for non-fueled definition, the TEDE based mass limit calculated for inside the reactor building is used since it is not filtered. This mass is adjusted for the public TEDE of 0.01 rem and for the normal ventilation mode. A TEDE of 0.01 rem is the public constraint dose.

Changes to removal rate and exposure time affect the time-integrated exposure as described in EQ 14 through 17. This gives the following simplified general equation for TEDE:

$$TEDE = C(t+T)\frac{[1-e^{-kt}]}{k} DCF = \frac{A_D}{V}(t+T)\frac{[1-e^{-kt}]}{k} DCF$$

where it is noted that no filter retention or atmospheric dispersion occurs, mass is related to the dispersed activity, free reactor building volume is constant at 2.4E9 ml, the dose conversion factor, DCF, is the constant for a given release, and the fissionable material activity is long-lived compared to the exposure time for 5 air changes. With these observations, the TEDE equation is simplified as being related to the product of the mass and integrated time as follows:

$$TEDE \; \alpha \; \frac{[1-e^{-kt}]}{k} \cdot Mass$$

TEDE is proportional to the integrated time and mass.

An exposure time of at least 5 air changes in normal ventilation following the release of materials is used. After 5 air changes, the fraction remaining is less than 0.007 [exp(-5)] indicating that most of the activity has been exhausted from the reactor building.

For fueled experiments performed in confinement ventilation with an exposure time of 0.05 h, the integrated time is approximately 5.0E-2 h. For non-fueled experiments in normal ventilation with an exposure time of 3.8hours, the integrated time is approximately 7.5E- 1 h.

				Time for 5			
Ventialtion Mode	**Removal Rate Constant, k**			**air changes**		**Integrated Time**	
Confine	0.425	per h		0.050	h	0.049	h
Normal	1.327	per h		3.767	h	0.748	h

Occupancy during the entire exposure time of 3.8 h in normal ventilation is conservatively assumed.

Correction for the ventilation mode and exposure time was made neglecting radioactive decay; this gives k = v instead of v+λ. where v is the ventilation removal rate constant. Neglecting decay is conservative, i.e. it over-estimates the time-integrated exposure.

Using the proportional relationship given above, the mass (m) for non-fueled experiments is calculated by adjusting the previously calculated TEDE based mass (M^{TEDE}), integrated times, and TEDE limits follows:

0.01 rem α (0.75 h)(m) and 0.5 rem α (0.05 h)M^{TEDE}

Or, [0.75 h / 0.01 rem] m α [0.05 h/ 0.5 rem] M^{TEDE}

The mass for non-fueled experiments is therefore estimated as follows:

$$m = \frac{(0.01\ rem)(0.05\ h)}{(0.5\ rem)(0.75\ h)} M^{TEDE} = 1.33E-3\ \ M^{TEDE} \qquad \text{EQ 31}$$

With the ingrowth of fission and activation products and removal of the fissionable material initially present, the reference dose varies with time and fluence rate. TEDE data given Section H for the reference mass was used to determine the TEDE mass limit (M^{TEDE}) for fueled experiments for different irradiation times. Results for "m" are given in TS 3.8 Table 3.8-2.

In addition, fueled experiments apply to sources in which the encapsulation fails. TS 1.2.9 states that items such as detectors, foils, etc. are excluded. These items are considered self-encapsulated and therefore do not produce an airborne radiation hazard. External dose rates are reviewed as required by TS for experiments and the radiation protection program.

TS 1.2.9 and 1.2.9e are changed based on the above analysis to keep airborne releases within the public constraint dose to the following:

Fueled Experiment is an experiment that involves the use of fissionable material within the reactor building meeting Specification 3.8 criteria.

Fueled experiments exclude the following:

- Self-encapsulated materials, such as detectors, foils, wires, sealed sources, and fuel with cladding that contain fissionable material
- Fissionable material in amounts less than the values listed in Specification 3.8 Table 3.8-2. For mixtures, the sum of the fractions of the initial experiment mass to the mass threshold for each i^{th} fissionable material shall not exceed a value of 1:

$$\sum_i \frac{Mass_i^{Experiment}}{Mass_i^{Threshold}} \leq 1$$

F. CONCLUSIONS

TS 3.8 on limitations and conditions for fueled experiments is revised based on satisfying the following criteria:

- Radiation dose from an experiment failure does not exceed 10 percent of the occupational annual limits inside the reactor building or 10 percent of the annual limits to members of the public outside the reactor building given in 10 CFR Part 20. Non-fueled experiments are based on an experiment failure that does not exceed the public TEDE constraint of 0.01 rem.
- An experiment failure does not exceed the emergency action level for an unusual event as defined in the facility emergency plan.
- An experiment failure does not exceed the requirement for a reportable event as defined in TS
- Radioactivity produced by a fueled experiment does not exceed the quantity of concern limits given in 10 CFR Part 37 for Category 2.

Data in TS Table 3.8-1 is approximated and based on realistic, but conservative, assumptions. The following items are considered to be approximated or conservative:

- Dispersion factor, D: A bounding value of 0.01 is used. Most data indicates lower values are appropriate.
- Dose Conversion Factor, DCF, is based on 10 CFR Part 20 Appendix B. Appendix B is rounded off to one significant figure.
- Reaction cross sections are approximated. The highest value for a mixed neutron energy field is used. The cross-sections giving the highest doses were used.
- Fission yields for some materials were not available. The fission yields for similar materials were used. These were associated with fissionable materials produced by decay or activation.
- Activity calculations use approximate solutions.
- Averaging of masses of fissionable material is approximated.

TS 1.2.9 was revised to provide masses of fissionable materials that do not exceed the public constraint dose and to exclude self-encapsulated items such as detectors, foils, wire, sealed sources, and fuel with cladding.

TS 5.2.a is revised to specify the reactor building volume as 2.4E9 ml. This value is given in the current SAR and was verified by measurement in this analysis.

Possession limits on the reactor facility license do not exceed quantity of concern limits given in 10 CFR Part 37 for Category 2. Materials shall be stored as required by TS and the facility security plan and radiation protection program.

G. FISSIONABLE MATERIAL DECAY AND ACTIVATION CHAINS

Fissionable Material Decay Chain	Activation Product and Decay Chain		Fissionable Material Decay Chain	Activation Product and Decay Chain
U232	U233		Pu238	Pu239
Th228			U234	
Ra224				
Rn220			Pu239	Pu240
			U235	
U233	U234			
Th229			Pu239	
			U235m	
U234	U235		U235	
Th230				
			Pu240	Pu241
U235	U236		U236	
Th231				
Pa231			Pu241	Pu242
			Am241	
U236	U237		Np237	
Th232	Np237			
			Pu242	Pu243
U237	U238		U238	Am243
Np237	Th234			
	Pa234m		Pu243	Pu244
	Pa234		Am243	
	U234			
			Pu244	Pu245
	U238		U240	Am245
	Th234		Np240	Cm245
	Pa234m		Pu240	
	U234			
U238	U239			
Th234	Np239			
Pa234m	Pu239			
Pa234				
U234				
U238				
Th234				
Pa234m				
U234				

Fissionable Material Decay Chain	Activation Product and Decay Chain		Fissionable Material Decay Chain	Activation Product and Decay Chain
Cm242	Cm243		Cf249	Cf250
Pu238	Am243		Cm245	Cm246
U234			Pu241	Pu242
	Cm243		Am241	
	Pu239			
			Cf251	Cf252
Cm243	Cm244		Cm247	Cm248
Am243	Pu240			
			Am241	Am242
			Np237	Cm242
				Pu238
Cm244	Cm245			Am242
Pu240	Pu241			Pu242
	Am241			
			Am242	Am243
Cm245	Cm246		Cm242	
Pu241	Pu242		Pu238	
Am241				
			Am242	
Cm246	Cm247		Pu242	
Pu242				
			Am243	Am244
Cm248	Cm249		Np239	Cm244
Pu244	Bk249		Pu239	Pu240

Fissionable Material Decay Chain	Activation Product and Decay Chain		Fissionable Material Decay Chain	Activation Product and Decay Chain
Th229	Th230		Th232	Th233
Ra225	Ra226		Ra228	Pa233
Ac225			Ac228	U233
Fr221			Th228	
At217			Ra224	
Rn217			Rn220	
Po213				
Pb209			Th227	Th228
Bi209			Ra223	Ra224
			Rn219	Rn220
Th229				
Ra225			Np237	Np238
Ac225			Pa233	Pu238
Fr221			U233	U234
At217				
B1213			Np238	Np239
Tl209			Pu238	Pu239
Pb209			U234	
Bi209				
Th229			Th230	Th231
Ra225			Ra226	Pa231
Ac225				
Fr221				
At217				
B1213				
Po213				
Pb209				
Bi209				

Fissionable Material Decay Chain	Activation Product and Decay Chain		Fissionable Material Decay Chain	Activation Product and Decay Chain
Pa231	Pa232		Pa232	Pa233
Ac227	U232		U232	U233
Th227	Th228			
Ra223	Ra224			
Rn219	Rn220			
Pa231				
Ac227				
Fr223				
Ra223				
Rn219				
Pa231				
Ac227				
Fr223				
At219				
Bi215				
Po215				
Pb211				
Bi211				
Tl207				
Pa231				
Ac227				
Fr223				
At219				
Bi215				
Po215				
Pb211				
Bi211				
Po211				

H. DOSE and MASS CALCULATION RESULTS

Data provided:

- Reference doses
- Mass values at irradiation time "t" and average mass at fluence rates of 1E13 $cm^{-2}s^{-1}$ and 1E10 $cm^{-2}s^{-1}$
- Mass limits

Mass limits provided TS 3.8 Table 3.8-1 are the more limiting of the preceding times or of the values calculated from thermal, non-thermal fluence, and possession limits.

Am241 Non-thermal Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Am241	Reference dose					Am242	Reference dose				
1.00E+01	3.59E-03	7.19E-04	1.15E-05	4.43E+02	5.91E+03	1.25E-02	7.71E-01	1.37E-01	2.17E-03	5.93E-07	7.90E-06	1.66E-11
3.00E+01	1.65E-02	4.67E-03	6.15E-05	4.43E+02	5.91E+03	1.25E-02	3.77E+00	9.50E-01	1.24E-02	1.78E-06	2.37E-05	4.99E-11
1.00E+02	3.89E-02	1.18E-02	1.68E-04	4.43E+02	5.91E+03	1.25E-02	8.94E+00	2.42E+00	3.41E-02	5.93E-06	7.90E-05	1.66E-10
3.00E+02	6.59E-02	2.45E-02	3.51E-04	4.43E+02	5.91E+03	1.25E-02	1.52E+01	5.05E+00	7.20E-02	1.78E-05	2.37E-04	4.99E-10
1.00E+03	9.39E-02	5.13E-02	5.63E-04	4.43E+02	5.91E+03	1.25E-02	2.14E+01	1.07E+01	1.16E-01	5.93E-05	7.90E-04	1.66E-09
3.00E+03	1.24E-01	1.23E-01	6.77E-04	4.43E+02	5.91E+03	1.25E-02	2.77E+01	2.60E+01	1.39E-01	1.78E-04	2.37E-03	4.99E-09
1.00E+04	1.78E-01	4.27E-01	9.17E-04	4.45E+02	5.93E+03	1.26E-02	3.95E+01	9.10E+01	1.90E-01	5.93E-04	7.90E-03	1.66E-08
3.00E+04	2.60E-01	1.25E+00	1.45E-03	4.48E+02	5.96E+03	1.27E-02	5.86E+01	2.67E+02	3.01E-01	1.78E-03	2.37E-02	4.99E-08
1.00E+05	4.17E-01	3.27E+00	2.89E-03	4.55E+02	6.03E+03	1.30E-02	9.42E+01	6.88E+02	5.92E-01	5.93E-03	7.90E-02	1.66E-07
3.00E+05	5.87E-01	6.58E+00	7.40E-03	4.60E+02	6.08E+03	1.31E-02	1.31E+02	1.34E+03	1.46E+00	1.78E-02	2.37E-01	4.99E-07
1.00E+06	8.13E-01	1.28E+01	3.48E-02	4.61E+02	6.09E+03	1.32E-02	1.74E+02	2.52E+03	6.60E+00	5.67E-02	7.56E-01	1.59E-06
3.00E+06	1.14E+00	1.90E+01	1.13E-01	4.63E+02	6.10E+03	1.32E-02	2.37E+02	3.70E+03	2.11E+01	1.78E-01	2.37E+00	4.99E-06
1.00E+07	1.43E+00	2.44E+01	1.61E-01	4.67E+02	6.15E+03	1.34E-02	2.95E+02	4.77E+03	3.01E+01	5.93E-01	7.90E+00	1.66E-05
3.15E+07	1.88E+00	3.64E+01	1.67E-01	4.80E+02	6.30E+03	1.41E-02	3.87E+02	7.21E+03	3.13E+01	1.87E+00	2.49E+01	5.24E-05

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm242	Reference dose					Pu242	Reference dose				
1.00E+01	4.61E-03	1.07E-03	1.48E-05	0.00E+00	8.39E-04	0.00E+00	9.33E-04	2.75E-04	3.18E-06	2.92E-01	6.81E+00	1.43E-05
3.00E+01	1.26E-02	3.05E-03	4.33E-05	0.00E+00	2.26E-03	0.00E+00	2.44E-03	6.99E-04	8.54E-06	2.92E-01	6.81E+00	1.43E-05
1.00E+02	3.11E-02	8.60E-03	1.24E-04	0.00E+00	5.93E-03	0.00E+00	5.63E-03	1.63E-03	2.18E-05	2.92E-01	6.81E+00	1.43E-05
3.00E+02	5.64E-02	2.01E-02	2.74E-04	0.00E+00	5.93E-03	0.00E+00	9.19E-03	3.11E-03	4.34E-05	2.93E-01	6.81E+00	1.43E-05
1.00E+03	8.69E-02	4.70E-02	4.54E-04	0.00E+00	1.80E-02	0.00E+00	1.26E-02	6.21E-03	6.77E-05	2.93E-01	6.81E+00	1.43E-05
3.00E+03	1.26E-01	1.19E-01	5.66E-04	0.00E+00	1.89E-02	1.22E-15	1.61E-02	1.47E-02	8.01E-05	2.94E-01	6.81E+00	1.44E-05
1.00E+04	2.17E-01	4.13E-01	8.19E-04	2.76E-10	1.92E-02	1.41E-14	2.28E-02	5.01E-02	1.06E-04	2.98E-01	6.82E+00	1.46E-05
3.00E+04	3.82E-01	1.21E+00	1.39E-03	2.47E-09	1.96E-02	1.27E-13	3.34E-02	1.43E-01	1.62E-04	3.09E-01	6.86E+00	1.50E-05
1.00E+05	6.33E-01	3.21E+00	3.01E-03	2.74E-08	2.10E-02	1.41E-12	5.21E-02	3.53E-01	3.00E-04	3.33E-01	7.11E+00	1.58E-05
3.00E+05	8.47E-01	6.68E+00	8.44E-03	2.47E-07	2.90E-02	1.27E-11	6.97E-02	6.38E-01	6.49E-04	3.92E-01	7.89E+00	1.74E-05
1.00E+06	1.11E+00	1.36E+01	4.22E-02	2.73E-06	9.27E-02	1.41E-10	8.68E-02	1.08E+00	2.57E-03	5.97E-01	1.06E+01	2.32E-05
3.00E+06	1.49E+00	2.04E+01	1.38E-01	2.43E-05	2.87E-01	1.25E-09	1.10E-01	1.52E+00	7.94E-03	1.18E+00	1.85E+01	3.96E-05
1.00E+07	1.81E+00	2.58E+01	1.98E-01	2.60E-04	4.09E-01	1.33E-08	1.33E-01	1.93E+00	1.13E-02	3.24E+00	4.58E+01	9.71E-05
3.15E+07	2.25E+00	3.79E+01	2.04E-01	2.36E-03	4.48E-01	1.20E-07	1.69E-01	2.86E+00	1.17E-02	9.53E+00	1.30E+02	2.73E-04

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TED Rem
	Pu240	Reference dose				
1.00E+01	2.50E-03	7.24E-04	8.84E-06	4.05E-03	1.21E-03	1.32E-05
3.00E+01	6.62E-03	1.88E-03	2.40E-05	1.06E-02	3.22E-03	3.57E-05
1.00E+02	1.57E-02	4.54E-03	6.26E-05	2.53E-02	8.56E-03	9.59E-05
3.00E+02	2.59E-02	9.07E-03	1.27E-04	4.26E-02	1.96E-02	1.32E-04
1.00E+03	3.52E-02	1.87E-02	2.01E-04	5.92E-02	4.89E-02	3.21E-04
3.00E+03	4.38E-02	4.51E-02	2.40E-04	7.62E-02	1.25E-01	3.94E-04
1.00E+04	5.81E-02	1.56E-01	3.24E-04	1.12E-01	3.77E-01	5.66E-04
3.00E+04	7.72E-02	4.54E-01	5.07E-04	1.82E-01	1.04E+00	9.76E-04
1.00E+05	1.12E-01	1.14E+00	9.67E-04	3.35E-01	2.86E+00	2.11E-03
3.00E+05	1.50E-01	2.14E+00	2.23E-03	4.82E-01	4.47E+00	5.36E-03
1.00E+06	2.09E-01	3.81E+00	9.51E-03	6.48E-01	1.05E+01	2.40E-02
3.00E+06	2.96E-01	5.43E+00	3.01E-02	9.04E-01	1.49E+01	7.78E-02
1.00E+07	3.70E-01	6.70E+00	4.27E-02	1.23E+00	1.94E+01	1.17E-01
3.15E+07	4.79E-01	9.49E+00	4.42E-02	1.88E+00	3.16E+01	1.36E-01

Am241 Non-thermal

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Am241	Am242	Cm242	Pu242	Pu238	Am241	Am242	Cm242	Pu242	Pu238
1.00E+01	1.00E+00	6.50E-08	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-08	0.00E+00	0.00E+00	0.00E+00
3.00E+01	1.00E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00	1.00E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00
1.00E+02	1.00E+00	6.50E-07	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-07	0.00E+00	0.00E+00	0.00E+00
3.00E+02	1.00E+00	1.95E-06	2.92E-09	0.00E+00	0.00E+00	1.00E+00	1.95E-06	2.92E-09	0.00E+00	0.00E+00
1.00E+03	1.00E+00	6.45E-06	3.23E-08	6.52E-09	0.00E+00	1.00E+00	6.45E-06	3.23E-08	6.52E-09	0.00E+00
3.00E+03	1.00E+00	1.90E-05	2.89E-07	5.83E-08	0.00E+00	1.00E+00	1.90E-05	2.89E-07	5.83E-08	0.00E+00
1.00E+04	1.00E+00	6.12E-05	3.12E-06	6.30E-07	0.00E+00	1.00E+00	6.12E-05	3.12E-06	6.30E-07	0.00E+00
3.00E+04	1.00E+00	1.64E-04	2.60E-05	5.25E-06	0.00E+00	1.00E+00	1.64E-04	2.60E-05	5.25E-06	0.00E+00
1.00E+05	9.98E-01	3.78E-04	2.26E-04	4.56E-05	1.09E-09	9.99E-01	3.78E-04	2.26E-04	4.56E-05	1.09E-09
3.00E+05	9.95E-01	5.26E-04	1.18E-03	2.39E-04	1.92E-08	9.98E-01	5.25E-04	1.18E-03	2.38E-04	1.92E-08
1.00E+06	9.85E-01	5.41E-04	4.95E-03	1.00E-03	3.04E-07	9.92E-01	5.37E-04	4.91E-03	9.92E-04	3.02E-07
3.00E+06	9.55E-01	5.41E-04	1.58E-02	3.18E-03	3.06E-06	9.77E-01	5.29E-04	1.54E-02	3.11E-03	2.99E-06
1.00E+07	8.58E-01	5.41E-04	5.36E-02	1.08E-02	3.53E-05	9.27E-01	5.02E-04	4.97E-02	1.00E-02	3.27E-05
3.15E+07	6.16E-01	5.41E-04	1.69E-01	3.43E-02	3.53E-04	7.93E-01	4.29E-04	1.34E-01	2.72E-02	2.80E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	3.59E-03	7.19E-04	1.15E-05	4.43E+02	5.91E+03	1.25E-02
3.00E+01	1.65E-02	4.67E-03	6.15E-05	4.43E+02	5.91E+03	1.25E-02
1.00E+02	3.89E-02	1.18E-02	1.68E-04	4.43E+02	5.91E+03	1.25E-02
3.00E+02	6.59E-02	2.45E-02	3.51E-04	4.43E+02	5.91E+03	1.25E-02
1.00E+03	9.40E-02	5.14E-02	5.64E-04	4.43E+02	5.91E+03	1.25E-02
3.00E+03	1.24E-01	1.23E-01	6.80E-04	4.43E+02	5.91E+03	1.25E-02
1.00E+04	1.80E-01	4.32E-01	9.28E-04	4.45E+02	5.93E+03	1.26E-02
3.00E+04	2.70E-01	1.30E+00	1.50E-03	4.48E+02	5.96E+03	1.27E-02
1.00E+05	4.52E-01	3.53E+00	3.12E-03	4.54E+02	6.02E+03	1.29E-02
3.00E+05	6.55E-01	7.28E+00	8.16E-03	4.58E+02	6.05E+03	1.31E-02
1.00E+06	9.06E-01	1.41E+01	3.83E-02	4.54E+02	5.99E+03	1.30E-02
3.00E+06	1.27E+00	2.09E+01	1.24E-01	4.42E+02	5.83E+03	1.26E-02
1.00E+07	1.57E+00	2.63E+01	1.74E-01	4.00E+02	5.27E+03	1.15E-02
3.15E+07	1.96E+00	3.72E+01	1.74E-01	2.96E+02	3.89E+03	8.78E-03

Am241 TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TOTAL DOSE TEDE (reactor) rem	Max TODE rem	Public TEDE rem
1.13E-03	8.46E-04	8.01E-01		4.43E+02	5.91E+03	1.25E-02
1.13E-03	8.46E-04	7.98E-01		4.43E+02	5.91E+03	1.25E-02
1.13E-03	8.46E-04	7.91E-01		4.43E+02	5.91E+03	1.26E-02
1.13E-03	8.46E-04	7.80E-01		4.43E+02	5.91E+03	1.28E-02
1.13E-03	8.46E-04	7.67E-01		4.43E+02	5.91E+03	1.30E-02
1.13E-03	8.46E-04	7.59E-01		4.43E+02	5.91E+03	1.32E-02
1.12E-03	8.44E-04	7.42E-01		4.45E+02	5.93E+03	1.35E-02
1.11E-03	8.39E-04	7.06E-01		4.48E+02	5.96E+03	1.42E-02
1.10E-03	8.31E-04	6.23E-01		4.55E+02	6.02E+03	1.60E-02
1.09E-03	8.26E-04	4.71E-01		4.59E+02	6.05E+03	2.12E-02
1.10E-03	8.34E-04	1.95E-01		4.55E+02	5.99E+03	5.13E-02
1.13E-03	8.58E-04	7.34E-02		4.43E+02	5.83E+03	1.36E-01
1.24E-03	9.49E-04	5.38E-02		4.02E+02	5.27E+03	1.86E-01
1.68E-03	1.29E-03	5.48E-02		2.98E+02	3.89E+03	1.83E-01

Am241 Non-thermal

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Am241	Am242	Cm242	Pu242	Pu238	Am241	Am242	Cm242	Pu242	Pu238
1.00E+01	1.00E+00	6.50E-11	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-11	0.00E+00	0.00E+00	0.00E+00
3.00E+01	1.00E+00	1.95E-10	0.00E+00	0.00E+00	0.00E+00	1.00E+00	1.95E-10	0.00E+00	0.00E+00	0.00E+00
1.00E+02	1.00E+00	6.50E-10	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-10	0.00E+00	0.00E+00	0.00E+00
3.00E+02	1.00E+00	1.95E-09	2.92E-12	0.00E+00	0.00E+00	1.00E+00	1.95E-09	2.92E-12	0.00E+00	0.00E+00
1.00E+03	1.00E+00	6.45E-09	3.23E-11	6.52E-12	0.00E+00	1.00E+00	6.45E-09	3.23E-11	6.52E-12	0.00E+00
3.00E+03	1.00E+00	1.90E-08	2.89E-10	5.83E-11	0.00E+00	1.00E+00	1.90E-08	2.89E-10	5.83E-11	0.00E+00
1.00E+04	1.00E+00	6.12E-08	3.12E-09	6.30E-10	0.00E+00	1.00E+00	6.12E-08	3.12E-09	6.30E-10	0.00E+00
3.00E+04	1.00E+00	1.64E-07	2.60E-08	5.25E-09	0.00E+00	1.00E+00	1.64E-07	2.60E-08	5.25E-09	0.00E+00
1.00E+05	1.00E+00	3.78E-07	2.26E-07	4.56E-08	1.09E-12	1.00E+00	3.78E-07	2.26E-07	4.56E-08	1.09E-12
3.00E+05	1.00E+00	5.26E-07	1.18E-06	2.39E-07	1.92E-11	1.00E+00	5.26E-07	1.18E-06	2.39E-07	1.92E-11
1.00E+06	1.00E+00	5.41E-07	4.95E-06	1.00E-06	3.04E-10	1.00E+00	5.41E-07	4.95E-06	1.00E-06	3.04E-10
3.00E+06	1.00E+00	5.41E-07	1.58E-05	3.18E-06	3.06E-09	1.00E+00	5.41E-07	1.58E-05	3.18E-06	3.06E-09
1.00E+07	9.99E-01	5.41E-07	5.36E-05	1.08E-05	3.53E-08	1.00E+00	5.41E-07	5.36E-05	1.08E-05	3.53E-08
3.15E+07	9.98E-01	5.41E-07	1.69E-04	3.43E-05	3.53E-07	9.99E-01	5.40E-07	1.69E-04	3.43E-05	3.53E-07

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	3.59E-06	7.19E-07	1.15E-08	4.43E+02	5.91E+03	1.25E-02
3.00E+01	1.65E-05	4.67E-06	6.15E-08	4.43E+02	5.91E+03	1.25E-02
1.00E+02	3.89E-05	1.18E-05	1.68E-07	4.43E+02	5.91E+03	1.25E-02
3.00E+02	6.59E-05	2.45E-05	3.51E-07	4.43E+02	5.91E+03	1.25E-02
1.00E+03	9.39E-05	5.13E-05	5.63E-07	4.43E+02	5.91E+03	1.25E-02
3.00E+03	1.24E-04	1.23E-04	6.77E-07	4.43E+02	5.91E+03	1.25E-02
1.00E+04	1.78E-04	4.27E-04	9.17E-07	4.45E+02	5.93E+03	1.26E-02
3.00E+04	2.60E-04	1.25E-03	1.45E-06	4.48E+02	5.96E+03	1.27E-02
1.00E+05	4.17E-04	3.27E-03	2.89E-06	4.55E+02	6.03E+03	1.30E-02
3.00E+05	5.87E-04	6.58E-03	7.40E-06	4.60E+02	6.08E+03	1.31E-02
1.00E+06	8.13E-04	1.28E-02	3.48E-05	4.61E+02	6.09E+03	1.32E-02
3.00E+06	1.14E-03	1.90E-02	1.13E-04	4.62E+02	6.10E+03	1.32E-02
1.00E+07	1.43E-03	2.44E-02	1.61E-04	4.66E+02	6.14E+03	1.34E-02
3.15E+07	1.88E-03	3.64E-02	1.67E-04	4.79E+02	6.28E+03	1.41E-02

Am-241 Mass Calculations

Am241 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.00E+01	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+01	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+02	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+02	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+03	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+03	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
3.00E+04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
1.00E+05	8.3E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04
3.00E+05	8.3E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04
1.00E+06	8.3E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04
3.00E+06	8.6E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04	8.2E-04
1.00E+07	9.5E-04	8.3E-04	8.2E-04	8.1E-04	8.1E-04	8.1E-04	8.1E-04
3.15E+07	1.3E-03	8.3E-04	8.0E-04	8.0E-04	8.0E-04	8.0E-04	8.0E-04

Am-241 Thermal Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Am241	Reference dose					Am242	*Reference dose*				
1.00E+01	1.05E-03	2.10E-04	3.37E-06	4.43E+02	5.90E+03	1.24E-02	7.34E-01	1.31E-01	2.07E-03	5.67E-07	7.56E-06	1.59E-11
3.00E+01	4.83E-03	1.36E-03	1.80E-05	4.43E+02	5.90E+03	1.24E-02	3.59E+00	9.04E-01	1.18E-02	1.70E-06	2.27E-05	4.77E-11
1.00E+02	1.14E-02	3.46E-03	4.90E-05	4.43E+02	5.90E+03	1.24E-02	8.51E+00	2.30E+00	3.24E-02	5.67E-06	7.56E-05	1.59E-10
3.00E+02	1.92E-02	7.16E-03	1.03E-04	4.43E+02	5.90E+03	1.24E-02	1.44E+01	4.81E+00	6.85E-02	1.70E-05	2.27E-04	4.77E-10
1.00E+03	2.74E-02	1.50E-02	1.64E-04	4.43E+02	5.91E+03	1.24E-02	2.04E+01	1.02E+01	1.10E-01	5.67E-05	7.56E-04	1.59E-09
3.00E+03	3.61E-02	3.59E-02	1.98E-04	4.43E+02	5.91E+03	1.25E-02	2.64E+01	2.47E+01	1.32E-01	1.70E-04	2.27E-03	4.77E-09
1.00E+04	5.19E-02	1.25E-01	2.68E-04	4.43E+02	5.91E+03	1.25E-02	3.76E+01	8.67E+01	1.81E-01	5.67E-04	7.56E-03	1.59E-08
3.00E+04	7.60E-02	3.66E-01	4.25E-04	4.44E+02	5.92E+03	1.25E-02	5.58E+01	2.54E+02	2.87E-01	1.70E-03	2.27E-02	4.77E-08
1.00E+05	1.22E-01	9.56E-01	8.46E-04	4.48E+02	5.95E+03	1.26E-02	8.97E+01	6.56E+02	5.64E-01	5.67E-03	7.56E-02	1.59E-07
3.00E+05	1.72E-01	1.92E+00	2.16E-03	4.50E+02	5.97E+03	1.27E-02	1.25E+02	1.28E+03	1.39E+00	1.70E-02	2.27E-01	4.77E-07
1.00E+06	2.38E-01	3.74E+00	1.02E-02	4.50E+02	5.98E+03	1.27E-02	1.66E+02	2.40E+03	6.29E+00	5.67E-02	7.56E-01	1.59E-06
3.00E+06	3.34E-01	5.56E+00	3.30E-02	4.51E+02	5.98E+03	1.28E-02	2.26E+02	3.53E+03	2.01E+01	1.70E-01	2.27E+00	4.77E-06
1.00E+07	4.19E-01	7.12E+00	4.71E-02	4.53E+02	6.00E+03	1.28E-02	2.81E+02	4.55E+03	2.87E+01	5.67E-01	7.56E+00	1.59E-05
3.15E+07	5.49E-01	1.07E+01	4.89E-02	4.58E+02	6.06E+03	1.31E-02	3.69E+02	6.87E+03	2.98E+01	1.70E+00	2.27E+01	4.77E-05

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm242	Reference dose					Pu242	Reference dose				
1.00E+01	4.61E-03	1.07E-03	1.48E-05	2.48E-13	3.83E-04	0.00E+00	2.13E-06	6.42E-07	7.21E-09	1.26E-07	6.18E-06	5.34E-12
3.00E+01	1.26E-02	3.05E-03	4.33E-05	1.40E-12	1.03E-03	0.00E+00	5.57E-06	1.62E-06	1.93E-08	3.78E-07	1.48E-05	1.60E-11
1.00E+02	3.11E-02	8.60E-03	1.24E-04	1.40E-12	2.71E-03	0.00E+00	1.28E-05	3.77E-06	4.97E-08	1.26E-06	3.21E-05	5.33E-11
3.00E+02	5.64E-02	2.01E-02	2.74E-04	1.40E-12	5.44E-03	1.17E-17	2.07E-05	7.24E-06	1.00E-07	3.77E-06	5.42E-05	1.60E-10
1.00E+03	8.69E-02	4.70E-02	4.54E-04	1.40E-12	8.19E-03	4.44E-17	2.81E-05	1.43E-05	1.57E-07	1.25E-05	7.56E-05	5.26E-10
3.00E+03	1.26E-01	1.19E-01	5.66E-04	1.12E-11	8.63E-03	6.57E-16	3.53E-05	3.29E-05	1.86E-07	3.65E-05	8.85E-05	1.54E-09
1.00E+04	2.17E-01	4.13E-01	8.19E-04	1.23E-10	8.74E-03	6.81E-15	4.81E-05	1.08E-04	2.42E-07	1.13E-04	1.89E-04	4.66E-09
3.00E+04	3.82E-01	1.21E+00	1.39E-03	1.10E-09	8.92E-03	6.02E-14	6.64E-05	2.99E-04	3.62E-07	2.83E-04	8.76E-04	1.11E-08
1.00E+05	6.33E-01	3.21E+00	3.01E-03	1.22E-08	9.58E-03	6.66E-13	9.71E-05	7.15E-04	6.39E-07	6.82E-04	4.86E-03	2.37E-08
3.00E+05	8.47E-01	6.68E+00	8.44E-03	1.10E-07	1.32E-02	5.98E-12	1.25E-04	1.25E-03	1.29E-06	1.66E-03	1.78E-02	5.12E-08
1.00E+06	1.11E+00	1.36E+01	4.22E-02	1.21E-06	4.23E-02	6.58E-11	1.55E-04	2.05E-03	4.78E-06	5.07E-03	6.32E-02	1.47E-07
3.00E+06	1.49E+00	2.04E+01	1.38E-01	1.06E-05	1.31E-01	5.77E-10	1.98E-04	2.81E-03	1.45E-05	1.48E-02	1.93E-01	4.20E-07
1.00E+07	1.81E+00	2.58E+01	1.98E-01	1.08E-04	1.85E-01	5.88E-09	2.36E-04	3.43E-03	2.04E-05	4.89E-02	6.47E-01	1.37E-06
3.15E+07	2.25E+00	3.79E+01	2.04E-01	8.61E-04	1.92E-01	4.65E-08	2.95E-04	4.80E-03	2.11E-05	1.54E-01	2.04E+00	4.31E-06

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu238	Reference dose				
1.00E+01	2.15E-02	5.47E-03	7.15E-05	2.49E-07	3.29E-03	1.22E-11
3.00E+01	5.75E-02	1.42E-02	1.94E-04	7.46E-07	8.26E-03	3.66E-11
1.00E+02	1.40E-01	3.50E-02	5.10E-04	2.49E-06	1.91E-02	1.22E-10
3.00E+02	2.35E-01	7.06E-02	1.04E-03	7.46E-06	8.26E-02	3.66E-10
1.00E+03	3.14E-01	1.43E-01	1.65E-03	2.49E-05	4.85E-02	1.22E-09
3.00E+03	3.77E-01	3.36E-01	2.00E-03	7.46E-05	5.18E-02	3.66E-09
1.00E+04	4.75E-01	1.16E+00	2.75E-03	2.49E-04	5.36E-02	1.22E-08
3.00E+04	5.99E-01	3.41E+00	4.29E-03	7.46E-04	6.85E-02	3.66E-08
1.00E+05	8.35E-01	8.86E+00	8.13E-03	2.49E-03	1.11E-01	1.22E-07
3.00E+05	1.14E+00	1.77E+01	2.01E-02	7.46E-03	2.38E-01	3.66E-07
1.00E+06	1.71E+00	3.41E+01	9.29E-02	2.49E-02	7.33E-01	1.22E-06
3.00E+06	2.57E+00	4.99E+01	3.00E-01	7.46E-02	2.17E+00	3.66E-06
1.00E+07	3.24E+00	6.11E+01	4.27E-01	2.49E-01	6.39E+00	1.22E-05
3.15E+07	4.16E+00	8.49E+01	4.40E-01	7.83E-01	1.88E+01	3.84E-05

Am-241 Thermal

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Am241	Am242	Cm242	Pu242	Pu238	Am241	Am242	Cm242	Pu242	Pu238
1.00E+01	1.00E+00	6.50E-08	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-08	0.00E+00	0.00E+00	0.00E+00
3.00E+01	1.00E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00	1.00E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00
1.00E+02	1.00E+00	6.50E-07	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-07	0.00E+00	0.00E+00	0.00E+00
3.00E+02	1.00E+00	1.95E-06	2.92E-09	0.00E+00	0.00E+00	1.00E+00	1.95E-06	2.92E-09	0.00E+00	0.00E+00
1.00E+03	1.00E+00	6.45E-06	3.23E-08	6.52E-09	0.00E+00	1.00E+00	6.45E-06	3.23E-08	6.52E-09	0.00E+00
3.00E+03	1.00E+00	1.90E-05	2.89E-07	5.83E-08	0.00E+00	1.00E+00	1.90E-05	2.89E-07	5.83E-08	0.00E+00
1.00E+04	1.00E+00	6.12E-05	3.12E-06	6.30E-07	0.00E+00	1.00E+00	6.12E-05	3.12E-06	6.30E-07	0.00E+00
3.00E+04	1.00E+00	1.64E-04	2.60E-05	5.25E-06	0.00E+00	1.00E+00	1.64E-04	2.60E-05	5.25E-06	0.00E+00
1.00E+05	9.99E-01	3.78E-04	2.26E-04	4.56E-05	1.09E-09	1.00E+00	3.78E-04	2.26E-04	4.56E-05	1.09E-09
3.00E+05	9.98E-01	5.26E-04	1.18E-03	2.39E-04	1.92E-08	9.99E-01	5.25E-04	1.18E-03	2.39E-04	1.92E-08
1.00E+06	9.93E-01	5.41E-04	4.95E-03	1.00E-03	3.04E-07	9.97E-01	5.39E-04	4.93E-03	9.97E-04	3.03E-07
3.00E+06	9.81E-01	5.41E-04	1.58E-02	3.18E-03	3.06E-06	9.90E-01	5.36E-04	1.56E-02	3.15E-03	3.03E-06
1.00E+07	9.37E-01	5.41E-04	5.36E-02	1.08E-02	3.53E-05	9.68E-01	5.24E-04	5.19E-02	1.05E-02	3.42E-05
3.15E+07	8.14E-01	5.41E-04	1.69E-01	3.43E-02	3.53E-04	9.04E-01	4.89E-04	1.53E-01	3.10E-02	3.19E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	1.05E-03	2.10E-04	3.37E-06	4.42E+02	5.90E+03	1.24E-02
3.00E+01	4.83E-03	1.36E-03	1.80E-05	4.42E+02	5.90E+03	1.24E-02
1.00E+02	1.14E-02	3.46E-03	4.90E-05	4.42E+02	5.90E+03	1.24E-02
3.00E+02	1.93E-02	7.16E-03	1.03E-04	4.42E+02	5.90E+03	1.24E-02
1.00E+03	2.76E-02	1.51E-02	1.65E-04	4.42E+02	5.91E+03	1.24E-02
3.00E+03	3.66E-02	3.64E-02	2.00E-04	4.42E+02	5.91E+03	1.25E-02
1.00E+04	5.42E-02	1.30E-01	2.79E-04	4.43E+02	5.91E+03	1.25E-02
3.00E+04	8.51E-02	4.08E-01	4.72E-04	4.44E+02	5.92E+03	1.25E-02
1.00E+05	1.56E-01	1.20E+00	1.06E-03	4.47E+02	5.95E+03	1.26E-02
3.00E+05	2.38E-01	2.60E+00	2.90E-03	4.49E+02	5.95E+03	1.27E-02
1.00E+06	3.32E-01	5.09E+00	1.37E-02	4.47E+02	5.94E+03	1.27E-02
3.00E+06	4.75E-01	7.71E+00	4.56E-02	4.42E+02	5.87E+03	1.25E-02
1.00E+07	6.47E-01	1.06E+01	7.08E-02	4.24E+02	5.62E+03	1.20E-02
3.15E+07	1.02E+00	1.88E+01	9.00E-02	3.73E+02	4.93E+03	1.07E-02

Am241 TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TOTAL DOSE TEDE (reactor) rem	Max TODE rem	Public TEDE rem
1.13E-03	8.47E-04	8.05E-01		4.43E+02	5.90E+03	1.24E-02
1.13E-03	8.47E-04	8.04E-01		4.43E+02	5.90E+03	1.24E-02
1.13E-03	8.47E-04	8.02E-01		4.43E+02	5.90E+03	1.25E-02
1.13E-03	8.47E-04	7.98E-01		4.43E+02	5.90E+03	1.25E-02
1.13E-03	8.46E-04	7.94E-01		4.43E+02	5.91E+03	1.26E-02
1.13E-03	8.46E-04	7.90E-01		4.43E+02	5.91E+03	1.27E-02
1.13E-03	8.46E-04	7.86E-01		4.43E+02	5.91E+03	1.27E-02
1.13E-03	8.45E-04	7.71E-01		4.44E+02	5.92E+03	1.30E-02
1.12E-03	8.41E-04	7.31E-01		4.47E+02	5.95E+03	1.37E-02
1.11E-03	8.40E-04	6.42E-01		4.49E+02	5.95E+03	1.56E-02
1.12E-03	8.42E-04	3.79E-01		4.47E+02	5.94E+03	2.64E-02
1.13E-03	8.52E-04	1.72E-01		4.43E+02	5.87E+03	5.81E-02
1.18E-03	8.90E-04	1.21E-01		4.24E+02	5.62E+03	8.29E-02
1.34E-03	1.01E-03	9.93E-02		3.74E+02	4.93E+03	1.01E-01

Am-241 Thermal

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Am241	Am242	Cm242	Pu242	Pu238	Am241	Am242	Cm242	Pu242	Pu238
1.00E+01	1.00E+00	6.50E-11	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-11	0.00E+00	0.00E+00	0.00E+00
3.00E+01	1.00E+00	1.95E-10	0.00E+00	0.00E+00	0.00E+00	1.00E+00	1.95E-10	0.00E+00	0.00E+00	0.00E+00
1.00E+02	1.00E+00	6.50E-10	0.00E+00	0.00E+00	0.00E+00	1.00E+00	6.50E-10	0.00E+00	0.00E+00	0.00E+00
3.00E+02	1.00E+00	1.95E-09	2.92E-12	0.00E+00	0.00E+00	1.00E+00	1.95E-09	2.92E-12	0.00E+00	0.00E+00
1.00E+03	1.00E+00	6.45E-09	3.23E-11	6.52E-12	0.00E+00	1.00E+00	6.45E-09	3.23E-11	6.52E-12	0.00E+00
3.00E+03	1.00E+00	1.90E-08	2.89E-10	5.83E-11	0.00E+00	1.00E+00	1.90E-08	2.89E-10	5.83E-11	0.00E+00
1.00E+04	1.00E+00	6.12E-08	3.12E-09	6.30E-10	0.00E+00	1.00E+00	6.12E-08	3.12E-09	6.30E-10	0.00E+00
3.00E+04	1.00E+00	1.64E-07	2.60E-08	5.25E-09	0.00E+00	1.00E+00	1.64E-07	2.60E-08	5.25E-09	0.00E+00
1.00E+05	1.00E+00	3.78E-07	2.26E-07	4.56E-08	1.09E-12	1.00E+00	3.78E-07	2.26E-07	4.56E-08	1.09E-12
3.00E+05	1.00E+00	5.26E-07	1.18E-06	2.39E-07	1.92E-11	1.00E+00	5.26E-07	1.18E-06	2.39E-07	1.92E-11
1.00E+06	1.00E+00	5.41E-07	4.95E-06	1.00E-06	3.04E-10	1.00E+00	5.41E-07	4.95E-06	1.00E-06	3.04E-10
3.00E+06	1.00E+00	5.41E-07	1.58E-05	3.18E-06	3.06E-09	1.00E+00	5.41E-07	1.58E-05	3.18E-06	3.06E-09
1.00E+07	9.99E-01	5.41E-07	5.36E-05	1.08E-05	3.53E-08	1.00E+00	5.41E-07	5.36E-05	1.08E-05	3.53E-08
3.15E+07	9.98E-01	5.41E-07	1.69E-04	3.43E-05	3.53E-07	9.99E-01	5.41E-07	1.69E-04	3.43E-05	3.53E-07

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	1.05E-06	2.10E-07	3.37E-09	4.42E+02	5.90E+03	1.24E-02
3.00E+01	4.83E-06	1.36E-06	1.80E-08	4.42E+02	5.90E+03	1.24E-02
1.00E+02	1.14E-05	3.46E-06	4.90E-08	4.42E+02	5.90E+03	1.24E-02
3.00E+02	1.92E-05	7.16E-06	1.03E-07	4.42E+02	5.90E+03	1.24E-02
1.00E+03	2.74E-05	1.50E-05	1.64E-07	4.42E+02	5.91E+03	1.24E-02
3.00E+03	3.61E-05	3.59E-05	1.98E-07	4.42E+02	5.91E+03	1.25E-02
1.00E+04	5.19E-05	1.25E-04	2.68E-07	4.43E+02	5.91E+03	1.25E-02
3.00E+04	7.60E-05	3.66E-04	4.25E-07	4.44E+02	5.92E+03	1.25E-02
1.00E+05	1.22E-04	9.56E-04	8.46E-07	4.47E+02	5.95E+03	1.26E-02
3.00E+05	1.72E-04	1.92E-03	2.16E-06	4.50E+02	5.97E+03	1.27E-02
1.00E+06	2.38E-04	3.74E-03	1.02E-05	4.50E+02	5.97E+03	1.27E-02
3.00E+06	3.34E-04	5.56E-03	3.30E-05	4.51E+02	5.98E+03	1.28E-02
1.00E+07	4.19E-04	7.13E-03	4.71E-05	4.52E+02	6.00E+03	1.28E-02
3.15E+07	5.49E-04	1.07E-02	4.89E-05	4.58E+02	6.05E+03	1.31E-02

Mass Calculations

Am241 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.00E+01	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+01	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+02	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+02	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+03	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+03	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
3.00E+04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04	8.5E-04
1.00E+05	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
3.00E+05	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
1.00E+06	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
3.00E+06	8.5E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04	8.4E-04
1.00E+07	8.9E-04	8.4E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04
3.15E+07	1.0E-03	8.4E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04	8.3E-04

Am-243 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Am243	Reference dose					Am244	Reference dose				
1.00E+01	7.51E-04	1.52E-04	2.45E-06	2.58E+01	3.44E+02	7.27E-04	8.06E-01	1.64E-01	2.63E-03	4.01E-04	3.58E-01	1.24E-08
3.00E+01	3.74E-03	9.90E-04	1.32E-05	2.58E+01	3.44E+02	7.27E-04	4.04E+00	1.07E+00	1.42E-02	1.20E-03	9.25E-01	3.74E-08
1.00E+02	8.86E-03	2.55E-03	3.66E-05	2.58E+01	3.44E+02	7.27E-04	9.54E+00	2.75E+00	3.95E-02	4.01E-03	2.24E+00	1.24E-07
3.00E+02	1.51E-02	5.36E-03	7.82E-05	2.58E+01	3.44E+02	7.27E-04	1.63E+01	5.77E+00	8.42E-02	1.20E-02	4.21E+00	3.77E-07
1.00E+03	2.18E-02	1.12E-02	1.26E-04	2.59E+01	3.46E+02	7.30E-04	2.35E+01	1.20E+01	1.35E-01	3.97E-02	6.37E+00	1.54E-01
3.00E+03	2.96E-02	2.63E-02	1.49E-04	2.62E+01	3.49E+02	7.38E-04	3.19E+01	2.83E+01	1.61E-01	1.17E-01	7.61E+00	3.62E-06
1.00E+04	4.61E-02	8.90E-02	1.97E-04	2.70E+01	3.59E+02	7.64E-04	4.97E+01	9.59E+01	2.13E-01	3.65E-01	1.08E+01	1.13E-05
3.00E+04	7.44E-02	2.56E-01	3.03E-04	2.96E+01	3.89E+02	8.49E-04	8.01E+01	2.76E+02	3.27E-01	9.17E-01	1.78E+01	2.86E-05
1.00E+05	1.23E-01	6.46E-01	5.73E-04	3.95E+01	4.94E+02	1.18E-03	1.32E+02	6.96E+02	6.17E-01	1.80E+00	2.89E+01	5.60E-05
3.00E+05	1.66E-01	1.23E+00	1.35E-03	6.95E+01	7.96E+02	2.23E-03	1.78E+02	1.33E+03	1.45E+00	2.14E+00	3.43E+01	6.68E-05
1.00E+06	2.06E-01	2.26E+00	5.91E-03	1.76E+02	1.86E+03	5.96E-03	2.22E+02	2.43E+03	6.37E+00	2.28E+00	4.48E+01	7.24E-05
3.00E+06	2.60E-01	3.25E+00	1.88E-02	4.77E+02	4.87E+03	1.66E-02	2.80E+02	3.50E+03	2.02E+01	2.64E+00	7.60E+01	8.77E-05
1.00E+07	3.05E-01	3.99E+00	2.67E-02	1.53E+03	1.54E+04	5.34E-02	3.28E+02	4.29E+03	2.87E+01	3.91E+00	1.06E+02	1.42E-04
3.15E+07	3.69E-01	5.58E+00	2.75E-02	4.70E+03	4.71E+04	1.65E-01	3.97E+02	6.01E+03	2.96E+01	7.82E+00	1.45E+02	3.06E-04

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm244	Reference dose					Pu239	Reference dose				
1.00E+01	6.04E-03	1.61E-03	2.12E-05	4.58E+00	1.07E+02	2.25E-04	5.71E-01	1.49E-01	1.86E-03	4.58E+00	1.07E+02	2.25E-04
3.00E+01	1.62E-02	4.40E-03	6.04E-05	4.58E+00	1.07E+02	2.25E-04	1.53E+00	3.91E-01	5.06E-03	4.58E+00	1.07E+02	2.25E-04
1.00E+02	3.87E-02	1.12E-02	1.65E-04	4.58E+00	1.08E+02	2.25E-04	3.68E+00	9.68E-01	1.34E-02	4.58E+00	1.08E+02	2.25E-04
3.00E+02	6.77E-02	2.31E-02	3.46E-04	4.58E+00	1.08E+02	2.25E-04	6.14E+00	1.98E+00	2.74E-02	4.58E+00	1.08E+02	2.25E-04
1.00E+03	1.04E-01	4.68E-02	5.54E-04	4.58E+00	1.09E+02	2.25E-04	8.28E+00	4.22E+00	4.36E-02	4.58E+00	1.09E+02	2.25E-04
3.00E+03	1.57E-01	1.04E-01	6.57E-04	4.58E+00	1.09E+02	2.25E-04	1.01E+01	1.04E+01	5.34E-02	4.58E+00	1.09E+02	2.25E-04
1.00E+04	2.81E-01	3.36E-01	8.54E-04	4.58E+00	1.09E+02	2.25E-04	1.31E+01	3.66E+01	7.52E-02	4.58E+00	1.09E+02	2.25E-04
3.00E+04	5.02E-01	9.49E-01	1.27E-03	4.58E+00	1.09E+02	2.25E-04	1.73E+01	1.08E+02	1.22E-01	4.58E+00	1.09E+02	2.25E-04
1.00E+05	8.34E-01	2.40E+00	2.32E-03	4.59E+00	1.10E+02	2.25E-04	2.50E+01	2.78E+02	2.39E-01	4.59E+00	1.10E+02	2.25E-04
3.00E+05	1.08E+00	4.72E+00	5.48E-03	4.60E+00	1.10E+02	2.26E-04	3.45E+01	5.44E+02	5.86E-01	4.60E+00	1.10E+02	2.26E-04
1.00E+06	1.26E+00	9.09E+00	2.47E-02	4.63E+00	1.15E+02	2.28E-04	5.11E+01	1.02E+03	2.66E+00	4.63E+00	1.15E+02	2.28E-04
3.00E+06	1.50E+00	1.36E+01	7.97E-02	4.74E+00	1.29E+02	2.33E-04	7.60E+01	1.49E+03	8.57E+00	4.74E+00	1.29E+02	2.33E-04
1.00E+07	1.74E+00	1.80E+01	1.14E-01	5.10E+00	1.45E+02	2.51E-04	9.77E+01	1.88E+03	1.22E+01	5.10E+00	1.45E+02	2.51E-04
3.15E+07	2.13E+00	2.81E+01	1.19E-01	6.23E+00	1.71E+02	3.07E-04	1.30E+02	2.76E+03	1.27E+01	6.23E+00	1.71E+02	3.07E-04

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem
	Pu240	Reference dose				
1.00E+01	2.50E-03	7.24E-04	8.84E-06	4.05E-03	1.21E-03	1.32E-05
3.00E+01	6.62E-03	1.88E-03	2.40E-05	1.06E-02	3.22E-03	3.57E-05
1.00E+02	1.57E-02	4.54E-03	6.26E-05	2.53E-02	8.56E-03	9.59E-05
3.00E+02	2.59E-02	9.07E-03	1.27E-04	4.26E-02	1.96E-02	1.32E-04
1.00E+03	3.52E-02	1.87E-02	2.01E-04	5.92E-02	4.89E-02	3.21E-04
3.00E+03	4.38E-02	4.51E-02	2.40E-04	7.62E-02	1.25E-01	3.94E-04
1.00E+04	5.81E-02	1.56E-01	3.24E-04	1.12E-01	3.77E-01	5.66E-04
3.00E+04	7.72E-02	4.54E-01	5.07E-04	1.82E-01	1.04E+00	9.76E-04
1.00E+05	1.12E-01	1.14E+00	9.67E-04	3.35E-01	2.86E+00	2.11E-03
3.00E+05	1.50E-01	2.14E+00	2.23E-03	4.82E-01	4.47E+00	5.36E-03
1.00E+06	2.09E-01	3.81E+00	9.51E-03	6.48E-01	1.05E+01	2.40E-02
3.00E+06	2.96E-01	5.43E+00	3.01E-02	9.04E-01	1.49E+01	7.78E-02
1.00E+07	3.70E-01	6.70E+00	4.27E-02	1.23E+00	1.94E+01	1.17E-01
3.15E+07	4.79E-01	9.49E+00	4.42E-02	1.88E+00	3.16E+01	1.36E-01

Am-243

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Am243	Am244	Cm244	Pu239	Pu240	Am243	Am244	Cm244	Pu239	Pu240
1.00E+01	1.00E+00	1.80E-07	1.70E-11	4.61E-03	0.00E+00	1.00E+00	1.80E-07	1.70E-11	4.61E-03	0.00E+00
3.00E+01	1.00E+00	5.39E-07	1.54E-10	4.61E-03	0.00E+00	1.00E+00	5.39E-07	1.54E-10	4.61E-03	0.00E+00
1.00E+02	1.00E+00	1.80E-06	1.70E-09	4.61E-03	0.00E+00	1.00E+00	1.80E-06	1.70E-09	4.61E-03	0.00E+00
3.00E+02	1.00E+00	5.38E-06	1.54E-08	4.61E-03	0.00E+00	1.00E+00	5.38E-06	1.54E-08	4.61E-03	0.00E+00
1.00E+03	1.00E+00	1.78E-05	1.70E-07	4.61E-03	0.00E+00	1.00E+00	1.78E-05	1.70E-07	4.61E-03	0.00E+00
3.00E+03	1.00E+00	5.24E-05	1.51E-06	4.61E-03	0.00E+00	1.00E+00	5.24E-05	1.51E-06	4.61E-03	0.00E+00
1.00E+04	1.00E+00	1.64E-04	1.61E-05	4.61E-03	0.00E+00	1.00E+00	1.64E-04	1.61E-05	4.61E-03	0.00E+00
3.00E+04	9.99E-01	4.11E-04	1.29E-04	4.61E-03	1.62E-09	1.00E+00	4.11E-04	1.29E-04	4.61E-03	1.62E-09
1.00E+05	9.98E-01	8.03E-04	9.95E-04	4.61E-03	4.53E-08	9.99E-01	8.02E-04	9.94E-04	4.61E-03	4.53E-08
3.00E+05	9.95E-01	9.40E-04	4.45E-03	4.61E-03	6.92E-07	9.97E-01	9.37E-04	4.44E-03	4.60E-03	6.90E-07
1.00E+06	9.82E-01	9.43E-04	1.70E-02	4.62E-03	9.73E-06	9.91E-01	9.35E-04	1.68E-02	4.58E-03	9.64E-06
3.00E+06	9.48E-01	9.43E-04	5.29E-02	4.62E-03	9.38E-05	9.74E-01	9.18E-04	5.15E-02	4.50E-03	9.13E-05
1.00E+07	8.36E-01	9.43E-04	1.78E-01	4.64E-03	1.07E-03	9.15E-01	8.63E-04	1.63E-01	4.25E-03	9.80E-04
3.15E+07	5.69E-01	9.43E-04	5.55E-01	4.73E-03	1.06E-02	7.64E-01	7.21E-04	4.24E-01	3.61E-03	8.10E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	3.38E-03	8.41E-04	1.10E-05	2.59E+01	3.45E+02	7.28E-04
3.00E+01	1.08E-02	2.79E-03	3.65E-05	2.59E+01	3.45E+02	7.28E-04
1.00E+02	2.58E-02	7.01E-03	9.84E-05	2.59E+01	3.45E+02	7.28E-04
3.00E+02	4.35E-02	1.45E-02	2.05E-04	2.59E+01	3.45E+02	7.28E-04
1.00E+03	6.04E-02	3.08E-02	3.29E-04	2.59E+01	3.47E+02	7.34E-04
3.00E+03	7.79E-02	7.57E-02	4.04E-04	2.62E+01	3.50E+02	7.39E-04
1.00E+04	1.15E-01	2.74E-01	5.79E-04	2.70E+01	3.60E+02	7.65E-04
3.00E+04	1.87E-01	8.66E-01	9.99E-04	2.96E+01	3.89E+02	8.50E-04
1.00E+05	3.45E-01	2.49E+00	2.17E-03	3.94E+01	4.94E+02	1.18E-03
3.00E+05	4.96E-01	5.00E+00	5.43E-03	6.91E+01	7.93E+02	2.22E-03
1.00E+06	6.66E-01	9.34E+00	2.44E-02	1.73E+02	1.83E+03	5.86E-03
3.00E+06	9.29E-01	1.38E+01	7.95E-02	4.53E+02	4.63E+03	1.57E-02
1.00E+07	1.26E+00	1.83E+01	1.20E-01	1.28E+03	1.29E+04	4.48E-02
3.15E+07	1.94E+00	3.06E+01	1.39E-01	2.67E+03	2.69E+04	9.53E-02

Am243 TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TOTAL DOSE TEDE (reactor) rem	Max TODE rem	Public TEDE rem
1.93E-02	1.45E-02	1.35E+01		2.59E+01	3.45E+02	7.39E-04
1.93E-02	1.45E-02	1.31E+01		2.59E+01	3.45E+02	7.65E-04
1.93E-02	1.45E-02	1.21E+01		2.59E+01	3.45E+02	8.26E-04
1.93E-02	1.45E-02	1.07E+01		2.59E+01	3.45E+02	9.33E-04
1.92E-02	1.44E-02	9.41E+00		2.60E+01	3.47E+02	1.06E-03
1.90E-02	1.43E-02	8.75E+00		2.63E+01	3.50E+02	1.14E-03
1.84E-02	1.39E-02	7.44E+00		2.71E+01	3.60E+02	1.34E-03
1.68E-02	1.29E-02	5.41E+00		2.98E+01	3.89E+02	1.85E-03
1.26E-02	1.01E-02	2.98E+00		3.98E+01	4.94E+02	3.36E-03
7.18E-03	6.31E-03	1.31E+00		6.96E+01	7.93E+02	7.65E-03
2.89E-03	2.74E-03	3.30E-01		1.73E+02	1.83E+03	3.03E-02
1.10E-03	1.08E-03	1.05E-01		4.54E+02	4.63E+03	9.52E-02
3.90E-04	3.88E-04	6.08E-02		1.28E+03	1.29E+04	1.65E-01
1.87E-04	1.86E-04	4.27E-02		2.68E+03	2.69E+04	2.34E-01

Am-243

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Am243	Am244	Cm244	Pu239	Pu240	Am243	Am244	Cm244	Pu239	Pu240
1.00E+01	1.00E+00	1.80E-10	1.70E-14	4.61E-03	0.00E+00	1.00E+00	1.80E-10	1.70E-14	4.61E-03	0.00E+00
3.00E+01	1.00E+00	5.39E-10	1.54E-13	4.61E-03	0.00E+00	1.00E+00	5.39E-10	1.54E-13	4.61E-03	0.00E+00
1.00E+02	1.00E+00	1.80E-09	1.70E-12	4.61E-03	0.00E+00	1.00E+00	1.80E-09	1.70E-12	4.61E-03	0.00E+00
3.00E+02	1.00E+00	5.38E-09	1.54E-11	4.61E-03	0.00E+00	1.00E+00	5.38E-09	1.54E-11	4.61E-03	0.00E+00
1.00E+03	1.00E+00	1.78E-08	1.70E-10	4.61E-03	0.00E+00	1.00E+00	1.78E-08	1.70E-10	4.61E-03	0.00E+00
3.00E+03	1.00E+00	5.24E-08	1.51E-09	4.61E-03	0.00E+00	1.00E+00	5.24E-08	1.51E-09	4.61E-03	0.00E+00
1.00E+04	1.00E+00	1.64E-07	1.61E-08	4.61E-03	0.00E+00	1.00E+00	1.64E-07	1.61E-08	4.61E-03	0.00E+00
3.00E+04	1.00E+00	4.11E-07	1.29E-07	4.61E-03	1.62E-12	1.00E+00	4.11E-07	1.29E-07	4.61E-03	1.62E-12
1.00E+05	1.00E+00	8.03E-07	9.95E-07	4.61E-03	4.53E-11	1.00E+00	8.03E-07	9.95E-07	4.61E-03	4.53E-11
3.00E+05	1.00E+00	9.40E-07	4.45E-06	4.61E-03	6.92E-10	1.00E+00	9.40E-07	4.45E-06	4.61E-03	6.92E-10
1.00E+06	1.00E+00	9.43E-07	1.70E-05	4.62E-03	9.73E-09	1.00E+00	9.43E-07	1.70E-05	4.62E-03	9.73E-09
3.00E+06	1.00E+00	9.43E-07	5.29E-05	4.62E-03	9.38E-08	1.00E+00	9.43E-07	5.29E-05	4.62E-03	9.38E-08
1.00E+07	1.00E+00	9.43E-07	1.78E-04	4.64E-03	1.07E-06	1.00E+00	9.43E-07	1.78E-04	4.64E-03	1.07E-06
3.15E+07	9.99E-01	9.43E-07	5.55E-04	4.73E-03	1.06E-05	1.00E+00	9.43E-07	5.55E-04	4.73E-03	1.06E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	3.38E-06	8.41E-07	1.10E-08	2.59E+01	3.45E+02	7.28E-04
3.00E+01	1.08E-05	2.79E-06	3.65E-08	2.59E+01	3.45E+02	7.28E-04
1.00E+02	2.58E-05	7.01E-06	9.83E-08	2.59E+01	3.45E+02	7.28E-04
3.00E+02	4.34E-05	1.45E-05	2.05E-07	2.59E+01	3.45E+02	7.28E-04
1.00E+03	6.00E-05	3.06E-05	3.27E-07	2.59E+01	3.47E+02	7.31E-04
3.00E+03	7.62E-05	7.42E-05	3.95E-07	2.62E+01	3.50E+02	7.39E-04
1.00E+04	1.07E-04	2.58E-04	5.44E-07	2.70E+01	3.60E+02	7.65E-04
3.00E+04	1.54E-04	7.53E-04	8.65E-07	2.96E+01	3.89E+02	8.50E-04
1.00E+05	2.38E-04	1.93E-03	1.68E-06	3.95E+01	4.95E+02	1.19E-03
3.00E+05	3.25E-04	3.74E-03	4.05E-06	6.95E+01	7.96E+02	2.23E-03
1.00E+06	4.42E-04	6.98E-03	1.82E-05	1.76E+02	1.86E+03	5.96E-03
3.00E+06	6.11E-04	1.01E-02	5.84E-05	4.77E+02	4.87E+03	1.66E-02
1.00E+07	7.58E-04	1.27E-02	8.34E-05	1.53E+03	1.54E+04	5.34E-02
3.15E+07	9.84E-04	1.87E-02	8.75E-05	4.70E+03	4.70E+04	1.65E-01

Mass calculations

Am243 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.00E+01	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.00E+01	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.00E+02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.00E+02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.00E+03	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.00E+03	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.00E+04	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
3.00E+04	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02
1.00E+05	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02	1.0E-02
3.00E+05	6.3E-03	6.3E-03	6.3E-03	6.3E-03	6.3E-03	6.3E-03	6.3E-03
1.00E+06	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
3.00E+06	1.1E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
1.00E+07	3.9E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04
3.15E+07	1.9E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04

Cf-249 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Irradiation Time "t" s
	Cf249	Reference dose					Cf250	Reference dose					
1.00E+01	5.36E-01	1.12E-01	1.70E-03	7.05E+02	1.06E+04	2.98E-02	4.68E-03	9.77E-04	1.48E-05	2.30E-04	5.13E-03	9.74E-09	1.00E+01
3.00E+01	2.60E+00	6.48E-01	8.46E-03	7.05E+02	1.06E+04	2.98E-02	2.28E-02	5.69E-03	7.42E-05	6.91E-04	1.48E-02	2.93E-08	3.00E+01
1.00E+02	6.52E+00	1.71E+00	2.34E-02	7.05E+02	1.06E+04	2.98E-02	5.72E-02	1.50E-02	2.05E-04	2.30E-03	4.53E-02	9.74E-08	1.00E+02
3.00E+02	1.29E+01	3.74E+00	4.96E-02	7.05E+02	1.06E+04	2.98E-02	1.13E-01	3.28E-02	4.35E-04	6.91E-03	1.23E-01	2.93E-07	3.00E+02
1.00E+03	2.66E+01	8.52E+00	8.07E-02	7.05E+02	1.06E+04	2.98E-02	2.34E-01	7.47E-02	7.08E-04	2.30E-02	3.74E-01	9.74E-07	1.00E+03
3.00E+03	5.67E+01	2.17E+01	9.94E-02	7.05E+02	1.06E+04	2.98E-02	4.97E-01	1.90E-01	8.71E-04	6.91E-02	1.07E+00	2.93E-06	3.00E+03
1.00E+04	1.42E+02	7.48E+01	1.43E-01	7.06E+02	1.06E+04	2.98E-02	1.25E+00	6.56E-01	1.25E-03	2.30E-01	3.48E+00	9.74E-06	1.00E+04
3.00E+04	3.10E+02	2.17E+02	2.50E-01	7.07E+02	1.06E+04	2.98E-02	2.72E+00	1.91E+00	2.19E-03	6.91E-01	1.04E+01	2.93E-05	3.00E+04
1.00E+05	5.49E+02	5.75E+02	5.77E-01	7.10E+02	1.07E+04	3.01E-02	4.81E+00	5.04E+00	5.06E-03	2.30E+00	3.46E+01	9.74E-05	1.00E+05
3.00E+05	7.03E+02	1.18E+03	1.73E+00	7.20E+02	1.08E+04	3.04E-02	6.17E+00	1.04E+01	1.51E-02	6.91E+00	1.03E+02	2.93E-04	3.00E+05
1.00E+06	7.73E+02	2.39E+03	8.85E+00	7.54E+02	1.16E+04	3.18E-02	6.78E+00	2.09E+01	7.76E-02	2.30E+01	3.46E+02	9.74E-04	1.00E+06
3.00E+06	8.53E+02	3.74E+03	2.91E+01	8.50E+02	1.36E+04	3.52E-02	7.48E+00	3.28E+01	2.55E-01	6.91E+01	1.03E+03	2.68E-01	3.00E+06
1.00E+07	9.38E+02	5.49E+03	4.18E+01	1.19E+03	2.04E+04	4.80E-02	8.23E+00	4.81E+01	3.66E-01	2.30E+02	3.45E+03	9.74E-03	1.00E+07
3.15E+07	1.09E+03	9.81E+03	4.39E+01	2.21E+03	4.08E+04	8.63E-02	9.55E+00	8.60E+01	3.85E-01	7.46E-03	2.76E+01	4.12E-07	3.15E+07

Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
Cm246	Reference dose					Cm245	Reference dose				
3.08E-03	9.14E-04	1.09E-05	1.56E-10	5.59E+02	4.69E-15	1.35E+00	3.95E-01	4.88E-03	1.34E+00	2.23E+01	4.46E-05
8.14E-03	2.42E-03	3.06E-05	4.67E-10	5.59E+02	1.41E-14	3.63E+00	1.06E+00	1.35E-02	1.34E+00	2.23E+01	4.46E-05
1.89E-02	5.79E-03	8.09E-05	1.56E-09	5.59E+02	4.69E-14	8.66E+00	2.54E+00	3.44E-02	1.34E+00	2.23E+01	4.46E-05
3.24E-02	1.11E-02	1.66E-04	4.67E-09	5.59E+02	1.41E-13	1.51E+01	5.02E+00	6.81E-02	1.34E+00	2.23E+01	4.46E-05
5.10E-02	2.09E-02	2.60E-04	1.56E-08	5.59E+02	4.69E-13	2.46E+01	1.03E+01	1.06E-01	1.34E+00	2.23E+01	4.46E-05
8.09E-02	4.31E-02	3.03E-04	4.67E-08	5.59E+02	1.41E-12	4.13E+01	2.46E+01	1.26E-01	1.34E+00	2.23E+01	4.46E-05
1.55E-01	1.32E-01	3.74E-04	1.56E-07	5.59E+02	4.69E-12	8.54E+01	8.23E+01	1.68E-01	1.34E+00	2.23E+01	4.46E-05
2.91E-01	3.64E-01	5.26E-04	4.67E-07	5.59E+02	1.41E-11	1.70E+02	2.34E+02	2.63E-01	1.34E+00	2.23E+01	4.46E-05
4.99E-01	8.77E-01	8.89E-04	1.56E-06	5.59E+02	4.69E-11	3.00E+02	5.86E+02	5.02E-01	1.34E+00	2.23E+01	4.46E-05
6.48E-01	1.61E+00	1.85E-03	4.67E-06	5.59E+02	1.41E-10	3.95E+02	1.11E+03	1.17E+00	1.34E+00	2.23E+01	4.46E-05
7.16E-01	2.90E+00	7.35E-03	1.56E-05	5.59E+02	4.69E-10	4.42E+02	2.06E+03	5.17E+00	1.34E+00	2.23E+01	4.46E-05
7.88E-01	4.21E+00	2.29E-02	4.67E-05	5.58E+02	1.41E-09	4.92E+02	3.01E+03	1.67E+01	1.34E+00	2.23E+01	4.46E-05
8.64E-01	5.55E+00	3.25E-02	1.56E-04	5.53E+02	4.69E-09	5.39E+02	3.87E+03	2.39E+01	1.35E+00	2.24E+01	4.46E-05
9.95E-01	8.68E+00	3.41E-02	2.62E-04	4.39E-02	1.11E-08	6.14E+02	5.80E+03	2.48E+01	1.47E-01	9.33E-01	3.83E-06

Cf-249

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cf249	Cf250	Cm246	Cm245	Cf249	Cf250	Cm246	Cm245
1.00E+01	1.00E+00	5.06E-08	0.00E+00	9.41E-02	1.00E+00	5.06E-08	0.00E+00	9.41E-02
3.00E+01	1.00E+00	1.52E-07	0.00E+00	9.41E-02	1.00E+00	1.52E-07	0.00E+00	9.41E-02
1.00E+02	1.00E+00	5.06E-07	0.00E+00	9.41E-02	1.00E+00	5.06E-07	0.00E+00	9.41E-02
3.00E+02	1.00E+00	1.52E-06	0.00E+00	9.41E-02	1.00E+00	1.52E-06	0.00E+00	9.41E-02
1.00E+03	1.00E+00	5.06E-06	0.00E+00	9.41E-02	1.00E+00	5.06E-06	0.00E+00	9.41E-02
3.00E+03	1.00E+00	1.52E-05	0.00E+00	9.41E-02	1.00E+00	1.52E-05	0.00E+00	9.41E-02
1.00E+04	1.00E+00	5.06E-05	4.18E-10	9.41E-02	1.00E+00	5.06E-05	4.18E-10	9.41E-02
3.00E+04	9.99E-01	1.52E-04	3.77E-09	9.41E-02	1.00E+00	1.52E-04	3.77E-09	9.41E-02
1.00E+05	9.97E-01	5.06E-04	4.18E-08	9.41E-02	9.99E-01	5.05E-04	4.17E-08	9.40E-02
3.00E+05	9.91E-01	1.52E-03	3.77E-07	9.41E-02	9.96E-01	1.51E-03	3.75E-07	9.37E-02
1.00E+06	9.71E-01	5.06E-03	4.18E-06	9.41E-02	9.86E-01	4.99E-03	4.12E-06	9.27E-02
3.00E+06	9.16E-01	1.51E-02	3.76E-05	9.41E-02	9.58E-01	1.45E-02	3.60E-05	9.01E-02
1.00E+07	7.47E-01	5.02E-02	4.16E-04	9.41E-02	8.68E-01	4.36E-02	3.61E-04	8.16E-02

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	6.63E-01	1.49E-01	2.16E-03	7.05E+02	1.06E+04	2.98E-02
3.00E+01	2.94E+00	7.48E-01	9.74E-03	7.05E+02	1.06E+04	2.98E-02
1.00E+02	7.33E+00	1.95E+00	2.66E-02	7.05E+02	1.06E+04	2.98E-02
3.00E+02	1.44E+01	4.22E+00	5.60E-02	7.05E+02	1.06E+04	2.98E-02
1.00E+03	2.90E+01	9.49E+00	9.07E-02	7.05E+02	1.06E+04	2.98E-02
3.00E+03	6.05E+01	2.40E+01	1.11E-01	7.05E+02	1.06E+04	2.98E-02
1.00E+04	1.50E+02	8.25E+01	1.59E-01	7.06E+02	1.06E+04	2.98E-02
3.00E+04	3.26E+02	2.39E+02	2.74E-01	7.06E+02	1.06E+04	2.98E-02
1.00E+05	5.76E+02	6.29E+02	6.23E-01	7.08E+02	1.06E+04	3.00E-02
3.00E+05	7.37E+02	1.28E+03	1.83E+00	7.14E+02	1.07E+04	3.01E-02
1.00E+06	8.03E+02	2.54E+03	9.21E+00	7.33E+02	1.13E+04	3.09E-02
3.00E+06	8.61E+02	3.85E+03	2.94E+01	7.80E+02	1.25E+04	3.63E-02
1.00E+07	8.59E+02	5.08E+03	3.82E+01	9.02E+02	1.54E+04	3.64E-02

Cf249 TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TOTAL DOSE TEDE (reactor) rem	Max TODE rem	Public TEDE rem
7.08E-04	4.72E-04	3.13E-01		7.06E+02	1.06E+04	3.20E-02
7.06E-04	4.72E-04	2.53E-01		7.08E+02	1.06E+04	3.96E-02
7.02E-04	4.72E-04	1.77E-01		7.12E+02	1.06E+04	5.64E-02
6.95E-04	4.72E-04	1.16E-01		7.19E+02	1.06E+04	8.59E-02
6.81E-04	4.72E-04	8.30E-02		7.34E+02	1.06E+04	1.21E-01
6.53E-04	4.72E-04	7.09E-02		7.66E+02	1.06E+04	1.41E-01
5.84E-04	4.72E-04	5.30E-02		8.56E+02	1.06E+04	1.89E-01
4.85E-04	4.73E-04	3.29E-02		1.03E+03	1.06E+04	3.04E-01
3.89E-04	4.70E-04	1.53E-02		1.28E+03	1.06E+04	6.53E-01
3.45E-04	4.65E-04	5.38E-03		1.45E+03	1.07E+04	1.86E+00
3.26E-04	4.44E-04	1.08E-03		1.54E+03	1.13E+04	9.24E+00
3.05E-04	4.01E-04	3.40E-04		1.64E+03	1.25E+04	2.94E+01
2.84E-04	3.24E-04	2.61E-04		1.76E+03	1.54E+04	3.82E+01

Cf-249

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cf249	Cf250	Cm246	Cm245	Cf249	Cf250	Cm246	Cm245
1.00E+01	1.00E+00	5.06E-11	0.00E+00	9.41E-02	1.00E+00	5.06E-11	0.00E+00	9.41E-02
3.00E+01	1.00E+00	1.52E-10	0.00E+00	9.41E-02	1.00E+00	1.52E-10	0.00E+00	9.41E-02
1.00E+02	1.00E+00	5.06E-10	0.00E+00	9.41E-02	1.00E+00	5.06E-10	0.00E+00	9.41E-02
3.00E+02	1.00E+00	1.52E-09	0.00E+00	9.41E-02	1.00E+00	1.52E-09	0.00E+00	9.41E-02
1.00E+03	1.00E+00	5.06E-09	0.00E+00	9.41E-02	1.00E+00	5.06E-09	0.00E+00	9.41E-02
3.00E+03	1.00E+00	1.52E-08	0.00E+00	9.41E-02	1.00E+00	1.52E-08	0.00E+00	9.41E-02
1.00E+04	1.00E+00	5.06E-08	4.18E-13	9.41E-02	1.00E+00	5.06E-08	4.18E-13	9.41E-02
3.00E+04	1.00E+00	1.52E-07	3.77E-12	9.41E-02	1.00E+00	1.52E-07	3.77E-12	9.41E-02
1.00E+05	1.00E+00	5.06E-07	4.18E-11	9.41E-02	1.00E+00	5.06E-07	4.18E-11	9.41E-02
3.00E+05	1.00E+00	1.52E-06	3.77E-10	9.41E-02	1.00E+00	1.52E-06	3.77E-10	9.41E-02
1.00E+06	1.00E+00	5.06E-06	4.18E-09	9.41E-02	1.00E+00	5.06E-06	4.18E-09	9.41E-02
3.00E+06	1.00E+00	1.51E-05	3.76E-08	9.41E-02	1.00E+00	1.51E-05	3.76E-08	9.41E-02
1.00E+07	9.99E-01	5.02E-05	4.16E-07	9.41E-02	1.00E+00	5.02E-05	4.16E-07	9.41E-02

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	6.63E-04	1.49E-04	2.16E-06	7.05E+02	1.06E+04	2.98E-02
3.00E+01	2.94E-03	7.48E-04	9.74E-06	7.05E+02	1.06E+04	2.98E-02
1.00E+02	7.33E-03	1.95E-03	2.66E-05	7.05E+02	1.06E+04	2.98E-02
3.00E+02	1.44E-02	4.22E-03	5.60E-05	7.05E+02	1.06E+04	2.98E-02
1.00E+03	2.90E-02	9.49E-03	9.07E-05	7.05E+02	1.06E+04	2.98E-02
3.00E+03	6.05E-02	2.40E-02	1.11E-04	7.05E+02	1.06E+04	2.98E-02
1.00E+04	1.50E-01	8.25E-02	1.59E-04	7.06E+02	1.06E+04	2.98E-02
3.00E+04	3.26E-01	2.40E-01	2.75E-04	7.07E+02	1.06E+04	2.98E-02
1.00E+05	5.77E-01	6.30E-01	6.24E-04	7.10E+02	1.07E+04	3.01E-02
3.00E+05	7.40E-01	1.29E+00	1.84E-03	7.20E+02	1.08E+04	3.04E-02
1.00E+06	8.15E-01	2.58E+00	9.34E-03	7.54E+02	1.16E+04	3.18E-02
3.00E+06	8.99E-01	4.02E+00	3.07E-02	8.50E+02	1.36E+04	3.52E-02
1.00E+07	9.89E-01	5.85E+00	4.40E-02	1.19E+03	2.04E+04	4.80E-02

Cf249 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.00E+01	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.00E+01	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.00E+02	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.00E+02	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.00E+03	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.00E+03	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.00E+04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.00E+04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
1.00E+05	3.9E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04	4.7E-04
3.00E+05	3.4E-04	4.6E-04	4.6E-04	4.6E-04	4.6E-04	4.6E-04	4.6E-04
1.00E+06	3.3E-04	4.3E-04	4.3E-04	4.3E-04	4.3E-04	4.3E-04	4.3E-04
3.00E+06	3.0E-04	3.7E-04	3.7E-04	3.7E-04	3.7E-04	3.7E-04	3.7E-04
1.00E+07	2.6E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04	2.5E-04

Cf-251 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cf251	Reference dose					Cf252	Reference dose				
1.00E+01	1.10E+00	1.79E-01	3.02E-03	2.73E+02	4.08E+03	1.15E-02	2.28E-02	3.72E-03	6.27E-05	1.01E-04	3.36E+05	4.93E-09
3.00E+01	6.34E+00	2.00E+00	2.50E-02	2.73E+02	4.09E+03	1.15E-02	1.32E-01	4.18E-02	5.22E-04	3.03E-04	3.36E+05	1.48E-08
1.00E+02	1.53E+01	4.99E+00	6.93E-02	2.73E+02	4.09E+03	1.15E-02	3.18E-01	1.04E-01	1.45E-03	1.01E-03	3.36E+05	4.93E-08
3.00E+02	2.97E+01	9.99E+00	1.47E-01	2.73E+02	4.09E+03	1.15E-02	6.19E-01	2.08E-01	3.06E-03	3.03E-03	3.36E+05	1.48E-07
1.00E+03	6.17E+01	1.98E+01	2.34E-01	2.73E+02	4.11E+03	1.15E-02	1.29E+00	4.12E-01	4.88E-03	1.01E-02	3.36E+05	4.93E-07
3.00E+03	1.32E+02	4.44E+01	2.69E-01	2.75E+02	4.13E+03	1.16E-02	2.75E+00	9.26E-01	5.61E-03	3.03E-02	3.36E+05	1.48E-06
1.00E+04	3.31E+02	1.46E+02	3.29E-01	2.83E+02	4.19E+03	1.19E-02	6.90E+00	3.04E+00	6.87E-03	1.01E-01	3.36E+05	4.93E-06
3.00E+04	7.20E+02	4.12E+02	4.79E-01	3.03E+02	4.39E+03	1.26E-02	1.50E+01	8.60E+00	9.99E-03	3.03E-01	3.36E+05	1.48E-05
1.00E+05	1.30E+03	1.02E+03	8.84E-01	3.72E+02	5.09E+03	1.52E-02	2.71E+01	2.12E+01	1.85E-02	1.01E+00	3.36E+05	4.92E-05
3.00E+05	1.69E+03	1.87E+03	1.95E+00	5.69E+02	7.07E+03	2.26E-02	3.52E+01	3.91E+01	4.08E-02	3.02E+00	3.36E+05	1.46E-04
1.00E+06	1.80E+03	3.27E+03	7.93E+00	1.26E+03	1.40E+04	4.84E-02	3.76E+01	6.82E+01	1.66E-01	9.88E+00	3.36E+05	4.71E-04
3.00E+06	1.88E+03	4.70E+03	2.47E+01	3.21E+03	3.35E+04	1.22E-01	3.92E+01	9.80E+01	5.15E-01	2.61E+01	3.36E+05	1.21E-03
1.00E+07	1.96E+03	6.18E+03	3.51E+01	9.75E+03	9.92E+04	3.68E-01	4.09E+01	1.29E+02	7.32E-01	2.61E+01	3.36E+05	1.21E-03

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm248	Reference dose					Cm247	Reference dose				
1.00E+01	7.76E-03	2.67E-03	2.95E-05	1.58E-05	2.83E-03	2.52E-10	1.81E-01	3.31E-02	5.42E-04	4.38E-05	2.66E-01	1.56E-05
3.00E+01	2.03E-02	6.87E-03	8.07E-05	4.72E-05	6.93E-03	7.47E-10	1.04E+00	3.08E-01	3.89E-03	4.41E-05	4.28E-01	1.55E-09
1.00E+02	4.56E-02	1.55E-02	2.06E-04	1.57E-04	1.57E-02	2.50E-09	2.40E+00	7.36E-01	1.03E-02	4.49E-05	7.73E-01	1.58E-09
3.00E+02	7.80E-02	2.80E-02	4.10E-04	4.67E-04	2.90E-02	7.70E-09	4.12E+00	1.42E+00	2.11E-02	4.73E-05	1.23E+00	1.67E-09
1.00E+03	1.29E-01	4.95E-02	6.35E-04	1.53E-03	5.34E-02	2.78E-08	6.49E+00	2.66E+00	3.31E-02	5.55E-05	1.66E+00	1.95E-09
3.00E+03	2.20E-01	9.71E-02	7.26E-04	4.38E-03	1.05E-01	9.97E-08	1.03E+01	5.48E+00	3.85E-02	7.89E-05	1.73E+00	2.78E-09
1.00E+04	4.59E-01	2.82E-01	8.63E-04	1.32E-02	3.04E-01	4.49E-07	1.97E+01	1.68E+01	4.76E-02	1.61E-04	1.73E+00	5.68E-09
3.00E+04	9.13E-01	7.48E-01	1.15E-03	3.56E-02	9.25E-01	1.66E-06	3.70E+01	4.63E+01	6.69E-02	3.95E-04	1.74E+00	1.39E-08
1.00E+05	1.61E+00	1.74E+00	1.85E-03	1.13E-01	3.13E+00	5.99E-06	6.35E+01	1.12E+02	1.13E-01	1.22E-03	1.79E+00	4.29E-08
3.00E+05	2.10E+00	3.04E+00	3.50E-03	3.33E-01	9.42E+00	1.84E-05	8.24E+01	2.05E+02	2.35E-01	3.56E-03	1.98E+00	1.26E-07
1.00E+06	2.26E+00	5.12E+00	1.25E-02	1.11E+00	3.14E+01	6.19E-05	9.11E+01	3.68E+02	9.35E-01	1.18E-02	3.38E+00	4.15E-07
3.00E+06	2.38E+00	7.18E+00	3.76E-02	3.38E+00	9.42E+01	1.87E-04	1.00E+02	5.36E+02	2.91E+00	3.52E-02	7.59E+00	1.24E-06
1.00E+07	2.51E+00	9.16E+00	5.31E-02	1.18E+01	3.10E+02	6.39E-04	1.10E+02	7.07E+02	4.14E+00	1.18E-01	1.11E+01	4.12E-06

Cf-251

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cf251	Cf252	Cm248	Cm247		Cf251	Cf252	Cm248	Cm247
1.00E+01	1.00E+00	2.87E-07	0.00E+00	3.73E-02	0.00E+00	1.00E+00	2.87E-07	0.00E+00	3.73E-02
3.00E+01	1.00E+00	8.61E-07	0.00E+00	3.73E-02	0.00E+00	1.00E+00	8.61E-07	0.00E+00	3.73E-02
1.00E+02	1.00E+00	2.87E-06	0.00E+00	3.73E-02	0.00E+00	1.00E+00	2.87E-06	0.00E+00	3.73E-02
3.00E+02	1.00E+00	8.61E-06	0.00E+00	3.73E-02	0.00E+00	1.00E+00	8.61E-06	0.00E+00	3.73E-02
1.00E+03	1.00E+00	2.87E-05	0.00E+00	3.73E-02	0.00E+00	1.00E+00	2.87E-05	0.00E+00	3.73E-02
3.00E+03	1.00E+00	8.61E-05	0.00E+00	3.73E-02	0.00E+00	1.00E+00	8.61E-05	0.00E+00	3.73E-02
1.00E+04	9.99E-01	2.87E-04	1.14E-08	3.73E-02	0.00E+00	1.00E+00	2.87E-04	1.14E-08	3.73E-02
3.00E+04	9.98E-01	8.61E-04	1.03E-07	3.73E-02	0.00E+00	9.99E-01	8.60E-04	1.03E-07	3.73E-02
1.00E+05	9.92E-01	2.87E-03	1.14E-06	3.73E-02	0.00E+00	9.96E-01	2.86E-03	1.14E-06	3.71E-02
3.00E+05	9.76E-01	8.60E-02	1.02E-05	3.73E-02	0.00E+00	9.88E-01	8.50E-02	1.01E-05	3.68E-02
1.00E+06	9.21E-01	2.86E-02	1.14E-04	3.73E-02	0.00E+00	9.60E-01	2.75E-02	1.09E-04	3.58E-02
3.00E+06	7.82E-01	8.51E-02	1.02E-03	3.73E-02	0.00E+00	8.87E-01	7.55E-02	9.04E-04	3.31E-02
1.00E+07	4.41E-01	2.76E-01	1.11E-02	3.73E-02	0.00E+00	6.83E-01	1.88E-01	7.58E-03	2.55E-02

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	1.10E+00	1.80E-01	3.04E-03	2.72E+02	4.08E+03	1.15E-02
3.00E+01	6.38E+00	2.02E+00	2.52E-02	2.72E+02	4.09E+03	1.15E-02
1.00E+02	1.53E+01	5.02E+00	6.97E-02	2.72E+02	4.09E+03	1.15E-02
3.00E+02	2.98E+01	1.00E+01	1.47E-01	2.72E+02	4.09E+03	1.15E-02
1.00E+03	6.19E+01	1.99E+01	2.35E-01	2.73E+02	4.12E+03	1.15E-02
3.00E+03	1.32E+02	4.46E+01	2.70E-01	2.75E+02	4.15E+03	1.16E-02
1.00E+04	3.31E+02	1.46E+02	3.31E-01	2.82E+02	4.28E+03	1.18E-02
3.00E+04	7.20E+02	4.13E+02	4.81E-01	3.02E+02	4.67E+03	1.26E-02
1.00E+05	1.30E+03	1.02E+03	8.85E-01	3.69E+02	6.01E+03	1.51E-02
3.00E+05	1.67E+03	1.86E+03	1.94E+00	5.56E+02	3.58E+04	2.21E-02
1.00E+06	1.73E+03	3.15E+03	7.66E+00	1.16E+03	2.25E+04	4.46E-02
3.00E+06	1.67E+03	4.19E+03	2.20E+01	2.51E+03	5.48E+04	9.53E-02
1.00E+07	1.35E+03	4.26E+03	2.42E+01	4.31E+03	1.36E+05	1.63E-01

Cf251 TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TOTAL DOSE TEDE (reactor) rem	Max TODE rem	Public TEDE rem
1.83E-03	1.22E-03	6.88E-01	2.74E+02	4.08E+03	1.45E-02
1.79E-03	1.22E-03	2.73E-01	2.79E+02	4.09E+03	3.66E-02
1.74E-03	1.22E-03	1.23E-01	2.88E+02	4.09E+03	8.12E-02
1.65E-03	1.22E-03	6.29E-02	3.02E+02	4.09E+03	1.59E-01
1.49E-03	1.21E-03	4.06E-02	3.35E+02	4.12E+03	2.46E-01
1.23E-03	1.20E-03	3.55E-02	4.07E+02	4.15E+03	2.82E-01
8.15E-04	1.17E-03	2.92E-02	6.14E+02	4.28E+03	3.43E-01
4.89E-04	1.07E-03	2.03E-02	1.02E+03	4.67E+03	4.93E-01
3.00E-04	8.31E-04	1.11E-02	1.67E+03	6.01E+03	9.00E-01
2.24E-04	1.40E-04	5.09E-03	2.23E+03	3.58E+04	1.96E+00
1.73E-04	2.22E-04	1.30E-03	2.89E+03	2.25E+04	7.70E+00
1.19E-04	9.13E-05	4.53E-04	4.18E+03	5.48E+04	2.21E+01
8.83E-05	3.67E-05	4.10E-04	5.66E+03	1.36E+05	2.44E+01

Cf-251

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cf251	Cf252	Cm248	Cm247	Cf251	Cf252	Cm248	Cm247
1.00E+01	1.00E+00	2.87E-10	0.00E+00	3.73E-02	1.00E+00	2.87E-10	0.00E+00	3.73E-02
3.00E+01	1.00E+00	8.61E-10	0.00E+00	3.73E-02	1.00E+00	8.61E-10	0.00E+00	3.73E-02
1.00E+02	1.00E+00	2.87E-09	0.00E+00	3.73E-02	1.00E+00	2.87E-09	0.00E+00	3.73E-02
3.00E+02	1.00E+00	8.61E-09	0.00E+00	3.73E-02	1.00E+00	8.61E-09	0.00E+00	3.73E-02
1.00E+03	1.00E+00	2.87E-08	0.00E+00	3.73E-02	1.00E+00	2.87E-08	0.00E+00	3.73E-02
3.00E+03	1.00E+00	8.61E-08	0.00E+00	3.73E-02	1.00E+00	8.61E-08	0.00E+00	3.73E-02
1.00E+04	1.00E+00	2.87E-07	1.14E-11	3.73E-02	1.00E+00	2.87E-07	1.14E-11	3.73E-02
3.00E+04	1.00E+00	8.61E-07	1.03E-10	3.73E-02	1.00E+00	8.61E-07	1.03E-10	3.73E-02
1.00E+05	1.00E+00	2.87E-06	1.14E-09	3.73E-02	1.00E+00	2.87E-06	1.14E-09	3.73E-02
3.00E+05	1.00E+00	8.60E-05	1.02E-08	3.73E-02	1.00E+00	8.60E-05	1.02E-08	3.73E-02
1.00E+06	1.00E+00	2.86E-05	1.14E-07	3.73E-02	1.00E+00	2.86E-05	1.14E-07	3.73E-02
3.00E+06	1.00E+00	8.51E-05	1.02E-06	3.73E-02	1.00E+00	8.51E-05	1.02E-06	3.73E-02
1.00E+07	9.99E-01	2.76E-04	1.11E-05	3.73E-02	9.99E-01	2.76E-04	1.11E-05	3.73E-02

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	TOTAL DOSE					
1.00E+01	1.10E-03	1.80E-04	3.04E-06	2.73E+02	4.08E+03	1.15E-02
3.00E+01	6.38E-03	2.02E-03	2.52E-05	2.73E+02	4.09E+03	1.15E-02
1.00E+02	1.53E-02	5.02E-03	6.97E-05	2.72E+02	4.09E+03	1.15E-02
3.00E+02	2.98E-02	1.00E-02	1.47E-04	2.72E+02	4.09E+03	1.15E-02
1.00E+03	6.19E-02	1.99E-02	2.35E-04	2.73E+02	4.11E+03	1.15E-02
3.00E+03	1.32E-01	4.46E-02	2.70E-04	2.75E+02	4.13E+03	1.16E-02
1.00E+04	3.32E-01	1.46E-01	3.31E-04	2.82E+02	4.19E+03	1.19E-02
3.00E+04	7.21E-01	4.14E-01	4.81E-04	3.02E+02	4.39E+03	1.26E-02
1.00E+05	1.30E+00	1.02E+00	8.89E-04	3.72E+02	5.09E+03	1.52E-02
3.00E+05	1.69E+00	1.88E+00	1.96E-03	5.69E+02	7.10E+03	2.26E-02
1.00E+06	1.80E+00	3.28E+00	7.97E-03	1.26E+03	1.40E+04	4.84E-02
3.00E+06	1.88E+00	4.71E+00	2.48E-02	3.21E+03	3.35E+04	1.22E-01
1.00E+07	1.97E+00	6.20E+00	3.52E-02	9.74E+03	9.92E+04	3.68E-01

Cf251 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.00E+01	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.00E+01	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
1.00E+02	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.00E+02	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
1.00E+03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.00E+03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
1.00E+04	8.1E-04	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03	1.2E-03
3.00E+04	4.9E-04	1.1E-03	1.1E-03	1.1E-03	1.1E-03	1.1E-03	1.1E-03
1.00E+05	3.0E-04	9.6E-04	9.8E-04	9.8E-04	9.8E-04	9.8E-04	9.8E-04
3.00E+05	1.4E-04	5.0E-04	6.8E-04	7.0E-04	7.1E-04	7.1E-04	7.1E-04
1.00E+06	1.7E-04	3.4E-04	3.6E-04	3.6E-04	3.6E-04	3.6E-04	3.6E-04
3.00E+06	9.1E-05	1.4E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04
1.00E+07	3.7E-05	5.0E-05	5.0E-05	5.0E-05	5.0E-05	5.0E-05	5.0E-05

Cm-242 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm242						Cm243					
1.00E+01	4.61E-03	1.07E-03	1.48E-05	1.76E+04	1.85E+05	8.29E-01	7.91E-01	1.95E-01	2.66E-03	1.67E-04	1.68E-01	5.88E-09
3.00E+01	1.26E-02	3.05E-03	4.33E-05	1.76E+04	1.85E+05	8.29E-01	2.14E+00	5.43E-01	7.65E-03	5.00E-04	4.43E-01	1.76E-08
1.00E+02	3.11E-02	8.60E-03	1.24E-04	1.76E+04	1.85E+05	8.29E-01	5.25E+00	1.45E+00	2.13E-02	1.67E-03	1.11E+00	5.88E-08
3.00E+02	5.64E-02	2.01E-02	2.74E-04	1.76E+04	1.85E+05	8.29E-01	9.32E+00	3.16E+00	4.58E-02	5.00E-03	2.14E+00	1.76E-07
1.00E+03	8.69E-02	4.70E-02	4.54E-04	1.76E+04	1.85E+05	8.29E-01	1.43E+01	6.82E+00	7.44E-02	1.67E-02	3.23E+00	5.88E-07
3.00E+03	1.26E-01	1.19E-01	5.66E-04	1.76E+04	1.85E+05	8.29E-01	2.10E+01	1.61E+01	9.04E-02	5.00E-02	3.73E+00	1.76E-06
1.00E+04	2.17E-01	4.13E-01	8.19E-04	1.76E+04	1.85E+05	8.29E-01	3.66E+01	5.35E+01	1.23E-01	1.67E-01	4.93E+00	5.88E-06
3.00E+04	3.82E-01	1.21E+00	1.39E-03	1.76E+04	1.85E+05	8.29E-01	6.40E+01	1.53E+02	1.94E-01	5.00E-01	8.30E+00	1.76E-05
1.00E+05	6.33E-01	3.21E+00	3.01E-03	1.76E+04	1.85E+05	8.32E-01	1.04E+02	3.98E+02	3.79E-01	1.67E+00	2.01E+01	5.88E-05
3.00E+05	8.47E-01	6.68E+00	8.44E-03	1.76E+04	1.85E+05	8.32E-01	1.35E+02	8.09E+02	9.66E-01	5.00E+00	5.43E+01	1.76E-04
1.00E+06	1.11E+00	1.36E+01	4.22E-02	1.76E+04	1.86E+05	8.32E-01	1.66E+02	1.61E+03	4.62E+00	1.67E+01	1.78E+02	5.88E-04
3.00E+06	1.49E+00	2.04E+01	1.38E-01	1.77E+04	1.87E+05	8.35E-01	2.11E+02	2.45E+03	1.51E+01	4.99E+01	5.32E+02	1.76E-03
1.00E+07	1.81E+00	2.58E+01	1.98E-01	1.78E+04	1.90E+05	8.43E-01	2.54E+02	3.29E+03	2.17E+01	1.66E+02	1.70E+03	5.85E-03
3.15E+07	2.25E+00	3.79E+01	2.04E-01	1.80E+04	1.96E+05	8.55E-01	3.26E+02	5.27E+03	2.27E+01	5.15E+02	5.20E+03	1.82E-02

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu239						Pu238					
1.00E+01	5.71E-01	1.49E-01	1.86E-03	1.88E-06	1.35E-01	3.04E-11	2.15E-02	5.47E-03	7.15E-05	2.37E-07	5.05E-03	1.17E-11
3.00E+01	1.53E+00	3.91E-01	5.06E-03	5.63E-06	3.38E-01	9.14E-11	5.75E-02	1.42E-02	1.94E-04	7.09E-07	1.27E-02	3.49E-11
1.00E+02	3.68E+00	9.68E-01	1.34E-02	1.86E-05	7.78E-01	3.04E-10	1.40E-01	3.50E-02	5.10E-04	2.37E-06	2.93E-02	1.17E-10
3.00E+02	6.14E+00	1.98E+00	2.74E-02	5.39E-05	1.38E+00	9.06E-10	2.35E-01	7.06E-02	1.04E-03	7.09E-06	5.22E-02	3.49E-10
1.00E+03	8.28E+00	4.22E+00	4.36E-02	1.63E-04	1.93E+00	2.95E-09	3.14E-01	1.43E-01	1.65E-03	2.37E-05	7.40E-02	1.17E-09
3.00E+03	1.01E+01	1.04E+01	5.34E-02	3.82E-04	2.03E+00	8.49E-09	3.77E-01	3.36E-01	2.00E-03	7.09E-05	7.84E-02	3.49E-09
1.00E+04	1.31E+01	3.66E+01	7.52E-02	8.23E-04	2.06E+00	2.67E-08	4.75E-01	1.16E+00	2.75E-03	2.37E-04	8.30E-02	1.17E-08
3.00E+04	1.73E+01	1.08E+02	1.22E-01	1.87E-03	2.11E+00	7.81E-08	5.99E-01	3.41E+00	4.29E-03	7.09E-04	9.50E-02	3.49E-08
1.00E+05	2.50E+01	2.78E+02	2.39E-01	5.51E-03	2.28E+00	2.58E-07	8.35E-01	8.86E+00	8.13E-03	2.37E-03	1.37E-01	1.17E-07
3.00E+05	3.45E+01	5.44E+02	5.86E-01	1.59E-02	2.99E+00	7.70E-07	1.14E+00	1.77E+01	2.01E-02	7.09E-03	2.63E-01	3.49E-07
1.00E+06	5.11E+01	1.02E+03	2.66E+00	5.23E-02	7.77E+00	2.57E-06	1.71E+00	3.41E+01	9.29E-02	2.37E-02	7.88E-01	1.17E-06
3.00E+06	7.60E+01	1.49E+03	8.57E+00	1.57E-01	2.22E+01	7.70E-06	2.57E+00	4.99E+01	3.00E-01	7.09E-02	2.32E+00	3.49E-06
1.00E+07	9.77E+01	1.88E+03	1.22E+01	5.20E-01	3.80E+01	2.57E-05	3.24E+00	6.11E+01	4.27E-01	2.37E-01	6.43E+00	1.17E-05
3.15E+07	1.30E+02	2.76E+03	1.27E+01	1.64E+00	6.42E+01	8.09E-05	4.16E+00	8.49E+01	4.40E-01	7.45E-01	1.83E+01	3.66E-05

Cm-242

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm242	Cm243	Pu239	Pu238	Cm242	Cm243	Pu239	Pu238
1.00E+01	1.00E+00	1.08E-08	0.00E+00	4.91E-01	1.00E+00	1.08E-08	0.00E+00	4.91E-01
3.00E+01	1.00E+00	3.25E-08	0.00E+00	4.91E-01	1.00E+00	3.25E-08	0.00E+00	4.91E-01
1.00E+02	1.00E+00	1.08E-07	0.00E+00	4.91E-01	1.00E+00	1.08E-07	0.00E+00	4.91E-01
3.00E+02	1.00E+00	3.25E-07	0.00E+00	4.91E-01	1.00E+00	3.25E-07	0.00E+00	4.91E-01
1.00E+03	1.00E+00	1.08E-06	0.00E+00	4.91E-01	1.00E+00	1.08E-06	0.00E+00	4.91E-01
3.00E+03	1.00E+00	3.25E-06	0.00E+00	4.91E-01	1.00E+00	3.25E-06	0.00E+00	4.91E-01
1.00E+04	9.99E-01	1.08E-05	0.00E+00	4.91E-01	1.00E+00	1.08E-05	0.00E+00	4.91E-01
3.00E+04	9.98E-01	3.25E-05	3.51E-10	4.91E-01	9.99E-01	3.25E-05	3.51E-10	4.91E-01
1.00E+05	9.95E-01	1.08E-04	3.90E-09	4.93E-01	9.97E-01	1.08E-04	3.89E-09	4.92E-01
3.00E+05	9.85E-01	3.25E-04	3.51E-08	4.98E-01	9.92E-01	3.23E-04	3.48E-08	4.94E-01
1.00E+06	9.51E-01	1.08E-03	3.90E-07	5.14E-01	9.75E-01	1.05E-03	3.80E-07	5.01E-01
3.00E+06	8.60E-01	3.25E-03	3.51E-06	5.58E-01	9.28E-01	3.02E-03	3.26E-06	5.18E-01
1.00E+07	6.04E-01	1.08E-02	3.89E-05	6.80E-01	7.85E-01	8.48E-03	3.06E-05	5.34E-01
3.15E+07	2.04E-01	3.38E-02	3.84E-04	8.72E-01	5.01E-01	1.69E-02	1.92E-04	4.37E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.52E-02	3.76E-03	5.00E-05	1.76E+04	1.85E+05	8.29E-01
3.00E+01	4.08E-02	1.00E-02	1.39E-04	1.76E+04	1.85E+05	8.29E-01
1.00E+02	1.00E-01	2.58E-02	3.75E-04	1.76E+04	1.85E+05	8.29E-01
3.00E+02	1.72E-01	5.47E-02	7.86E-04	1.76E+04	1.85E+05	8.29E-01
1.00E+03	2.41E-01	1.17E-01	1.27E-03	1.76E+04	1.85E+05	8.29E-01
3.00E+03	3.11E-01	2.84E-01	1.55E-03	1.76E+04	1.85E+05	8.29E-01
1.00E+04	4.51E-01	9.84E-01	2.17E-03	1.76E+04	1.85E+05	8.29E-01
3.00E+04	6.77E-01	2.89E+00	3.50E-03	1.76E+04	1.85E+05	8.28E-01
1.00E+05	1.05E+00	7.60E+00	7.04E-03	1.75E+04	1.84E+05	8.28E-01
3.00E+05	1.45E+00	1.56E+01	1.86E-02	1.73E+04	1.82E+05	8.20E-01
1.00E+06	2.11E+00	3.20E+01	9.26E-02	1.67E+04	1.77E+05	7.91E-01
3.00E+06	3.35E+00	5.22E+01	3.30E-01	1.52E+04	1.60E+05	7.18E-01
1.00E+07	5.31E+00	8.09E+01	5.68E-01	1.07E+04	1.15E+05	5.10E-01
3.15E+07	8.48E+00	1.46E+02	6.81E-01	3.70E+03	4.02E+04	1.75E-01

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
2.84E-05	2.70E-05	1.21E-02	1.76E+04	1.85E+05	8.29E-01
2.84E-05	2.70E-05	1.21E-02	1.76E+04	1.85E+05	8.29E-01
2.84E-05	2.70E-05	1.21E-02	1.76E+04	1.85E+05	8.30E-01
2.84E-05	2.70E-05	1.20E-02	1.76E+04	1.85E+05	8.30E-01
2.84E-05	2.70E-05	1.20E-02	1.76E+04	1.85E+05	8.31E-01
2.84E-05	2.70E-05	1.20E-02	1.76E+04	1.85E+05	8.31E-01
2.84E-05	2.70E-05	1.20E-02	1.76E+04	1.85E+05	8.31E-01
2.85E-05	2.71E-05	1.20E-02	1.76E+04	1.85E+05	8.32E-01
2.86E-05	2.72E-05	1.20E-02	1.75E+04	1.84E+05	8.35E-01
2.89E-05	2.74E-05	1.19E-02	1.73E+04	1.82E+05	8.38E-01
2.99E-05	2.83E-05	1.13E-02	1.67E+04	1.77E+05	8.84E-01
3.29E-05	3.12E-05	9.55E-03	1.52E+04	1.60E+05	1.05E+00
4.66E-05	4.36E-05	9.28E-03	1.07E+04	1.15E+05	1.08E+00
1.35E-04	1.24E-04	1.17E-02	3.70E+03	4.02E+04	8.56E-01

Cm-242

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm242	Cm243	Pu239	Pu238	Cm242	Cm243	Pu239	Pu238
1.00E+01	1.00E+00	1.08E-11	0.00E+00	4.91E-01	1.00E+00	1.08E-11	0.00E+00	4.91E-01
3.00E+01	1.00E+00	3.25E-11	0.00E+00	4.91E-01	1.00E+00	3.25E-11	0.00E+00	4.91E-01
1.00E+02	1.00E+00	1.08E-10	0.00E+00	4.91E-01	1.00E+00	1.08E-10	0.00E+00	4.91E-01
3.00E+02	1.00E+00	3.25E-10	0.00E+00	4.91E-01	1.00E+00	3.25E-10	0.00E+00	4.91E-01
1.00E+03	1.00E+00	1.08E-09	0.00E+00	4.91E-01	1.00E+00	1.08E-09	0.00E+00	4.91E-01
3.00E+03	1.00E+00	3.25E-09	0.00E+00	4.91E-01	1.00E+00	3.25E-09	0.00E+00	4.91E-01
1.00E+04	1.00E+00	1.08E-08	0.00E+00	4.91E-01	1.00E+00	1.08E-08	0.00E+00	4.91E-01
3.00E+04	9.99E-01	3.25E-08	3.51E-13	4.91E-01	9.99E-01	3.25E-08	3.51E-13	4.91E-01
1.00E+05	9.95E-01	1.08E-07	3.90E-12	4.93E-01	9.98E-01	1.08E-07	3.89E-12	4.92E-01
3.00E+05	9.85E-01	3.25E-07	3.51E-11	4.98E-01	9.93E-01	3.23E-07	3.48E-11	4.94E-01
1.00E+06	9.52E-01	1.08E-06	3.90E-10	5.14E-01	9.76E-01	1.05E-06	3.81E-10	5.02E-01
3.00E+06	8.63E-01	3.25E-06	3.51E-09	5.58E-01	9.30E-01	3.02E-06	3.26E-09	5.19E-01
1.00E+07	6.11E-01	1.08E-05	3.89E-08	6.80E-01	7.90E-01	8.53E-06	3.07E-08	5.37E-01
3.15E+07	2.12E-01	3.38E-05	3.84E-07	8.72E-01	5.08E-01	1.72E-05	1.95E-07	4.43E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.52E-05	3.76E-06	5.00E-08	1.76E+04	1.85E+05	8.29E-01
3.00E+01	4.08E-05	1.00E-05	1.39E-07	1.76E+04	1.85E+05	8.29E-01
1.00E+02	1.00E-04	2.58E-05	3.75E-07	1.76E+04	1.85E+05	8.29E-01
3.00E+02	1.72E-04	5.47E-05	7.86E-07	1.76E+04	1.85E+05	8.29E-01
1.00E+03	2.41E-04	1.17E-04	1.27E-06	1.76E+04	1.85E+05	8.29E-01
3.00E+03	3.11E-04	2.84E-04	1.55E-06	1.76E+04	1.85E+05	8.29E-01
1.00E+04	4.51E-04	9.84E-04	2.17E-06	1.76E+04	1.85E+05	8.29E-01
3.00E+04	6.75E-04	2.88E-03	3.50E-06	1.76E+04	1.85E+05	8.28E-01
1.00E+05	1.04E-03	7.56E-03	7.00E-06	1.75E+04	1.84E+05	8.28E-01
3.00E+05	1.41E-03	1.54E-02	1.83E-05	1.73E+04	1.82E+05	8.20E-01
1.00E+06	1.94E-03	3.03E-02	8.78E-05	1.67E+04	1.77E+05	7.92E-01
3.00E+06	2.72E-03	4.49E-02	2.85E-04	1.52E+04	1.61E+05	7.20E-01
1.00E+07	3.17E-03	5.32E-02	3.86E-04	1.08E+04	1.16E+05	5.16E-01
3.15E+07	2.99E-03	5.69E-02	2.99E-04	3.82E+03	4.16E+04	1.81E-01

Cm242 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+01	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+02	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+02	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+03	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+03	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+04	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+04	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
3.0E+05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05	2.7E-05
1.0E+06	2.8E-05	2.8E-05	2.8E-05	2.8E-05	2.8E-05	2.8E-05	2.8E-05
3.0E+06	3.1E-05	3.1E-05	3.1E-05	3.1E-05	3.1E-05	3.1E-05	3.1E-05
1.0E+07	4.4E-05	4.3E-05	4.3E-05	4.3E-05	4.3E-05	4.3E-05	4.3E-05
3.2E+07	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04

Cm-243 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm243						Cm244					
1.00E+01	7.91E-01	1.95E-01	2.66E-03	4.21E+03	6.32E+04	1.78E-01	6.04E-03	1.61E-03	2.12E-05	1.47E-06	1.23E-03	2.11E-11
3.00E+01	2.14E+00	5.43E-01	7.65E-03	4.21E+03	6.32E+04	1.78E-01	1.62E-02	4.40E-03	6.04E-05	4.39E-06	3.16E-03	6.32E-11
1.00E+02	5.25E+00	1.45E+00	2.13E-02	4.21E+03	6.32E+04	1.78E-01	3.87E-02	1.12E-02	1.65E-04	1.47E-05	7.64E-03	2.11E-10
3.00E+02	9.32E+00	3.16E+00	4.58E-02	4.21E+03	6.32E+04	1.78E-01	6.77E-02	2.31E-02	3.46E-04	4.39E-05	1.42E-02	6.32E-10
1.00E+03	1.43E+01	6.82E+00	7.44E-02	4.21E+03	6.32E+04	1.78E-01	1.04E-01	4.68E-02	5.54E-04	1.47E-04	2.13E-02	2.11E-09
3.00E+03	2.10E+01	1.61E+01	9.04E-02	4.21E+03	6.32E+04	1.78E-01	1.57E-01	1.04E-01	6.57E-04	4.39E-04	2.52E-02	6.32E-09
1.00E+04	3.66E+01	5.35E+01	1.23E-01	4.21E+03	6.32E+04	1.78E-01	2.81E-01	3.36E-01	8.54E-04	1.47E-03	3.56E-02	2.11E-08
3.00E+04	6.40E+01	1.53E+02	1.94E-01	4.21E+03	6.32E+04	1.78E-01	5.02E-01	9.49E-01	1.27E-03	4.39E-03	6.51E-02	6.32E-08
1.00E+05	1.04E+02	3.98E+02	3.79E-01	4.21E+03	6.32E+04	1.78E-01	8.34E-01	2.40E+00	2.32E-03	1.47E-02	1.68E-01	2.11E-07
3.00E+05	1.35E+02	8.09E+02	9.66E-01	4.22E+03	6.33E+04	1.78E-01	1.08E+00	4.72E+00	5.48E-03	4.39E-02	4.64E-01	6.32E-07
1.00E+06	1.66E+02	1.61E+03	4.62E+00	4.23E+03	6.33E+04	1.79E-01	1.26E+00	9.09E+00	2.47E-02	1.47E-01	1.52E+00	2.11E-06
3.00E+06	2.11E+02	2.45E+03	1.51E+01	4.26E+03	6.37E+04	1.80E-01	1.50E+00	1.36E+01	7.97E-02	4.39E-01	4.53E+00	6.32E-06
1.00E+07	2.54E+02	3.29E+03	2.17E+01	4.38E+03	6.48E+04	1.84E-01	1.74E+00	1.80E+01	1.14E-01	1.47E+00	1.49E+01	2.11E-05
3.15E+07	3.26E+02	5.27E+03	2.27E+01	4.73E+03	6.87E+04	1.96E-01	2.13E+00	2.81E+01	1.19E-01	4.61E+00	4.63E+01	6.65E-05

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu240						Pu239					
1.00E+01	2.50E-03	7.24E-04	8.84E-06	8.67E-04	2.24E-02	8.04E-09	5.71E-01	1.49E-01	1.86E-03	4.57E+00	1.07E+02	2.25E-04
3.00E+01	6.62E-03	1.88E-03	2.40E-05	2.60E-03	6.70E-02	2.40E-08	1.53E+00	3.91E-01	5.06E-03	4.57E+00	1.07E+02	2.25E-04
1.00E+02	1.57E-02	4.54E-03	6.26E-05	8.67E-03	2.22E-01	8.04E-08	3.68E+00	9.68E-01	1.34E-02	4.57E+00	1.07E+02	2.25E-04
3.00E+02	2.59E-02	9.07E-03	1.27E-04	2.60E-02	6.59E-01	2.40E-07	6.14E+00	1.98E+00	2.74E-02	4.57E+00	1.07E+02	2.25E-04
1.00E+03	3.52E-02	1.87E-02	2.01E-04	8.67E-02	2.18E+00	8.04E-07	8.28E+00	4.22E+00	4.36E-02	4.57E+00	1.07E+02	2.25E-04
3.00E+03	4.38E-02	4.51E-02	2.40E-04	2.60E-01	6.49E+00	2.40E-06	1.01E+01	1.04E+01	5.34E-02	4.57E+00	1.07E+02	2.25E-04
1.00E+04	5.81E-02	1.56E-01	3.24E-04	8.67E-01	2.16E+01	8.04E-06	1.31E+01	3.66E+01	7.52E-02	4.57E+00	1.07E+02	2.25E-04
3.00E+04	7.72E-02	4.54E-01	5.07E-04	2.60E+00	6.48E+01	2.40E-05	1.73E+01	1.08E+02	1.22E-01	4.57E+00	1.07E+02	2.25E-04
1.00E+05	1.12E-01	1.14E+00	9.67E-04	8.67E+00	2.16E+02	8.04E-05	2.50E+01	2.78E+02	2.39E-01	4.57E+00	1.07E+02	2.25E-04
3.00E+05	1.50E-01	2.14E+00	2.23E-03	2.60E+01	6.48E+02	2.40E-04	3.45E+01	5.44E+02	5.86E-01	4.57E+00	1.07E+02	2.25E-04
1.00E+06	2.09E-01	3.81E+00	9.51E-03	8.67E+01	2.16E+03	8.04E-04	5.11E+01	1.02E+03	2.66E+00	4.57E+00	1.07E+02	2.25E-04
3.00E+06	2.96E-01	5.43E+00	3.01E-02	2.60E+02	6.48E+03	2.40E-03	7.60E+01	1.49E+03	8.57E+00	4.57E+00	1.07E+02	2.25E-04
1.00E+07	3.70E-01	6.70E+00	4.27E-02	8.67E+02	2.16E+04	8.04E-03	9.77E+01	1.88E+03	1.22E+01	4.57E+00	1.07E+02	2.25E-04
3.15E+07	4.79E-01	9.49E+00	4.42E-02	2.78E+03	6.82E+04	2.54E-02	1.30E+02	2.76E+03	1.27E+01	4.57E+00	1.07E+02	2.25E-04

Cm-243

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm243	Cm244	Pu240	Pu239				
1.00E+01	1.00E+00	1.98E-08	0.00E+00	1.20E-03	1.00E+00	1.98E-08	0.00E+00	1.20E-03
3.00E+01	1.00E+00	5.94E-08	0.00E+00	1.20E-03	1.00E+00	5.94E-08	0.00E+00	1.20E-03
1.00E+02	1.00E+00	1.98E-07	0.00E+00	1.20E-03	1.00E+00	1.98E-07	0.00E+00	1.20E-03
3.00E+02	1.00E+00	5.94E-07	0.00E+00	1.20E-03	1.00E+00	5.94E-07	0.00E+00	1.20E-03
1.00E+03	1.00E+00	1.98E-06	0.00E+00	1.20E-03	1.00E+00	1.98E-06	0.00E+00	1.20E-03
3.00E+03	1.00E+00	5.94E-06	0.00E+00	1.20E-03	1.00E+00	5.94E-06	0.00E+00	1.20E-03
1.00E+04	1.00E+00	1.98E-05	1.19E-10	1.20E-03	1.00E+00	1.98E-05	1.19E-10	1.20E-03
3.00E+04	9.99E-01	5.94E-05	1.07E-09	1.20E-03	1.00E+00	5.94E-05	1.07E-09	1.20E-03
1.00E+05	9.98E-01	1.98E-04	1.19E-08	1.20E-03	9.99E-01	1.98E-04	1.19E-08	1.20E-03
3.00E+05	9.95E-01	5.94E-04	1.05E-07	1.20E-03	9.97E-01	5.92E-04	1.05E-07	1.20E-03
1.00E+06	9.82E-01	1.98E-03	1.19E-06	1.20E-03	9.91E-01	1.96E-03	1.18E-06	1.19E-03
3.00E+06	9.47E-01	5.94E-03	1.07E-05	1.20E-03	9.73E-01	5.78E-03	1.04E-05	1.17E-03
1.00E+07	8.33E-01	1.97E-02	1.19E-04	1.21E-03	9.14E-01	1.80E-02	1.09E-04	1.11E-03
3.15E+07	5.63E-01	6.12E-02	1.17E-03	1.23E-03	7.61E-01	4.66E-02	8.90E-04	9.36E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	7.92E-01	1.95E-01	2.66E-03	4.21E+03	6.32E+04	1.78E-01
3.00E+01	2.15E+00	5.44E-01	7.66E-03	4.21E+03	6.32E+04	1.78E-01
1.00E+02	5.25E+00	1.45E+00	2.13E-02	4.21E+03	6.32E+04	1.78E-01
3.00E+02	9.33E+00	3.16E+00	4.58E-02	4.21E+03	6.32E+04	1.78E-01
1.00E+03	1.43E+01	6.82E+00	7.45E-02	4.21E+03	6.32E+04	1.78E-01
3.00E+03	2.10E+01	1.61E+01	9.04E-02	4.21E+03	6.32E+04	1.78E-01
1.00E+04	3.66E+01	5.35E+01	1.23E-01	4.21E+03	6.32E+04	1.78E-01
3.00E+04	6.40E+01	1.54E+02	1.94E-01	4.21E+03	6.31E+04	1.78E-01
1.00E+05	1.04E+02	3.98E+02	3.79E-01	4.20E+03	6.31E+04	1.78E-01
3.00E+05	1.34E+02	8.07E+02	9.64E-01	4.19E+03	6.29E+04	1.77E-01
1.00E+06	1.64E+02	1.60E+03	4.58E+00	4.15E+03	6.22E+04	1.75E-01
3.00E+06	2.05E+02	2.39E+03	1.47E+01	4.03E+03	6.03E+04	1.70E-01
1.00E+07	2.33E+02	3.01E+03	1.99E+01	3.65E+03	5.40E+04	1.53E-01
3.15E+07	2.48E+02	4.01E+03	1.73E+01	2.67E+03	3.88E+04	1.11E-01

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
1.19E-04	7.92E-05	5.53E-02	4.21E+03	6.32E+04	1.81E-01
1.19E-04	7.92E-05	5.38E-02	4.21E+03	6.32E+04	1.86E-01
1.19E-04	7.92E-05	5.01E-02	4.21E+03	6.32E+04	1.99E-01
1.19E-04	7.92E-05	4.47E-02	4.22E+03	6.32E+04	2.24E-01
1.18E-04	7.92E-05	3.96E-02	4.22E+03	6.32E+04	2.53E-01
1.18E-04	7.92E-05	3.72E-02	4.23E+03	6.32E+04	2.68E-01
1.18E-04	7.92E-05	3.32E-02	4.24E+03	6.32E+04	3.01E-01
1.17E-04	7.92E-05	2.69E-02	4.27E+03	6.31E+04	3.72E-01
1.16E-04	7.93E-05	1.80E-02	4.30E+03	6.31E+04	5.56E-01
1.16E-04	7.95E-05	8.76E-03	4.33E+03	6.29E+04	1.14E+00
1.16E-04	8.04E-05	2.10E-03	4.31E+03	6.22E+04	4.76E+00
1.18E-04	8.29E-05	6.71E-04	4.24E+03	6.03E+04	1.49E+01
1.29E-04	9.25E-05	5.00E-04	3.88E+03	5.40E+04	2.00E+01
1.72E-04	1.29E-04	5.75E-04	2.91E+03	3.88E+04	1.74E+01

Cm-243

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm243	Cm244	Pu240	Pu239					
1.00E+01	1.00E+00	1.98E-11	0.00E+00	1.20E-03		1.00E+00	1.98E-11	0.00E+00	1.20E-03
3.00E+01	1.00E+00	5.94E-11	0.00E+00	1.20E-03		1.00E+00	5.94E-11	0.00E+00	1.20E-03
1.00E+02	1.00E+00	1.98E-10	0.00E+00	1.20E-03		1.00E+00	1.98E-10	0.00E+00	1.20E-03
3.00E+02	1.00E+00	5.94E-10	0.00E+00	1.20E-03		1.00E+00	5.94E-10	0.00E+00	1.20E-03
1.00E+03	1.00E+00	1.98E-09	0.00E+00	1.20E-03		1.00E+00	1.98E-09	0.00E+00	1.20E-03
3.00E+03	1.00E+00	5.94E-09	0.00E+00	1.20E-03		1.00E+00	5.94E-09	0.00E+00	1.20E-03
1.00E+04	1.00E+00	1.98E-08	1.19E-13	1.20E-03		1.00E+00	1.98E-08	1.19E-13	1.20E-03
3.00E+04	1.00E+00	5.94E-08	1.07E-12	1.20E-03		1.00E+00	5.94E-08	1.07E-12	1.20E-03
1.00E+05	1.00E+00	1.98E-07	1.19E-11	1.20E-03		1.00E+00	1.98E-07	1.19E-11	1.20E-03
3.00E+05	1.00E+00	5.94E-07	1.05E-10	1.20E-03		1.00E+00	5.94E-07	1.05E-10	1.20E-03
1.00E+06	9.99E-01	1.98E-06	1.19E-09	1.20E-03		1.00E+00	1.98E-06	1.19E-09	1.20E-03
3.00E+06	9.98E-01	5.94E-06	1.07E-08	1.20E-03		9.99E-01	5.93E-06	1.07E-08	1.20E-03
1.00E+07	9.93E-01	1.97E-05	1.19E-07	1.21E-03		9.96E-01	1.96E-05	1.19E-07	1.21E-03
3.15E+07	9.77E-01	6.12E-05	1.17E-06	1.23E-03		9.88E-01	6.05E-05	1.16E-06	1.22E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	7.92E-04	1.95E-04	2.66E-06	4.21E+03	6.32E+04	1.78E-01
3.00E+01	2.15E-03	5.44E-04	7.66E-06	4.21E+03	6.32E+04	1.78E-01
1.00E+02	5.25E-03	1.45E-03	2.13E-05	4.21E+03	6.32E+04	1.78E-01
3.00E+02	9.33E-03	3.16E-03	4.58E-05	4.21E+03	6.32E+04	1.78E-01
1.00E+03	1.43E-02	6.82E-03	7.45E-05	4.21E+03	6.32E+04	1.78E-01
3.00E+03	2.10E-02	1.61E-02	9.04E-05	4.21E+03	6.32E+04	1.78E-01
1.00E+04	3.66E-02	5.35E-02	1.23E-04	4.21E+03	6.32E+04	1.78E-01
3.00E+04	6.40E-02	1.54E-01	1.94E-04	4.21E+03	6.32E+04	1.78E-01
1.00E+05	1.04E-01	3.98E-01	3.79E-04	4.21E+03	6.32E+04	1.78E-01
3.00E+05	1.35E-01	8.09E-01	9.67E-04	4.22E+03	6.32E+04	1.78E-01
1.00E+06	1.66E-01	1.61E+00	4.62E-03	4.22E+03	6.33E+04	1.79E-01
3.00E+06	2.11E-01	2.45E+00	1.51E-02	4.25E+03	6.35E+04	1.79E-01
1.00E+07	2.53E-01	3.28E+00	2.16E-02	4.34E+03	6.43E+04	1.83E-01
3.15E+07	3.22E-01	5.21E+00	2.24E-02	4.61E+03	6.71E+04	1.92E-01

Cm243 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+01	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+02	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+02	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+03	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+03	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+04	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+04	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+06	8.0E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
3.0E+06	8.3E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05	7.9E-05
1.0E+07	9.3E-05	7.9E-05	7.8E-05	7.8E-05	7.8E-05	7.8E-05	7.8E-05
3.2E+07	1.3E-04	7.9E-05	7.5E-05	7.5E-05	7.5E-05	7.5E-05	7.5E-05

Cm-244 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm244						Cm245					
1.00E+01	6.04E-03	1.61E-03	2.12E-05	9.17E+03	8.42E+04	2.95E-01	1.35E+00	3.95E-01	4.88E-03	1.91E-06	3.63E-01	8.04E-11
3.00E+01	1.62E-02	4.40E-03	6.04E-05	8.33E+03	8.33E+04	2.95E-01	3.63E+00	1.06E+00	1.35E-02	5.72E-06	9.00E-01	2.41E-10
1.00E+02	3.87E-02	1.12E-02	1.65E-04	8.33E+03	8.33E+04	2.95E-01	8.66E+00	2.54E+00	3.44E-02	1.91E-05	2.03E+00	8.04E-10
3.00E+02	6.77E-02	2.31E-02	3.46E-04	8.33E+03	8.33E+04	2.95E-01	1.51E+01	5.02E+00	6.81E-02	5.72E-05	3.45E+00	2.41E-09
1.00E+03	1.04E-01	4.68E-02	5.54E-04	8.33E+03	8.33E+04	2.95E-01	2.46E+01	1.03E+01	1.06E-01	1.91E-04	4.78E+00	8.04E-09
3.00E+03	1.57E-01	1.04E-01	6.57E-04	8.33E+03	8.33E+04	2.95E-01	4.13E+01	2.46E+01	1.26E-01	5.72E-04	4.98E+00	2.41E-08
1.00E+04	2.81E-01	3.36E-01	8.54E-04	8.33E+03	8.33E+04	2.95E-01	8.54E+01	8.23E+01	1.68E-01	1.91E-03	5.03E+00	8.04E-08
3.00E+04	5.02E-01	9.49E-01	1.27E-03	8.33E+03	8.33E+04	2.95E-01	1.70E+02	2.34E+02	2.63E-01	5.72E-03	5.12E+00	2.41E-07
1.00E+05	8.34E-01	2.40E+00	2.32E-03	8.33E+03	8.33E+04	2.95E-01	3.00E+02	5.86E+02	5.02E-01	1.91E-02	5.41E+00	8.04E-07
3.00E+05	1.08E+00	4.72E+00	5.48E-03	8.33E+03	8.33E+04	2.95E-01	3.95E+02	1.11E+03	1.17E+00	5.72E-02	6.67E+00	2.41E-06
1.00E+06	1.26E+00	9.09E+00	2.47E-02	8.33E+03	8.33E+04	2.95E-01	4.42E+02	2.06E+03	5.17E+00	1.91E-01	1.53E+01	8.04E-06
3.00E+06	1.50E+00	1.36E+01	7.97E-02	8.33E+03	8.33E+04	2.95E-01	4.92E+02	3.01E+03	1.67E+01	5.72E-01	4.19E+01	2.41E-05
1.00E+07	1.74E+00	1.80E+01	1.14E-01	8.33E+03	8.33E+04	2.95E-01	5.39E+02	3.87E+03	2.39E+01	1.91E+00	6.92E+01	8.04E-05
3.15E+07	2.13E+00	2.81E+01	1.19E-01	8.33E+03	8.33E+04	2.95E-01	6.14E+02	5.80E+03	2.48E+01	6.01E+00	1.10E+02	2.53E-04

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu241						Pu240					
1.00E+01	8.71E-01	2.56E-01	2.96E-03	1.09E-08	2.43E-01	5.40E-13	2.50E-03	7.24E-04	8.84E-06	9.00E-04	2.25E-02	8.41E-09
3.00E+01	2.29E+00	6.52E-01	7.95E-03	3.28E-08	5.90E-01	1.62E-12	6.62E-03	1.88E-03	2.40E-05	2.63E-03	6.67E-02	2.44E-08
1.00E+02	5.36E+00	1.53E+00	2.05E-02	1.09E-07	1.30E+00	5.40E-12	1.57E-02	4.54E-03	6.26E-05	8.67E-03	2.22E-01	8.04E-08
3.00E+02	8.78E+00	2.94E+00	4.10E-02	3.28E-07	2.19E+00	1.62E-11	2.59E-02	9.07E-03	1.27E-04	2.59E-02	6.59E-01	2.41E-07
1.00E+03	1.19E+01	5.86E+00	6.41E-02	1.09E-06	3.01E+00	5.40E-11	3.52E-02	1.87E-02	2.01E-04	8.67E-02	2.18E+00	8.04E-07
3.00E+03	1.47E+01	1.38E+01	7.62E-02	3.28E-06	3.13E+00	1.62E-10	4.38E-02	4.51E-02	2.40E-04	2.59E-01	6.49E+00	2.41E-06
1.00E+04	1.96E+01	4.70E+01	1.02E-01	1.09E-05	3.16E+00	5.40E-10	5.81E-02	1.56E-01	3.24E-04	8.67E-01	2.16E+01	8.04E-06
3.00E+04	2.66E+01	1.35E+02	1.57E-01	3.28E-05	3.18E+00	1.62E-09	7.72E-02	4.54E-01	5.07E-04	2.59E+00	6.48E+01	2.41E-05
1.00E+05	3.87E+01	3.37E+02	2.93E-01	1.09E-04	3.28E+00	5.40E-09	1.12E-01	1.14E+00	9.67E-04	8.67E+00	2.16E+02	8.04E-05
3.00E+05	5.12E+01	6.25E+02	6.57E-01	3.28E-04	3.77E+00	1.62E-08	1.50E-01	2.14E+00	2.23E-03	2.59E+01	6.48E+02	2.41E-04
1.00E+06	6.82E+01	1.10E+03	2.72E+00	1.09E-03	7.65E+00	5.40E-08	2.09E-01	3.81E+00	9.51E-03	8.67E+01	2.16E+03	8.04E-04
3.00E+06	9.30E+01	1.55E+03	8.48E+00	3.28E-03	1.93E+01	1.62E-07	2.96E-01	5.43E+00	3.01E-02	2.59E+02	6.48E+03	2.41E-03
1.00E+07	1.15E+02	1.94E+03	1.20E+01	1.09E-02	2.66E+01	5.40E-07	3.70E-01	6.70E+00	4.27E-02	8.67E+02	2.16E+04	8.04E-03
3.15E+07	1.49E+02	2.81E+03	1.25E+01	3.44E-02	2.72E+01	1.70E-06	4.79E-01	9.49E+00	4.42E-02	2.78E+03	6.82E+04	2.54E-02

Cm-244

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm244	Cm245	Pu241	Pu240		Cm244	Cm245	Pu241	Pu240
1.00E+01	1.00E+00	5.91E-08	0.00E+00	4.91E-01		1.00E+00	5.91E-08	0.00E+00	4.91E-01
3.00E+01	1.00E+00	1.77E-07	0.00E+00	4.91E-01		1.00E+00	1.77E-07	0.00E+00	4.91E-01
1.00E+02	1.00E+00	5.91E-07	0.00E+00	4.91E-01		1.00E+00	5.91E-07	0.00E+00	4.91E-01
3.00E+02	1.00E+00	1.77E-06	0.00E+00	4.91E-01		1.00E+00	1.77E-06	0.00E+00	4.91E-01
1.00E+03	1.00E+00	5.91E-06	0.00E+00	4.91E-01		1.00E+00	5.91E-06	0.00E+00	4.91E-01
3.00E+03	1.00E+00	1.77E-05	0.00E+00	4.91E-01		1.00E+00	1.77E-05	0.00E+00	4.91E-01
1.00E+04	1.00E+00	5.91E-05	0.00E+00	4.91E-01		1.00E+00	5.91E-05	0.00E+00	4.91E-01
3.00E+04	1.00E+00	1.77E-04	0.00E+00	4.91E-01		1.00E+00	1.77E-04	0.00E+00	4.91E-01
1.00E+05	9.99E-01	5.91E-04	0.00E+00	4.91E-01		1.00E+00	5.91E-04	0.00E+00	4.91E-01
3.00E+05	9.98E-01	1.77E-03	0.00E+00	4.91E-01		9.99E-01	1.77E-03	0.00E+00	4.90E-01
1.00E+06	9.93E-01	5.91E-03	7.50E-09	4.91E-01		9.96E-01	5.89E-03	7.47E-09	4.89E-01
3.00E+06	9.78E-01	1.77E-02	6.76E-08	4.93E-01		9.89E-01	1.75E-02	6.69E-08	4.88E-01
1.00E+07	9.30E-01	5.91E-02	7.48E-07	4.97E-01		9.65E-01	5.70E-02	7.21E-07	4.79E-01
3.15E+07	7.96E-01	1.86E-01	7.34E-06	5.10E-01		8.94E-01	1.66E-01	6.56E-06	4.56E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	7.27E-03	1.97E-03	2.55E-05	9.17E+03	8.42E+04	2.95E-01
3.00E+01	1.95E-02	5.32E-03	7.21E-05	8.33E+03	8.33E+04	2.95E-01
1.00E+02	4.65E-02	1.34E-02	1.95E-04	8.33E+03	8.33E+04	2.95E-01
3.00E+02	8.05E-02	2.76E-02	4.09E-04	8.33E+03	8.33E+04	2.95E-01
1.00E+03	1.22E-01	5.60E-02	6.53E-04	8.33E+03	8.33E+04	2.95E-01
3.00E+03	1.79E-01	1.27E-01	7.77E-04	8.33E+03	8.33E+04	2.95E-01
1.00E+04	3.15E-01	4.17E-01	1.02E-03	8.33E+03	8.33E+04	2.95E-01
3.00E+04	5.70E-01	1.21E+00	1.57E-03	8.33E+03	8.33E+04	2.95E-01
1.00E+05	1.07E+00	3.31E+00	3.09E-03	8.33E+03	8.34E+04	2.95E-01
3.00E+05	1.85E+00	7.73E+00	8.63E-03	8.33E+03	8.35E+04	2.95E-01
1.00E+06	3.96E+00	2.31E+01	5.97E-02	8.32E+03	8.38E+04	2.94E-01
3.00E+06	1.03E+01	6.88E+01	3.86E-01	8.28E+03	8.47E+04	2.90E-01
1.00E+07	3.26E+01	2.41E+02	1.49E+00	8.18E+03	8.82E+04	2.79E-01
3.15E+07	1.04E+02	9.94E+02	4.26E+00	8.05E+03	1.01E+05	2.48E-01

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
5.45E-05	5.94E-05	3.39E-02		9.17E+03	8.42E+04	2.95E-01
6.00E-05	6.00E-05	3.38E-02		8.33E+03	8.33E+04	2.95E-01
6.00E-05	6.00E-05	3.38E-02		8.33E+03	8.33E+04	2.96E-01
6.00E-05	6.00E-05	3.38E-02		8.33E+03	8.33E+04	2.96E-01
6.00E-05	6.00E-05	3.38E-02		8.33E+03	8.33E+04	2.96E-01
6.00E-05	6.00E-05	3.38E-02		8.33E+03	8.33E+04	2.96E-01
6.00E-05	6.00E-05	3.37E-02		8.33E+03	8.33E+04	2.96E-01
6.00E-05	6.00E-05	3.37E-02		8.33E+03	8.33E+04	2.97E-01
6.00E-05	6.00E-05	3.35E-02		8.33E+03	8.34E+04	2.98E-01
6.00E-05	5.99E-05	3.30E-02		8.33E+03	8.35E+04	3.03E-01
6.01E-05	5.97E-05	2.83E-02		8.32E+03	8.38E+04	3.53E-01
6.03E-05	5.90E-05	1.48E-02		8.29E+03	8.47E+04	6.76E-01
6.09E-05	5.67E-05	5.65E-03		8.21E+03	8.82E+04	1.77E+00
6.13E-05	4.95E-05	2.22E-03		8.15E+03	1.01E+05	4.50E+00

Cm-244

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm244	Cm245	Pu241	Pu240		Cm244	Cm245	Pu241	Pu240
1.00E+01	1.00E+00	5.91E-11	0.00E+00	4.91E-01		1.00E+00	5.91E-11	0.00E+00	4.91E-01
3.00E+01	1.00E+00	1.77E-10	0.00E+00	4.91E-01		1.00E+00	1.77E-10	0.00E+00	4.91E-01
1.00E+02	1.00E+00	5.91E-10	0.00E+00	4.91E-01		1.00E+00	5.91E-10	0.00E+00	4.91E-01
3.00E+02	1.00E+00	1.77E-09	0.00E+00	4.91E-01		1.00E+00	1.77E-09	0.00E+00	4.91E-01
1.00E+03	1.00E+00	5.91E-09	0.00E+00	4.91E-01		1.00E+00	5.91E-09	0.00E+00	4.91E-01
3.00E+03	1.00E+00	1.77E-08	0.00E+00	4.91E-01		1.00E+00	1.77E-08	0.00E+00	4.91E-01
1.00E+04	1.00E+00	5.91E-08	0.00E+00	4.91E-01		1.00E+00	5.91E-08	0.00E+00	4.91E-01
3.00E+04	1.00E+00	1.77E-07	0.00E+00	4.91E-01		1.00E+00	1.77E-07	0.00E+00	4.91E-01
1.00E+05	1.00E+00	5.91E-07	0.00E+00	4.91E-01		1.00E+00	5.91E-07	0.00E+00	4.91E-01
3.00E+05	1.00E+00	1.77E-06	0.00E+00	4.91E-01		1.00E+00	1.77E-06	0.00E+00	4.91E-01
1.00E+06	9.99E-01	5.91E-06	7.50E-12	4.91E-01		9.99E-01	5.91E-06	7.50E-12	4.91E-01
3.00E+06	9.96E-01	1.77E-05	6.76E-11	4.93E-01		9.98E-01	1.77E-05	6.75E-11	4.92E-01
1.00E+07	9.88E-01	5.91E-05	7.48E-10	4.97E-01		9.94E-01	5.87E-05	7.43E-10	4.94E-01
3.15E+07	9.62E-01	1.86E-04	7.34E-09	5.10E-01		9.81E-01	1.82E-04	7.20E-09	5.00E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	7.27E-06	1.97E-06	2.55E-08	9.17E+03	8.42E+04	2.95E-01
3.00E+01	1.95E-05	5.32E-06	7.21E-08	8.33E+03	8.33E+04	2.95E-01
1.00E+02	4.65E-05	1.34E-05	1.95E-07	8.33E+03	8.33E+04	2.95E-01
3.00E+02	8.05E-05	2.76E-05	4.09E-07	8.33E+03	8.33E+04	2.95E-01
1.00E+03	1.22E-04	5.59E-05	6.52E-07	8.33E+03	8.33E+04	2.95E-01
3.00E+03	1.79E-04	1.26E-04	7.75E-07	8.33E+03	8.33E+04	2.95E-01
1.00E+04	3.10E-04	4.12E-04	1.01E-06	8.33E+03	8.33E+04	2.95E-01
3.00E+04	5.40E-04	1.17E-03	1.52E-06	8.33E+03	8.34E+04	2.95E-01
1.00E+05	8.89E-04	2.96E-03	2.80E-06	8.34E+03	8.34E+04	2.95E-01
3.00E+05	1.15E-03	5.77E-03	6.58E-06	8.34E+03	8.36E+04	2.95E-01
1.00E+06	1.37E-03	1.10E-02	2.94E-05	8.37E+03	8.43E+04	2.95E-01
3.00E+06	1.66E-03	1.63E-02	9.47E-05	8.43E+03	8.62E+04	2.95E-01
1.00E+07	1.94E-03	2.14E-02	1.36E-04	8.66E+03	9.30E+04	2.96E-01
3.15E+07	2.44E-03	3.34E-02	1.43E-04	9.44E+03	1.15E+05	2.97E-01

Cm244 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	5.5E-05	5.5E-05	5.5E-05	5.5E-05	5.5E-05	5.5E-05	5.5E-05
3.0E+01	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
1.0E+02	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
3.0E+02	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
1.0E+03	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
3.0E+03	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
1.0E+04	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
3.0E+04	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
1.0E+05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
3.0E+05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05	6.0E-05
1.0E+06	6.0E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05	5.9E-05
3.0E+06	5.9E-05	5.8E-05	5.8E-05	5.8E-05	5.8E-05	5.8E-05	5.8E-05
1.0E+07	5.7E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05
3.2E+07	4.9E-05	4.4E-05	4.4E-05	4.3E-05	4.3E-05	4.3E-05	4.3E-05

Cm-245 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm245						Cm246					
1.00E+01	1.35E+00	3.95E-01	4.88E-03	3.08E+01	3.18E+02	1.29E-03	3.08E-03	9.14E-04	1.09E-05	1.42E-10	5.59E+02	3.98E-15
3.00E+01	3.63E+00	1.06E+00	1.35E-02	3.08E+01	3.18E+02	1.29E-03	8.14E-03	2.42E-03	3.06E-05	4.24E-10	5.59E+02	1.20E-14
1.00E+02	8.66E+00	2.54E+00	3.44E-02	3.08E+01	3.19E+02	1.29E-03	1.89E-02	5.79E-03	8.09E-05	1.42E-09	5.59E+02	3.98E-14
3.00E+02	1.51E+01	5.02E+00	6.81E-02	3.08E+01	3.21E+02	1.29E-03	3.24E-02	1.11E-02	1.66E-04	4.24E-09	5.59E+02	1.20E-13
1.00E+03	2.46E+01	1.03E+01	1.06E-01	3.08E+01	3.22E+02	1.29E-03	5.10E-02	2.09E-02	2.60E-04	1.42E-08	5.59E+02	3.98E-13
3.00E+03	4.13E+01	2.46E+01	1.26E-01	3.08E+01	3.22E+02	1.29E-03	8.09E-02	4.31E-02	3.03E-04	4.24E-08	5.59E+02	1.20E-12
1.00E+04	8.54E+01	8.23E+01	1.68E-01	3.08E+01	3.22E+02	1.29E-03	1.55E-01	1.32E-01	3.74E-04	1.42E-07	5.59E+02	3.98E-12
3.00E+04	1.70E+02	2.34E+02	2.63E-01	3.08E+01	3.22E+02	1.29E-03	2.91E-01	3.64E-01	5.26E-04	4.24E-07	5.59E+02	1.20E-11
1.00E+05	3.00E+02	5.86E+02	5.02E-01	3.08E+01	3.22E+02	1.29E-03	4.99E-01	8.77E-01	8.89E-04	1.42E-06	5.59E+02	3.98E-11
3.00E+05	3.95E+02	1.11E+03	1.17E+00	3.08E+01	3.24E+02	1.30E-03	6.48E-01	1.61E+00	1.85E-03	4.24E-06	5.59E+02	1.20E-10
1.00E+06	4.42E+02	2.06E+03	5.17E+00	3.10E+01	3.33E+02	1.30E-03	7.16E-01	2.90E+00	7.35E-03	1.42E-05	5.59E+02	3.98E-10
3.00E+06	4.92E+02	3.01E+03	1.67E+01	3.14E+01	3.59E+02	1.31E-03	7.88E-01	4.21E+00	2.29E-02	4.24E-05	5.59E+02	1.20E-09
1.00E+07	5.39E+02	3.87E+03	2.39E+01	3.28E+01	3.87E+02	1.37E-03	8.64E-01	5.55E+00	3.25E-02	1.42E-04	5.59E+02	3.98E-09
3.15E+07	6.14E+02	5.80E+03	2.48E+01	3.68E+01	4.28E+02	1.54E-03	9.95E-01	8.68E+00	3.41E-02	4.46E-04	5.59E+02	1.26E-08

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu241						Pu240					
1.00E+01	8.71E-01	2.56E-01	2.96E-03	7.58E-04	2.55E-01	3.21E-08	2.50E-03	7.24E-04	8.84E-06	7.80E-04	2.49E-04	3.26E-06
3.00E+01	2.29E+00	6.52E-01	7.95E-03	7.58E-04	6.02E-01	3.21E-08	6.62E-03	1.88E-03	2.40E-05	2.00E-03	6.67E-04	8.93E-06
1.00E+02	5.36E+00	1.53E+00	2.05E-02	7.58E-04	1.31E+00	3.21E-08	1.57E-02	4.54E-03	6.26E-05	4.72E-03	1.79E-03	2.43E-05
3.00E+02	8.78E+00	2.94E+00	4.10E-02	7.58E-04	2.20E+00	3.21E-08	2.59E-02	9.07E-03	1.27E-04	7.98E-03	4.08E-03	5.08E-05
1.00E+03	1.19E+01	5.86E+00	6.41E-02	7.58E-04	3.02E+00	3.21E-08	3.52E-02	1.87E-02	2.01E-04	1.14E-02	1.00E-02	8.11E-05
3.00E+03	1.47E+01	1.38E+01	7.62E-02	7.60E-04	3.15E+00	3.21E-08	4.38E-02	4.51E-02	2.40E-04	1.50E-02	2.52E-02	9.65E-05
1.00E+04	1.96E+01	4.70E+01	1.02E-01	7.68E-04	3.17E+00	3.27E-08	5.81E-02	1.56E-01	3.24E-04	2.15E-02	7.31E-02	1.27E-04
3.00E+04	2.66E+01	1.35E+02	1.57E-01	7.89E-04	3.19E+00	3.35E-08	7.72E-02	4.54E-01	5.07E-04	3.15E-02	1.87E-01	1.93E-04
1.00E+05	3.87E+01	3.37E+02	2.93E-01	8.67E-04	3.29E+00	3.75E-08	1.12E-01	1.14E+00	9.67E-04	5.04E-02	4.68E-01	3.71E-04
3.00E+05	5.12E+01	6.25E+02	6.57E-01	1.08E-03	3.78E+00	4.83E-08	1.50E-01	2.14E+00	2.23E-03	7.09E-02	9.40E-01	9.21E-04
1.00E+06	6.82E+01	1.10E+03	2.72E+00	1.85E-03	7.67E+00	8.61E-08	2.09E-01	3.81E+00	9.51E-03	9.86E-02	1.77E+00	4.27E-03
3.00E+06	9.30E+01	1.55E+03	8.48E+00	4.04E-03	1.93E+01	1.94E-07	2.96E-01	5.43E+00	3.01E-02	1.38E-01	2.54E+00	1.38E-02
1.00E+07	1.15E+02	1.94E+03	1.20E+01	1.18E-02	2.66E+01	6.25E-07	3.70E-01	6.70E+00	4.27E-02	1.74E-01	3.19E+00	1.96E-02
3.15E+07	1.49E+02	2.81E+03	1.25E+01	3.53E-02	2.73E+01	1.74E-06	4.79E-01	9.49E+00	4.42E-02	2.27E-01	4.65E+00	2.04E-02

Cm-245

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm245	Cm246	Pu241	Am241		Cm245	Cm246	Pu241	Am241
1.00E+01	1.00E+00	3.60E-08	1.51E-03	2.42E-03		1.00E+00	3.60E-08	1.51E-03	2.42E-03
3.00E+01	1.00E+00	1.08E-07	1.51E-03	2.42E-03		1.00E+00	1.08E-07	1.51E-03	2.42E-03
1.00E+02	1.00E+00	3.60E-07	1.51E-03	2.42E-03		1.00E+00	3.60E-07	1.51E-03	2.42E-03
3.00E+02	1.00E+00	1.08E-06	1.51E-03	2.42E-03		1.00E+00	1.08E-06	1.51E-03	2.42E-03
1.00E+03	1.00E+00	3.60E-06	1.51E-03	2.42E-03		1.00E+00	3.60E-06	1.51E-03	2.42E-03
3.00E+03	1.00E+00	1.08E-05	1.51E-03	2.42E-03		1.00E+00	1.08E-05	1.51E-03	2.42E-03
1.00E+04	1.00E+00	3.60E-05	1.51E-03	2.42E-03		1.00E+00	3.60E-05	1.51E-03	2.42E-03
3.00E+04	9.99E-01	1.08E-04	1.51E-03	2.42E-03		1.00E+00	1.08E-04	1.51E-03	2.42E-03
1.00E+05	9.98E-01	3.60E-04	1.51E-03	2.42E-03		9.99E-01	3.60E-04	1.51E-03	2.42E-03
3.00E+05	9.93E-01	1.08E-03	1.51E-03	2.42E-03		9.96E-01	1.08E-03	1.50E-03	2.41E-03
1.00E+06	9.75E-01	3.60E-03	1.51E-03	2.42E-03		9.88E-01	3.56E-03	1.49E-03	2.39E-03
3.00E+06	9.28E-01	1.08E-02	1.51E-03	2.43E-03		9.63E-01	1.04E-02	1.45E-03	2.34E-03
1.00E+07	7.79E-01	3.60E-02	1.51E-03	2.44E-03		8.85E-01	3.19E-02	1.34E-03	2.16E-03
3.15E+07	4.55E-01	1.14E-01	1.51E-03	2.49E-03		6.92E-01	7.89E-02	1.05E-03	1.72E-03

Time "t" s	TEDE Rem	TODE(thy) Rem	Public TEDE Rem	TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.35E+00	3.95E-01	4.89E-03	3.08E+01	3.18E+02	1.29E-03
3.00E+01	3.64E+00	1.06E+00	1.35E-02	3.08E+01	3.18E+02	1.29E-03
1.00E+02	8.67E+00	2.54E+00	3.45E-02	3.08E+01	3.19E+02	1.29E-03
3.00E+02	1.51E+01	5.02E+00	6.82E-02	3.08E+01	3.21E+02	1.29E-03
1.00E+03	2.46E+01	1.04E+01	1.06E-01	3.08E+01	3.22E+02	1.29E-03
3.00E+03	4.13E+01	2.46E+01	1.27E-01	3.08E+01	3.22E+02	1.29E-03
1.00E+04	8.54E+01	8.24E+01	1.69E-01	3.08E+01	3.22E+02	1.29E-03
3.00E+04	1.70E+02	2.34E+02	2.63E-01	3.08E+01	3.21E+02	1.29E-03
1.00E+05	3.00E+02	5.86E+02	5.02E-01	3.08E+01	3.21E+02	1.29E-03
3.00E+05	3.94E+02	1.11E+03	1.16E+00	3.06E+01	3.22E+02	1.29E-03
1.00E+06	4.37E+02	2.04E+03	5.11E+00	3.02E+01	3.26E+02	1.28E-03
3.00E+06	4.74E+02	2.90E+03	1.61E+01	2.91E+01	3.39E+02	1.25E-03
1.00E+07	4.77E+02	3.42E+03	2.11E+01	2.55E+01	3.21E+02	1.12E-03
3.15E+07	4.25E+02	4.02E+03	1.72E+01	1.68E+01	2.58E+02	7.54E-04

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
1.55E-02	1.57E-02	1.62E+00		3.22E+01	3.18E+02	6.18E-03
1.45E-02	1.57E-02	6.75E-01		3.45E+01	3.18E+02	1.48E-02
1.27E-02	1.57E-02	2.80E-01		3.95E+01	3.19E+02	3.58E-02
1.09E-02	1.56E-02	1.44E-01		4.60E+01	3.21E+02	6.95E-02
9.02E-03	1.55E-02	9.28E-02		5.54E+01	3.22E+02	1.08E-01
6.93E-03	1.55E-02	7.82E-02		7.22E+01	3.22E+02	1.28E-01
4.30E-03	1.55E-02	5.89E-02		1.16E+02	3.22E+02	1.70E-01
2.49E-03	1.56E-02	3.79E-02		2.01E+02	3.21E+02	2.64E-01
1.51E-03	8.54E-03	1.99E-02		3.31E+02	5.86E+02	5.03E-01
1.18E-03	4.50E-03	8.58E-03		4.24E+02	1.11E+03	1.17E+00
1.07E-03	2.45E-03	1.96E-03		4.67E+02	2.04E+03	5.11E+00
9.93E-04	1.72E-03	6.22E-04		5.04E+02	2.90E+03	1.61E+01
9.94E-04	1.46E-03	4.73E-04		5.03E+02	3.42E+03	2.11E+01
1.13E-03	1.24E-03	5.81E-04		4.42E+02	4.02E+03	1.72E+01

Cm-245

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm245	Cm246	Pu241	Am241		Cm245	Cm246	Pu241	Am241
1.00E+01	1.00E+00	3.60E-11	1.51E-03	2.42E-03		1.00E+00	3.60E-11	1.51E-03	2.42E-03
3.00E+01	1.00E+00	1.08E-10	1.51E-03	2.42E-03		1.00E+00	1.08E-10	1.51E-03	2.42E-03
1.00E+02	1.00E+00	3.60E-10	1.51E-03	2.42E-03		1.00E+00	3.60E-10	1.51E-03	2.42E-03
3.00E+02	1.00E+00	1.08E-09	1.51E-03	2.42E-03		1.00E+00	1.08E-09	1.51E-03	2.42E-03
1.00E+03	1.00E+00	3.60E-09	1.51E-03	2.42E-03		1.00E+00	3.60E-09	1.51E-03	2.42E-03
3.00E+03	1.00E+00	1.08E-08	1.51E-03	2.42E-03		1.00E+00	1.08E-08	1.51E-03	2.42E-03
1.00E+04	1.00E+00	3.60E-08	1.51E-03	2.42E-03		1.00E+00	3.60E-08	1.51E-03	2.42E-03
3.00E+04	1.00E+00	1.08E-07	1.51E-03	2.42E-03		1.00E+00	1.08E-07	1.51E-03	2.42E-03
1.00E+05	1.00E+00	3.60E-07	1.51E-03	2.42E-03		1.00E+00	3.60E-07	1.51E-03	2.42E-03
3.00E+05	1.00E+00	1.08E-06	1.51E-03	2.42E-03		1.00E+00	1.08E-06	1.51E-03	2.42E-03
1.00E+06	1.00E+00	3.60E-06	1.51E-03	2.42E-03		1.00E+00	3.60E-06	1.51E-03	2.42E-03
3.00E+06	1.00E+00	1.08E-05	1.51E-03	2.43E-03		1.00E+00	1.08E-05	1.51E-03	2.43E-03
1.00E+07	1.00E+00	3.60E-05	1.51E-03	2.44E-03		1.00E+00	3.60E-05	1.51E-03	2.44E-03
3.15E+07	9.99E-01	1.14E-04	1.51E-03	2.49E-03		1.00E+00	1.14E-04	1.51E-03	2.49E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.35E-03	3.95E-04	4.89E-06	3.08E+01	3.18E+02	1.29E-03
3.00E+01	3.64E-03	1.06E-03	1.35E-05	3.08E+01	3.18E+02	1.29E-03
1.00E+02	8.67E-03	2.54E-03	3.45E-05	3.08E+01	3.19E+02	1.29E-03
3.00E+02	1.51E-02	5.02E-03	6.82E-05	3.08E+01	3.21E+02	1.29E-03
1.00E+03	2.46E-02	1.04E-02	1.06E-04	3.08E+01	3.22E+02	1.29E-03
3.00E+03	4.13E-02	2.46E-02	1.27E-04	3.08E+01	3.22E+02	1.29E-03
1.00E+04	8.54E-02	8.24E-02	1.69E-04	3.08E+01	3.22E+02	1.29E-03
3.00E+04	1.70E-01	2.34E-01	2.63E-04	3.08E+01	3.22E+02	1.29E-03
1.00E+05	3.01E-01	5.86E-01	5.02E-04	3.08E+01	3.22E+02	1.29E-03
3.00E+05	3.95E-01	1.12E+00	1.17E-03	3.08E+01	3.24E+02	1.30E-03
1.00E+06	4.42E-01	2.06E+00	5.17E-03	3.10E+01	3.33E+02	1.31E-03
3.00E+06	4.92E-01	3.01E+00	1.67E-02	3.14E+01	3.59E+02	1.35E-03
1.00E+07	5.39E-01	3.87E+00	2.39E-02	3.27E+01	3.87E+02	1.42E-03
3.15E+07	6.14E-01	5.81E+00	2.48E-02	3.68E+01	4.27E+02	1.59E-03

Cm245 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+01	1.5E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
1.0E+02	1.3E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+02	1.1E-02	1.5E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
1.0E+03	9.0E-03	1.5E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+03	6.9E-03	1.4E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
1.0E+04	4.3E-03	1.3E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+04	2.5E-03	1.0E-02	1.5E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
1.0E+05	1.5E-03	8.2E-03	1.5E-02	1.6E-02	1.6E-02	1.6E-02	1.6E-02
3.0E+05	1.2E-03	7.1E-03	1.4E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02
1.0E+06	1.1E-03	6.7E-03	1.4E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02
3.0E+06	6.2E-04	6.0E-03	1.4E-02	1.4E-02	1.4E-02	1.4E-02	1.4E-02
1.0E+07	4.7E-04	4.2E-03	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02
3.2E+07	5.8E-04	4.2E-03	1.2E-02	1.2E-02	1.2E-02	1.2E-02	1.2E-02

Cm-246 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm246						Cm247					
1.00E+01	3.08E-03	9.14E-04	1.09E-05	5.28E+01	5.28E+02	2.23E-03	1.81E-01	3.31E-02	5.42E-04	1.18E-07	1.10E-01	4.12E-12
3.00E+01	8.14E-03	2.42E-03	3.06E-05	5.28E+01	5.28E+02	2.23E-03	1.04E+00	3.08E-01	3.89E-03	3.52E-07	2.73E-01	1.24E-11
1.00E+02	1.89E-02	5.79E-03	8.09E-05	5.28E+01	5.28E+02	2.23E-03	2.40E+00	7.36E-01	1.03E-02	1.18E-06	6.17E-01	4.12E-11
3.00E+02	3.24E-02	1.11E-02	1.66E-04	5.28E+01	5.28E+02	2.23E-03	4.12E+00	1.42E+00	2.11E-02	3.52E-06	1.08E+00	1.24E-10
1.00E+03	5.10E-02	2.09E-02	2.60E-04	5.28E+01	5.28E+02	2.23E-03	6.49E+00	2.66E+00	3.31E-02	1.18E-05	1.50E+00	4.12E-10
3.00E+03	8.09E-02	4.31E-02	3.03E-04	5.28E+01	5.28E+02	2.23E-03	1.03E+01	5.48E+00	3.85E-02	3.52E-05	1.57E+00	1.24E-09
1.00E+04	1.55E-01	1.32E-01	3.74E-04	5.28E+01	5.28E+02	2.23E-03	1.97E+01	1.68E+01	4.76E-02	1.18E-04	1.58E+00	4.12E-09
3.00E+04	2.91E-01	3.64E-01	5.26E-04	5.28E+01	5.28E+02	2.23E-03	3.70E+01	4.63E+01	6.69E-02	3.52E-04	1.59E+00	1.24E-08
1.00E+05	4.99E-01	8.77E-01	8.89E-04	5.28E+01	5.28E+02	2.23E-03	6.35E+01	1.12E+02	1.13E-01	1.18E-03	1.63E+00	4.12E-08
3.00E+05	6.48E-01	1.61E+00	1.85E-03	5.28E+01	5.28E+02	2.23E-03	8.24E+01	2.05E+02	2.35E-01	3.52E-03	1.83E+00	1.24E-07
1.00E+06	7.16E-01	2.90E+00	7.35E-03	5.28E+01	5.28E+02	2.23E-03	9.11E+01	3.68E+02	9.35E-01	1.18E-02	3.23E+00	4.12E-07
3.00E+06	7.88E-01	4.21E+00	2.29E-02	5.28E+01	5.28E+02	2.23E-03	1.00E+02	5.36E+02	2.91E+00	3.52E-02	7.43E+00	1.24E-06
1.00E+07	8.64E-01	5.55E+00	3.25E-02	5.28E+01	5.28E+02	2.23E-03	1.10E+02	7.07E+02	4.14E+00	1.18E-01	1.10E+01	4.12E-06
3.15E+07	9.95E-01	8.68E+00	3.41E-02	5.28E+01	5.28E+02	2.23E-03	1.27E+02	1.10E+03	4.34E+00	3.69E-01	1.46E+01	1.30E-05

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu242					
1.00E+01	9.33E-04	2.75E-04	3.18E-06	7.57E-06	2.62E-04	3.35E-10
3.00E+01	2.44E-03	6.99E-04	8.54E-06	2.27E-05	6.32E-04	1.01E-09
1.00E+02	5.63E-03	1.63E-03	2.18E-05	7.56E-05	1.38E-03	3.35E-09
3.00E+02	9.19E-03	3.11E-03	4.34E-05	1.81E-04	2.32E-03	1.02E-08
1.00E+03	1.26E-02	6.21E-03	6.77E-05	7.48E-04	3.24E-03	3.32E-08
3.00E+03	1.61E-02	1.47E-02	8.01E-05	2.19E-03	3.96E-03	9.66E-08
1.00E+04	2.28E-02	5.01E-02	1.06E-04	6.77E-03	1.00E-02	2.93E-07
3.00E+04	3.34E-02	1.43E-01	1.62E-04	1.70E-02	5.12E-02	6.96E-07
1.00E+05	5.21E-02	3.53E-01	3.00E-04	4.09E-02	2.94E-01	1.46E-06
3.00E+05	6.97E-02	6.38E-01	6.49E-04	9.92E-02	1.08E+00	3.12E-06
1.00E+06	8.68E-02	1.08E+00	2.57E-03	3.04E-01	3.80E+00	8.89E-06
3.00E+06	1.10E-01	1.52E+00	7.94E-03	8.92E-01	1.16E+01	2.54E-05
1.00E+07	1.33E-01	1.93E+00	1.13E-02	2.93E+00	3.88E+01	8.29E-05
3.15E+07	1.69E-01	2.86E+00	1.17E-02	9.17E+00	1.23E+02	2.60E-04

Cm-246

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm246	Cm247	Pu242					
1.00E+01	1.00E+00	1.15E-08	7.18E-03			1.00E+00	1.15E-08	7.18E-03
3.00E+01	1.00E+00	3.44E-08	7.18E-03			1.00E+00	3.44E-08	7.18E-03
1.00E+02	1.00E+00	1.14E-07	7.18E-03			1.00E+00	1.14E-07	7.18E-03
3.00E+02	1.00E+00	3.43E-07	7.18E-03			1.00E+00	3.43E-07	7.18E-03
1.00E+03	1.00E+00	1.14E-06	7.18E-03			1.00E+00	1.14E-06	7.18E-03
3.00E+03	1.00E+00	3.43E-06	7.18E-03			1.00E+00	3.43E-06	7.18E-03
1.00E+04	1.00E+00	1.14E-05	7.18E-03			1.00E+00	1.14E-05	7.18E-03
3.00E+04	1.00E+00	3.43E-05	7.18E-03			1.00E+00	3.43E-05	7.18E-03
1.00E+05	1.00E+00	1.14E-04	7.18E-03			1.00E+00	1.14E-04	7.18E-03
3.00E+05	1.00E+00	3.43E-04	7.18E-03			1.00E+00	3.43E-04	7.18E-03
1.00E+06	9.99E-01	1.14E-03	7.19E-03			9.99E-01	1.14E-03	7.19E-03
3.00E+06	9.96E-01	3.43E-03	7.19E-03			9.98E-01	3.42E-03	7.18E-03
1.00E+07	9.88E-01	1.14E-02	7.23E-03			9.94E-01	1.13E-02	7.19E-03
3.15E+07	9.63E-01	3.61E-02	7.32E-03			9.81E-01	3.54E-02	7.18E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	3.09E-03	9.16E-04	1.09E-05	5.27E+01	5.27E+02	2.23E-03
3.00E+01	8.16E-03	2.43E-03	3.07E-05	5.27E+01	5.27E+02	2.23E-03
1.00E+02	1.89E-02	5.80E-03	8.11E-05	5.27E+01	5.27E+02	2.23E-03
3.00E+02	3.25E-02	1.12E-02	1.66E-04	5.27E+01	5.27E+02	2.23E-03
1.00E+03	5.11E-02	2.09E-02	2.61E-04	5.27E+01	5.27E+02	2.23E-03
3.00E+03	8.11E-02	4.32E-02	3.03E-04	5.27E+01	5.27E+02	2.23E-03
1.00E+04	1.55E-01	1.33E-01	3.76E-04	5.27E+01	5.27E+02	2.23E-03
3.00E+04	2.92E-01	3.66E-01	5.30E-04	5.27E+01	5.27E+02	2.23E-03
1.00E+05	5.07E-01	8.92E-01	9.04E-04	5.27E+01	5.27E+02	2.23E-03
3.00E+05	6.76E-01	1.69E+00	1.93E-03	5.27E+01	5.27E+02	2.23E-03
1.00E+06	8.20E-01	3.32E+00	8.43E-03	5.27E+01	5.27E+02	2.23E-03
3.00E+06	1.13E+00	6.05E+00	3.28E-02	5.26E+01	5.26E+02	2.22E-03
1.00E+07	2.11E+00	1.35E+01	7.94E-02	5.21E+01	5.22E+02	2.21E-03
3.15E+07	5.46E+00	4.77E+01	1.87E-01	5.09E+01	5.09E+02	2.15E-03

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
9.48E-03	9.48E-03	4.46E+00		5.28E+01	5.27E+02	2.24E-03
9.48E-03	9.48E-03	4.42E+00		5.28E+01	5.27E+02	2.26E-03
9.48E-03	9.48E-03	4.32E+00		5.28E+01	5.27E+02	2.31E-03
9.47E-03	9.48E-03	4.17E+00		5.28E+01	5.27E+02	2.40E-03
9.47E-03	9.48E-03	4.01E+00		5.28E+01	5.27E+02	2.49E-03
9.46E-03	9.48E-03	3.94E+00		5.28E+01	5.27E+02	2.54E-03
9.45E-03	9.48E-03	3.83E+00		5.29E+01	5.27E+02	2.61E-03
9.43E-03	9.48E-03	3.62E+00		5.30E+01	5.27E+02	2.76E-03
9.39E-03	9.48E-03	3.19E+00		5.33E+01	5.27E+02	3.14E-03
9.36E-03	9.48E-03	2.40E+00		5.34E+01	5.27E+02	4.16E-03
9.34E-03	9.49E-03	9.38E-01		5.35E+01	5.27E+02	1.07E-02
9.31E-03	9.51E-03	2.85E-01		5.37E+01	5.26E+02	3.51E-02
9.22E-03	9.58E-03	1.23E-01		5.43E+01	5.22E+02	8.16E-02
8.87E-03	9.81E-03	5.28E-02		5.63E+01	5.09E+02	1.89E-01

Cm-246

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm246	Cm247	Pu242					
1.00E+01	1.00E+00	1.15E-11	7.18E-03			1.00E+00	1.15E-11	7.18E-03
3.00E+01	1.00E+00	3.44E-11	7.18E-03			1.00E+00	3.44E-11	7.18E-03
1.00E+02	1.00E+00	1.14E-10	7.18E-03			1.00E+00	1.14E-10	7.18E-03
3.00E+02	1.00E+00	3.43E-10	7.18E-03			1.00E+00	3.43E-10	7.18E-03
1.00E+03	1.00E+00	1.14E-09	7.18E-03			1.00E+00	1.14E-09	7.18E-03
3.00E+03	1.00E+00	3.43E-09	7.18E-03			1.00E+00	3.43E-09	7.18E-03
1.00E+04	1.00E+00	1.14E-08	7.18E-03			1.00E+00	1.14E-08	7.18E-03
3.00E+04	1.00E+00	3.43E-08	7.18E-03			1.00E+00	3.43E-08	7.18E-03
1.00E+05	1.00E+00	1.14E-07	7.18E-03			1.00E+00	1.14E-07	7.18E-03
3.00E+05	1.00E+00	3.43E-07	7.18E-03			1.00E+00	3.43E-07	7.18E-03
1.00E+06	1.00E+00	1.14E-06	7.19E-03			1.00E+00	1.14E-06	7.19E-03
3.00E+06	1.00E+00	3.43E-06	7.19E-03			1.00E+00	3.43E-06	7.19E-03
1.00E+07	1.00E+00	1.14E-05	7.23E-03			1.00E+00	1.14E-05	7.23E-03
3.15E+07	1.00E+00	3.61E-05	7.32E-03			1.00E+00	3.61E-05	7.32E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	3.09E-06	9.16E-07	1.09E-08	5.28E+01	5.28E+02	2.23E-03
3.00E+01	8.16E-06	2.43E-06	3.07E-08	5.28E+01	5.28E+02	2.23E-03
1.00E+02	1.89E-05	5.80E-06	8.11E-08	5.28E+01	5.28E+02	2.23E-03
3.00E+02	3.25E-05	1.12E-05	1.66E-07	5.28E+01	5.28E+02	2.23E-03
1.00E+03	5.11E-05	2.09E-05	2.61E-07	5.28E+01	5.28E+02	2.23E-03
3.00E+03	8.11E-05	4.32E-05	3.03E-07	5.28E+01	5.28E+02	2.23E-03
1.00E+04	1.55E-04	1.33E-04	3.75E-07	5.28E+01	5.28E+02	2.23E-03
3.00E+04	2.91E-04	3.65E-04	5.27E-07	5.28E+01	5.28E+02	2.23E-03
1.00E+05	4.99E-04	8.80E-04	8.91E-07	5.28E+01	5.28E+02	2.23E-03
3.00E+05	6.48E-04	1.62E-03	1.85E-06	5.28E+01	5.28E+02	2.23E-03
1.00E+06	7.17E-04	2.90E-03	7.37E-06	5.28E+01	5.28E+02	2.23E-03
3.00E+06	7.89E-04	4.23E-03	2.29E-05	5.28E+01	5.28E+02	2.23E-03
1.00E+07	8.66E-04	5.58E-03	3.27E-05	5.28E+01	5.28E+02	2.23E-03
3.15E+07	1.00E-03	8.74E-03	3.44E-05	5.28E+01	5.28E+02	2.23E-03

Cm246 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+01	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+02	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+02	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+04	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+04	9.4E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+05	9.4E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+05	9.4E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+06	9.3E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.0E+06	9.3E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
1.0E+07	9.2E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03
3.2E+07	8.9E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03	9.5E-03

Cm-248 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Cm248						Cm249					
1.00E+01	7.76E-03	2.67E-03	2.95E-05	2.18E+00	3.12E+01	7.70E-05	4.11E-02	5.91E-03	9.36E-05	6.01E+02	8.67E+03	9.43E-03
3.00E+01	2.03E-02	6.87E-03	8.07E-05	2.18E+00	3.12E+01	7.70E-05	2.78E-01	9.45E-02	1.11E-03	6.01E+02	8.67E+03	9.43E-03
1.00E+02	4.56E-02	1.55E-02	2.06E-04	2.18E+00	3.12E+01	7.70E-05	6.27E-01	2.13E-01	2.83E-03	6.01E+02	8.67E+03	9.43E-03
3.00E+02	7.80E-02	2.80E-02	4.10E-04	2.18E+00	3.12E+01	7.70E-05	1.07E+00	3.85E-01	5.64E-03	6.01E+02	8.67E+03	9.43E-03
1.00E+03	1.29E-01	4.95E-02	6.35E-04	2.18E+00	3.12E+01	7.70E-05	1.77E+00	6.81E-01	8.73E-03	6.01E+02	8.67E+03	9.43E-03
3.00E+03	2.20E-01	9.71E-02	7.26E-04	2.19E+00	3.13E+01	7.70E-05	3.03E+00	1.34E+00	9.99E-03	6.01E+02	8.67E+03	9.43E-03
1.00E+04	4.59E-01	2.82E-01	8.63E-04	2.20E+00	3.15E+01	7.75E-05	6.31E+00	3.88E+00	1.19E-02	6.01E+02	8.67E+03	9.43E-03
3.00E+04	9.13E-01	7.48E-01	1.15E-03	2.22E+00	3.22E+01	7.87E-05	1.26E+01	1.03E+01	1.59E-02	6.01E+02	8.67E+03	9.43E-03
1.00E+05	1.61E+00	1.74E+00	1.85E-03	2.30E+00	3.43E+01	8.35E-05	2.22E+01	2.39E+01	2.54E-02	6.01E+02	8.67E+03	9.43E-03
3.00E+05	2.10E+00	3.04E+00	3.50E-03	2.52E+00	4.06E+01	9.54E-05	2.89E+01	4.18E+01	4.82E-02	6.01E+02	8.67E+03	9.43E-03
1.00E+06	2.26E+00	5.12E+00	1.25E-02	3.29E+00	6.26E+01	1.39E-04	3.10E+01	7.03E+01	1.72E-01	6.01E+02	8.67E+03	9.43E-03
3.00E+06	2.38E+00	7.18E+00	3.76E-02	5.57E+00	1.25E+02	2.65E-04	3.27E+01	9.87E+01	5.16E-01	6.02E+02	8.67E+03	9.46E-03
1.00E+07	2.51E+00	9.16E+00	5.31E-02	1.40E+01	3.41E+02	7.16E-04	3.44E+01	1.26E+02	7.29E-01	6.03E+02	8.67E+03	9.54E-03
3.15E+07	2.73E+00	1.37E+01	5.54E-02	4.39E+01	9.83E+02	2.18E-03	3.75E+01	1.89E+02	7.61E-01	6.10E+02	8.75E+03	9.74E-03

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Bk249						Cf249					
1.00E+01	1.72E-03	2.47E-04	3.92E-06	7.47E-04	2.39E-02	2.23E-08	5.36E-01	1.12E-01	1.70E-03	4.91E-04	2.02E-01	1.84E-08
3.00E+01	1.17E-02	3.96E-03	4.65E-05	2.24E-03	7.08E-02	6.70E-08	2.60E+00	6.48E-01	8.46E-03	1.48E-03	5.29E-01	5.54E-08
1.00E+02	2.63E-02	8.91E-03	1.18E-04	7.45E-03	2.31E-01	2.23E-07	6.52E+00	1.71E+00	2.34E-02	4.91E-03	1.32E+00	1.84E-07
3.00E+02	4.50E-02	1.61E-02	2.36E-04	2.23E-02	6.79E-01	6.65E-07	1.29E+01	3.74E+00	4.96E-02	1.48E-02	2.58E+00	5.54E-07
1.00E+03	7.42E-02	2.85E-02	3.66E-04	7.25E-02	2.19E+00	2.17E-06	2.66E+01	8.52E+00	8.07E-02	4.91E-02	4.29E+00	1.84E-06
3.00E+03	1.27E-01	5.59E-02	4.18E-04	2.05E-01	6.18E+00	6.13E-06	5.67E+01	2.17E+01	9.94E-02	1.48E-01	6.42E+00	5.54E-06
1.00E+04	2.64E-01	1.62E-01	4.97E-04	5.63E-01	1.69E+01	1.50E-05	1.42E+02	7.48E+01	1.43E-01	4.91E-01	1.33E+01	1.84E-05
3.00E+04	5.26E-01	4.31E-01	6.65E-04	1.04E+00	3.13E+01	3.12E-05	3.10E+02	2.17E+02	2.50E-01	1.48E+00	3.30E+01	5.54E-05
1.00E+05	9.29E-01	1.00E+00	1.06E-03	1.24E+00	3.75E+01	3.72E-05	5.49E+02	5.75E+02	5.77E-01	4.91E+00	1.02E+02	1.84E-04
3.00E+05	1.21E+00	1.75E+00	2.02E-03	1.25E+00	3.75E+01	3.72E-05	7.03E+02	1.18E+03	1.73E+00	1.48E+01	3.00E+02	5.54E-04
1.00E+06	1.30E+00	2.95E+00	7.21E-03	1.25E+00	3.75E+01	3.72E-05	7.73E+02	2.39E+03	8.85E+00	4.90E+01	1.00E+03	1.84E-03
3.00E+06	1.37E+00	4.14E+00	2.16E-02	1.25E+00	3.75E+01	3.72E-05	8.53E+02	3.74E+03	2.91E+01	1.47E+02	2.99E+03	5.51E-03
1.00E+07	1.44E+00	5.28E+00	3.06E-02	1.25E+00	3.75E+01	3.72E-05	9.38E+02	5.49E+03	4.18E+01	4.87E+02	9.83E+03	1.83E-02
3.15E+07	1.57E+00	7.92E+00	3.19E-02	1.25E+00	3.75E+01	3.72E-05	1.09E+03	9.81E+03	4.39E+01	1.51E+03	3.02E+04	5.65E-02

Cm-248

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm248	Cm249	Bk249	Cf249	Cm248	Cm249	Bk249	Cf249
1.00E+01	1.00E+00	2.61E-08	2.37E-11	0.00E+00	1.00E+00	2.61E-08	2.37E-11	0.00E+00
3.00E+01	1.00E+00	7.81E-08	2.13E-10	0.00E+00	1.00E+00	7.81E-08	2.13E-10	0.00E+00
1.00E+02	1.00E+00	2.59E-07	2.36E-09	0.00E+00	1.00E+00	2.59E-07	2.36E-09	0.00E+00
3.00E+02	1.00E+00	7.62E-07	2.10E-08	0.00E+00	1.00E+00	7.62E-07	2.10E-08	0.00E+00
1.00E+03	1.00E+00	2.39E-06	2.23E-07	1.90E-12	1.00E+00	2.39E-06	2.23E-07	1.90E-12
3.00E+03	1.00E+00	6.04E-06	1.79E-06	4.69E-11	1.00E+00	6.04E-06	1.79E-06	4.69E-11
1.00E+04	1.00E+00	1.20E-05	1.41E-05	1.33E-09	1.00E+00	1.20E-05	1.41E-05	1.33E-09
3.00E+04	1.00E+00	1.43E-05	6.40E-05	2.06E-08	1.00E+00	1.43E-05	6.40E-05	2.06E-08
1.00E+05	1.00E+00	1.44E-05	2.46E-04	2.93E-07	1.00E+00	1.44E-05	2.46E-04	2.93E-07
3.00E+05	9.99E-01	1.44E-05	7.66E-04	2.83E-06	1.00E+00	1.44E-05	7.66E-04	2.83E-06
1.00E+06	9.97E-01	1.44E-05	2.56E-03	3.21E-05	9.99E-01	1.44E-05	2.56E-03	3.21E-05
3.00E+06	9.92E-01	1.44E-05	7.53E-03	2.86E-04	9.96E-01	1.43E-05	7.50E-03	2.85E-04
1.00E+07	9.73E-01	1.44E-05	2.31E-02	3.01E-03	9.87E-01	1.42E-05	2.28E-02	2.97E-03
3.15E+07	9.18E-01	1.44E-05	5.68E-02	2.53E-02	9.58E-01	1.38E-05	5.44E-02	2.42E-02

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	7.76E-03	2.67E-03	2.95E-05	2.18E+00	3.12E+01	7.70E-05
3.00E+01	2.03E-02	6.87E-03	8.07E-05	2.18E+00	3.12E+01	7.70E-05
1.00E+02	4.56E-02	1.55E-02	2.06E-04	2.18E+00	3.12E+01	7.70E-05
3.00E+02	7.81E-02	2.80E-02	4.10E-04	2.18E+00	3.12E+01	7.70E-05
1.00E+03	1.29E-01	4.95E-02	6.35E-04	2.18E+00	3.12E+01	7.70E-05
3.00E+03	2.20E-01	9.71E-02	7.26E-04	2.20E+00	3.14E+01	7.70E-05
1.00E+04	4.59E-01	2.82E-01	8.63E-04	2.21E+00	3.16E+01	7.76E-05
3.00E+04	9.13E-01	7.48E-01	1.15E-03	2.23E+00	3.23E+01	7.88E-05
1.00E+05	1.61E+00	1.74E+00	1.85E-03	2.31E+00	3.45E+01	8.36E-05
3.00E+05	2.10E+00	3.05E+00	3.51E-03	2.52E+00	4.07E+01	9.55E-05
1.00E+06	2.28E+00	5.19E+00	1.28E-02	3.30E+00	6.27E+01	1.39E-04
3.00E+06	2.62E+00	8.25E+00	4.59E-02	5.58E+00	1.25E+02	2.65E-04
1.00E+07	5.29E+00	2.55E+01	1.77E-01	1.51E+01	3.62E+02	7.53E-04
3.15E+07	2.91E+01	2.51E+02	1.12E+00	7.86E+01	1.67E+03	3.43E-03

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
2.28E-01	1.60E-01	9.40E+01	2.19E+00	3.12E+01	1.06E-04
2.27E-01	1.60E-01	6.34E+01	2.20E+00	3.12E+01	1.58E-04
2.24E-01	1.60E-01	3.54E+01	2.23E+00	3.12E+01	2.83E-04
2.21E-01	1.60E-01	2.05E+01	2.26E+00	3.12E+01	4.87E-04
2.16E-01	1.60E-01	1.40E+01	2.31E+00	3.12E+01	7.12E-04
2.07E-01	1.59E-01	1.24E+01	2.42E+00	3.14E+01	8.04E-04
1.88E-01	1.58E-01	1.06E+01	2.67E+00	3.16E+01	9.41E-04
1.59E-01	1.55E-01	8.11E+00	3.14E+00	3.23E+01	1.23E-03
1.28E-01	1.45E-01	5.18E+00	3.92E+00	3.45E+01	1.93E-03
1.08E-01	1.23E-01	2.77E+00	4.63E+00	4.07E+01	3.61E-03
8.96E-02	7.98E-02	7.72E-01	5.58E+00	6.27E+01	1.30E-02
6.10E-02	3.99E-02	2.17E-01	8.20E+00	1.25E+02	4.61E-02
2.45E-02	1.38E-02	5.62E-02	2.04E+01	3.62E+02	1.78E-01
4.64E-03	3.00E-03	8.90E-03	1.08E+02	1.67E+03	1.12E+00

Cm-248

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Cm248	Cm249	Bk249	Cf249	Cm248	Cm249	Bk249	Cf249
1.00E+01	1.00E+00	2.61E-11	2.37E-14	0.00E+00	1.00E+00	2.61E-11	2.37E-14	0.00E+00
3.00E+01	1.00E+00	7.81E-11	2.13E-13	0.00E+00	1.00E+00	7.81E-11	2.13E-13	0.00E+00
1.00E+02	1.00E+00	2.59E-10	2.36E-12	0.00E+00	1.00E+00	2.59E-10	2.36E-12	0.00E+00
3.00E+02	1.00E+00	7.62E-10	2.10E-11	0.00E+00	1.00E+00	7.62E-10	2.10E-11	0.00E+00
1.00E+03	1.00E+00	2.39E-09	2.23E-10	1.90E-15	1.00E+00	2.39E-09	2.23E-10	1.90E-15
3.00E+03	1.00E+00	6.04E-09	1.79E-09	4.69E-14	1.00E+00	6.04E-09	1.79E-09	4.69E-14
1.00E+04	1.00E+00	1.20E-08	1.41E-08	1.33E-12	1.00E+00	1.20E-08	1.41E-08	1.33E-12
3.00E+04	1.00E+00	1.43E-08	6.40E-08	2.06E-11	1.00E+00	1.43E-08	6.40E-08	2.06E-11
1.00E+05	1.00E+00	1.44E-08	2.46E-07	2.93E-10	1.00E+00	1.44E-08	2.46E-07	2.93E-10
3.00E+05	1.00E+00	1.44E-08	7.66E-07	2.83E-09	1.00E+00	1.44E-08	7.66E-07	2.83E-09
1.00E+06	1.00E+00	1.44E-08	2.56E-06	3.21E-08	1.00E+00	1.44E-08	2.56E-06	3.21E-08
3.00E+06	1.00E+00	1.44E-08	7.53E-06	2.86E-07	1.00E+00	1.44E-08	7.53E-06	2.86E-07
1.00E+07	1.00E+00	1.44E-08	2.31E-05	3.01E-06	1.00E+00	1.44E-08	2.31E-05	3.01E-06
3.15E+07	1.00E+00	1.44E-08	5.68E-05	2.53E-05	1.00E+00	1.44E-08	5.68E-05	2.53E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	7.76E-06	2.67E-06	2.95E-08	2.18E+00	3.12E+01	7.70E-05
3.00E+01	2.03E-05	6.87E-06	8.07E-08	2.18E+00	3.12E+01	7.70E-05
1.00E+02	4.56E-05	1.55E-05	2.06E-07	2.18E+00	3.12E+01	7.70E-05
3.00E+02	7.80E-05	2.80E-05	4.10E-07	2.18E+00	3.12E+01	7.70E-05
1.00E+03	1.29E-04	4.95E-05	6.35E-07	2.18E+00	3.12E+01	7.70E-05
3.00E+03	2.20E-04	9.71E-05	7.26E-07	2.19E+00	3.13E+01	7.70E-05
1.00E+04	4.59E-04	2.82E-04	8.63E-07	2.20E+00	3.15E+01	7.75E-05
3.00E+04	9.13E-04	7.48E-04	1.15E-06	2.22E+00	3.22E+01	7.87E-05
1.00E+05	1.61E-03	1.74E-03	1.85E-06	2.30E+00	3.43E+01	8.35E-05
3.00E+05	2.10E-03	3.04E-03	3.50E-06	2.52E+00	4.06E+01	9.54E-05
1.00E+06	2.26E-03	5.12E-03	1.25E-05	3.29E+00	6.26E+01	1.39E-04
3.00E+06	2.38E-03	7.18E-03	3.76E-05	5.57E+00	1.25E+02	2.65E-04
1.00E+07	2.51E-03	9.18E-03	5.32E-05	1.40E+01	3.41E+02	7.16E-04
3.15E+07	2.75E-03	1.40E-02	5.65E-05	4.40E+01	9.84E+02	2.18E-03

Cm248 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+02	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+02	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+03	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+03	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+04	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
3.0E+04	1.5E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01	1.6E-01
1.0E+05	1.3E-01	1.5E-01	1.5E-01	1.5E-01	1.5E-01	1.5E-01	1.5E-01
3.0E+05	1.1E-01	1.2E-01	1.2E-01	1.2E-01	1.2E-01	1.2E-01	1.2E-01
1.0E+06	8.0E-02	8.0E-02	8.0E-02	8.0E-02	8.0E-02	8.0E-02	8.0E-02
3.0E+06	4.0E-02	4.0E-02	4.0E-02	4.0E-02	4.0E-02	4.0E-02	4.0E-02
1.0E+07	1.4E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02
3.2E+07	3.0E-03	4.8E-03	5.0E-03	5.1E-03	5.1E-03	5.1E-03	5.1E-03

Np-237 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Np237						Np238					
1.00E+01	1.47E-03	3.12E-04	3.86E-06	1.21E-01	1.82E+00	5.14E-06	1.10E+00	1.50E-01	2.28E-03	1.59E-04	2.23E-09	2.50E-09
3.00E+01	3.82E-03	7.98E-04	1.04E-05	1.22E-01	1.83E+00	5.14E-06	5.78E+00	1.31E+00	1.63E-02	4.77E-04	2.00E-08	7.48E-09
1.00E+02	9.00E-03	1.91E-03	2.69E-05	1.23E-01	1.85E+00	5.17E-06	1.35E+01	3.08E+00	4.28E-02	1.58E-03	2.21E-07	2.48E-08
3.00E+02	1.46E-02	3.76E-03	5.42E-05	1.26E-01	1.91E+00	5.31E-06	2.16E+01	5.90E+00	8.74E-02	4.64E-03	1.96E-06	7.28E-08
1.00E+03	1.87E-02	7.56E-03	8.58E-05	1.36E-01	2.12E+00	5.74E-06	2.78E+01	1.12E+01	1.38E-01	1.44E-02	2.08E-05	2.26E-07
3.00E+03	2.16E-02	1.77E-02	1.06E-04	1.65E-01	2.70E+00	6.93E-06	3.22E+01	2.49E+01	1.66E-01	3.58E-02	1.65E-04	5.61E-07
1.00E+04	2.59E-02	6.03E-02	1.51E-04	2.67E-01	4.75E+00	1.12E-05	3.88E+01	8.30E+01	2.26E-01	6.80E-02	1.25E-03	1.07E-06
3.00E+04	3.10E-02	1.74E-01	2.35E-04	5.51E-01	1.05E+01	2.30E-05	4.66E+01	2.38E+02	3.39E-01	7.81E-02	5.47E-03	1.23E-06
1.00E+05	4.07E-02	4.41E-01	4.20E-04	1.47E+00	2.98E+01	6.25E-05	6.10E+01	5.96E+02	5.89E-01	7.89E-02	2.07E-02	1.27E-06
3.00E+05	5.34E-02	8.45E-01	9.42E-04	3.65E+00	7.83E+01	1.64E-04	7.88E+01	1.13E+03	1.29E+00	8.08E-02	6.42E-02	1.36E-06
1.00E+06	7.81E-02	1.56E+00	4.00E-03	9.33E+00	2.23E+02	4.69E-04	1.10E+02	2.03E+03	5.34E+00	8.73E-02	2.17E-01	1.68E-06
3.00E+06	1.16E-01	2.29E+00	1.26E-02	2.40E+01	6.13E+02	1.30E-03	1.58E+02	2.90E+03	1.66E+01	1.06E-01	6.52E-01	2.59E-06
1.00E+07	1.54E-01	3.04E+00	1.80E-02	7.52E+01	1.98E+03	4.17E-03	1.98E+02	3.56E+03	2.35E+01	1.71E-01	2.18E+00	5.80E-06
3.15E+07	2.17E-01	4.79E+00	1.89E-02	2.32E+02	6.15E+03	1.30E-02	2.55E+02	4.98E+03	2.42E+01	3.72E-01	6.85E+00	1.56E-05

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu238						U234					
1.00E+01	5.70E-01	1.73E-01	1.89E-03	2.38E-07	5.05E-03	1.17E-11	1.08E-03	1.48E-04	2.48E-06	5.32E-12	3.64E-04	2.43E-16
3.00E+01	1.50E+00	4.57E-01	5.07E-02	7.13E-07	1.27E-02	3.51E-11	4.89E-03	9.38E-04	1.27E-05	1.47E-11	8.92E-04	6.67E-16
1.00E+02	3.61E+00	1.20E+00	1.33E-02	2.38E-06	2.93E-02	1.17E-10	1.27E-02	2.15E-03	3.20E-05	5.07E-11	1.96E-03	2.31E-15
3.00E+02	6.03E+00	2.73E+00	2.73E-02	7.13E-06	5.22E-02	3.51E-10	2.11E-02	3.95E-03	6.27E-05	1.52E-10	3.31E-03	6.93E-15
1.00E+03	8.13E+00	6.83E+00	4.32E-02	2.38E-05	7.40E-02	1.17E-09	2.64E-02	7.12E-03	9.72E-05	5.09E-10	4.49E-03	2.32E-14
3.00E+03	9.92E+00	1.74E+01	5.21E-02	7.13E-05	7.84E-02	3.51E-09	2.92E-02	1.50E-02	1.21E-04	1.53E-09	4.67E-03	6.96E-14
1.00E+04	1.28E+01	5.10E+01	7.15E-02	2.38E-04	8.30E-02	1.17E-08	3.32E-02	4.95E-02	1.71E-04	5.08E-09	4.73E-03	2.32E-13
3.00E+04	1.69E+01	1.30E+02	1.12E-01	7.13E-04	9.50E-02	3.51E-08	3.77E-02	1.45E-01	2.55E-04	1.53E-08	4.80E-03	6.96E-13
1.00E+05	2.46E+01	3.23E+02	2.11E-01	2.38E-03	1.37E-01	1.17E-07	4.62E-02	3.80E-01	4.21E-04	5.08E-08	4.93E-03	2.32E-12
3.00E+05	3.38E+01	6.30E+02	5.02E-01	7.13E-03	2.64E-01	3.51E-07	5.80E-02	7.54E-01	9.05E-04	1.53E-07	5.23E-03	6.96E-12
1.00E+06	5.01E+01	1.15E+03	2.25E+00	2.38E-02	7.90E-01	1.17E-06	8.12E-02	1.43E+00	3.81E-03	5.08E-07	1.12E-02	2.32E-11
3.00E+06	7.46E+01	1.63E+03	7.19E+00	7.13E-02	2.32E+00	3.51E-06	1.17E-01	2.11E+00	1.21E-02	1.53E-06	2.83E-02	6.96E-11
1.00E+07	9.58E+01	2.01E+03	1.03E+01	2.38E-01	6.45E+00	1.17E-05	1.51E-01	2.73E+00	1.72E-02	5.08E-06	3.88E-02	2.32E-10
3.15E+07	1.28E+02	2.87E+03	1.06E+01	7.48E-01	1.83E+01	3.68E-05	2.05E-01	4.14E+00	1.79E-02	1.60E-05	3.90E-02	7.30E-10

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U233					
1.00E+01	6.91E-01	1.04E-01	1.80E-03	2.37E-09	2.21E-01	1.30E-13
3.00E+01	2.98E+00	5.90E-01	8.29E-03	7.11E-09	5.53E-01	3.92E-13
1.00E+02	7.54E+00	1.40E+00	2.14E-02	2.37E-08	1.26E+00	1.30E-12
3.00E+02	1.26E+01	2.66E+00	4.27E-02	7.11E-08	2.18E+00	3.92E-12
1.00E+03	1.59E+01	4.91E+00	6.73E-02	2.37E-07	3.02E+00	1.30E-11
3.00E+03	1.77E+01	1.02E+01	8.49E-02	7.11E-07	3.15E+00	3.92E-11
1.00E+04	2.04E+01	3.28E+01	1.23E-01	2.37E-06	3.19E+00	1.30E-10
3.00E+04	2.33E+01	9.47E+01	1.83E-01	7.11E-06	3.25E+00	3.92E-10
1.00E+05	2.88E+01	2.47E+02	2.94E-01	2.37E-05	3.33E+00	1.30E-09
3.00E+05	3.66E+01	4.97E+02	6.25E-01	7.11E-05	3.80E+00	3.92E-09
1.00E+06	5.30E+01	9.75E+02	2.67E+00	2.37E-04	7.76E+00	1.30E-08
3.00E+06	7.87E+01	1.46E+03	8.55E+00	7.11E-04	2.00E+01	3.92E-08
1.00E+07	1.03E+02	1.94E+03	1.22E+01	2.37E-03	2.75E+01	1.30E-07
3.15E+07	1.43E+02	3.03E+03	1.28E+01	7.46E-03	2.76E+01	4.12E-07

Np-237

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Np237	Np238	Pu238	U234	U233	Np237	Np238	Pu238	U234	U233
1.00E+01	1.00E+00	6.64E-08	0.00E+00	0.00E+00	1.60E-05	1.00E+00	6.64E-08	0.00E+00	0.00E+00	1.60E-05
3.00E+01	1.00E+00	1.99E-07	0.00E+00	0.00E+00	1.60E-05	1.00E+00	1.99E-07	0.00E+00	0.00E+00	1.60E-05
1.00E+02	1.00E+00	6.64E-07	0.00E+00	0.00E+00	1.60E-05	1.00E+00	6.64E-07	0.00E+00	0.00E+00	1.60E-05
3.00E+02	1.00E+00	1.99E-06	1.13E-09	0.00E+00	1.60E-05	1.00E+00	1.99E-06	1.13E-09	0.00E+00	1.60E-05
1.00E+03	1.00E+00	6.64E-06	1.26E-08	0.00E+00	1.60E-05	1.00E+00	6.64E-06	1.26E-08	0.00E+00	1.60E-05
3.00E+03	1.00E+00	1.99E-05	1.13E-07	0.00E+00	1.60E-05	1.00E+00	1.99E-05	1.13E-07	0.00E+00	1.60E-05
1.00E+04	1.00E+00	6.51E-05	1.24E-06	0.00E+00	1.60E-05	1.00E+00	6.51E-05	1.24E-06	0.00E+00	1.60E-05
3.00E+04	1.00E+00	1.88E-04	1.09E-05	0.00E+00	1.60E-05	1.00E+00	1.88E-04	1.09E-05	0.00E+00	1.60E-05
1.00E+05	9.99E-01	5.53E-04	1.11E-04	9.58E-10	1.60E-05	1.00E+00	5.53E-04	1.11E-04	9.58E-10	1.60E-05
3.00E+05	9.98E-01	1.19E-03	8.02E-04	2.19E-08	1.60E-05	9.99E-01	1.19E-03	8.01E-04	2.19E-08	1.60E-05
1.00E+06	9.93E-01	1.71E-03	4.93E-03	5.07E-07	1.60E-05	9.97E-01	1.70E-03	4.91E-03	5.05E-07	1.59E-05
3.00E+06	9.80E-01	1.75E-03	1.82E-02	6.29E-06	1.60E-05	9.90E-01	1.73E-03	1.80E-02	6.23E-06	1.58E-05
1.00E+07	9.36E-01	1.75E-03	6.45E-02	7.89E-05	1.60E-05	9.68E-01	1.69E-03	6.24E-02	7.63E-05	1.55E-05
3.15E+07	8.12E-01	1.75E-03	2.07E-01	8.01E-04	1.60E-05	9.03E-01	1.58E-03	1.87E-01	7.23E-04	1.44E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.48E-03	3.13E-04	3.89E-06	1.21E-01	1.82E+00	5.14E-06
3.00E+01	3.86E-03	8.08E-04	1.05E-05	1.22E-01	1.83E+00	5.14E-06
1.00E+02	9.13E-03	1.94E-03	2.73E-05	1.22E-01	1.85E+00	5.17E-06
3.00E+02	1.48E-02	3.81E-03	5.51E-05	1.26E-01	1.91E+00	5.31E-06
1.00E+03	1.92E-02	7.71E-03	8.77E-05	1.36E-01	2.12E+00	5.74E-06
3.00E+03	2.25E-02	1.84E-02	1.11E-04	1.65E-01	2.70E+00	6.93E-06
1.00E+04	2.87E-02	6.62E-02	1.68E-04	2.67E-01	4.75E+00	1.12E-05
3.00E+04	4.03E-02	2.22E-01	3.02E-04	5.51E-01	1.05E+01	2.30E-05
1.00E+05	7.76E-02	8.10E-01	7.74E-04	1.47E+00	2.97E+01	6.24E-05
3.00E+05	1.75E-01	2.70E+00	2.89E-03	3.64E+00	7.81E+01	1.64E-04
1.00E+06	5.13E-01	1.07E+01	2.42E-02	9.27E+00	2.21E+02	4.66E-04
3.00E+06	1.73E+00	3.66E+01	1.71E-01	2.35E+01	6.01E+02	1.27E-03
1.00E+07	6.47E+00	1.34E+02	6.98E-01	7.04E+01	1.85E+03	3.91E-03
3.15E+07	2.44E+01	5.48E+02	2.04E+00	1.88E+02	5.00E+03	1.06E-02

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
4.09E+00	2.75E+00	1.11E+03		1.22E-01	1.82E+00	9.03E-06
3.98E+00	2.74E+00	6.39E+02		1.26E-01	1.83E+00	1.56E-05
3.80E+00	2.70E+00	3.08E+02		1.32E-01	1.85E+00	3.24E-05
3.55E+00	2.62E+00	1.66E+02		1.41E-01	1.91E+00	6.04E-05
3.23E+00	2.36E+00	1.07E+02		1.55E-01	2.12E+00	9.35E-05
2.67E+00	1.85E+00	8.49E+01		1.88E-01	2.70E+00	1.18E-04
1.69E+00	1.05E+00	5.59E+01		2.95E-01	4.75E+00	1.79E-04
8.46E-01	4.76E-01	3.07E+01		5.91E-01	1.05E+01	3.25E-04
3.24E-01	1.68E-01	1.20E+01		1.54E+00	2.97E+01	8.37E-04
1.31E-01	6.40E-02	3.27E+00		3.82E+00	7.81E+01	3.05E-03
5.11E-02	2.26E-02	4.06E-01		9.79E+00	2.21E+02	2.46E-02
1.98E-02	8.32E-03	5.80E-02		2.53E+01	6.01E+02	1.72E-01
6.51E-03	2.70E-03	1.43E-02		7.68E+01	1.85E+03	7.02E-01
2.35E-03	1.00E-03	4.87E-03		2.13E+02	5.00E+03	2.06E+00

Np-237

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Np237	Np238	Pu238	U234	U233	Np237	Np238	Pu238	U234	U233
1.00E+01	1.00E+00	6.64E-11	0.00E+00	0.00E+00	1.60E-05	1.00E+00	6.64E-11	0.00E+00	0.00E+00	1.60E-05
3.00E+01	1.00E+00	1.99E-10	0.00E+00	0.00E+00	1.60E-05	1.00E+00	1.99E-10	0.00E+00	0.00E+00	1.60E-05
1.00E+02	1.00E+00	6.64E-10	0.00E+00	0.00E+00	1.60E-05	1.00E+00	6.64E-10	0.00E+00	0.00E+00	1.60E-05
3.00E+02	1.00E+00	1.99E-09	1.13E-12	0.00E+00	1.60E-05	1.00E+00	1.99E-09	1.13E-12	0.00E+00	1.60E-05
1.00E+03	1.00E+00	6.64E-09	1.26E-11	0.00E+00	1.60E-05	1.00E+00	6.64E-09	1.26E-11	0.00E+00	1.60E-05
3.00E+03	1.00E+00	1.99E-08	1.13E-10	0.00E+00	1.60E-05	1.00E+00	1.99E-08	1.13E-10	0.00E+00	1.60E-05
1.00E+04	1.00E+00	6.51E-08	1.24E-09	0.00E+00	1.60E-05	1.00E+00	6.51E-08	1.24E-09	0.00E+00	1.60E-05
3.00E+04	1.00E+00	1.88E-07	1.09E-08	0.00E+00	1.60E-05	1.00E+00	1.88E-07	1.09E-08	0.00E+00	1.60E-05
1.00E+05	1.00E+00	5.53E-07	1.11E-07	9.58E-13	1.60E-05	1.00E+00	5.53E-07	1.11E-07	9.58E-13	1.60E-05
3.00E+05	1.00E+00	1.19E-06	8.02E-07	2.19E-11	1.60E-05	1.00E+00	1.19E-06	8.02E-07	2.19E-11	1.60E-05
1.00E+06	1.00E+00	1.71E-06	4.93E-06	5.07E-10	1.60E-05	1.00E+00	1.71E-06	4.93E-06	5.07E-10	1.60E-05
3.00E+06	1.00E+00	1.75E-06	1.82E-05	6.29E-09	1.60E-05	1.00E+00	1.75E-06	1.82E-05	6.29E-09	1.60E-05
1.00E+07	1.00E+00	1.75E-06	6.45E-05	7.89E-08	1.60E-05	1.00E+00	1.75E-06	6.45E-05	7.89E-08	1.60E-05
3.15E+07	1.00E+00	1.75E-06	2.07E-04	8.01E-07	1.60E-05	1.00E+00	1.75E-06	2.07E-04	8.01E-07	1.60E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.48E-06	3.13E-07	3.89E-09	1.21E-01	1.82E+00	5.14E-06
3.00E+01	3.86E-06	8.08E-07	1.05E-08	1.22E-01	1.83E+00	5.14E-06
1.00E+02	9.12E-06	1.94E-06	2.72E-08	1.22E-01	1.85E+00	5.17E-06
3.00E+02	1.48E-05	3.80E-06	5.49E-08	1.26E-01	1.91E+00	5.31E-06
1.00E+03	1.90E-05	7.64E-06	8.68E-08	1.36E-01	2.12E+00	5.74E-06
3.00E+03	2.19E-05	1.79E-05	1.08E-07	1.65E-01	2.70E+00	6.93E-06
1.00E+04	2.62E-05	6.08E-05	1.53E-07	2.67E-01	4.75E+00	1.12E-05
3.00E+04	3.14E-05	1.76E-04	2.38E-07	5.51E-01	1.05E+01	2.30E-05
1.00E+05	4.12E-05	4.45E-04	4.25E-07	1.47E+00	2.98E+01	6.25E-05
3.00E+05	5.41E-05	8.54E-04	9.54E-07	3.65E+00	7.82E+01	1.64E-04
1.00E+06	7.93E-05	1.58E-03	4.06E-06	9.33E+00	2.22E+02	4.69E-04
3.00E+06	1.19E-04	2.35E-03	1.29E-05	2.40E+01	6.13E+02	1.30E-03
1.00E+07	1.62E-04	3.21E-03	1.89E-05	7.52E+01	1.97E+03	4.17E-03
3.15E+07	2.47E-04	5.44E-03	2.14E-05	2.32E+02	6.15E+03	1.30E-02

Np237 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00
3.0E+01	2.7E+00	2.7E+00	2.7E+00	2.7E+00	2.7E+00	2.7E+00	2.7E+00
1.0E+02	2.7E+00	2.7E+00	2.7E+00	2.7E+00	2.7E+00	2.7E+00	2.7E+00
3.0E+02	2.6E+00	2.6E+00	2.6E+00	2.6E+00	2.6E+00	2.6E+00	2.6E+00
1.0E+03	2.4E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00
3.0E+03	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
1.0E+04	1.1E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00
3.0E+04	4.8E-01	4.8E-01	4.8E-01	4.8E-01	4.8E-01	4.8E-01	4.8E-01
1.0E+05	1.7E-01	1.7E-01	1.7E-01	1.7E-01	1.7E-01	1.7E-01	1.7E-01
3.0E+05	6.4E-02	6.4E-02	6.4E-02	6.4E-02	6.4E-02	6.4E-02	6.4E-02
1.0E+06	2.3E-02	2.2E-02	2.2E-02	2.2E-02	2.2E-02	2.2E-02	2.2E-02
3.0E+06	8.3E-03	8.2E-03	8.2E-03	8.2E-03	8.2E-03	8.2E-03	8.2E-03
1.0E+07	2.7E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03	2.5E-03
3.2E+07	1.0E-03	8.3E-04	8.1E-04	8.1E-04	8.1E-04	8.1E-04	8.1E-04

Pa-231 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pa231						Pa232					
1.00E+01	2.39E-03	3.05E-04	4.17E-06	8.03E+01	1.38E+03	3.31E-03	2.41E+00	2.14E-01	3.79E-03	8.06E-07	4.59E-01	4.84E-11
3.00E+01	6.37E-03	7.77E-04	1.12E-05	8.03E+01	1.38E+03	3.31E-03	1.02E+01	1.24E+00	1.80E-02	2.45E-06	1.18E+00	1.47E-10
1.00E+02	1.61E-02	1.89E-03	3.01E-05	8.03E+01	1.38E+03	3.31E-03	2.58E+01	3.03E+00	4.82E-02	8.58E-06	2.74E+00	5.09E-10
3.00E+02	2.71E-02	3.66E-03	6.18E-05	8.03E+01	1.38E+03	3.31E-03	4.33E+01	5.85E+00	9.89E-02	2.92E-05	4.87E+00	1.70E-09
1.00E+03	3.40E-02	6.64E-03	9.94E-05	8.03E+01	1.38E+03	3.31E-03	5.45E+01	1.06E+01	1.59E-01	1.38E-04	6.79E+00	7.64E-09
3.00E+03	3.67E-02	1.32E-02	1.30E-04	8.03E+01	1.38E+03	3.31E-03	5.88E+01	2.11E+01	2.08E-01	7.50E-04	7.10E+00	3.96E-08
1.00E+04	4.02E-02	3.96E-02	1.95E-04	8.07E+01	1.39E+03	3.34E-03	6.44E+01	6.34E+01	3.12E-01	6.42E-03	7.33E+00	3.23E-07
3.00E+04	4.39E-02	1.09E-01	2.85E-04	8.15E+01	1.42E+03	3.37E-03	7.03E+01	1.75E+02	4.56E-01	5.09E-02	8.24E+00	2.53E-06
1.00E+05	5.01E-02	2.69E-01	4.10E-04	8.42E+01	1.48E+03	3.51E-03	8.03E+01	4.30E+02	6.57E-01	4.79E-01	1.58E+01	2.37E-05
3.00E+05	5.77E-02	5.05E-01	7.19E-04	9.00E+01	1.58E+03	3.76E-03	9.24E+01	8.09E+02	1.15E+00	3.07E+00	6.14E+01	1.51E-04
1.00E+06	7.23E-02	9.22E-01	2.53E-03	1.07E+02	1.63E+03	4.47E-03	1.16E+02	1.48E+03	4.05E+00	1.58E+01	2.87E+02	7.73E-04
3.00E+06	9.49E-02	1.34E+00	7.68E-03	1.53E+02	1.65E+03	6.40E-03	1.52E+02	2.14E+03	1.23E+01	5.28E+01	9.42E+02	2.60E-03
1.00E+07	1.16E-01	1.70E+00	1.09E-02	3.15E+02	1.78E+03	1.33E-02	1.86E+02	2.73E+03	1.74E+01	1.76E+02	3.08E+03	8.63E-03
3.15E+07	1.49E-01	2.53E+00	1.13E-02	8.42E+02	2.71E+03	3.59E-02	2.38E+02	4.06E+03	1.81E+01	4.94E+02	8.58E+03	2.43E-02

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U232					
1.00E+01	3.75E-01	5.54E-02	1.02E-03	7.92E-09	9.83E-02	4.53E-13
3.00E+01	1.46E+00	2.73E-01	4.17E-03	2.36E-08	2.56E-01	1.33E-12
1.00E+02	3.70E+00	6.82E-01	1.12E-02	7.92E-08	6.18E-01	4.53E-12
3.00E+02	6.39E+00	1.35E+00	2.32E-02	2.36E-07	1.14E+00	1.33E-11
1.00E+03	8.34E+00	2.47E+00	3.72E-02	7.92E-07	1.62E+00	4.53E-11
3.00E+03	9.17E+00	4.92E+00	4.71E-02	2.36E-06	1.68E+00	1.33E-10
1.00E+04	1.02E+01	1.57E+01	6.88E-02	7.92E-06	1.72E+00	4.53E-10
3.00E+04	1.14E+01	4.63E+01	1.03E-01	2.36E-05	1.75E+00	1.33E-09
1.00E+05	1.38E+01	1.26E+02	1.67E-01	7.92E-05	1.81E+00	4.53E-09
3.00E+05	1.80E+01	2.70E+02	3.77E-01	2.36E-04	2.12E+00	1.33E-08
1.00E+06	2.82E+01	5.63E+02	1.71E+00	7.92E-04	4.73E+00	4.53E-08
3.00E+06	4.45E+01	8.71E+02	5.55E+00	2.36E-03	1.28E+01	1.33E-07
1.00E+07	6.04E+01	1.19E+03	7.95E+00	7.92E-03	1.77E+01	4.53E-07
3.15E+07	8.63E+01	1.93E+03	8.32E+00	2.48E-02	1.78E+01	1.40E-06

Pa-231

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pa231	Pa232	U232			Pa231	Pa232	U232
1.00E+01	1.00E+00	5.98E-08	1.80E-12			1.00E+00	5.98E-08	1.80E-12
1.00E+01	1.00E+00	1.79E-07	1.65E-11			1.00E+00	1.79E-07	1.65E-11
1.00E+01	1.00E+00	5.97E-07	1.83E-10			1.00E+00	5.97E-07	1.83E-10
1.00E+01	1.00E+00	1.79E-06	1.65E-09			1.00E+00	1.79E-06	1.65E-09
1.00E+01	1.00E+00	5.96E-06	1.83E-08			1.00E+00	5.96E-06	1.83E-08
1.00E+01	1.00E+00	1.78E-05	1.64E-07			1.00E+00	1.78E-05	1.64E-07
1.00E+01	1.00E+00	5.80E-05	1.80E-06			1.00E+00	5.80E-05	1.80E-06
1.00E+01	1.00E+00	1.64E-04	1.55E-05			1.00E+00	1.64E-04	1.55E-05
1.00E+01	9.99E-01	4.47E-04	1.51E-04			1.00E+00	4.47E-04	1.51E-04
1.00E+01	9.98E-01	8.20E-04	9.72E-04			9.99E-01	8.19E-04	9.71E-04
1.00E+01	9.94E-01	9.74E-04	5.00E-03			9.97E-01	9.71E-04	4.99E-03
1.00E+01	9.82E-01	9.76E-04	1.69E-02			9.91E-01	9.67E-04	1.67E-02
1.00E+01	9.42E-01	9.76E-04	5.87E-02			9.71E-01	9.47E-04	5.70E-02
1.00E+01	8.29E-01	9.76E-04	1.86E-01			9.12E-01	8.90E-04	1.70E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	2.39E-03	3.05E-04	4.17E-06	8.02E+01	1.37E+03	3.31E-03
3.00E+01	6.37E-03	7.77E-04	1.12E-05	8.02E+01	1.37E+03	3.31E-03
1.00E+02	1.61E-02	1.89E-03	3.01E-05	8.02E+01	1.37E+03	3.31E-03
3.00E+02	2.71E-02	3.67E-03	6.19E-05	8.02E+01	1.37E+03	3.31E-03
1.00E+03	3.44E-02	6.70E-03	1.00E-04	8.02E+01	1.37E+03	3.31E-03
3.00E+03	3.78E-02	1.35E-02	1.34E-04	8.03E+01	1.38E+03	3.31E-03
1.00E+04	4.40E-02	4.33E-02	2.13E-04	8.07E+01	1.39E+03	3.34E-03
3.00E+04	5.56E-02	1.39E-01	3.61E-04	8.15E+01	1.42E+03	3.37E-03
1.00E+05	8.81E-02	4.80E-01	7.29E-04	8.41E+01	1.48E+03	3.51E-03
3.00E+05	1.51E-01	1.43E+00	2.03E-03	8.98E+01	1.58E+03	3.76E-03
1.00E+06	3.25E-01	5.16E+00	1.50E-02	1.06E+02	1.62E+03	4.45E-03
3.00E+06	9.87E-01	1.80E+01	1.12E-01	1.50E+02	1.62E+03	6.28E-03
1.00E+07	3.73E+00	7.18E+01	4.80E-01	2.97E+02	1.68E+03	1.25E-02
3.15E+07	1.50E+01	3.33E+02	1.44E+00	6.98E+02	2.26E+03	2.98E-02

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
4.09E+00	2.75E+00	1.10E+03		1.22E-01	1.82E+00	9.08E-06
3.99E+00	2.73E+00	6.17E+02		1.25E-01	1.83E+00	1.62E-05
3.80E+00	2.66E+00	2.82E+02		1.31E-01	1.88E+00	3.54E-05
3.56E+00	2.51E+00	1.43E+02		1.40E-01	1.99E+00	6.97E-05
3.23E+00	2.08E+00	9.29E+01		1.55E-01	2.40E+00	1.08E-04
2.67E+00	1.40E+00	7.48E+01		1.87E-01	3.56E+00	1.34E-04
1.70E+00	6.56E-01	5.06E+01		2.95E-01	7.62E+00	1.98E-04
8.47E-01	2.61E-01	2.87E+01		5.90E-01	1.92E+01	3.48E-04
3.25E-01	8.54E-02	1.18E+01		1.54E+00	5.85E+01	8.50E-04
1.32E-01	3.28E-02	3.68E+00		3.79E+00	1.52E+02	2.72E-03
5.22E-02	1.46E-02	7.11E-01		9.57E+00	3.43E+02	1.41E-02
2.07E-02	6.84E-03	2.09E-01		2.42E+01	7.32E+02	4.79E-02
6.81E-03	2.46E-03	1.14E-01		7.34E+01	2.03E+03	8.76E-02
2.37E-03	8.82E-04	6.72E-02		2.11E+02	5.67E+03	1.49E-01

Pa-231

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pa231	Pa232	U232			Pa231	Pa232	U232
1.00E+01	1.00E+00	5.98E-11	1.80E-15			1.00E+00	5.98E-11	1.80E-15
1.00E+01	1.00E+00	1.79E-10	1.65E-14			1.00E+00	1.79E-10	1.65E-14
1.00E+01	1.00E+00	5.97E-10	1.83E-13			1.00E+00	5.97E-10	1.83E-13
1.00E+01	1.00E+00	1.79E-09	1.65E-12			1.00E+00	1.79E-09	1.65E-12
1.00E+01	1.00E+00	5.96E-09	1.83E-11			1.00E+00	5.96E-09	1.83E-11
1.00E+01	1.00E+00	1.78E-08	1.64E-10			1.00E+00	1.78E-08	1.64E-10
1.00E+01	1.00E+00	5.80E-08	1.80E-09			1.00E+00	5.80E-08	1.80E-09
1.00E+01	1.00E+00	1.64E-07	1.55E-08			1.00E+00	1.64E-07	1.55E-08
1.00E+01	1.00E+00	4.47E-07	1.51E-07			1.00E+00	4.47E-07	1.51E-07
1.00E+01	1.00E+00	8.20E-07	9.72E-07			1.00E+00	8.20E-07	9.72E-07
1.00E+01	1.00E+00	9.74E-07	5.00E-06			1.00E+00	9.74E-07	5.00E-06
1.00E+01	1.00E+00	9.76E-07	1.69E-05			1.00E+00	9.76E-07	1.69E-05
1.00E+01	1.00E+00	9.76E-07	5.87E-05			1.00E+00	9.76E-07	5.87E-05
1.00E+01	1.00E+00	9.76E-07	1.86E-04			1.00E+00	9.76E-07	1.86E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	2.39E-06	3.05E-07	4.17E-09	8.02E+01	1.37E+03	3.31E-03
3.00E+01	6.37E-06	7.77E-07	1.12E-08	8.02E+01	1.37E+03	3.31E-03
1.00E+02	1.61E-05	1.89E-06	3.01E-08	8.02E+01	1.37E+03	3.31E-03
3.00E+02	2.71E-05	3.66E-06	6.18E-08	8.02E+01	1.37E+03	3.31E-03
1.00E+03	3.40E-05	6.64E-06	9.94E-08	8.02E+01	1.37E+03	3.31E-03
3.00E+03	3.67E-05	1.32E-05	1.30E-07	8.03E+01	1.38E+03	3.31E-03
1.00E+04	4.02E-05	3.96E-05	1.95E-07	8.07E+01	1.39E+03	3.34E-03
3.00E+04	4.39E-05	1.09E-04	2.85E-07	8.15E+01	1.42E+03	3.37E-03
1.00E+05	5.02E-05	2.69E-04	4.10E-07	8.42E+01	1.48E+03	3.51E-03
3.00E+05	5.78E-05	5.06E-04	7.20E-07	9.00E+01	1.58E+03	3.76E-03
1.00E+06	7.26E-05	9.26E-04	2.55E-06	1.07E+02	1.62E+03	4.47E-03
3.00E+06	9.58E-05	1.35E-03	7.78E-06	1.52E+02	1.65E+03	6.40E-03
1.00E+07	1.20E-04	1.78E-03	1.13E-05	3.15E+02	1.78E+03	1.33E-02
3.15E+07	1.65E-04	2.90E-03	1.28E-05	8.41E+02	2.71E+03	3.59E-02

Pa231 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+01	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+02	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+02	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
1.0E+04	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03	3.6E-03
3.0E+04	3.5E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03
1.0E+05	3.4E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03
3.0E+05	3.2E-03	3.2E-03	3.2E-03	3.2E-03	3.2E-03	3.2E-03	3.2E-03
1.0E+06	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03
3.0E+06	3.1E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03	3.0E-03
1.0E+07	1.7E-03	1.6E-03	1.6E-03	1.6E-03	1.6E-03	1.6E-03	1.6E-03
3.2E+07	7.0E-04	6.1E-04	6.0E-04	5.9E-04	5.9E-04	5.9E-04	5.9E-04

Pu-238 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu238						*Pu239*					
1.00E+01	2.15E-02	5.47E-03	7.15E-05	1.10E+03	2.94E+04	6.22E-02	5.70E-01	1.73E-01	1.89E-03	1.88E-06	1.35E-01	3.04E-11
3.00E+01	5.75E-02	1.42E-02	1.94E-04	1.10E+03	2.94E+04	6.22E-02	1.50E+00	4.57E-01	5.07E-02	5.63E-06	3.38E-01	9.14E-11
1.00E+02	1.40E-01	3.50E-02	5.10E-04	1.10E+03	2.94E+04	6.22E-02	3.61E+00	1.20E+00	1.33E-02	1.86E-05	7.78E-01	3.04E-10
3.00E+02	2.35E-01	7.06E-02	1.04E-03	1.10E+03	2.94E+04	6.22E-02	6.03E+00	2.73E+00	2.73E-02	5.39E-05	1.38E+00	9.06E-10
1.00E+03	3.14E-01	1.43E-01	1.65E-03	1.10E+03	2.94E+04	6.22E-02	8.13E+00	6.83E+00	4.32E-02	1.63E-04	1.93E+00	2.95E-09
3.00E+03	3.77E-01	3.36E-01	2.00E-03	1.10E+03	2.94E+04	6.22E-02	9.92E+00	1.74E+01	5.21E-02	3.82E-04	2.03E+00	8.49E-09
1.00E+04	4.75E-01	1.16E+00	2.75E-03	1.10E+03	2.94E+04	6.22E-02	1.28E+01	5.10E+01	7.15E-02	8.23E-04	2.06E+00	2.67E-08
3.00E+04	5.99E-01	3.41E+00	4.29E-03	1.10E+03	2.94E+04	6.22E-02	1.69E+01	1.30E+02	1.12E-01	1.87E-03	2.11E+00	7.81E-08
1.00E+05	8.35E-01	8.86E+00	8.13E-03	1.10E+03	2.94E+04	6.22E-02	2.46E+01	3.23E+02	2.11E-01	5.51E-03	2.28E+00	2.58E-07
3.00E+05	1.14E+00	1.77E+01	2.01E-02	1.10E+03	2.94E+04	6.22E-02	3.38E+01	6.30E+02	5.02E-01	1.59E-02	2.99E+00	7.70E-07
1.00E+06	1.71E+00	3.41E+01	9.29E-02	1.10E+03	2.94E+04	6.22E-02	5.01E+01	1.15E+03	2.25E+00	5.23E-02	7.77E+00	2.57E-06
3.00E+06	2.57E+00	4.99E+01	3.00E-01	1.10E+03	2.94E+04	6.22E-02	7.46E+01	1.63E+03	7.19E+00	1.57E-01	2.22E+01	7.70E-06
1.00E+07	3.24E+00	6.11E+01	4.27E-01	1.10E+03	2.94E+04	6.22E-02	9.58E+01	2.01E+03	1.03E+01	5.20E-01	3.80E+01	2.57E-05
3.15E+07	4.16E+00	8.49E+01	4.40E-01	1.10E+03	2.94E+04	6.22E-02	1.28E+02	2.87E+03	1.06E+01	1.64E+00	6.42E+01	8.09E-05

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U234					
1.00E+01	1.08E-03	1.48E-04	2.48E-06	2.46E-04	5.19E-03	1.04E-08
3.00E+01	4.89E-03	9.38E-04	1.27E-05	2.46E-04	5.80E-03	1.04E-08
1.00E+02	1.27E-02	2.15E-03	3.20E-05	2.46E-04	6.87E-03	1.04E-08
3.00E+02	2.11E-02	3.95E-03	6.27E-05	2.46E-04	8.22E-03	1.04E-08
1.00E+03	2.64E-02	7.12E-03	9.72E-05	2.46E-04	9.42E-03	1.04E-08
3.00E+03	2.92E-02	1.50E-02	1.21E-04	2.46E-04	9.58E-03	1.04E-08
1.00E+04	3.32E-02	4.95E-02	1.71E-04	2.46E-04	9.67E-03	1.04E-08
3.00E+04	3.77E-02	1.45E-01	2.55E-04	2.46E-04	9.67E-03	1.04E-08
1.00E+05	4.62E-02	3.80E-01	4.21E-04	2.46E-04	9.83E-03	1.04E-08
3.00E+05	5.80E-02	7.54E-01	9.05E-04	2.46E-04	1.05E-02	1.04E-08
1.00E+06	8.12E-02	1.43E+00	3.81E-03	2.46E-04	1.61E-02	1.04E-08
3.00E+06	1.17E-01	2.11E+00	1.21E-02	2.47E-04	3.33E-02	1.05E-08
1.00E+07	1.51E-01	2.73E+00	1.72E-02	2.50E-04	4.37E-02	1.06E-08
3.15E+07	2.05E-01	4.14E+00	1.79E-02	2.62E-04	4.39E-02	1.11E-08

Pu-238

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu238	Pu239	U234			Pu238	Pu239	U234
1.00E+01	1.00E+00	5.19E-08	5.00E-01			1.00E+00	5.19E-08	5.00E-01
3.00E+01	1.00E+00	1.56E-07	5.00E-01			1.00E+00	1.56E-07	5.00E-01
1.00E+02	1.00E+00	5.19E-07	5.00E-01			1.00E+00	5.19E-07	5.00E-01
3.00E+02	1.00E+00	1.56E-06	5.00E-01			1.00E+00	1.56E-06	5.00E-01
1.00E+03	1.00E+00	5.19E-06	5.00E-01			1.00E+00	5.19E-06	5.00E-01
3.00E+03	1.00E+00	1.56E-05	5.00E-01			1.00E+00	1.56E-05	5.00E-01
1.00E+04	1.00E+00	5.19E-05	5.00E-01			1.00E+00	5.19E-05	5.00E-01
3.00E+04	1.00E+00	1.56E-04	5.00E-01			1.00E+00	1.56E-04	5.00E-01
1.00E+05	9.99E-01	5.19E-04	5.00E-01			1.00E+00	5.19E-04	5.00E-01
3.00E+05	9.98E-01	1.56E-03	5.00E-01			9.99E-01	1.56E-03	5.00E-01
1.00E+06	9.94E-01	5.19E-03	5.00E-01			9.97E-01	5.18E-03	4.99E-01
3.00E+06	9.83E-01	1.56E-02	5.00E-01			9.92E-01	1.55E-02	4.96E-01
1.00E+07	9.45E-01	5.19E-02	5.01E-01			9.72E-01	5.04E-02	4.87E-01
3.15E+07	8.36E-01	1.64E-01	5.04E-01			9.15E-01	1.50E-01	4.61E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	2.20E-02	5.55E-03	7.27E-05	1.10E+03	2.94E+04	6.22E-02
3.00E+01	6.00E-02	1.47E-02	2.00E-04	1.10E+03	2.94E+04	6.22E-02
1.00E+02	1.47E-01	3.61E-02	5.26E-04	1.10E+03	2.94E+04	6.22E-02
3.00E+02	2.46E-01	7.25E-02	1.07E-03	1.10E+03	2.94E+04	6.22E-02
1.00E+03	3.27E-01	1.47E-01	1.70E-03	1.10E+03	2.94E+04	6.22E-02
3.00E+03	3.92E-01	3.44E-01	2.06E-03	1.10E+03	2.94E+04	6.22E-02
1.00E+04	4.93E-01	1.19E+00	2.84E-03	1.10E+03	2.94E+04	6.22E-02
3.00E+04	6.20E-01	3.50E+00	4.44E-03	1.10E+03	2.94E+04	6.22E-02
1.00E+05	8.71E-01	9.21E+00	8.45E-03	1.10E+03	2.94E+04	6.22E-02
3.00E+05	1.22E+00	1.90E+01	2.13E-02	1.10E+03	2.94E+04	6.21E-02
1.00E+06	2.01E+00	4.07E+01	1.06E-01	1.09E+03	2.92E+04	6.18E-02
3.00E+06	3.76E+00	7.56E+01	4.15E-01	1.08E+03	2.89E+04	6.11E-02
1.00E+07	8.06E+00	1.62E+02	9.41E-01	1.04E+03	2.78E+04	5.88E-02
3.15E+07	2.30E+01	5.10E+02	2.01E+00	9.20E+02	2.46E+04	5.20E-02

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
4.55E-04	1.70E-04	1.61E-01		1.10E+03	2.94E+04	6.23E-02
4.55E-04	1.70E-04	1.60E-01		1.10E+03	2.94E+04	6.24E-02
4.54E-04	1.70E-04	1.59E-01		1.10E+03	2.94E+04	6.27E-02
4.54E-04	1.70E-04	1.58E-01		1.10E+03	2.94E+04	6.33E-02
4.54E-04	1.70E-04	1.57E-01		1.10E+03	2.94E+04	6.39E-02
4.54E-04	1.70E-04	1.56E-01		1.10E+03	2.94E+04	6.43E-02
4.54E-04	1.70E-04	1.54E-01		1.10E+03	2.94E+04	6.50E-02
4.54E-04	1.70E-04	1.50E-01		1.10E+03	2.94E+04	6.66E-02
4.54E-04	1.70E-04	1.42E-01		1.10E+03	2.94E+04	7.06E-02
4.55E-04	1.70E-04	1.20E-01		1.10E+03	2.94E+04	8.34E-02
4.56E-04	1.71E-04	5.95E-02		1.10E+03	2.92E+04	1.68E-01
4.61E-04	1.73E-04	2.10E-02		1.09E+03	2.89E+04	4.76E-01
4.77E-04	1.80E-04	1.00E-02		1.05E+03	2.78E+04	1.00E+00
5.30E-04	2.03E-04	4.85E-03		9.43E+02	2.46E+04	2.06E+00

Pu-238

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu238	Pu239	U234			Pu238	Pu239	U234
1.00E+01	1.00E+00	5.19E-11	5.00E-01			1.00E+00	5.19E-11	5.00E-01
3.00E+01	1.00E+00	1.56E-10	5.00E-01			1.00E+00	1.56E-10	5.00E-01
1.00E+02	1.00E+00	5.19E-10	5.00E-01			1.00E+00	5.19E-10	5.00E-01
3.00E+02	1.00E+00	1.56E-09	5.00E-01			1.00E+00	1.56E-09	5.00E-01
1.00E+03	1.00E+00	5.19E-09	5.00E-01			1.00E+00	5.19E-09	5.00E-01
3.00E+03	1.00E+00	1.56E-08	5.00E-01			1.00E+00	1.56E-08	5.00E-01
1.00E+04	1.00E+00	5.19E-08	5.00E-01			1.00E+00	5.19E-08	5.00E-01
3.00E+04	1.00E+00	1.56E-07	5.00E-01			1.00E+00	1.56E-07	5.00E-01
1.00E+05	1.00E+00	5.19E-07	5.00E-01			1.00E+00	5.19E-07	5.00E-01
3.00E+05	1.00E+00	1.56E-06	5.00E-01			1.00E+00	1.56E-06	5.00E-01
1.00E+06	1.00E+00	5.19E-06	5.00E-01			1.00E+00	5.19E-06	5.00E-01
3.00E+06	9.99E-01	1.56E-05	5.00E-01			1.00E+00	1.56E-05	5.00E-01
1.00E+07	9.97E-01	5.19E-05	5.01E-01			9.99E-01	5.18E-05	5.00E-01
3.15E+07	9.92E-01	1.64E-04	5.04E-01			9.96E-01	1.63E-04	5.02E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	2.20E-05	5.55E-06	7.27E-08	1.10E+03	2.94E+04	6.22E-02
3.00E+01	6.00E-05	1.47E-05	2.00E-07	1.10E+03	2.94E+04	6.22E-02
1.00E+02	1.47E-04	3.61E-05	5.26E-07	1.10E+03	2.94E+04	6.22E-02
3.00E+02	2.46E-04	7.25E-05	1.07E-06	1.10E+03	2.94E+04	6.22E-02
1.00E+03	3.27E-04	1.47E-04	1.70E-06	1.10E+03	2.94E+04	6.22E-02
3.00E+03	3.92E-04	3.44E-04	2.06E-06	1.10E+03	2.94E+04	6.22E-02
1.00E+04	4.92E-04	1.19E-03	2.84E-06	1.10E+03	2.94E+04	6.22E-02
3.00E+04	6.18E-04	3.48E-03	4.42E-06	1.10E+03	2.94E+04	6.22E-02
1.00E+05	8.59E-04	9.05E-03	8.34E-06	1.10E+03	2.94E+04	6.22E-02
3.00E+05	1.17E-03	1.81E-02	2.05E-05	1.10E+03	2.94E+04	6.22E-02
1.00E+06	1.75E-03	3.48E-02	9.48E-05	1.10E+03	2.94E+04	6.22E-02
3.00E+06	2.62E-03	5.10E-02	3.06E-04	1.10E+03	2.94E+04	6.21E-02
1.00E+07	3.32E-03	6.25E-02	4.36E-04	1.10E+03	2.93E+04	6.20E-02
3.15E+07	4.27E-03	8.71E-02	4.49E-04	1.09E+03	2.92E+04	6.17E-02

Pu238 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.0E+01	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
1.0E+02	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.0E+02	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
1.0E+03	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.0E+03	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
1.0E+04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.0E+04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
1.0E+05	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.0E+05	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
1.0E+06	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.0E+06	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
1.0E+07	1.8E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
3.2E+07	2.0E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04

Pu-239 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu239						Pu240					
1.00E+01	5.71E-01	1.49E-01	1.86E-03	4.57E+00	1.07E+02	2.25E-04	2.50E-03	7.24E-04	8.84E-06	8.67E-04	2.24E-02	8.04E-09
3.00E+01	1.53E+00	3.91E-01	5.06E-03	4.57E+00	1.07E+02	2.25E-04	6.62E-03	1.88E-03	2.40E-05	2.60E-03	6.70E-02	2.40E-08
1.00E+02	3.68E+00	9.68E-01	1.34E-02	4.57E+00	1.08E+02	2.25E-04	1.57E-02	4.54E-03	6.26E-05	8.67E-03	2.22E-01	8.04E-08
3.00E+02	6.14E+00	1.98E+00	2.74E-02	4.57E+00	1.08E+02	2.25E-04	2.59E-02	9.07E-03	1.27E-04	2.60E-02	6.59E-01	2.40E-07
1.00E+03	8.28E+00	4.22E+00	4.36E-02	4.57E+00	1.08E+02	2.25E-04	3.52E-02	1.87E-02	2.01E-04	8.67E-02	2.18E+00	8.04E-07
3.00E+03	1.01E+01	1.04E+01	5.34E-02	4.57E+00	1.08E+02	2.25E-04	4.38E-02	4.51E-02	2.40E-04	2.60E-01	6.49E+00	2.40E-06
1.00E+04	1.31E+01	3.66E+01	7.52E-02	4.57E+00	1.08E+02	2.25E-04	5.81E-02	1.56E-01	3.24E-04	8.67E-01	2.16E+01	8.04E-06
3.00E+04	1.73E+01	1.08E+02	1.22E-01	4.57E+00	1.08E+02	2.25E-04	7.72E-02	4.54E-01	5.07E-04	2.60E+00	6.48E+01	2.40E-05
1.00E+05	2.50E+01	2.78E+02	2.39E-01	4.58E+00	1.09E+02	2.25E-04	1.12E-01	1.14E+00	9.67E-04	8.67E+00	2.16E+02	8.04E-05
3.00E+05	3.45E+01	5.44E+02	5.86E-01	4.58E+00	1.09E+02	2.26E-04	1.50E-01	2.14E+00	2.23E-03	2.60E+01	6.48E+02	2.40E-04
1.00E+06	5.11E+01	1.02E+03	2.66E+00	4.62E+00	1.14E+02	2.28E-04	2.09E-01	3.81E+00	9.51E-03	8.67E+01	2.16E+03	8.04E-04
3.00E+06	7.60E+01	1.49E+03	8.57E+00	4.73E+00	1.28E+02	2.33E-04	2.96E-01	5.43E+00	3.01E-02	2.60E+02	6.48E+03	2.40E-03
1.00E+07	9.77E+01	1.88E+03	1.22E+01	5.08E+00	1.44E+02	2.51E-04	3.70E-01	6.70E+00	4.27E-02	8.67E+02	2.16E+04	8.04E-03
3.15E+07	1.30E+02	2.76E+03	1.27E+01	6.21E+00	1.71E+02	5.11E-03	4.79E-01	9.49E+00	4.42E-02	2.78E+03	6.82E+04	2.54E-02

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U235					
1.00E+01	4.41E-01	7.26E-02	1.12E-03	5.93E-11	1.86E-01	2.78E-11
3.00E+01	2.33E+00	4.80E-01	6.19E-03	5.93E-11	4.52E-01	2.78E-11
1.00E+02	5.62E+00	1.09E+00	1.54E-02	5.93E-11	9.75E-01	2.78E-11
3.00E+02	8.99E+00	1.99E+00	2.98E-02	5.93E-11	1.61E+00	2.78E-11
1.00E+03	1.11E+01	3.76E+00	4.60E-02	5.93E-11	2.17E+00	2.78E-11
3.00E+03	1.25E+01	8.58E+00	5.73E-02	5.97E-07	2.25E+00	2.81E-11
1.00E+04	1.44E+01	2.83E+01	8.22E-02	6.13E-07	2.28E+00	2.87E-11
3.00E+04	1.65E+01	7.99E+01	1.24E-01	6.59E-07	2.31E+00	3.10E-11
1.00E+05	2.04E+01	1.98E+02	2.03E-01	8.22E-07	2.36E+00	3.86E-11
3.00E+05	2.52E+01	3.56E+02	3.90E-01	1.28E-06	2.61E+00	6.05E-11
1.00E+06	3.33E+01	5.89E+02	1.41E+00	2.91E-06	4.57E+00	1.37E-10
3.00E+06	4.54E+01	8.05E+02	4.26E+00	7.53E-06	1.05E+01	3.55E-10
1.00E+07	5.56E+01	9.53E+02	6.00E+00	2.38E-05	1.41E+01	1.12E-09
3.15E+07	6.93E+01	1.27E+03	6.16E+00	7.35E-05	1.41E+01	3.46E-09

Pu-239

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu239	Pu240	U235			Pu239	Pu240	U235
1.00E+01	1.00E+00	3.11E-08	1.42E-03			1.00E+00	3.11E-08	1.42E-03
3.00E+01	1.00E+00	9.34E-08	1.42E-03			1.00E+00	9.34E-08	1.42E-03
1.00E+02	1.00E+00	3.11E-07	1.42E-03			1.00E+00	3.11E-07	1.42E-03
3.00E+02	1.00E+00	9.34E-07	1.42E-03			1.00E+00	9.34E-07	1.42E-03
1.00E+03	1.00E+00	3.11E-06	1.42E-03			1.00E+00	3.11E-06	1.42E-03
3.00E+03	1.00E+00	9.34E-06	1.42E-03			1.00E+00	9.34E-06	1.42E-03
1.00E+04	1.00E+00	3.11E-05	1.42E-03			1.00E+00	3.11E-05	1.42E-03
3.00E+04	1.00E+00	9.34E-05	1.42E-03			1.00E+00	9.34E-05	1.42E-03
1.00E+05	9.99E-01	3.11E-04	1.42E-03			9.99E-01	3.11E-04	1.42E-03
3.00E+05	9.97E-01	9.34E-04	1.42E-03			9.98E-01	9.32E-04	1.42E-03
1.00E+06	9.89E-01	3.11E-03	1.42E-03			9.95E-01	3.09E-03	1.41E-03
3.00E+06	9.68E-01	9.34E-03	1.42E-03			9.84E-01	9.19E-03	1.40E-03
1.00E+07	8.96E-01	3.11E-02	1.42E-03			9.47E-01	2.95E-02	1.34E-03
3.15E+07	7.07E-01	9.81E-02	1.44E-03			8.45E-01	8.29E-02	1.22E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	5.71E-01	1.49E-01	1.86E-03	4.57E+00	1.07E+02	2.25E-04
3.00E+01	1.53E+00	3.92E-01	5.07E-03	4.57E+00	1.07E+02	2.25E-04
1.00E+02	3.68E+00	9.69E-01	1.34E-02	4.57E+00	1.08E+02	2.25E-04
3.00E+02	6.15E+00	1.98E+00	2.75E-02	4.57E+00	1.08E+02	2.25E-04
1.00E+03	8.30E+00	4.22E+00	4.37E-02	4.57E+00	1.08E+02	2.25E-04
3.00E+03	1.01E+01	1.04E+01	5.35E-02	4.57E+00	1.08E+02	2.25E-04
1.00E+04	1.31E+01	3.67E+01	7.54E-02	4.57E+00	1.08E+02	2.25E-04
3.00E+04	1.73E+01	1.08E+02	1.22E-01	4.57E+00	1.08E+02	2.25E-04
1.00E+05	2.51E+01	2.79E+02	2.40E-01	4.57E+00	1.09E+02	2.25E-04
3.00E+05	3.45E+01	5.44E+02	5.86E-01	4.59E+00	1.09E+02	2.26E-04
1.00E+06	5.08E+01	1.02E+03	2.65E+00	4.84E+00	1.20E+02	2.28E-04
3.00E+06	7.48E+01	1.47E+03	8.43E+00	7.00E+00	1.85E+02	2.48E-04
1.00E+07	9.26E+01	1.79E+03	1.16E+01	3.15E+01	8.00E+02	4.75E-04
3.15E+07	1.10E+02	2.34E+03	1.07E+01	2.77E+02	6.81E+03	6.11E-03

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
9.73E-02	4.69E-02	4.80E+00		5.14E+00	1.07E+02	2.08E-03
8.20E-02	4.69E-02	1.89E+00		6.10E+00	1.07E+02	5.30E-03
6.06E-02	4.65E-02	7.34E-01		8.25E+00	1.08E+02	1.36E-02
4.66E-02	4.65E-02	3.61E-01		1.07E+01	1.08E+02	2.77E-02
3.89E-02	4.62E-02	2.28E-01		1.29E+01	1.08E+02	4.39E-02
3.40E-02	4.62E-02	1.86E-01		1.47E+01	1.08E+02	5.37E-02
2.83E-02	4.62E-02	1.32E-01		1.77E+01	1.08E+02	7.56E-02
2.29E-02	4.62E-02	8.18E-02		2.19E+01	1.08E+02	1.22E-01
1.69E-02	1.80E-02	4.17E-02		2.96E+01	2.79E+02	2.40E-01
1.28E-02	9.19E-03	1.71E-02		3.91E+01	5.44E+02	5.86E-01
8.98E-03	4.92E-03	3.77E-03		5.57E+01	1.02E+03	2.65E+00
6.11E-03	3.41E-03	1.19E-03		8.18E+01	1.47E+03	8.43E+00
4.03E-03	2.80E-03	8.64E-04		1.24E+02	1.79E+03	1.16E+01
1.29E-03	7.34E-04	9.33E-04		3.87E+02	6.81E+03	1.07E+01

Pu-239

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu239	Pu240	U235			Pu239	Pu240	U235
1.00E+01	1.00E+00	3.11E-11	1.42E-03			1.00E+00	3.11E-11	1.42E-03
3.00E+01	1.00E+00	9.34E-11	1.42E-03			1.00E+00	9.34E-11	1.42E-03
1.00E+02	1.00E+00	3.11E-10	1.42E-03			1.00E+00	3.11E-10	1.42E-03
3.00E+02	1.00E+00	9.34E-10	1.42E-03			1.00E+00	9.34E-10	1.42E-03
1.00E+03	1.00E+00	3.11E-09	1.42E-03			1.00E+00	3.11E-09	1.42E-03
3.00E+03	1.00E+00	9.34E-09	1.42E-03			1.00E+00	9.34E-09	1.42E-03
1.00E+04	1.00E+00	3.11E-08	1.42E-03			1.00E+00	3.11E-08	1.42E-03
3.00E+04	1.00E+00	9.34E-08	1.42E-03			1.00E+00	9.34E-08	1.42E-03
1.00E+05	1.00E+00	3.11E-07	1.42E-03			1.00E+00	3.11E-07	1.42E-03
3.00E+05	1.00E+00	9.34E-07	1.42E-03			1.00E+00	9.34E-07	1.42E-03
1.00E+06	1.00E+00	3.11E-06	1.42E-03			1.00E+00	3.11E-06	1.42E-03
3.00E+06	1.00E+00	9.34E-06	1.42E-03			1.00E+00	9.34E-06	1.42E-03
1.00E+07	1.00E+00	3.11E-05	1.42E-03			1.00E+00	3.11E-05	1.42E-03
3.15E+07	1.00E+00	9.81E-05	1.44E-03			1.00E+00	9.81E-05	1.44E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	5.71E-04	1.49E-04	1.86E-06	4.57E+00	1.07E+02	2.25E-04
3.00E+01	1.53E-03	3.92E-04	5.07E-06	4.57E+00	1.07E+02	2.25E-04
1.00E+02	3.68E-03	9.69E-04	1.34E-05	4.57E+00	1.08E+02	2.25E-04
3.00E+02	6.15E-03	1.98E-03	2.75E-05	4.57E+00	1.08E+02	2.25E-04
1.00E+03	8.30E-03	4.22E-03	4.37E-05	4.57E+00	1.08E+02	2.25E-04
3.00E+03	1.01E-02	1.04E-02	5.35E-05	4.57E+00	1.08E+02	2.25E-04
1.00E+04	1.31E-02	3.67E-02	7.54E-05	4.57E+00	1.08E+02	2.25E-04
3.00E+04	1.73E-02	1.08E-01	1.22E-04	4.57E+00	1.08E+02	2.25E-04
1.00E+05	2.51E-02	2.79E-01	2.40E-04	4.57E+00	1.09E+02	2.25E-04
3.00E+05	3.46E-02	5.45E-01	5.87E-04	4.58E+00	1.09E+02	2.26E-04
1.00E+06	5.11E-02	1.02E+00	2.67E-03	4.62E+00	1.14E+02	2.28E-04
3.00E+06	7.60E-02	1.49E+00	8.57E-03	4.73E+00	1.28E+02	2.33E-04
1.00E+07	9.77E-02	1.89E+00	1.22E-02	5.11E+00	1.45E+02	2.51E-04
3.15E+07	1.30E-01	2.76E+00	1.27E-02	6.48E+00	1.77E+02	5.11E-03

Pu239 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02
3.0E+01	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02
1.0E+02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02
3.0E+02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02	4.7E-02
1.0E+03	3.9E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
3.0E+03	3.4E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
1.0E+04	2.8E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
3.0E+04	2.3E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
1.0E+05	1.7E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
3.0E+05	9.2E-03	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
1.0E+06	3.8E-03	3.8E-02	4.4E-02	4.4E-02	4.4E-02	4.4E-02	4.4E-02
3.0E+06	1.2E-03	1.2E-02	3.9E-02	3.9E-02	3.9E-02	3.9E-02	3.9E-02
1.0E+07	8.6E-04	8.2E-03	3.3E-02	3.5E-02	3.5E-02	3.5E-02	3.5E-02
3.2E+07	7.3E-04	6.0E-03	2.1E-02	2.8E-02	2.9E-02	2.9E-02	2.9E-02

Pu-240 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu240						Pu241					
1.00E+01	4.54E-05	1.29E-05	1.56E-07	1.66E+02	2.21E+03	2.89E-03	8.71E-01	2.56E-01	2.96E-03	1.31E-08	2.92E-01	1.90E-12
3.00E+01	1.21E-04	3.33E-05	4.23E-07	1.66E+02	2.21E+03	2.89E-03	2.29E+00	6.52E-01	7.95E-03	3.94E-08	7.08E-01	5.70E-12
1.00E+02	2.85E-04	8.01E-05	1.10E-06	1.66E+02	2.21E+03	2.89E-03	5.36E+00	1.53E+00	2.05E-02	1.31E-07	1.56E+00	1.90E-11
3.00E+02	4.70E-04	1.59E-04	2.24E-06	1.66E+02	2.21E+03	2.89E-03	8.78E+00	2.94E+00	4.10E-02	3.94E-07	2.63E+00	5.70E-11
1.00E+03	6.33E-04	3.27E-04	3.54E-06	1.66E+02	2.21E+03	2.89E-03	1.19E+01	5.86E+00	6.41E-02	1.31E-06	3.61E+00	1.90E-10
3.00E+03	7.79E-04	7.86E-04	4.25E-06	1.66E+02	2.21E+03	2.89E-03	1.47E+01	1.38E+01	7.62E-02	3.94E-06	3.76E+00	5.70E-10
1.00E+04	1.02E-03	2.72E-03	5.78E-06	1.66E+02	2.21E+03	2.89E-03	1.96E+01	4.70E+01	1.02E-01	1.31E-05	3.79E+00	1.90E-09
3.00E+04	1.32E-03	7.87E-03	9.05E-06	1.66E+02	2.22E+03	2.89E-03	2.66E+01	1.35E+02	1.57E-01	3.94E-05	3.82E+00	5.70E-09
1.00E+05	1.88E-03	1.98E-02	1.70E-05	1.66E+02	2.22E+03	2.90E-03	3.87E+01	3.37E+02	2.93E-01	1.31E-04	3.93E+00	1.90E-08
3.00E+05	2.52E-03	3.69E-02	3.85E-05	1.67E+02	2.24E+03	2.92E-03	5.12E+01	6.25E+02	6.57E-01	3.94E-04	4.52E+00	5.70E-08
1.00E+06	3.52E-03	6.52E-02	1.61E-04	1.70E+02	2.30E+03	2.98E-03	6.82E+01	1.10E+03	2.72E+00	1.31E-03	9.18E+00	1.90E-07
3.00E+06	5.00E-03	9.31E-02	5.06E-04	1.77E+02	2.48E+03	3.17E-03	9.30E+01	1.55E+03	8.48E+00	3.94E-03	2.32E+01	5.70E-07
1.00E+07	6.37E-03	1.18E-01	7.19E-04	2.01E+02	3.09E+03	3.84E-03	1.15E+02	1.94E+03	1.20E+01	1.31E-02	3.19E+01	1.90E-06
3.15E+07	8.50E-03	1.74E-01	7.47E-04	2.79E+02	4.97E+03	5.91E-03	1.49E+02	2.81E+03	1.25E+01	4.13E-02	3.26E+01	5.98E-06

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Am241						U236					
1.00E+01	1.05E-03	2.10E-04	3.37E-06	1.08E-03	1.12E-02	1.23E-07	3.19E-03	5.01E-04	7.41E-06	2.91E-06	1.83E-03	3.58E-10
3.00E+01	4.83E-03	1.36E-03	1.80E-05	3.23E-03	3.41E-02	3.69E-07	1.73E-02	3.81E-03	4.73E-05	8.72E-06	4.83E-03	1.07E-09
1.00E+02	1.14E-02	3.46E-03	4.90E-05	1.08E-02	1.12E-01	1.23E-06	4.16E-02	8.36E-03	1.16E-04	2.91E-05	9.20E-03	3.58E-09
3.00E+02	1.92E-02	7.16E-03	1.03E-04	3.23E-02	3.31E-01	3.69E-06	6.69E-02	1.49E-02	2.23E-04	8.72E-05	1.49E-02	1.07E-08
1.00E+03	2.74E-02	1.50E-02	1.64E-04	1.07E-01	1.08E+00	1.23E-05	8.34E-02	2.66E-02	3.43E-04	2.91E-04	1.99E-02	3.58E-08
3.00E+03	3.61E-02	3.59E-02	1.98E-04	3.18E-01	3.19E+00	3.64E-05	9.35E-02	5.68E-02	4.19E-04	8.71E-04	2.07E-02	1.07E-07
1.00E+04	5.19E-02	1.25E-01	2.68E-04	1.02E+00	1.02E+01	1.16E-04	1.08E-01	1.84E-01	5.80E-04	2.89E-03	2.09E-02	3.56E-07
3.00E+04	7.60E-02	3.66E-01	4.25E-04	2.72E+00	2.72E+01	3.11E-04	1.23E-01	5.25E-01	8.55E-04	8.57E-03	2.11E-02	1.06E-06
1.00E+05	1.22E-01	9.56E-01	8.46E-04	6.30E+00	6.30E+01	7.19E-04	1.50E-01	1.30E+00	1.38E-03	2.47E-02	2.16E-02	3.38E-06
3.00E+05	1.72E-01	1.92E+00	2.16E-03	8.81E+00	8.81E+01	1.01E-03	1.83E-01	2.34E+00	2.61E-03	7.34E-02	2.35E-02	9.03E-06
1.00E+06	2.38E-01	3.74E+00	1.02E-02	9.24E+00	9.28E+01	1.07E-03	2.37E-01	3.88E+00	9.31E-03	1.70E-01	3.89E-02	2.09E-05
3.00E+06	3.34E-01	5.56E+00	3.30E-02	9.88E+00	9.88E+01	1.15E-03	3.19E-01	5.36E+00	2.79E-02	2.38E-01	8.50E-02	2.93E-05
1.00E+07	4.19E-01	7.12E+00	4.71E-02	1.20E+01	1.21E+02	1.45E-03	3.96E-01	6.62E+00	3.94E-02	2.45E-01	1.13E-01	3.01E-05
3.15E+07	5.49E-01	1.07E+01	4.89E-02	1.89E+01	1.98E+02	2.42E-03	5.14E-01	9.44E+00	4.08E-02	2.45E-01	1.13E-01	3.01E-05

Pu-240

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu240	Pu241	Am241	U236	Pu240	Pu241	Am241	U236
1.00E+01	1.00E+00	2.86E-08	0.00E+00	4.92E-01	1.00E+00	2.86E-08	0.00E+00	4.92E-01
3.00E+01	1.00E+00	8.58E-08	0.00E+00	4.92E-01	1.00E+00	8.58E-08	0.00E+00	4.92E-01
1.00E+02	1.00E+00	2.86E-07	0.00E+00	4.92E-01	1.00E+00	2.86E-07	0.00E+00	4.92E-01
3.00E+02	1.00E+00	8.58E-07	0.00E+00	4.92E-01	1.00E+00	8.58E-07	0.00E+00	4.92E-01
1.00E+03	1.00E+00	2.86E-06	2.20E-12	4.92E-01	1.00E+00	2.86E-06	2.20E-12	4.92E-01
3.00E+03	1.00E+00	8.58E-06	2.00E-11	4.92E-01	1.00E+00	8.58E-06	2.00E-11	4.92E-01
1.00E+04	1.00E+00	2.86E-05	2.20E-10	4.92E-01	1.00E+00	2.86E-05	2.20E-10	4.92E-01
3.00E+04	1.00E+00	8.58E-05	2.00E-09	4.92E-01	1.00E+00	8.58E-05	2.00E-09	4.92E-01
1.00E+05	1.00E+00	2.86E-04	2.20E-08	4.92E-01	1.00E+00	2.86E-04	2.20E-08	4.92E-01
3.00E+05	9.99E-01	8.58E-04	2.00E-07	4.92E-01	1.00E+00	8.58E-04	2.00E-07	4.92E-01
1.00E+06	9.97E-01	2.86E-03	2.19E-06	4.92E-01	9.99E-01	2.86E-03	2.19E-06	4.91E-01
3.00E+06	9.91E-01	8.56E-03	2.00E-05	4.92E-01	9.96E-01	8.52E-03	1.99E-05	4.90E-01
1.00E+07	9.72E-01	2.84E-02	2.18E-04	4.92E-01	9.86E-01	2.80E-02	2.15E-04	4.85E-01
3.15E+07	9.14E-01	8.79E-02	2.14E-03	4.92E-01	9.56E-01	8.41E-02	2.05E-03	4.70E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.61E-03	2.59E-04	3.80E-06	1.66E+02	2.21E+03	2.89E-03
3.00E+01	8.63E-03	1.91E-03	2.37E-05	1.66E+02	2.21E+03	2.89E-03
1.00E+02	2.07E-02	4.19E-03	5.82E-05	1.66E+02	2.21E+03	2.89E-03
3.00E+02	3.34E-02	7.49E-03	1.12E-04	1.66E+02	2.21E+03	2.89E-03
1.00E+03	4.17E-02	1.35E-02	1.73E-04	1.66E+02	2.21E+03	2.89E-03
3.00E+03	4.69E-02	2.89E-02	2.11E-04	1.66E+02	2.21E+03	2.89E-03
1.00E+04	5.46E-02	9.48E-02	2.94E-04	1.66E+02	2.21E+03	2.89E-03
3.00E+04	6.40E-02	2.78E-01	4.43E-04	1.66E+02	2.22E+03	2.89E-03
1.00E+05	8.67E-02	7.56E-01	7.77E-04	1.66E+02	2.22E+03	2.90E-03
3.00E+05	1.36E-01	1.72E+00	1.89E-03	1.67E+02	2.24E+03	2.92E-03
1.00E+06	3.15E-01	5.10E+00	1.25E-02	1.70E+02	2.29E+03	2.98E-03
3.00E+06	9.54E-01	1.60E+01	8.65E-02	1.76E+02	2.46E+03	3.16E-03
1.00E+07	3.43E+00	5.77E+01	3.56E-01	1.95E+02	3.00E+03	3.75E-03
3.15E+07	1.28E+01	2.41E+02	1.07E+00	2.55E+02	4.54E+03	5.42E-03

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
3.01E-03	2.26E-03	3.46E+00	1.66E+02	2.21E+03	2.89E-03
3.01E-03	2.26E-03	3.43E+00	1.66E+02	2.21E+03	2.91E-03
3.01E-03	2.26E-03	3.39E+00	1.66E+02	2.21E+03	2.95E-03
3.01E-03	2.26E-03	3.33E+00	1.66E+02	2.21E+03	3.00E-03
3.01E-03	2.26E-03	3.27E+00	1.66E+02	2.21E+03	3.06E-03
3.01E-03	2.26E-03	3.22E+00	1.66E+02	2.21E+03	3.10E-03
3.01E-03	2.26E-03	3.14E+00	1.66E+02	2.21E+03	3.18E-03
3.01E-03	2.25E-03	3.00E+00	1.66E+02	2.22E+03	3.33E-03
3.01E-03	2.25E-03	2.72E+00	1.66E+02	2.22E+03	3.68E-03
2.99E-03	2.23E-03	2.08E+00	1.67E+02	2.24E+03	4.81E-03
2.94E-03	2.18E-03	6.46E-01	1.70E+02	2.29E+03	1.55E-02
2.83E-03	2.03E-03	1.12E-01	1.77E+02	2.46E+03	8.96E-02
2.51E-03	1.66E-03	2.78E-02	1.99E+02	3.00E+03	3.60E-01
1.87E-03	1.10E-03	9.32E-03	2.68E+02	4.54E+03	1.07E+00

Pu-240

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu240	Pu241	Am241	U236		Pu240	Pu241	Am241	U236
1.00E+01	1.00E+00	2.86E-11	0.00E+00	4.92E-01		1.00E+00	2.86E-11	0.00E+00	4.92E-01
3.00E+01	1.00E+00	8.58E-11	0.00E+00	4.92E-01		1.00E+00	8.58E-11	0.00E+00	4.92E-01
1.00E+02	1.00E+00	2.86E-10	0.00E+00	4.92E-01		1.00E+00	2.86E-10	0.00E+00	4.92E-01
3.00E+02	1.00E+00	8.58E-10	0.00E+00	4.92E-01		1.00E+00	8.58E-10	0.00E+00	4.92E-01
1.00E+03	1.00E+00	2.86E-09	2.20E-15	4.92E-01		1.00E+00	2.86E-09	2.20E-15	4.92E-01
3.00E+03	1.00E+00	8.58E-09	2.00E-14	4.92E-01		1.00E+00	8.58E-09	2.00E-14	4.92E-01
1.00E+04	1.00E+00	2.86E-08	2.20E-13	4.92E-01		1.00E+00	2.86E-08	2.20E-13	4.92E-01
3.00E+04	1.00E+00	8.58E-08	2.00E-12	4.92E-01		1.00E+00	8.58E-08	2.00E-12	4.92E-01
1.00E+05	1.00E+00	2.86E-07	2.20E-11	4.92E-01		1.00E+00	2.86E-07	2.20E-11	4.92E-01
3.00E+05	1.00E+00	8.58E-07	2.00E-10	4.92E-01		1.00E+00	8.58E-07	2.00E-10	4.92E-01
1.00E+06	1.00E+00	2.86E-06	2.19E-09	4.92E-01		1.00E+00	2.86E-06	2.19E-09	4.92E-01
3.00E+06	1.00E+00	8.56E-06	2.00E-08	4.92E-01		1.00E+00	8.56E-06	2.00E-08	4.92E-01
1.00E+07	1.00E+00	2.84E-05	2.18E-07	4.92E-01		1.00E+00	2.84E-05	2.18E-07	4.92E-01
3.15E+07	1.00E+00	8.79E-05	2.14E-06	4.92E-01		1.00E+00	8.79E-05	2.14E-06	4.92E-01

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.61E-06	2.59E-07	3.80E-09	1.66E+02	2.21E+03	2.89E-03
3.00E+01	8.63E-06	1.91E-06	2.37E-08	1.66E+02	2.21E+03	2.89E-03
1.00E+02	2.07E-05	4.19E-06	5.82E-08	1.66E+02	2.21E+03	2.89E-03
3.00E+02	3.34E-05	7.49E-06	1.12E-07	1.66E+02	2.21E+03	2.89E-03
1.00E+03	4.17E-05	1.34E-05	1.72E-07	1.66E+02	2.21E+03	2.89E-03
3.00E+03	4.68E-05	2.87E-05	2.11E-07	1.66E+02	2.21E+03	2.89E-03
1.00E+04	5.40E-05	9.35E-05	2.91E-07	1.66E+02	2.21E+03	2.89E-03
3.00E+04	6.17E-05	2.66E-04	4.30E-07	1.66E+02	2.22E+03	2.89E-03
1.00E+05	7.57E-05	6.60E-04	6.94E-07	1.66E+02	2.22E+03	2.90E-03
3.00E+05	9.24E-05	1.19E-03	1.33E-06	1.67E+02	2.24E+03	2.92E-03
1.00E+06	1.20E-04	1.98E-03	4.75E-06	1.70E+02	2.30E+03	2.99E-03
3.00E+06	1.63E-04	2.75E-03	1.43E-05	1.77E+02	2.48E+03	3.18E-03
1.00E+07	2.05E-04	3.43E-03	2.04E-05	2.01E+02	3.09E+03	3.85E-03
3.15E+07	2.74E-04	5.07E-03	2.19E-05	2.79E+02	4.97E+03	5.92E-03

Pu240 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+01	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+02	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+02	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+04	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+04	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
1.0E+05	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03	2.3E-03
3.0E+05	2.2E-03	2.2E-03	2.2E-03	2.2E-03	2.2E-03	2.2E-03	2.2E-03
1.0E+06	2.2E-03	2.2E-03	2.2E-03	2.2E-03	2.2E-03	2.2E-03	2.2E-03
3.0E+06	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03	2.0E-03
1.0E+07	1.7E-03	1.6E-03	1.6E-03	1.6E-03	1.6E-03	1.6E-03	1.6E-03
3.2E+07	1.1E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03

Pu-241 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu241						Pu242					
1.00E+01	8.71E-01	2.56E-01	2.96E-03	3.96E+02	8.24E+03	1.56E-02	9.33E-04	2.75E-04	3.18E-06	7.57E-06	1.37E-03	1.12E-06
3.00E+01	2.29E+00	6.52E-01	7.95E-03	3.96E+02	8.24E+03	1.56E-02	2.44E-03	6.99E-04	8.54E-06	2.27E-05	1.37E-03	3.36E-06
1.00E+02	5.36E+00	1.53E+00	2.05E-02	3.96E+02	8.24E+03	1.56E-02	5.63E-03	1.63E-03	2.18E-05	7.56E-05	1.37E-03	1.12E-05
3.00E+02	8.78E+00	2.94E+00	4.10E-02	3.96E+02	8.24E+03	1.56E-02	9.19E-03	3.11E-03	4.34E-05	2.26E-04	1.38E-03	3.35E-05
1.00E+03	1.19E+01	5.86E+00	6.41E-02	3.96E+02	8.25E+03	1.56E-02	1.26E-02	6.21E-03	6.77E-05	7.48E-04	1.45E-03	1.10E-04
3.00E+03	1.47E+01	1.38E+01	7.62E-02	3.96E+02	8.25E+03	1.56E-02	1.61E-02	1.47E-02	8.01E-05	2.19E-03	2.03E-03	3.21E-04
1.00E+04	1.96E+01	4.70E+01	1.02E-01	3.96E+02	8.25E+03	1.56E-02	2.28E-02	5.01E-02	1.06E-04	6.77E-03	8.04E-03	9.74E-04
3.00E+04	2.66E+01	1.35E+02	1.57E-01	3.96E+02	8.25E+03	1.56E-02	3.34E-02	1.43E-01	1.62E-04	1.70E-02	4.92E-02	2.32E-03
1.00E+05	3.87E+01	3.37E+02	2.93E-01	3.96E+02	8.25E+03	1.56E-02	5.21E-02	3.53E-01	3.00E-04	4.09E-02	2.92E-01	4.88E-03
3.00E+05	5.12E+01	6.25E+02	6.57E-01	3.96E+02	8.25E+03	1.56E-02	6.97E-02	6.38E-01	6.49E-04	9.92E-02	1.07E+00	1.04E-02
1.00E+06	6.82E+01	1.10E+03	2.72E+00	3.97E+02	8.26E+03	1.56E-02	8.68E-02	1.08E+00	2.57E-03	3.04E-01	3.79E+00	2.95E-02
3.00E+06	9.30E+01	1.55E+03	8.48E+00	3.97E+02	8.28E+03	1.56E-02	1.10E-01	1.52E+00	7.94E-03	8.92E-01	1.16E+01	8.46E-02
1.00E+07	1.15E+02	1.94E+03	1.20E+01	3.99E+02	8.32E+03	1.56E-02	1.33E-01	1.93E+00	1.13E-02	2.93E+00	3.88E+01	2.77E-01
3.15E+07	1.49E+02	2.81E+03	1.25E+01	4.06E+02	8.42E+03	1.58E-02	1.69E-01	2.86E+00	1.17E-02	9.17E+00	1.23E+02	8.66E-01

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Am241						Np237					
1.00E+01	3.59E-03	7.19E-04	1.15E-05	9.25E-03	1.60E-01	4.71E-07	1.47E-03	3.12E-04	3.86E-06	1.53E-04	3.24E-03	6.36E-09
3.00E+01	1.65E-02	4.67E-03	6.15E-05	1.35E-02	2.04E-01	6.36E-07	3.82E-03	7.98E-04	1.04E-05	4.48E-04	9.58E-03	1.85E-08
1.00E+02	3.89E-02	1.18E-02	1.68E-04	2.83E-02	3.57E-01	1.21E-06	9.00E-03	1.91E-03	2.69E-05	1.48E-03	3.11E-02	6.11E-08
3.00E+02	6.59E-02	2.45E-02	3.51E-04	7.03E-02	7.85E-01	3.12E-06	1.46E-02	3.76E-03	5.42E-05	4.43E-03	9.08E-02	1.83E-07
1.00E+03	9.39E-02	5.13E-02	5.63E-04	2.17E-01	2.26E+00	8.58E-06	1.87E-02	7.56E-03	8.58E-05	1.48E-02	2.98E-01	6.08E-07
3.00E+03	1.24E-01	1.23E-01	6.77E-04	6.29E-01	6.38E+00	2.47E-05	2.16E-02	1.77E-02	1.06E-04	4.41E-02	8.83E-01	1.82E-06
1.00E+04	1.78E-01	4.27E-01	9.17E-04	1.99E+00	2.01E+01	7.81E-05	2.59E-02	6.03E-02	1.51E-04	1.46E-01	2.93E+00	6.05E-06
3.00E+04	2.60E-01	1.25E+00	1.45E-03	5.33E+00	5.33E+01	2.08E-04	3.10E-02	1.74E-01	2.35E-04	4.30E-01	8.67E+00	1.79E-05
1.00E+05	4.17E-01	3.27E+00	2.89E-03	1.23E+01	1.23E+02	4.80E-04	4.07E-02	4.41E-01	4.20E-04	1.35E+00	2.78E+01	5.74E-05
3.00E+05	5.87E-01	6.58E+00	7.40E-03	1.73E+01	1.73E+02	6.73E-04	5.34E-02	8.45E-01	9.42E-04	3.53E+00	7.64E+01	1.59E-04
1.00E+06	8.13E-01	1.28E+01	3.48E-02	1.82E+01	1.82E+02	7.13E-04	7.81E-02	1.56E+00	4.00E-03	9.25E+00	2.21E+02	4.63E-04
3.00E+06	1.14E+00	1.90E+01	1.13E-01	1.93E+01	1.93E+02	7.70E-04	1.16E-01	2.29E+00	1.26E-02	2.39E+01	6.12E+02	1.29E-03
1.00E+07	1.43E+00	2.44E+01	1.61E-01	2.35E+01	2.38E+02	9.68E-04	1.54E-01	3.04E+00	1.80E-02	7.51E+01	1.98E+03	4.17E-03
3.15E+07	1.88E+00	3.64E+01	1.67E-01	3.71E+01	3.88E+02	1.61E-03	2.17E-01	4.79E+00	1.89E-02	2.32E+02	6.15E+03	1.30E-02

Pu-241

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu241	Pu242	Am241	Np237	Pu241	Pu242	Am241	Np237
1.00E+01	1.00E+00	3.76E-08	4.94E-01	6.25E-03	1.00E+00	3.76E-08	4.94E-01	6.25E-03
3.00E+01	1.00E+00	1.13E-07	4.94E-01	6.25E-03	1.00E+00	1.13E-07	4.94E-01	6.25E-03
1.00E+02	1.00E+00	3.76E-07	4.94E-01	6.25E-03	1.00E+00	3.76E-07	4.94E-01	6.25E-03
3.00E+02	1.00E+00	1.13E-06	4.94E-01	6.25E-03	1.00E+00	1.13E-06	4.94E-01	6.25E-03
1.00E+03	1.00E+00	3.76E-06	4.94E-01	6.25E-03	1.00E+00	3.76E-06	4.94E-01	6.25E-03
3.00E+03	1.00E+00	1.13E-05	4.94E-01	6.25E-03	1.00E+00	1.13E-05	4.94E-01	6.25E-03
1.00E+04	1.00E+00	3.76E-05	4.94E-01	6.25E-03	1.00E+00	3.76E-05	4.94E-01	6.25E-03
3.00E+04	1.00E+00	1.13E-04	4.94E-01	6.25E-03	1.00E+00	1.13E-04	4.94E-01	6.25E-03
1.00E+05	9.98E-01	3.76E-04	4.94E-01	6.25E-03	9.99E-01	3.76E-04	4.94E-01	6.25E-03
3.00E+05	9.95E-01	1.13E-03	4.94E-01	6.26E-03	9.98E-01	1.13E-03	4.93E-01	6.25E-03
1.00E+06	9.84E-01	3.76E-03	4.94E-01	6.27E-03	9.92E-01	3.73E-03	4.90E-01	6.22E-03
3.00E+06	9.53E-01	1.13E-02	4.96E-01	6.32E-03	9.77E-01	1.10E-02	4.84E-01	6.17E-03
1.00E+07	8.53E-01	3.76E-02	5.01E-01	6.50E-03	9.25E-01	3.48E-02	4.63E-01	6.01E-03
3.15E+07	6.06E-01	1.18E-01	5.16E-01	7.05E-03	7.87E-01	9.29E-02	4.06E-01	5.55E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	8.73E-01	2.56E-01	2.97E-03	3.96E+02	8.24E+03	1.56E-02
3.00E+01	2.30E+00	6.55E-01	7.98E-03	3.96E+02	8.24E+03	1.56E-02
1.00E+02	5.38E+00	1.54E+00	2.05E-02	3.96E+02	8.24E+03	1.56E-02
3.00E+02	8.81E+00	2.96E+00	4.12E-02	3.96E+02	8.24E+03	1.56E-02
1.00E+03	1.19E+01	5.88E+00	6.43E-02	3.96E+02	8.25E+03	1.56E-02
3.00E+03	1.48E+01	1.38E+01	7.65E-02	3.96E+02	8.25E+03	1.56E-02
1.00E+04	1.97E+01	4.72E+01	1.02E-01	3.97E+02	8.26E+03	1.56E-02
3.00E+04	2.67E+01	1.36E+02	1.58E-01	3.98E+02	8.27E+03	1.57E-02
1.00E+05	3.89E+01	3.39E+02	2.94E-01	4.01E+02	8.30E+03	1.58E-02
3.00E+05	5.14E+01	6.26E+02	6.59E-01	4.02E+02	8.30E+03	1.58E-02
1.00E+06	6.81E+01	1.09E+03	2.71E+00	3.99E+02	8.22E+03	1.58E-02
3.00E+06	9.13E+01	1.53E+03	8.34E+00	3.88E+02	7.99E+03	1.62E-02
1.00E+07	1.07E+02	1.81E+03	1.12E+01	3.53E+02	7.23E+03	2.43E-02
3.15E+07	1.18E+02	2.22E+03	9.88E+00	2.68E+02	5.36E+03	1.13E-01

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
1.26E-03	6.07E-04	5.40E-01	3.97E+02	8.24E+03	1.85E-02
1.26E-03	6.07E-04	4.25E-01	3.98E+02	8.24E+03	2.35E-02
1.25E-03	6.07E-04	2.77E-01	4.01E+02	8.24E+03	3.61E-02
1.24E-03	6.07E-04	1.76E-01	4.05E+02	8.24E+03	5.67E-02
1.23E-03	6.06E-04	1.25E-01	4.08E+02	8.25E+03	7.99E-02
1.22E-03	6.06E-04	1.09E-01	4.11E+02	8.25E+03	9.21E-02
1.20E-03	6.05E-04	8.49E-02	4.16E+02	8.26E+03	1.18E-01
1.18E-03	6.04E-04	5.77E-02	4.25E+02	8.27E+03	1.73E-01
1.14E-03	6.03E-04	3.23E-02	4.40E+02	8.30E+03	3.10E-01
1.10E-03	6.03E-04	1.48E-02	4.54E+02	8.30E+03	6.75E-01
1.07E-03	6.08E-04	3.66E-03	4.68E+02	8.22E+03	2.73E+00
1.04E-03	6.26E-04	1.20E-03	4.79E+02	7.99E+03	8.35E+00
1.09E-03	6.92E-04	8.91E-04	4.60E+02	7.23E+03	1.12E+01
1.29E-03	9.32E-04	1.00E-03	3.86E+02	5.36E+03	9.99E+00

Pu-241

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu241	Pu242	Am241	Np237	Pu241	Pu242	Am241	Np237
1.00E+01	1.00E+00	3.76E-11	4.94E-01	6.25E-03	1.00E+00	3.76E-11	4.94E-01	6.25E-03
3.00E+01	1.00E+00	1.13E-10	4.94E-01	6.25E-03	1.00E+00	1.13E-10	4.94E-01	6.25E-03
1.00E+02	1.00E+00	3.76E-10	4.94E-01	6.25E-03	1.00E+00	3.76E-10	4.94E-01	6.25E-03
3.00E+02	1.00E+00	1.13E-09	4.94E-01	6.25E-03	1.00E+00	1.13E-09	4.94E-01	6.25E-03
1.00E+03	1.00E+00	3.76E-09	4.94E-01	6.25E-03	1.00E+00	3.76E-09	4.94E-01	6.25E-03
3.00E+03	1.00E+00	1.13E-08	4.94E-01	6.25E-03	1.00E+00	1.13E-08	4.94E-01	6.25E-03
1.00E+04	1.00E+00	3.76E-08	4.94E-01	6.25E-03	1.00E+00	3.76E-08	4.94E-01	6.25E-03
3.00E+04	1.00E+00	1.13E-07	4.94E-01	6.25E-03	1.00E+00	1.13E-07	4.94E-01	6.25E-03
1.00E+05	1.00E+00	3.76E-07	4.94E-01	6.25E-03	1.00E+00	3.76E-07	4.94E-01	6.25E-03
3.00E+05	1.00E+00	1.13E-06	4.94E-01	6.26E-03	1.00E+00	1.13E-06	4.94E-01	6.26E-03
1.00E+06	9.98E-01	3.76E-06	4.94E-01	6.27E-03	9.99E-01	3.76E-06	4.94E-01	6.27E-03
3.00E+06	9.95E-01	1.13E-05	4.96E-01	6.32E-03	9.98E-01	1.13E-05	4.95E-01	6.31E-03
1.00E+07	9.85E-01	3.76E-05	5.01E-01	6.50E-03	9.92E-01	3.73E-05	4.97E-01	6.45E-03
3.15E+07	9.52E-01	1.18E-04	5.16E-01	7.05E-03	9.76E-01	1.15E-04	5.04E-01	6.88E-03

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	8.73E-04	2.56E-04	2.97E-06	3.96E+02	8.24E+03	1.56E-02
3.00E+01	2.30E-03	6.55E-04	7.98E-06	3.96E+02	8.24E+03	1.56E-02
1.00E+02	5.38E-03	1.54E-03	2.05E-05	3.96E+02	8.24E+03	1.56E-02
3.00E+02	8.81E-03	2.96E-03	4.12E-05	3.96E+02	8.24E+03	1.56E-02
1.00E+03	1.19E-02	5.88E-03	6.43E-05	3.96E+02	8.25E+03	1.56E-02
3.00E+03	1.48E-02	1.38E-02	7.65E-05	3.96E+02	8.25E+03	1.56E-02
1.00E+04	1.97E-02	4.72E-02	1.02E-04	3.97E+02	8.26E+03	1.56E-02
3.00E+04	2.67E-02	1.36E-01	1.58E-04	3.98E+02	8.28E+03	1.57E-02
1.00E+05	3.89E-02	3.39E-01	2.94E-04	4.02E+02	8.31E+03	1.58E-02
3.00E+05	5.15E-02	6.28E-01	6.60E-04	4.04E+02	8.33E+03	1.59E-02
1.00E+06	6.86E-02	1.10E+00	2.73E-03	4.05E+02	8.34E+03	1.59E-02
3.00E+06	9.33E-02	1.56E+00	8.52E-03	4.05E+02	8.34E+03	1.59E-02
1.00E+07	1.15E-01	1.94E+00	1.20E-02	4.05E+02	8.32E+03	1.59E-02
3.15E+07	1.47E-01	2.76E+00	1.23E-02	4.07E+02	8.26E+03	1.61E-02

Pu241 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+01	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
1.0E+02	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+02	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
1.0E+03	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+03	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
1.0E+04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04
3.0E+04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
1.0E+05	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
3.0E+05	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
1.0E+06	6.1E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
3.0E+06	6.3E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
1.0E+07	6.9E-04	6.1E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04	6.0E-04
3.2E+07	9.3E-04	6.3E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04	6.1E-04

Pu-242 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pu242						Pu243					
1.00E+01	9.33E-04	2.75E-04	3.18E-06	2.91E-01	6.79E+00	1.44E-05	1.97E-01	3.49E-02	5.41E-04	6.55E-11	1.26E-01	1.85E-15
3.00E+01	2.44E-03	6.99E-04	8.54E-06	2.91E-01	6.79E+00	1.44E-05	1.17E+00	3.35E-01	4.09E-03	1.94E-10	3.03E-01	5.45E-15
1.00E+02	5.63E-03	1.63E-03	2.18E-05	2.91E-01	6.79E+00	1.44E-05	2.70E+00	7.79E-01	1.04E-02	6.50E-10	6.58E-01	1.83E-14
3.00E+02	9.19E-03	3.11E-03	4.34E-05	2.92E-01	6.79E+00	1.44E-05	4.40E+00	1.49E+00	2.08E-02	1.95E-09	1.11E+00	5.48E-14
1.00E+03	1.26E-02	6.21E-03	6.77E-05	2.92E-01	6.79E+00	1.44E-05	6.03E+00	2.97E+00	3.24E-02	6.50E-09	1.52E+00	1.83E-13
3.00E+03	1.61E-02	1.47E-02	8.01E-05	2.93E-01	6.79E+00	1.45E-05	7.71E+00	7.05E+00	3.84E-02	1.95E-08	1.58E+00	5.48E-13
1.00E+04	2.28E-02	5.01E-02	1.06E-04	2.98E-01	6.80E+00	1.47E-05	1.09E+01	2.40E+01	5.07E-02	6.50E-08	1.59E+00	1.83E-12
3.00E+04	3.34E-02	1.43E-01	1.62E-04	3.08E-01	6.84E+00	1.51E-05	1.60E+01	6.85E+01	7.77E-02	1.95E-07	1.60E+00	5.48E-12
1.00E+05	5.21E-02	3.53E-01	3.00E-04	3.32E-01	7.08E+00	1.58E-05	2.50E+01	1.69E+02	1.44E-01	6.50E-07	1.64E+00	1.83E-11
3.00E+05	6.97E-02	6.38E-01	6.49E-04	3.91E-01	7.87E+00	1.75E-05	3.34E+01	3.06E+02	3.11E-01	1.95E-06	1.86E+00	5.48E-11
1.00E+06	8.68E-02	1.08E+00	2.57E-03	5.95E-01	1.06E+01	2.33E-05	4.16E+01	5.19E+02	1.23E+00	6.50E-06	3.58E+00	1.83E-10
3.00E+06	1.10E-01	1.52E+00	7.94E-03	1.18E+00	1.84E+01	3.98E-05	5.29E+01	7.30E+02	3.80E+00	1.95E-05	8.75E+00	5.48E-10
1.00E+07	1.33E-01	1.93E+00	1.13E-02	3.23E+00	4.57E+01	9.74E-05	6.37E+01	9.24E+02	5.39E+00	6.49E-05	1.18E+01	1.83E-09
3.15E+07	1.69E-01	2.86E+00	1.17E-02	9.50E+00	1.29E+02	2.74E-04	8.12E+01	1.37E+03	5.62E+00	2.04E-04	1.18E+01	5.77E-09

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Am243						U238					
1.00E+01	7.51E-04	1.52E-04	2.45E-06	1.18E-03	1.50E-02	3.66E-08	1.79E-04	2.89E-05	3.79E-07	8.11E-06	1.03E-04	8.43E-11
3.00E+01	3.74E-03	9.90E-04	1.32E-05	3.52E-03	4.48E-02	1.10E-07	1.09E-03	2.53E-04	2.99E-06	2.73E-05	2.40E-04	3.07E-10
1.00E+02	8.86E-03	2.55E-03	3.66E-05	1.18E-02	1.48E-01	3.66E-07	2.52E-03	5.53E-04	7.30E-06	1.26E-04	4.97E-04	1.65E-09
3.00E+02	1.51E-02	5.36E-03	7.82E-05	3.60E-02	4.44E-01	1.10E-06	3.96E-03	9.88E-04	1.41E-05	6.66E-04	7.98E-04	1.04E-08
1.00E+03	2.18E-02	1.12E-02	1.26E-04	1.18E-01	1.48E+00	3.66E-06	4.92E-03	1.81E-03	2.15E-05	4.84E-03	1.07E-03	8.09E-08
3.00E+03	2.96E-02	2.63E-02	1.49E-04	3.55E-01	4.41E+00	1.11E-05	5.51E-03	4.00E-03	2.58E-05	2.61E-02	1.11E-03	4.52E-07
1.00E+04	4.61E-02	8.90E-02	1.97E-04	1.20E+00	1.48E+01	3.81E-05	6.35E-03	1.31E-02	3.50E-05	8.42E-02	1.23E-03	1.47E-06
3.00E+04	7.44E-02	2.56E-01	3.03E-04	3.76E+00	4.43E+01	1.22E-04	7.34E-03	3.69E-02	5.20E-05	1.07E-01	1.80E-03	1.87E-09
1.00E+05	1.23E-01	6.46E-01	5.73E-04	1.36E+01	1.49E+02	4.57E-04	9.16E-03	9.04E-02	8.75E-05	1.08E-01	3.88E-03	1.88E-06
3.00E+05	1.66E-01	1.23E+00	1.35E-03	4.35E+01	4.50E+02	1.51E-03	1.13E-02	1.61E-01	1.72E-04	1.08E-01	9.92E-03	1.89E-06
1.00E+06	2.06E-01	2.26E+00	5.91E-03	1.49E+02	1.51E+03	5.23E-03	1.49E-02	2.64E-01	6.25E-04	1.08E-01	3.13E-02	1.94E-06
3.00E+06	2.60E-01	3.25E+00	1.88E-02	4.50E+02	4.51E+03	1.58E-02	2.04E-02	3.63E-01	1.88E-03	1.11E-01	9.25E-02	2.06E-06
1.00E+07	3.05E-01	3.99E+00	2.67E-02	1.50E+03	1.50E+04	5.28E-02	2.53E-02	4.45E-01	2.65E-03	1.20E-01	3.00E-01	2.50E-06
3.15E+07	3.69E-01	5.58E+00	2.75E-02	4.66E+03	4.66E+04	1.64E-01	3.27E-02	6.27E-01	2.74E-03	1.47E-01	9.33E-01	3.83E-06

Pu-242

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu242	Pu243	Am243	U238	Pu242	Pu243	Am243	U238
1.00E+01	1.00E+00	1.13E-07	2.20E-11	9.13E-05	1.00E+00	1.13E-07	2.20E-11	9.13E-05
3.00E+01	1.00E+00	3.40E-07	2.00E-10	9.13E-05	1.00E+00	3.40E-07	2.00E-10	9.13E-05
1.00E+02	1.00E+00	1.13E-06	2.20E-09	9.13E-05	1.00E+00	1.13E-06	2.20E-09	9.13E-05
3.00E+02	1.00E+00	3.40E-06	1.98E-08	9.13E-05	1.00E+00	3.40E-06	1.98E-08	9.13E-05
1.00E+03	1.00E+00	1.11E-05	2.18E-07	9.13E-05	1.00E+00	1.11E-05	2.18E-07	9.13E-05
3.00E+03	1.00E+00	3.21E-05	1.91E-06	9.13E-05	1.00E+00	3.21E-05	1.91E-06	9.13E-05
1.00E+04	1.00E+00	9.40E-05	1.94E-05	9.13E-05	1.00E+00	9.40E-05	1.94E-05	9.13E-05
3.00E+04	1.00E+00	2.01E-04	1.39E-04	9.13E-05	1.00E+00	2.01E-04	1.39E-04	9.13E-05
1.00E+05	9.99E-01	2.86E-04	8.49E-04	9.13E-05	9.99E-01	2.86E-04	8.49E-04	9.12E-05
3.00E+05	9.97E-01	2.92E-04	3.11E-03	9.13E-05	9.98E-01	2.92E-04	3.10E-03	9.11E-05
1.00E+06	9.89E-01	2.92E-04	1.11E-02	9.13E-05	9.94E-01	2.90E-04	1.10E-02	9.08E-05
3.00E+06	9.67E-01	2.92E-04	3.37E-02	9.14E-05	9.83E-01	2.87E-04	3.31E-02	8.99E-05
1.00E+07	8.93E-01	2.92E-04	1.13E-01	9.18E-05	9.46E-01	2.76E-04	1.07E-01	8.68E-05
3.15E+07	7.00E-01	2.92E-04	3.57E-01	9.31E-05	8.41E-01	2.46E-04	3.00E-01	7.83E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	9.33E-04	2.75E-04	3.18E-06	2.91E-01	6.79E+00	1.44E-05
3.00E+01	2.44E-03	6.99E-04	8.54E-06	2.91E-01	6.79E+00	1.44E-05
1.00E+02	5.64E-03	1.63E-03	2.18E-05	2.91E-01	6.79E+00	1.44E-05
3.00E+02	9.21E-03	3.12E-03	4.35E-05	2.92E-01	6.79E+00	1.44E-05
1.00E+03	1.27E-02	6.24E-03	6.81E-05	2.92E-01	6.79E+00	1.44E-05
3.00E+03	1.63E-02	1.50E-02	8.13E-05	2.93E-01	6.79E+00	1.45E-05
1.00E+04	2.38E-02	5.24E-02	1.11E-04	2.97E-01	6.80E+00	1.47E-05
3.00E+04	3.66E-02	1.57E-01	1.78E-04	3.09E-01	6.85E+00	1.51E-05
1.00E+05	5.94E-02	4.01E-01	3.41E-04	3.43E-01	7.19E+00	1.62E-05
3.00E+05	7.98E-02	7.30E-01	7.42E-04	5.25E-01	9.24E+00	2.21E-05
1.00E+06	1.01E-01	1.25E+00	2.98E-03	2.24E+00	2.72E+01	8.10E-05
3.00E+06	1.32E-01	1.82E+00	9.53E-03	1.63E+01	1.70E+02	5.72E-04
1.00E+07	1.76E-01	2.51E+00	1.50E-02	1.72E+02	1.74E+03	6.06E-03
3.15E+07	2.73E-01	4.42E+00	1.95E-02	1.67E+03	1.67E+04	5.88E-02

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
1.71E+00	7.36E-01	5.70E+02	2.92E-01	6.79E+00	1.76E-05
1.70E+00	7.36E-01	4.37E+02	2.93E-01	6.79E+00	2.29E-05
1.69E+00	7.36E-01	2.77E+02	2.96E-01	6.79E+00	3.62E-05
1.66E+00	7.36E-01	1.73E+02	3.01E-01	6.79E+00	5.79E-05
1.64E+00	7.36E-01	1.21E+02	3.04E-01	6.79E+00	8.25E-05
1.61E+00	7.36E-01	1.04E+02	3.10E-01	6.79E+00	9.58E-05
1.56E+00	7.35E-01	7.98E+01	3.21E-01	6.80E+00	1.25E-04
1.45E+00	7.30E-01	5.18E+01	3.45E-01	6.85E+00	1.93E-04
1.24E+00	6.95E-01	2.80E+01	4.02E-01	7.19E+00	3.58E-04
8.27E-01	5.41E-01	1.31E+01	6.05E-01	9.24E+00	7.65E-04
2.13E-01	1.84E-01	3.27E+00	2.34E+00	2.72E+01	3.06E-03
3.04E-02	2.95E-02	9.90E-01	1.64E+01	1.70E+02	1.01E-02
2.90E-03	2.88E-03	4.75E-01	1.73E+02	1.74E+03	2.10E-02
2.99E-04	2.99E-04	1.28E-01	1.67E+03	1.67E+04	7.83E-02

Pu-242

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g		Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Pu242	Pu243	Am243	U238		Pu242	Pu243	Am243	U238
1.00E+01	1.00E+00	1.13E-10	2.20E-14	9.13E-05		1.00E+00	1.13E-10	2.20E-14	9.13E-05
3.00E+01	1.00E+00	3.40E-10	2.00E-13	9.13E-05		1.00E+00	3.40E-10	2.00E-13	9.13E-05
1.00E+02	1.00E+00	1.13E-09	2.20E-12	9.13E-05		1.00E+00	1.13E-09	2.20E-12	9.13E-05
3.00E+02	1.00E+00	3.40E-09	1.98E-11	9.13E-05		1.00E+00	3.40E-09	1.98E-11	9.13E-05
1.00E+03	1.00E+00	1.11E-08	2.18E-10	9.13E-05		1.00E+00	1.11E-08	2.18E-10	9.13E-05
3.00E+03	1.00E+00	3.21E-08	1.91E-09	9.13E-05		1.00E+00	3.21E-08	1.91E-09	9.13E-05
1.00E+04	1.00E+00	9.40E-08	1.94E-08	9.13E-05		1.00E+00	9.40E-08	1.94E-08	9.13E-05
3.00E+04	1.00E+00	2.01E-07	1.39E-07	9.13E-05		1.00E+00	2.01E-07	1.39E-07	9.13E-05
1.00E+05	1.00E+00	2.86E-07	8.49E-07	9.13E-05		1.00E+00	2.86E-07	8.49E-07	9.13E-05
3.00E+05	1.00E+00	2.92E-07	3.11E-06	9.13E-05		1.00E+00	2.92E-07	3.11E-06	9.13E-05
1.00E+06	1.00E+00	2.92E-07	1.11E-05	9.13E-05		1.00E+00	2.92E-07	1.11E-05	9.13E-05
3.00E+06	1.00E+00	2.92E-07	3.37E-05	9.14E-05		1.00E+00	2.92E-07	3.37E-05	9.14E-05
1.00E+07	1.00E+00	2.92E-07	1.13E-04	9.18E-05		1.00E+00	2.92E-07	1.13E-04	9.18E-05
3.15E+07	1.00E+00	2.92E-07	3.57E-04	9.31E-05		1.00E+00	2.92E-07	3.57E-04	9.31E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	9.33E-07	2.75E-07	3.18E-09	2.91E-01	6.79E+00	1.44E-05
3.00E+01	2.44E-06	6.99E-07	8.54E-09	2.91E-01	6.79E+00	1.44E-05
1.00E+02	5.63E-06	1.63E-06	2.18E-08	2.91E-01	6.79E+00	1.44E-05
3.00E+02	9.19E-06	3.11E-06	4.34E-08	2.92E-01	6.79E+00	1.44E-05
1.00E+03	1.26E-05	6.21E-06	6.77E-08	2.92E-01	6.79E+00	1.44E-05
3.00E+03	1.61E-05	1.47E-05	8.01E-08	2.93E-01	6.79E+00	1.45E-05
1.00E+04	2.28E-05	5.01E-05	1.06E-07	2.98E-01	6.80E+00	1.47E-05
3.00E+04	3.34E-05	1.43E-04	1.62E-07	3.08E-01	6.84E+00	1.51E-05
1.00E+05	5.22E-05	3.53E-04	3.00E-07	3.32E-01	7.08E+00	1.58E-05
3.00E+05	6.97E-05	6.38E-04	6.49E-07	3.91E-01	7.87E+00	1.75E-05
1.00E+06	8.68E-05	1.08E-03	2.57E-06	5.97E-01	1.06E+01	2.33E-05
3.00E+06	1.10E-04	1.52E-03	7.95E-06	1.19E+00	1.86E+01	4.03E-05
1.00E+07	1.33E-04	1.93E-03	1.13E-05	3.39E+00	4.74E+01	1.03E-04
3.15E+07	1.70E-04	2.86E-03	1.17E-05	1.12E+01	1.46E+02	3.33E-04

Pu242 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
1.0E+02	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+02	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
1.0E+03	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+03	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
1.0E+04	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01	7.4E-01
3.0E+04	7.3E-01	7.3E-01	7.3E-01	7.3E-01	7.3E-01	7.3E-01	7.3E-01
1.0E+05	7.0E-01	7.1E-01	7.1E-01	7.1E-01	7.1E-01	7.1E-01	7.1E-01
3.0E+05	5.4E-01	6.2E-01	6.3E-01	6.4E-01	6.4E-01	6.4E-01	6.4E-01
1.0E+06	1.8E-01	4.1E-01	4.7E-01	4.7E-01	4.7E-01	4.7E-01	4.7E-01
3.0E+06	2.9E-02	1.5E-01	2.5E-01	2.7E-01	2.7E-01	2.7E-01	2.7E-01
1.0E+07	2.9E-03	2.3E-02	8.0E-02	1.1E-01	1.1E-01	1.1E-01	1.1E-01
3.2E+07	3.0E-04	2.8E-03	1.7E-02	3.4E-02	3.8E-02	3.9E-02	3.9E-02

Th-232 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem
	Th232						*Th233*					
1.00E+01	2.91E-04	4.48E-05	5.12E-07	1.59E-03	1.32E-03	7.19E-09	2.44E-02	2.52E-03	3.45E-05	2.93E-05	8.50E-03	1.22E-09
3.00E+01	8.04E-04	1.04E-04	1.27E-06	4.62E-03	1.38E-03	1.68E-08	1.55E-01	2.01E-02	2.46E-04	9.00E-05	1.98E-02	3.65E-09
1.00E+02	2.08E-03	2.09E-04	2.89E-06	1.49E-02	1.48E-03	4.95E-08	4.01E-01	4.04E-02	5.57E-04	3.19E-04	3.88E-02	1.22E-08
3.00E+02	3.30E-03	3.26E-04	5.03E-06	4.25E-02	1.57E-03	1.36E-07	6.37E-01	6.30E-02	9.71E-04	1.03E-03	5.68E-02	3.65E-08
1.00E+03	3.86E-03	4.96E-04	7.47E-06	1.19E-01	1.64E-03	3.79E-07	7.45E-01	9.58E-02	1.44E-03	3.63E-03	7.02E-02	1.22E-07
3.00E+03	4.03E-03	8.77E-04	9.91E-06	2.33E-01	1.65E-03	7.39E-07	7.77E-01	1.69E-01	1.91E-03	1.10E-01	7.18E-02	3.65E-07
1.00E+04	4.25E-03	2.36E-03	1.52E-05	2.93E-01	1.66E-03	9.42E-07	8.20E-01	4.56E-01	2.94E-03	3.69E-02	7.39E-02	1.22E-06
3.00E+04	4.48E-03	6.07E-03	2.19E-05	2.97E-01	1.67E-03	9.79E-07	8.64E-01	1.17E+00	4.23E-03	1.11E-01	7.54E-02	3.65E-06
1.00E+05	4.83E-03	1.39E-02	2.84E-05	2.99E-01	1.67E-03	1.09E-06	9.33E-01	2.67E+00	5.49E-03	3.64E-01	7.65E-02	1.20E-05
3.00E+05	5.18E-03	2.31E-02	3.93E-05	3.08E-01	1.68E-02	1.39E-06	1.00E+00	4.47E+00	7.59E-03	1.06E+00	7.93E-02	3.48E-05
1.00E+06	5.66E-03	3.56E-02	9.45E-05	3.35E-01	1.88E-03	2.32E-06	1.09E+00	6.87E+00	1.83E-02	3.15E+00	1.00E-01	1.04E-04
3.00E+06	6.39E-03	4.66E-02	2.47E-04	3.86E-01	2.43E-03	4.13E-06	1.23E+00	9.01E+00	4.77E-02	7.03E+00	1.63E-01	2.31E-04
1.00E+07	7.12E-03	5.31E-02	3.39E-04	4.43E-01	3.69E-03	6.14E-06	1.37E+00	1.03E+01	6.54E-02	1.08E+01	2.05E-01	3.54E-04
3.15E+07	8.15E-03	6.61E-02	3.46E-04	4.55E-01	7.24E-03	6.68E-06	1.57E+00	1.28E+01	6.68E-02	1.12E+01	2.25E-01	3.71E-04

Irradiation Time "t" s	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem
	U233					
1.00E+01	6.91E-01	1.04E-01	1.80E-03	2.37E-09	2.21E-01	1.30E-13
3.00E+01	2.98E+00	5.90E-01	8.29E-03	7.11E-09	5.53E-01	3.92E-13
1.00E+02	7.54E+00	1.40E+00	2.14E-02	2.37E-08	1.26E+00	1.30E-12
3.00E+02	1.26E+01	2.66E+00	4.27E-02	7.11E-08	2.18E+00	3.92E-12
1.00E+03	1.59E+01	4.91E+00	6.73E-02	2.37E-07	3.02E+00	1.30E-11
3.00E+03	1.77E+01	1.02E+01	8.49E-02	7.11E-07	3.15E+00	3.92E-11
1.00E+04	2.04E+01	3.28E+01	1.23E-01	2.37E-06	3.19E+00	1.30E-10
3.00E+04	2.33E+01	9.47E+01	1.83E-01	7.11E-06	3.25E+00	3.92E-10
1.00E+05	2.88E+01	2.47E+02	2.94E-01	2.37E-05	3.33E+00	1.30E-09
3.00E+05	3.66E+01	4.97E+02	6.25E-01	7.11E-05	3.80E+00	3.92E-09
1.00E+06	5.30E+01	9.75E+02	2.67E+00	2.37E-04	7.76E+00	1.30E-08
3.00E+06	7.87E+01	1.46E+03	8.55E+00	7.11E-04	2.00E+01	3.92E-08
1.00E+07	1.03E+02	1.94E+03	1.22E+01	2.37E-03	2.75E+01	1.30E-07
3.15E+07	1.43E+02	3.03E+03	1.28E+01	7.46E-03	2.76E+01	4.12E-07

Th-232

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Th232	Th233	U233			Th232	Th233	U233
1.00E+01	1.00E+00	8.57E-09	0.00E+00			1.00E+00	8.57E-09	0.00E+00
3.00E+01	1.00E+00	2.56E-08	0.00E+00			1.00E+00	2.56E-08	0.00E+00
1.00E+02	1.00E+00	8.38E-08	0.00E+00			1.00E+00	8.38E-08	0.00E+00
3.00E+02	1.00E+00	2.97E-07	0.00E+00			1.00E+00	2.97E-07	0.00E+00
1.00E+03	1.00E+00	6.71E-07	0.00E+00			1.00E+00	6.71E-07	0.00E+00
3.00E+03	1.00E+00	1.31E-06	0.00E+00			1.00E+00	1.31E-06	0.00E+00
1.00E+04	1.00E+00	1.65E-06	8.80E-09			1.00E+00	1.65E-06	8.80E-09
3.00E+04	1.00E+00	1.66E-06	1.01E-07			1.00E+00	1.66E-06	1.01E-07
1.00E+05	1.00E+00	1.66E-06	1.22E-06			1.00E+00	1.66E-06	1.22E-06
3.00E+05	1.00E+00	1.66E-06	1.10E-05			1.00E+00	1.66E-06	1.10E-05
1.00E+06	9.99E-01	1.66E-06	1.16E-04			1.00E+00	1.66E-06	1.16E-04
3.00E+06	9.97E-01	1.66E-06	8.71E-04			9.99E-01	1.66E-06	8.70E-04
1.00E+07	9.91E-01	1.66E-06	5.83E-03			9.96E-01	1.65E-06	5.81E-03
3.15E+07	9.73E-01	1.66E-06	2.42E-02			9.87E-01	1.64E-06	2.39E-02

Irradiation Time "t" s	Total Fission Product Dose			Total Fissionable Material Dose		
	TEDE Rem	TODE(thy) Rem	Public TEDE Rem	TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	2.91E-04	4.48E-05	5.12E-07	1.59E-03	1.32E-03	7.19E-09
3.00E+01	8.04E-04	1.04E-04	1.27E-06	4.62E-03	1.38E-03	1.68E-08
1.00E+02	2.08E-03	2.09E-04	2.89E-06	1.49E-02	1.48E-03	4.95E-08
3.00E+02	3.30E-03	3.26E-04	5.03E-06	4.25E-02	1.57E-03	1.36E-07
1.00E+03	3.86E-03	4.96E-04	7.47E-06	1.19E-01	1.64E-03	3.79E-07
3.00E+03	4.03E-03	8.77E-04	9.91E-06	2.32E-01	1.65E-03	7.39E-07
1.00E+04	4.25E-03	2.36E-03	1.52E-05	2.93E-01	1.66E-03	9.42E-07
3.00E+04	4.48E-03	6.09E-03	2.19E-05	2.97E-01	1.67E-03	9.79E-07
1.00E+05	4.87E-03	1.42E-02	2.88E-05	2.99E-01	1.67E-03	1.09E-06
3.00E+05	5.58E-03	2.86E-02	4.62E-05	3.08E-01	1.69E-02	1.39E-06
1.00E+06	1.18E-02	1.49E-01	4.04E-04	3.35E-01	2.77E-03	2.32E-06
3.00E+06	7.48E-02	1.32E+00	7.68E-03	3.85E-01	1.98E-02	4.12E-06
1.00E+07	6.06E-01	1.13E+01	7.13E-02	4.40E-01	1.64E-01	6.09E-06
3.15E+07	3.41E+00	7.24E+01	3.05E-01	4.43E-01	6.75E-01	6.51E-06

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
2.66E+02	3.80E+03	1.92E+04		1.88E-03	1.32E-03	5.20E-07
9.22E+01	3.64E+03	7.75E+03		5.42E-03	1.38E-03	1.29E-06
2.94E+01	3.39E+03	3.41E+03		1.70E-02	1.48E-03	2.94E-06
1.09E+01	3.19E+03	1.94E+03		4.58E-02	1.57E-03	5.16E-06
4.06E+00	3.05E+03	1.27E+03		1.23E-01	1.64E-03	7.85E-06
2.11E+00	3.03E+03	9.39E+02		2.37E-01	1.65E-03	1.06E-05
1.68E+00	2.12E+03	6.19E+02		2.98E-01	2.36E-03	1.62E-05
1.66E+00	8.22E+02	4.37E+02		3.01E-01	6.09E-03	2.29E-05
1.64E+00	3.53E+02	3.34E+02		3.04E-01	1.42E-02	2.99E-05
1.59E+00	1.75E+02	2.10E+02		3.14E-01	2.86E-02	4.76E-05
1.44E+00	3.37E+01	2.46E+01		3.47E-01	1.49E-01	4.07E-04
1.09E+00	3.79E+00	1.30E+00		4.60E-01	1.32E+00	7.68E-03
4.78E-01	4.42E-01	1.40E-01		1.05E+00	1.13E+01	7.13E-02
1.30E-01	6.91E-02	3.28E-02		3.86E+00	7.24E+01	3.05E-01

Th232

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	Th232	Th233	U233			Th232	Th233	U233
1.00E+01	1.00E+00	8.57E-12	0.00E+00			1.00E+00	8.57E-12	0.00E+00
3.00E+01	1.00E+00	2.56E-11	0.00E+00			1.00E+00	2.56E-11	0.00E+00
1.00E+02	1.00E+00	8.38E-11	0.00E+00			1.00E+00	8.38E-11	0.00E+00
3.00E+02	1.00E+00	2.97E-10	0.00E+00			1.00E+00	2.97E-10	0.00E+00
1.00E+03	1.00E+00	6.71E-10	0.00E+00			1.00E+00	6.71E-10	0.00E+00
3.00E+03	1.00E+00	1.31E-09	0.00E+00			1.00E+00	1.31E-09	0.00E+00
1.00E+04	1.00E+00	1.65E-09	8.80E-12			1.00E+00	1.65E-09	8.80E-12
3.00E+04	1.00E+00	1.66E-09	1.01E-10			1.00E+00	1.66E-09	1.01E-10
1.00E+05	1.00E+00	1.66E-09	1.22E-09			1.00E+00	1.66E-09	1.22E-09
3.00E+05	1.00E+00	1.66E-09	1.10E-08			1.00E+00	1.66E-09	1.10E-08
1.00E+06	1.00E+00	1.66E-09	1.16E-07			1.00E+00	1.66E-09	1.16E-07
3.00E+06	1.00E+00	1.66E-09	8.71E-07			1.00E+00	1.66E-09	8.71E-07
1.00E+07	1.00E+00	1.66E-09	5.83E-06			1.00E+00	1.66E-09	5.83E-06
3.15E+07	1.00E+00	1.66E-09	2.42E-05			1.00E+00	1.66E-09	2.42E-05

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	2.91E-07	4.48E-08	5.12E-10	1.59E-03	1.32E-03	7.19E-09
3.00E+01	8.04E-07	1.04E-07	1.27E-09	4.62E-03	1.38E-03	1.68E-08
1.00E+02	2.08E-06	2.09E-07	2.89E-09	1.49E-02	1.48E-03	4.95E-08
3.00E+02	3.30E-06	3.26E-07	5.03E-09	4.25E-02	1.57E-03	1.36E-07
1.00E+03	3.86E-06	4.96E-07	7.47E-09	1.19E-01	1.64E-03	3.79E-07
3.00E+03	4.03E-06	8.77E-07	9.91E-09	2.32E-01	1.65E-03	7.39E-07
1.00E+04	4.25E-06	2.36E-06	1.52E-08	2.93E-01	1.66E-03	9.42E-07
3.00E+04	4.48E-06	6.07E-06	2.19E-08	2.97E-01	1.67E-03	9.79E-07
1.00E+05	4.83E-06	1.39E-05	2.84E-08	2.99E-01	1.67E-03	1.09E-06
3.00E+05	5.18E-06	2.32E-05	3.93E-08	3.08E-01	1.68E-02	1.39E-06
1.00E+06	5.67E-06	3.57E-05	9.48E-08	3.35E-01	1.88E-03	2.32E-06
3.00E+06	6.46E-06	4.79E-05	2.54E-07	3.86E-01	2.45E-03	4.13E-06
1.00E+07	7.72E-06	6.44E-05	4.10E-07	4.43E-01	3.85E-03	6.14E-06
3.15E+07	1.16E-05	1.39E-04	6.55E-07	4.55E-01	7.91E-03	6.68E-06

Th232 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	2.7E+02	3.1E+02	3.1E+02	3.1E+02	3.1E+02	3.1E+02	3.1E+02
3.0E+01	9.2E+01	1.1E+02	1.1E+02	1.1E+02	1.1E+02	1.1E+02	1.1E+02
1.0E+02	2.9E+01	3.3E+01	3.3E+01	3.4E+01	3.4E+01	3.4E+01	3.4E+01
3.0E+02	1.1E+01	1.2E+01	1.2E+01	1.2E+01	1.2E+01	1.2E+01	1.2E+01
1.0E+03	4.1E+00	4.2E+00	4.2E+00	4.2E+00	4.2E+00	4.2E+00	4.2E+00
3.0E+03	2.1E+00	2.1E+00	2.2E+00	2.2E+00	2.2E+00	2.2E+00	2.2E+00
1.0E+04	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
3.0E+04	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
1.0E+05	1.6E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
3.0E+05	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00	1.6E+00
1.0E+06	1.4E+00	1.5E+00	1.5E+00	1.5E+00	1.5E+00	1.5E+00	1.5E+00
3.0E+06	1.1E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00
1.0E+07	1.4E-01	1.1E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00
3.2E+07	3.3E-02	1.0E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00	1.1E+00

U-232 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U232						U233					
1.00E+01	6.94E-02	1.03E-02	1.90E-04	4.82E+03	1.91E+04	2.11E-01	6.91E-01	1.04E-01	1.80E-03	2.37E-09	2.21E-01	1.30E-13
3.00E+01	2.71E-01	5.06E-02	7.73E-04	4.82E+03	1.91E+04	2.11E-01	2.98E+00	5.90E-01	8.29E-03	7.11E-09	5.53E-01	3.92E-13
1.00E+02	6.86E-01	1.26E-01	2.08E-03	4.82E+03	1.91E+04	2.11E-01	7.54E+00	1.40E+00	2.14E-02	2.37E-08	1.26E+00	1.30E-12
3.00E+02	1.18E+00	2.51E-01	4.31E-03	4.82E+03	1.91E+04	2.11E-01	1.26E+01	2.66E+00	4.27E-02	7.11E-08	2.18E+00	3.92E-12
1.00E+03	1.55E+00	4.57E-01	6.89E-03	4.82E+03	1.91E+04	2.11E-01	1.59E+01	4.91E+00	6.73E-02	2.37E-07	3.02E+00	1.30E-11
3.00E+03	1.70E+00	9.12E-01	8.73E-03	4.82E+03	1.91E+04	2.11E-01	1.77E+01	1.02E+01	8.49E-02	7.11E-07	3.15E+00	3.92E-11
1.00E+04	1.89E+00	2.91E+00	1.27E-02	4.82E+03	1.91E+04	2.11E-01	2.04E+01	3.28E+01	1.23E-01	2.37E-06	3.19E+00	1.30E-10
3.00E+04	2.11E+00	8.58E+00	1.91E-02	4.82E+03	1.91E+04	2.11E-01	2.33E+01	9.47E+01	1.83E-01	7.11E-06	3.25E+00	3.92E-10
1.00E+05	2.56E+00	2.34E+01	3.09E-02	4.82E+03	1.91E+04	2.11E-01	2.88E+01	2.47E+02	2.94E-01	2.37E-05	3.33E+00	1.30E-09
3.00E+05	3.34E+00	5.00E+01	6.98E-02	4.82E+03	1.91E+04	2.11E-01	3.66E+01	4.97E+02	6.25E-01	7.11E-05	3.80E+00	3.92E-09
1.00E+06	5.22E+00	1.04E+02	3.17E-01	4.82E+03	1.91E+04	2.11E-01	5.30E+01	9.75E+02	2.67E+00	2.37E-04	7.76E+00	1.30E-08
3.00E+06	8.25E+00	1.61E+02	1.03E+00	4.82E+03	1.91E+04	2.11E-01	7.87E+01	1.46E+03	8.55E+00	7.11E-04	2.00E+01	3.92E-08
1.00E+07	1.12E+01	2.20E+02	1.47E+00	4.82E+03	1.90E+04	2.11E-01	1.03E+02	1.94E+03	1.22E+01	2.37E-03	2.75E+01	1.30E-07
3.15E+07	1.60E+01	3.57E+02	1.54E+00	4.64E+03	1.89E+04	2.10E-01	1.43E+02	3.03E+03	1.28E+01	7.46E-03	2.76E+01	4.12E-07

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Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g				Average Mass, g Over "t"	Average Mass, g Over "t"
	U232	U233				U232	U233
1.00E+01	1.00E+00	7.29E-09				1.00E+00	7.29E-09
3.00E+01	1.00E+00	2.19E-08				1.00E+00	2.19E-08
1.00E+02	1.00E+00	7.29E-08				1.00E+00	7.29E-08
3.00E+02	1.00E+00	2.19E-07				1.00E+00	2.19E-07
1.00E+03	1.00E+00	7.29E-07				1.00E+00	7.29E-07
3.00E+03	1.00E+00	2.19E-06				1.00E+00	2.19E-06
1.00E+04	1.00E+00	7.29E-06				1.00E+00	7.29E-06
3.00E+04	1.00E+00	2.19E-05				1.00E+00	2.19E-05
1.00E+05	1.00E+00	7.29E-05				1.00E+00	7.29E-05
3.00E+05	9.99E-01	2.19E-04				1.00E+00	2.19E-04
1.00E+06	9.98E-01	7.29E-04				9.99E-01	7.28E-04
3.00E+06	9.95E-01	2.19E-03				9.97E-01	2.18E-03
1.00E+07	9.82E-01	7.29E-03				9.91E-01	7.22E-03
3.15E+07	9.45E-01	2.30E-02				9.72E-01	2.24E-02

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	6.94E-02	1.03E-02	1.90E-04	4.82E+03	1.91E+04	2.11E-01
3.00E+01	2.71E-01	5.06E-02	7.73E-04	4.82E+03	1.91E+04	2.11E-01
1.00E+02	6.86E-01	1.26E-01	2.08E-03	4.82E+03	1.91E+04	2.11E-01
3.00E+02	1.18E+00	2.51E-01	4.31E-03	4.82E+03	1.91E+04	2.11E-01
1.00E+03	1.55E+00	4.57E-01	6.89E-03	4.82E+03	1.91E+04	2.11E-01
3.00E+03	1.70E+00	9.12E-01	8.73E-03	4.82E+03	1.91E+04	2.11E-01
1.00E+04	1.89E+00	2.91E+00	1.27E-02	4.82E+03	1.91E+04	2.11E-01
3.00E+04	2.11E+00	8.58E+00	1.91E-02	4.82E+03	1.91E+04	2.11E-01
1.00E+05	2.57E+00	2.34E+01	3.10E-02	4.82E+03	1.91E+04	2.11E-01
3.00E+05	3.35E+00	5.01E+01	6.99E-02	4.81E+03	1.91E+04	2.11E-01
1.00E+06	5.26E+00	1.05E+02	3.19E-01	4.81E+03	1.90E+04	2.11E-01
3.00E+06	8.40E+00	1.64E+02	1.04E+00	4.79E+03	1.90E+04	2.10E-01
1.00E+07	1.18E+01	2.32E+02	1.55E+00	4.73E+03	1.87E+04	2.07E-01
3.15E+07	1.87E+01	4.15E+02	1.78E+00	4.38E+03	1.79E+04	1.99E-01

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g	TEDE rem	Max TODE rem	Public TEDE rem
1.04E-04	2.62E-04	4.73E-02	4.82E+03	1.91E+04	2.11E-01
1.04E-04	2.62E-04	4.72E-02	4.82E+03	1.91E+04	2.12E-01
1.04E-04	2.62E-04	4.69E-02	4.82E+03	1.91E+04	2.13E-01
1.04E-04	2.62E-04	4.64E-02	4.82E+03	1.91E+04	2.15E-01
1.04E-04	2.62E-04	4.59E-02	4.82E+03	1.91E+04	2.18E-01
1.04E-04	2.62E-04	4.55E-02	4.82E+03	1.91E+04	2.20E-01
1.04E-04	2.62E-04	4.47E-02	4.82E+03	1.91E+04	2.24E-01
1.04E-04	2.62E-04	4.35E-02	4.82E+03	1.91E+04	2.30E-01
1.04E-04	2.62E-04	4.13E-02	4.82E+03	1.91E+04	2.42E-01
1.04E-04	2.62E-04	3.56E-02	4.82E+03	1.91E+04	2.81E-01
1.04E-04	2.62E-04	1.89E-02	4.81E+03	1.90E+04	5.29E-01
1.04E-04	2.63E-04	7.98E-03	4.80E+03	1.90E+04	1.25E+00
1.05E-04	2.68E-04	5.70E-03	4.74E+03	1.87E+04	1.76E+00
1.14E-04	2.80E-04	5.04E-03	4.40E+03	1.79E+04	1.98E+00

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Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g				Average Mass, g Over "t"	Average Mass, g Over "t"
	U232	U233				U232	U233
1.00E+01	1.00E+00	7.29E-12				1.00E+00	7.29E-12
3.00E+01	1.00E+00	2.19E-11				1.00E+00	2.19E-11
1.00E+02	1.00E+00	7.29E-11				1.00E+00	7.29E-11
3.00E+02	1.00E+00	2.19E-10				1.00E+00	2.19E-10
1.00E+03	1.00E+00	7.29E-10				1.00E+00	7.29E-10
3.00E+03	1.00E+00	2.19E-09				1.00E+00	2.19E-09
1.00E+04	1.00E+00	7.29E-09				1.00E+00	7.29E-09
3.00E+04	1.00E+00	2.19E-08				1.00E+00	2.19E-08
1.00E+05	1.00E+00	7.29E-08				1.00E+00	7.29E-08
3.00E+05	1.00E+00	2.19E-07				1.00E+00	2.19E-07
1.00E+06	1.00E+00	7.29E-07				1.00E+00	7.29E-07
3.00E+06	9.99E-01	2.19E-06				1.00E+00	2.19E-06
1.00E+07	9.97E-01	7.29E-06				9.98E-01	7.28E-06
3.15E+07	9.90E-01	2.30E-05				9.95E-01	2.29E-05

Irradiation Time "t" s	Total Fission Product Dose			Total Fissionable Material Dose		
	TEDE Rem	TODE(thy) Rem	Public TEDE Rem	TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	6.94E-05	1.03E-05	1.90E-07	4.82E+03	1.91E+04	2.11E-01
3.00E+01	2.71E-04	5.06E-05	7.73E-07	4.82E+03	1.91E+04	2.11E-01
1.00E+02	6.86E-04	1.26E-04	2.08E-06	4.82E+03	1.91E+04	2.11E-01
3.00E+02	1.18E-03	2.51E-04	4.31E-06	4.82E+03	1.91E+04	2.11E-01
1.00E+03	1.55E-03	4.57E-04	6.89E-06	4.82E+03	1.91E+04	2.11E-01
3.00E+03	1.70E-03	9.12E-04	8.73E-06	4.82E+03	1.91E+04	2.11E-01
1.00E+04	1.89E-03	2.91E-03	1.27E-05	4.82E+03	1.91E+04	2.11E-01
3.00E+04	2.11E-03	8.58E-03	1.91E-05	4.82E+03	1.91E+04	2.11E-01
1.00E+05	2.56E-03	2.34E-02	3.09E-05	4.82E+03	1.91E+04	2.11E-01
3.00E+05	3.34E-03	5.00E-02	6.98E-05	4.82E+03	1.91E+04	2.11E-01
1.00E+06	5.22E-03	1.04E-01	3.17E-04	4.82E+03	1.91E+04	2.11E-01
3.00E+06	8.25E-03	1.61E-01	1.03E-03	4.81E+03	1.91E+04	2.11E-01
1.00E+07	1.12E-02	2.19E-01	1.47E-03	4.80E+03	1.89E+04	2.10E-01
3.15E+07	1.59E-02	3.55E-01	1.54E-03	4.60E+03	1.87E+04	2.08E-01

U232	Mass Limits (g) at fluence rates						
Time,s	1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.0E+01	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
1.0E+02	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.0E+02	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
1.0E+03	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.0E+03	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
1.0E+04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.0E+04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
1.0E+05	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.0E+05	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
1.0E+06	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.0E+06	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
1.0E+07	1.1E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
3.2E+07	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04

U-233 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U233						U234					
1.00E+01	6.91E-01	1.04E-01	1.80E-03	2.72E-01	9.08E-01	1.48E-05	1.08E-03	1.48E-04	2.48E-06	5.32E-12	3.64E-04	2.43E-16
3.00E+01	2.98E+00	5.90E-01	8.29E-03	2.72E-01	1.23E+00	1.48E-05	4.89E-03	9.38E-04	1.27E-05	1.47E-11	8.92E-04	6.67E-16
1.00E+02	7.54E+00	1.40E+00	2.14E-02	2.72E-01	1.94E+00	1.48E-05	1.27E-02	2.15E-03	3.20E-05	5.07E-11	1.96E-03	2.31E-15
3.00E+02	1.26E+01	2.66E+00	4.27E-02	2.72E-01	2.87E+00	1.48E-05	2.11E-02	3.95E-03	6.27E-05	1.52E-10	3.31E-03	6.93E-15
1.00E+03	1.59E+01	4.91E+00	6.73E-02	2.72E-01	3.70E+00	1.48E-05	2.64E-02	7.12E-03	9.72E-05	5.09E-10	4.49E-03	2.32E-14
3.00E+03	1.77E+01	1.02E+01	8.49E-02	2.72E-01	3.83E+00	1.48E-05	2.92E-02	1.50E-02	1.21E-04	1.53E-09	4.67E-03	6.96E-14
1.00E+04	2.04E+01	3.28E+01	1.23E-01	2.72E-01	3.88E+00	1.48E-05	3.32E-02	4.95E-02	1.71E-04	5.08E-09	4.73E-03	2.32E-13
3.00E+04	2.33E+01	9.47E+01	1.83E-01	2.72E-01	3.93E+00	1.48E-05	3.77E-02	1.45E-01	2.55E-04	1.53E-08	4.80E-03	6.96E-13
1.00E+05	2.88E+01	2.47E+02	2.94E-01	2.72E-01	4.02E+00	1.48E-05	4.62E-02	3.80E-01	4.21E-04	5.08E-08	4.93E-03	2.32E-12
3.00E+05	3.66E+01	4.97E+02	6.25E-01	2.72E-01	4.48E+00	1.48E-05	5.80E-02	7.54E-01	9.05E-04	1.53E-07	5.23E-03	6.96E-12
1.00E+06	5.30E+01	9.75E+02	2.67E+00	2.72E-01	8.42E+00	1.48E-05	8.12E-02	1.43E+00	3.81E-03	5.08E-07	1.12E-02	2.32E-11
3.00E+06	7.87E+01	1.46E+03	8.55E+00	2.73E-01	2.07E+01	1.49E-05	1.17E-01	2.11E+00	1.21E-02	1.53E-06	2.83E-02	6.96E-11
1.00E+07	1.03E+02	1.94E+03	1.22E+01	2.74E-01	2.82E+01	1.49E-05	1.51E-01	2.73E+00	1.72E-02	5.08E-06	3.88E-02	2.32E-10
3.15E+07	1.43E+02	3.03E+03	1.28E+01	2.79E-01	2.83E+01	1.52E-05	2.05E-01	4.14E+00	1.79E-02	1.60E-05	3.90E-02	7.30E-10

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Th229					
1.00E+01	1.27E+00	2.34E-01	3.09E-03	9.92E+02	1.12E+01	1.62E-02
3.00E+01	3.93E+00	5.59E-01	7.88E-03	9.92E+02	1.15E+01	1.62E-02
1.00E+02	1.18E+01	1.25E+00	1.98E-02	9.92E+02	1.21E+01	1.62E-02
3.00E+02	2.10E+01	2.20E+00	3.83E-02	9.92E+02	1.29E+01	1.62E-02
1.00E+03	2.64E+01	3.52E+00	5.91E-02	9.92E+02	1.36E+01	1.62E-02
3.00E+03	2.78E+01	5.82E+00	7.49E-02	9.92E+02	1.37E+01	1.62E-02
1.00E+04	2.94E+01	1.39E+01	1.07E-01	9.92E+02	1.38E+01	1.62E-02
3.00E+04	3.04E+01	3.32E+01	1.46E-01	9.92E+02	1.38E+01	1.62E-02
1.00E+05	3.19E+01	7.05E+01	1.80E-01	9.92E+02	1.38E+01	1.62E-02
3.00E+05	3.32E+01	1.08E+02	2.18E-01	9.92E+02	1.40E+01	1.62E-02
1.00E+06	3.50E+01	1.50E+02	3.91E-01	9.92E+02	1.47E+01	1.62E-02
3.00E+06	3.79E+01	1.85E+02	8.76E-01	9.92E+02	1.66E+01	1.62E-02
1.00E+07	4.19E+01	2.07E+02	1.17E+00	9.92E+02	2.03E+01	1.62E-02
3.15E+07	4.83E+01	2.50E+02	1.19E+00	9.92E+02	2.98E+01	1.62E-02

U-233

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U233	U234	Th229			U233	U234	Th229
1.00E+01	1.00E+00	1.39E-08	2.13E-04			1.00E+00	1.39E-08	2.13E-04
3.00E+01	1.00E+00	4.16E-08	2.13E-04			1.00E+00	4.16E-08	2.13E-04
1.00E+02	1.00E+00	1.39E-07	2.13E-04			1.00E+00	1.39E-07	2.13E-04
3.00E+02	1.00E+00	4.16E-07	2.13E-04			1.00E+00	4.16E-07	2.13E-04
1.00E+03	1.00E+00	1.39E-06	2.13E-04			1.00E+00	1.39E-06	2.13E-04
3.00E+03	1.00E+00	4.16E-06	2.13E-04			1.00E+00	4.16E-06	2.13E-04
1.00E+04	1.00E+00	1.39E-05	2.13E-04			1.00E+00	1.39E-05	2.13E-04
3.00E+04	1.00E+00	4.16E-05	2.13E-04			1.00E+00	4.16E-05	2.13E-04
1.00E+05	9.99E-01	1.39E-04	2.13E-04			1.00E+00	1.39E-04	2.13E-04
3.00E+05	9.97E-01	4.16E-04	2.13E-04			9.99E-01	4.15E-04	2.13E-04
1.00E+06	9.91E-01	1.39E-03	2.13E-04			9.96E-01	1.38E-03	2.12E-04
3.00E+06	9.73E-01	4.16E-03	2.14E-04			9.87E-01	4.10E-03	2.11E-04
1.00E+07	9.14E-01	1.39E-02	2.15E-04			9.56E-01	1.33E-02	2.06E-04
3.15E+07	7.53E-01	4.37E-02	2.18E-04			8.71E-01	3.81E-02	1.90E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	6.91E-01	1.04E-01	1.80E-03	4.83E-01	9.11E-01	1.83E-05
3.00E+01	2.98E+00	5.90E-01	8.30E-03	4.83E-01	1.24E+00	1.83E-05
1.00E+02	7.54E+00	1.40E+00	2.14E-02	4.83E-01	1.94E+00	1.83E-05
3.00E+02	1.26E+01	2.67E+00	4.27E-02	4.83E-01	2.87E+00	1.83E-05
1.00E+03	1.59E+01	4.91E+00	6.73E-02	4.83E-01	3.70E+00	1.83E-05
3.00E+03	1.78E+01	1.02E+01	8.49E-02	4.83E-01	3.84E+00	1.83E-05
1.00E+04	2.04E+01	3.28E+01	1.23E-01	4.83E-01	3.88E+00	1.83E-05
3.00E+04	2.33E+01	9.47E+01	1.83E-01	4.83E-01	3.94E+00	1.83E-05
1.00E+05	2.88E+01	2.47E+02	2.94E-01	4.83E-01	4.02E+00	1.82E-05
3.00E+05	3.66E+01	4.97E+02	6.24E-01	4.82E-01	4.47E+00	1.82E-05
1.00E+06	5.28E+01	9.70E+02	2.66E+00	4.80E-01	8.34E+00	1.81E-05
3.00E+06	7.76E+01	1.45E+03	8.43E+00	4.77E-01	2.01E+01	1.79E-05
1.00E+07	9.87E+01	1.85E+03	1.17E+01	4.64E-01	2.57E+01	1.71E-05
3.15E+07	1.24E+02	2.64E+03	1.11E+01	4.26E-01	2.13E+01	1.50E-05

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
4.26E-01	5.49E+00	5.49E+00		1.17E+00	9.11E-01	1.82E-03
1.44E-01	4.05E+00	1.20E+00		3.46E+00	1.24E+00	8.31E-03
6.23E-02	2.57E+00	4.67E-01		8.02E+00	1.94E+00	2.14E-02
3.83E-02	1.74E+00	2.34E-01		1.31E+01	2.87E+00	4.28E-02
3.04E-02	1.02E+00	1.48E-01		1.64E+01	4.91E+00	6.74E-02
2.74E-02	4.89E-01	1.18E-01		1.82E+01	1.02E+01	8.49E-02
2.40E-02	1.52E-01	8.15E-02		2.08E+01	3.28E+01	1.23E-01
2.10E-02	5.28E-02	5.47E-02		2.38E+01	9.47E+01	1.83E-01
1.71E-02	2.03E-02	3.40E-02		2.93E+01	2.47E+02	2.94E-01
1.35E-02	1.01E-02	1.60E-02		3.71E+01	4.97E+02	6.24E-01
9.39E-03	5.15E-03	3.76E-03		5.33E+01	9.70E+02	2.66E+00
6.40E-03	3.46E-03	1.19E-03		7.81E+01	1.45E+03	8.43E+00
5.04E-03	2.70E-03	8.56E-04		9.92E+01	1.85E+03	1.17E+01
4.01E-03	1.89E-03	8.99E-04		1.25E+02	2.64E+03	1.11E+01

U-233

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U233	U234	Th229			U233	U234	Th229
1.00E+01	1.00E+00	1.39E-11	2.13E-04			1.00E+00	1.39E-11	2.13E-04
3.00E+01	1.00E+00	4.16E-11	2.13E-04			1.00E+00	4.16E-11	2.13E-04
1.00E+02	1.00E+00	1.39E-10	2.13E-04			1.00E+00	1.39E-10	2.13E-04
3.00E+02	1.00E+00	4.16E-10	2.13E-04			1.00E+00	4.16E-10	2.13E-04
1.00E+03	1.00E+00	1.39E-09	2.13E-04			1.00E+00	1.39E-09	2.13E-04
3.00E+03	1.00E+00	4.16E-09	2.13E-04			1.00E+00	4.16E-09	2.13E-04
1.00E+04	1.00E+00	1.39E-08	2.13E-04			1.00E+00	1.39E-08	2.13E-04
3.00E+04	1.00E+00	4.16E-08	2.13E-04			1.00E+00	4.16E-08	2.13E-04
1.00E+05	1.00E+00	1.39E-07	2.13E-04			1.00E+00	1.39E-07	2.13E-04
3.00E+05	1.00E+00	4.16E-07	2.13E-04			1.00E+00	4.16E-07	2.13E-04
1.00E+06	1.00E+00	1.39E-06	2.13E-04			1.00E+00	1.39E-06	2.13E-04
3.00E+06	1.00E+00	4.16E-06	2.14E-04			1.00E+00	4.16E-06	2.14E-04
1.00E+07	1.00E+00	1.39E-05	2.15E-04			1.00E+00	1.39E-05	2.15E-04
3.15E+07	1.00E+00	4.37E-05	2.18E-04			1.00E+00	4.37E-05	2.18E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	6.91E-04	1.04E-04	1.80E-06	4.83E-01	9.11E-01	1.83E-05
3.00E+01	2.98E-03	5.90E-04	8.30E-06	4.83E-01	1.24E+00	1.83E-05
1.00E+02	7.54E-03	1.40E-03	2.14E-05	4.83E-01	1.94E+00	1.83E-05
3.00E+02	1.26E-02	2.67E-03	4.27E-05	4.83E-01	2.87E+00	1.83E-05
1.00E+03	1.59E-02	4.91E-03	6.73E-05	4.83E-01	3.70E+00	1.83E-05
3.00E+03	1.78E-02	1.02E-02	8.49E-05	4.83E-01	3.84E+00	1.83E-05
1.00E+04	2.04E-02	3.28E-02	1.23E-04	4.83E-01	3.88E+00	1.83E-05
3.00E+04	2.33E-02	9.47E-02	1.83E-04	4.83E-01	3.94E+00	1.83E-05
1.00E+05	2.88E-02	2.47E-01	2.94E-04	4.83E-01	4.02E+00	1.82E-05
3.00E+05	3.66E-02	4.97E-01	6.25E-04	4.83E-01	4.49E+00	1.83E-05
1.00E+06	5.30E-02	9.75E-01	2.67E-03	4.83E-01	8.42E+00	1.83E-05
3.00E+06	7.87E-02	1.46E+00	8.55E-03	4.85E-01	2.07E+01	1.83E-05
1.00E+07	1.03E-01	1.94E+00	1.22E-02	4.87E-01	2.82E+01	1.84E-05
3.15E+07	1.43E-01	3.03E+00	1.28E-02	4.95E-01	2.82E+01	1.87E-05

U233 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	4.3E-01	9.1E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
3.0E+01	1.4E-01	6.4E-01	9.8E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
1.0E+02	6.2E-02	4.0E-01	9.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
3.0E+02	3.8E-02	2.9E-01	8.2E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
1.0E+03	3.0E-02	2.4E-01	7.8E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
3.0E+03	2.7E-02	2.2E-01	7.6E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
1.0E+04	2.4E-02	2.0E-01	7.3E-01	9.9E-01	1.0E+00	1.0E+00	1.0E+00
3.0E+04	2.1E-02	1.8E-01	7.0E-01	9.9E-01	1.0E+00	1.0E+00	1.0E+00
1.0E+05	1.7E-02	1.5E-01	6.5E-01	9.8E-01	1.0E+00	1.0E+00	1.0E+00
3.0E+05	1.0E-02	1.0E-01	5.9E-01	9.6E-01	1.0E+00	1.0E+00	1.0E+00
1.0E+06	3.8E-03	3.7E-02	3.7E-01	5.9E-01	5.9E-01	5.9E-01	5.9E-01
3.0E+06	1.2E-03	1.2E-02	1.2E-01	2.4E-01	2.4E-01	2.4E-01	2.4E-01
1.0E+07	8.6E-04	8.2E-03	8.2E-02	1.8E-01	1.8E-01	1.8E-01	1.8E-01
3.2E+07	9.0E-04	7.9E-03	7.8E-02	1.8E-01	1.8E-01	1.8E-01	1.8E-01

U-234 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U234						U235					
1.00E+01	1.08E-03	1.48E-04	2.48E-06	1.60E-01	6.93E-02	9.03E-06	4.41E-01	7.26E-02	1.12E-03	2.32E-11	1.86E-01	1.09E-15
3.00E+01	4.89E-03	9.38E-04	1.27E-05	1.60E-01	6.98E-02	9.03E-06	2.33E+00	4.80E-01	6.19E-03	6.94E-11	4.52E-01	3.27E-15
1.00E+02	1.27E-02	2.15E-03	3.20E-05	1.60E-01	7.09E-02	9.03E-06	5.62E+00	1.09E+00	1.54E-02	2.32E-10	9.75E-01	1.09E-14
3.00E+02	2.11E-02	3.95E-03	6.27E-05	1.60E-01	7.23E-02	9.03E-06	8.99E+00	1.99E+00	2.98E-02	6.94E-10	1.61E+00	3.27E-14
1.00E+03	2.64E-02	7.12E-03	9.72E-05	1.60E-01	7.35E-02	9.03E-06	1.11E+01	3.76E+00	4.60E-02	2.32E-09	2.17E+00	1.09E-13
3.00E+03	2.92E-02	1.50E-02	1.21E-04	1.60E-01	7.37E-02	9.03E-06	1.25E+01	8.58E+00	5.73E-02	6.94E-09	2.25E+00	3.27E-13
1.00E+04	3.32E-02	4.95E-02	1.71E-04	1.60E-01	7.37E-02	9.03E-06	1.44E+01	2.83E+01	8.22E-02	2.32E-08	2.28E+00	1.09E-12
3.00E+04	3.77E-02	1.45E-01	2.55E-04	1.60E-01	7.38E-02	9.03E-06	1.65E+01	7.99E+01	1.24E-01	6.94E-08	2.31E+00	3.27E-12
1.00E+05	4.62E-02	3.80E-01	4.21E-04	1.60E-01	7.39E-02	9.03E-06	2.04E+01	1.98E+02	2.03E-01	2.32E-07	2.36E+00	1.09E-11
3.00E+05	5.80E-02	7.54E-01	9.05E-04	1.60E-01	7.46E-02	9.03E-06	2.52E+01	3.56E+02	3.90E-01	6.94E-07	2.61E+00	3.27E-11
1.00E+06	8.12E-02	1.43E+00	3.81E-03	1.60E-01	8.02E-02	9.03E-06	3.33E+01	5.89E+02	1.41E+00	2.32E-06	4.57E+00	1.09E-10
3.00E+06	1.17E-01	2.11E+00	1.21E-02	1.60E-01	9.75E-02	9.03E-06	4.54E+01	8.05E+02	4.26E+00	6.94E-06	1.05E+01	3.27E-10
1.00E+07	1.51E-01	2.73E+00	1.72E-02	1.61E-01	1.08E-01	9.03E-06	5.56E+01	9.53E+02	6.00E+00	2.32E-05	1.41E+01	1.09E-09
3.15E+07	2.05E-01	4.14E+00	1.79E-02	1.61E-01	1.08E-01	9.03E-06	6.93E+01	1.27E+03	6.16E+00	7.29E-05	1.41E+01	3.44E-09

Irradiation Time "t" s	ssion Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	onable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Th230					
1.00E+01	3.33E-04	3.44E-05	6.33E-07	7.66E-04	3.43E+01	3.61E-08
3.00E+01	1.61E-03	2.29E-04	3.22E-06	7.82E-04	3.43E+01	3.66E-08
1.00E+02	4.81E-03	5.12E-04	8.09E-06	8.33E-04	3.44E+01	3.92E-08
3.00E+02	8.59E-03	8.99E-04	1.57E-05	9.92E-04	3.44E+01	4.60E-08
1.00E+03	1.08E-02	1.44E-03	2.42E-05	1.53E-04	3.44E+01	7.04E-08
3.00E+03	1.14E-02	2.38E-03	3.06E-05	3.08E-03	3.44E+01	1.39E-07
1.00E+04	1.20E-02	5.70E-03	4.37E-05	8.33E-03	3.44E+01	3.72E-07
3.00E+04	1.24E-02	1.36E-02	5.97E-05	2.23E-02	3.44E+01	9.85E-07
1.00E+05	1.30E-02	2.88E-02	7.37E-05	6.16E-02	3.44E+01	2.62E-06
3.00E+05	1.36E-02	4.43E-02	8.93E-05	1.31E-01	3.50E+01	5.06E-06
1.00E+06	1.43E-02	6.12E-02	1.60E-04	2.83E-01	3.73E+01	8.89E-06
3.00E+06	1.55E-02	7.59E-02	3.58E-04	7.00E-01	4.43E+01	1.87E-05
1.00E+07	1.71E-02	8.46E-02	4.79E-04	2.16E+00	6.86E+01	5.28E-05
3.15E+07	1.98E-02	1.02E-01	4.89E-04	6.63E+00	1.43E+02	1.58E-04

U-234

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U234	U235	Th230			U234	U235	Th230
1.00E+01	1.00E+00	6.75E-08	1.40E-04			1.00E+00	6.75E-08	1.40E-04
3.00E+01	1.00E+00	1.80E-07	1.40E-04			1.00E+00	1.80E-07	1.40E-04
1.00E+02	1.00E+00	6.30E-07	1.40E-04			1.00E+00	6.30E-07	1.40E-04
3.00E+02	1.00E+00	1.89E-06	1.40E-04			1.00E+00	1.89E-06	1.40E-04
1.00E+03	1.00E+00	6.35E-06	1.40E-04			1.00E+00	6.35E-06	1.40E-04
3.00E+03	1.00E+00	1.90E-05	1.40E-04			1.00E+00	1.90E-05	1.40E-04
1.00E+04	1.00E+00	6.34E-05	1.40E-04			1.00E+00	6.34E-05	1.40E-04
3.00E+04	1.00E+00	1.90E-04	1.40E-04			1.00E+00	1.90E-04	1.40E-04
1.00E+05	9.99E-01	6.34E-04	1.40E-04			1.00E+00	6.34E-04	1.40E-04
3.00E+05	9.98E-01	1.90E-03	1.40E-04			9.99E-01	1.90E-03	1.40E-04
1.00E+06	9.94E-01	6.34E-03	1.40E-04			9.97E-01	6.32E-03	1.40E-04
3.00E+06	9.81E-01	1.90E-02	1.40E-04			9.91E-01	1.88E-02	1.39E-04
1.00E+07	9.39E-01	6.34E-02	1.40E-04			9.69E-01	6.14E-02	1.36E-04
3.15E+07	8.19E-01	2.00E-01	1.40E-04			9.07E-01	1.81E-01	1.27E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.08E-03	1.48E-04	2.48E-06	1.60E-01	7.41E-02	9.03E-06
3.00E+01	4.89E-03	9.38E-04	1.27E-05	1.60E-01	7.46E-02	9.03E-06
1.00E+02	1.27E-02	2.15E-03	3.20E-05	1.60E-01	7.57E-02	9.03E-06
3.00E+02	2.11E-02	3.96E-03	6.27E-05	1.60E-01	7.71E-02	9.03E-06
1.00E+03	2.64E-02	7.14E-03	9.74E-05	1.60E-01	7.83E-02	9.03E-06
3.00E+03	2.94E-02	1.51E-02	1.22E-04	1.60E-01	7.85E-02	9.03E-06
1.00E+04	3.41E-02	5.13E-02	1.76E-04	1.60E-01	7.86E-02	9.03E-06
3.00E+04	4.08E-02	1.60E-01	2.79E-04	1.60E-01	7.90E-02	9.03E-06
1.00E+05	5.92E-02	5.06E-01	5.49E-04	1.60E-01	8.02E-02	9.03E-06
3.00E+05	1.06E-01	1.43E+00	1.64E-03	1.60E-01	8.43E-02	9.01E-06
1.00E+06	2.92E-01	5.14E+00	1.27E-02	1.59E-01	1.14E-01	8.98E-06
3.00E+06	9.71E-01	1.72E+01	9.22E-02	1.57E-01	3.01E-01	8.86E-06
1.00E+07	3.56E+00	6.12E+01	3.85E-01	1.51E-01	1.00E+00	8.49E-06
3.15E+07	1.28E+01	2.33E+02	1.13E+00	1.33E-01	2.93E+00	7.42E-06

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
3.10E+00	6.74E+01	8.69E+02		1.61E-01	7.41E-02	1.15E-05
3.03E+00	6.70E+01	4.61E+02		1.65E-01	7.46E-02	2.17E-05
2.90E+00	6.60E+01	2.44E+02		1.73E-01	7.57E-02	4.10E-05
2.76E+00	6.49E+01	1.39E+02		1.81E-01	7.71E-02	7.17E-05
2.68E+00	6.38E+01	9.39E+01		1.86E-01	7.83E-02	1.06E-04
2.64E+00	6.37E+01	7.65E+01		1.89E-01	7.85E-02	1.31E-04
2.58E+00	6.36E+01	5.40E+01		1.94E-01	7.86E-02	1.85E-04
2.49E+00	3.12E+01	3.48E+01		2.01E-01	1.60E-01	2.88E-04
2.28E+00	9.89E+00	1.79E+01		2.19E-01	5.06E-01	5.58E-04
1.88E+00	3.50E+00	6.05E+00		2.65E-01	1.43E+00	1.65E-03
1.11E+00	9.72E-01	7.86E-01		4.51E-01	5.14E+00	1.27E-02
4.43E-01	2.90E-01	1.08E-01		1.13E+00	1.72E+01	9.22E-02
1.35E-01	8.17E-02	2.60E-02		3.71E+00	6.12E+01	3.85E-01
3.88E-02	2.14E-02	8.82E-03		1.29E+01	2.33E+02	1.13E+00

U-234

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U234	U235	Th230			U234	U235	Th230
1.00E+01	1.00E+00	6.75E-11	1.40E-04			1.00E+00	6.75E-11	1.40E-04
3.00E+01	1.00E+00	1.80E-10	1.40E-04			1.00E+00	1.80E-10	1.40E-04
1.00E+02	1.00E+00	6.30E-10	1.40E-04			1.00E+00	6.30E-10	1.40E-04
3.00E+02	1.00E+00	1.89E-09	1.40E-04			1.00E+00	1.89E-09	1.40E-04
1.00E+03	1.00E+00	6.35E-09	1.40E-04			1.00E+00	6.35E-09	1.40E-04
3.00E+03	1.00E+00	1.90E-08	1.40E-04			1.00E+00	1.90E-08	1.40E-04
1.00E+04	1.00E+00	6.34E-08	1.40E-04			1.00E+00	6.34E-08	1.40E-04
3.00E+04	1.00E+00	1.90E-07	1.40E-04			1.00E+00	1.90E-07	1.40E-04
1.00E+05	1.00E+00	6.34E-07	1.40E-04			1.00E+00	6.34E-07	1.40E-04
3.00E+05	1.00E+00	1.90E-06	1.40E-04			1.00E+00	1.90E-06	1.40E-04
1.00E+06	1.00E+00	6.34E-06	1.40E-04			1.00E+00	6.34E-06	1.40E-04
3.00E+06	1.00E+00	1.90E-05	1.40E-04			1.00E+00	1.90E-05	1.40E-04
1.00E+07	1.00E+00	6.34E-05	1.40E-04			1.00E+00	6.34E-05	1.40E-04
3.15E+07	1.00E+00	2.00E-04	1.40E-04			1.00E+00	2.00E-04	1.40E-04

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.08E-06	1.48E-07	2.48E-09	1.60E-01	7.41E-02	9.03E-06
3.00E+01	4.89E-06	9.38E-07	1.27E-08	1.60E-01	7.46E-02	9.03E-06
1.00E+02	1.27E-05	2.15E-06	3.20E-08	1.60E-01	7.57E-02	9.03E-06
3.00E+02	2.11E-05	3.95E-06	6.27E-08	1.60E-01	7.71E-02	9.03E-06
1.00E+03	2.64E-05	7.12E-06	9.72E-08	1.60E-01	7.83E-02	9.03E-06
3.00E+03	2.92E-05	1.50E-05	1.21E-07	1.60E-01	7.85E-02	9.03E-06
1.00E+04	3.32E-05	4.95E-05	1.71E-07	1.60E-01	7.85E-02	9.03E-06
3.00E+04	3.77E-05	1.45E-04	2.55E-07	1.60E-01	7.86E-02	9.03E-06
1.00E+05	4.62E-05	3.81E-04	4.21E-07	1.60E-01	7.87E-02	9.03E-06
3.00E+05	5.80E-05	7.54E-04	9.06E-07	1.60E-01	7.95E-02	9.03E-06
1.00E+06	8.14E-05	1.43E-03	3.82E-06	1.60E-01	8.54E-02	9.03E-06
3.00E+06	1.18E-04	2.12E-03	1.21E-05	1.60E-01	1.04E-01	9.03E-06
1.00E+07	1.55E-04	2.79E-03	1.76E-05	1.61E-01	1.18E-01	9.04E-06
3.15E+07	2.18E-04	4.39E-03	1.91E-05	1.62E-01	1.31E-01	9.05E-06

U234 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+01	3.0E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+02	2.9E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+02	2.8E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+03	2.7E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+03	2.6E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+04	2.6E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+04	2.5E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+05	2.3E+00	3.0E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+05	1.9E+00	3.0E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+06	7.9E-01	2.9E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+06	1.1E-01	2.8E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+07	2.6E-02	1.8E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.2E+07	8.8E-03	7.1E-01	3.0E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00

U-235 Non-Thermal Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem
	U235						U236					
1.00E+01	4.41E-01	7.26E-02	1.12E-03	5.63E-05	1.86E-01	2.64E-09	3.19E-03	5.01E-04	7.41E-06	2.43E-06	1.53E-03	1.02E-10
3.00E+01	2.33E+00	4.80E-01	6.19E-03	5.63E-05	4.52E-01	2.64E-09	1.73E-02	3.81E-03	4.73E-05	7.27E-06	4.03E-03	3.04E-10
1.00E+02	5.62E+00	1.09E+00	1.54E-02	5.63E-05	9.75E-01	2.64E-09	4.16E-02	8.36E-03	1.16E-04	2.43E-05	7.67E-03	1.02E-09
3.00E+02	8.99E+00	1.99E+00	2.98E-02	5.63E-05	1.61E+00	2.64E-09	6.69E-02	1.49E-02	2.23E-04	7.27E-05	1.24E-02	3.04E-09
1.00E+03	1.11E+01	3.76E+00	4.60E-02	5.63E-05	2.17E+00	2.64E-09	8.34E-02	2.66E-02	3.43E-04	2.43E-04	1.66E-02	1.02E-08
3.00E+03	1.25E+01	8.58E+00	5.73E-02	5.63E-05	2.25E+00	2.64E-09	9.35E-02	5.68E-02	4.19E-04	7.27E-04	1.73E-02	3.04E-08
1.00E+04	1.44E+01	2.83E+01	8.22E-02	5.63E-05	2.28E+00	2.65E-09	1.08E-01	1.84E-01	5.80E-04	2.41E-03	1.74E-02	1.01E-07
3.00E+04	1.65E+01	7.99E+01	1.24E-01	5.65E-05	2.31E+00	2.64E-09	1.23E-01	5.25E-01	8.55E-04	7.14E-03	1.76E-02	3.01E-07
1.00E+05	2.04E+01	1.98E+02	2.03E-01	5.66E-05	2.37E+00	2.65E-09	1.50E-01	1.30E+00	1.38E-03	2.28E-02	1.80E-02	9.60E-07
3.00E+05	2.52E+01	3.56E+02	3.90E-01	5.71E-05	2.61E+00	2.67E-09	1.83E-01	2.34E+00	2.61E-03	6.12E-02	1.96E-02	2.56E-06
1.00E+06	3.33E+01	5.89E+02	1.41E+00	5.87E-05	4.58E+00	2.74E-09	2.37E-01	3.88E+00	9.31E-03	1.42E-01	3.24E-02	5.94E-06
3.00E+06	4.54E+01	8.05E+02	4.26E+00	6.33E-05	1.05E+01	2.96E-09	3.19E-01	5.36E+00	2.79E-02	1.98E-01	7.08E-02	8.32E-06
1.00E+07	5.56E+01	9.53E+02	6.00E+00	7.96E-05	1.41E+01	3.72E-09	3.96E-01	6.62E+00	3.94E-02	2.04E-01	9.42E-02	8.55E-06
3.15E+07	6.93E+01	1.27E+03	6.16E+00	1.29E-04	1.41E+01	6.05E-09	5.14E-01	9.44E+00	4.08E-02	2.04E-01	9.42E-02	8.55E-06

Irradiation Time "t" s	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem
	Pa231					
1.00E+01	2.39E-03	3.05E-04	4.17E-06	6.81E+01	9.67E+02	2.75E-03
3.00E+01	6.37E-03	7.77E-04	1.12E-05	6.81E+01	9.67E+02	2.75E-03
1.00E+02	1.61E-02	1.89E-03	3.01E-05	6.81E+01	9.67E+02	2.75E-03
3.00E+02	2.71E-02	3.66E-03	6.18E-05	6.81E+01	9.67E+02	2.75E-03
1.00E+03	3.40E-02	6.64E-03	9.94E-05	6.81E+01	9.67E+02	2.75E-03
3.00E+03	3.67E-02	1.32E-02	1.30E-04	6.82E+01	9.75E+02	2.75E-03
1.00E+04	4.02E-02	3.96E-02	1.95E-04	6.85E+01	9.83E+02	2.77E-03
3.00E+04	4.39E-02	1.09E-01	2.85E-04	6.93E+01	1.01E+03	2.81E-03
1.00E+05	5.01E-02	2.69E-01	4.10E-04	7.19E+01	1.08E+03	2.93E-03
3.00E+05	5.77E-02	5.05E-01	7.19E-04	7.78E+01	1.18E+03	3.21E-03
1.00E+06	7.23E-02	9.22E-01	2.53E-03	9.42E+01	1.22E+03	3.92E-03
3.00E+06	9.49E-02	1.34E+00	7.68E-03	1.40E+02	1.24E+03	5.85E-03
1.00E+07	1.16E-01	1.70E+00	1.09E-02	3.03E+02	1.38E+03	1.21E-02
3.15E+07	1.49E-01	2.53E+00	1.13E-02	8.32E+02	2.30E+03	3.55E-02

U-235 Non-Thermal

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U235	U236	Pa231			U235	U236	Pa231
1.00E+01	1.00E+00	1.41E-08	4.87E-08			1.00E+00	1.41E-08	4.87E-08
3.00E+01	1.00E+00	4.22E-08	4.87E-08			1.00E+00	4.22E-08	4.87E-08
1.00E+02	1.00E+00	1.41E-07	4.87E-08			1.00E+00	1.41E-07	4.87E-08
3.00E+02	1.00E+00	4.22E-07	4.87E-08			1.00E+00	4.22E-07	4.87E-08
1.00E+03	1.00E+00	1.41E-06	4.87E-08			1.00E+00	1.41E-06	4.87E-08
3.00E+03	1.00E+00	4.22E-06	4.87E-08			1.00E+00	4.22E-06	4.87E-08
1.00E+04	1.00E+00	1.41E-05	4.87E-08			1.00E+00	1.41E-05	4.87E-08
3.00E+04	1.00E+00	4.22E-05	4.87E-08			1.00E+00	4.22E-05	4.87E-08
1.00E+05	9.99E-01	1.41E-04	4.87E-08			1.00E+00	1.41E-04	4.87E-08
3.00E+05	9.98E-01	4.22E-04	4.87E-08			9.99E-01	4.22E-04	4.86E-08
1.00E+06	9.93E-01	1.41E-03	4.87E-08			9.96E-01	1.40E-03	4.85E-08
3.00E+06	9.79E-01	4.22E-03	4.87E-08			9.89E-01	4.18E-03	4.82E-08
1.00E+07	9.31E-01	1.41E-02	4.87E-08			9.65E-01	1.36E-02	4.70E-08
3.15E+07	7.99E-01	4.43E-02	4.87E-08			8.96E-01	3.97E-02	4.36E-08

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	4.41E-01	7.26E-02	1.12E-03	5.96E-05	1.86E-01	2.78E-09
3.00E+01	2.33E+00	4.80E-01	6.19E-03	5.96E-05	4.52E-01	2.78E-09
1.00E+02	5.62E+00	1.09E+00	1.54E-02	5.96E-05	9.75E-01	2.78E-09
3.00E+02	8.99E+00	1.99E+00	2.98E-02	5.96E-05	1.61E+00	2.78E-09
1.00E+03	1.11E+01	3.76E+00	4.60E-02	5.96E-05	2.17E+00	2.78E-09
3.00E+03	1.25E+01	8.58E+00	5.73E-02	5.96E-05	2.25E+00	2.78E-09
1.00E+04	1.44E+01	2.83E+01	8.22E-02	5.96E-05	2.27E+00	2.78E-09
3.00E+04	1.65E+01	7.99E+01	1.24E-01	6.01E-05	2.31E+00	2.79E-09
1.00E+05	2.04E+01	1.98E+02	2.03E-01	6.33E-05	2.36E+00	2.92E-09
3.00E+05	2.52E+01	3.56E+02	3.90E-01	8.66E-05	2.61E+00	3.90E-09
1.00E+06	3.32E+01	5.87E+02	1.41E+00	2.63E-04	4.55E+00	1.13E-08
3.00E+06	4.50E+01	7.96E+02	4.22E+00	9.06E-04	1.03E+01	3.83E-08
1.00E+07	5.37E+01	9.20E+02	5.79E+00	2.97E-03	1.31E+01	1.25E-07
3.15E+07	6.21E+01	1.13E+03	5.52E+00	9.19E-03	1.13E+01	3.85E-07

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
1.13E+00	2.69E+01	8.96E+00		4.41E-01	1.86E-01	1.12E-03
2.14E-01	1.04E+01	1.61E+00		2.33E+00	4.80E-01	6.19E-03
8.89E-02	4.61E+00	6.49E-01		5.62E+00	1.09E+00	1.54E-02
5.56E-02	2.51E+00	3.36E-01		8.99E+00	1.99E+00	2.98E-02
4.49E-02	1.33E+00	2.17E-01		1.11E+01	3.76E+00	4.60E-02
4.01E-02	5.83E-01	1.74E-01		1.25E+01	8.58E+00	5.73E-02
3.47E-02	1.77E-01	1.22E-01		1.44E+01	2.83E+01	8.22E-02
3.03E-02	6.26E-02	8.05E-02		1.65E+01	7.99E+01	1.24E-01
2.45E-02	2.53E-02	4.93E-02		2.04E+01	1.98E+02	2.03E-01
1.99E-02	1.40E-02	2.57E-02		2.52E+01	3.56E+02	3.90E-01
1.51E-02	8.52E-03	7.11E-03		3.32E+01	5.87E+02	1.41E+00
1.11E-02	6.28E-03	2.37E-03		4.50E+01	7.96E+02	4.22E+00
9.32E-03	5.44E-03	1.73E-03		5.37E+01	9.20E+02	5.79E+00
8.05E-03	4.41E-03	1.81E-03		6.21E+01	1.13E+03	5.52E+00

U-235 Non-Thermal

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g	Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U235	U236	Pa231			U235	U236	Pa231
1.00E+01	1.00E+00	1.41E-11	4.87E-08			1.00E+00	1.41E-11	4.87E-08
3.00E+01	1.00E+00	4.22E-11	4.87E-08			1.00E+00	4.22E-11	4.87E-08
1.00E+02	1.00E+00	1.41E-10	4.87E-08			1.00E+00	1.41E-10	4.87E-08
3.00E+02	1.00E+00	4.22E-10	4.87E-08			1.00E+00	4.22E-10	4.87E-08
1.00E+03	1.00E+00	1.41E-09	4.87E-08			1.00E+00	1.41E-09	4.87E-08
3.00E+03	1.00E+00	4.22E-09	4.87E-08			1.00E+00	4.22E-09	4.87E-08
1.00E+04	1.00E+00	1.41E-08	4.87E-08			1.00E+00	1.41E-08	4.87E-08
3.00E+04	1.00E+00	4.22E-08	4.87E-08			1.00E+00	4.22E-08	4.87E-08
1.00E+05	1.00E+00	1.41E-07	4.87E-08			1.00E+00	1.41E-07	4.87E-08
3.00E+05	1.00E+00	4.22E-07	4.87E-08			1.00E+00	4.22E-07	4.87E-08
1.00E+06	1.00E+00	1.41E-06	4.87E-08			1.00E+00	1.41E-06	4.87E-08
3.00E+06	1.00E+00	4.22E-06	4.87E-08			1.00E+00	4.22E-06	4.87E-08
1.00E+07	1.00E+00	1.41E-05	4.87E-08			1.00E+00	1.41E-05	4.87E-08
3.15E+07	1.00E+00	4.43E-05	4.87E-08			1.00E+00	4.43E-05	4.87E-08

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	4.41E-04	7.26E-05	1.12E-06	5.96E-05	1.86E-01	2.78E-09
3.00E+01	2.33E-03	4.80E-04	6.19E-06	5.96E-05	4.52E-01	2.78E-09
1.00E+02	5.62E-03	1.09E-03	1.54E-05	5.96E-05	9.75E-01	2.78E-09
3.00E+02	8.99E-03	1.99E-03	2.98E-05	5.96E-05	1.61E+00	2.78E-09
1.00E+03	1.11E-02	3.76E-03	4.60E-05	5.96E-05	2.17E+00	2.78E-09
3.00E+03	1.25E-02	8.58E-03	5.73E-05	5.96E-05	2.25E+00	2.78E-09
1.00E+04	1.44E-02	2.83E-02	8.22E-05	5.96E-05	2.28E+00	2.78E-09
3.00E+04	1.65E-02	7.99E-02	1.24E-04	5.98E-05	2.31E+00	2.78E-09
1.00E+05	2.04E-02	1.98E-01	2.03E-04	6.01E-05	2.37E+00	2.79E-09
3.00E+05	2.52E-02	3.56E-01	3.90E-04	6.09E-05	2.61E+00	2.83E-09
1.00E+06	3.33E-02	5.89E-01	1.41E-03	6.35E-05	4.58E+00	2.94E-09
3.00E+06	4.54E-02	8.05E-01	4.26E-03	7.10E-05	1.05E+01	3.28E-09
1.00E+07	5.56E-02	9.53E-01	6.00E-03	9.72E-05	1.41E+01	4.43E-09
3.15E+07	6.93E-02	1.27E+00	6.16E-03	1.79E-04	1.41E+01	8.16E-09

U235 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.1E+00	1.1E+01	2.7E+01	2.7E+01	2.7E+01	2.7E+01	2.7E+01
3.0E+01	2.1E-01	2.1E+00	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
1.0E+02	8.9E-02	8.9E-01	5.1E+00	5.1E+00	5.1E+00	5.1E+00	5.1E+00
3.0E+02	5.6E-02	5.6E-01	3.1E+00	3.1E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+03	4.5E-02	4.5E-01	2.3E+00	2.3E+00	2.3E+00	2.3E+00	2.3E+00
3.0E+03	4.0E-02	4.0E-01	2.2E+00	2.2E+00	2.2E+00	2.2E+00	2.2E+00
1.0E+04	3.5E-02	3.5E-01	2.2E+00	2.2E+00	2.2E+00	2.2E+00	2.2E+00
3.0E+04	3.0E-02	3.0E-01	2.2E+00	2.2E+00	2.2E+00	2.2E+00	2.2E+00
1.0E+05	2.5E-02	2.5E-01	2.1E+00	2.1E+00	2.1E+00	2.1E+00	2.1E+00
3.0E+05	1.4E-02	1.4E-01	1.4E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
1.0E+06	7.1E-03	7.1E-02	7.1E-01	1.1E+00	1.1E+00	1.1E+00	1.1E+00
3.0E+06	2.4E-03	2.3E-02	2.3E-01	4.8E-01	4.8E-01	4.8E-01	4.8E-01
1.0E+07	1.7E-03	1.7E-02	1.7E-01	3.5E-01	3.5E-01	3.5E-01	3.5E-01
3.2E+07	1.8E-03	1.6E-02	1.6E-01	3.5E-01	3.5E-01	3.5E-01	3.5E-01

U-235 Thermal Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U235						U236					
1.00E+01	4.28E-01	7.77E-02	1.21E-03	5.64E-05	2.17E-01	2.64E-09	3.19E-03	5.01E-04	7.41E-06	2.43E-06	1.53E-03	1.02E-10
3.00E+01	2.20E+00	5.47E-01	6.98E-03	5.64E-05	5.22E-01	2.64E-09	1.73E-02	3.81E-03	4.73E-05	7.27E-06	4.03E-03	3.04E-10
1.00E+02	5.22E+00	1.21E+00	1.71E-02	5.64E-05	1.11E+00	2.64E-09	4.16E-02	8.36E-03	1.16E-04	2.43E-05	7.67E-03	1.02E-09
3.00E+02	8.33E+00	2.17E+00	3.26E-02	5.64E-05	1.81E+00	2.64E-09	6.69E-02	1.49E-02	2.23E-04	7.27E-05	1.24E-02	3.04E-09
1.00E+03	1.04E+01	3.87E+00	4.99E-02	5.64E-05	2.42E+00	2.64E-09	8.34E-02	2.66E-02	3.43E-04	2.43E-04	1.66E-02	1.02E-08
3.00E+03	1.17E+01	8.16E+00	6.11E-02	5.64E-05	2.51E+00	2.64E-09	9.35E-02	5.68E-02	4.19E-04	7.27E-04	1.73E-02	3.04E-08
1.00E+04	1.36E+01	2.62E+01	8.50E-02	5.64E-05	2.54E+00	2.64E-09	1.08E-01	1.84E-01	5.80E-04	2.41E-03	1.74E-02	1.01E-07
3.00E+04	1.55E+01	7.43E+01	1.25E-01	5.64E-05	2.57E+00	2.64E-09	1.23E-01	5.25E-01	8.55E-04	7.14E-03	1.76E-02	3.01E-07
1.00E+05	1.89E+01	1.84E+02	2.00E-01	5.67E-05	2.69E+00	2.65E-09	1.50E-01	1.30E+00	1.38E-03	2.28E-02	1.80E-02	9.60E-07
3.00E+05	2.33E+01	3.33E+02	3.85E-01	5.69E-05	2.87E+00	2.66E-09	1.83E-01	2.34E+00	2.61E-03	6.12E-02	1.96E-02	2.56E-06
1.00E+06	3.13E+01	5.61E+02	1.41E+00	5.80E-05	4.85E+00	2.71E-09	2.37E-01	3.88E+00	9.31E-03	1.42E-01	3.24E-02	5.94E-06
3.00E+06	4.31E+01	7.65E+02	4.28E+00	6.13E-05	1.08E+01	2.86E-09	3.19E-01	5.36E+00	2.79E-02	1.98E-01	7.08E-02	8.32E-06
1.00E+07	5.20E+01	8.66E+02	6.01E+00	7.27E-05	1.45E+01	3.40E-09	3.96E-01	6.62E+00	3.94E-02	2.04E-01	9.42E-02	8.55E-06
3.15E+07	6.19E+01	1.05E+03	6.12E+00	1.08E-04	1.45E+01	5.04E-09	5.14E-01	9.44E+00	4.08E-02	2.04E-01	9.42E-02	8.55E-06

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Pa231					
1.00E+01	2.53E-05	3.23E-06	4.42E-08	2.16E+01	3.07E+02	2.98E-04
3.00E+01	6.74E-05	8.23E-06	1.19E-07	2.16E+01	3.07E+02	2.98E-04
1.00E+02	1.70E-04	2.00E-05	3.19E-07	2.16E+01	3.07E+02	2.98E-04
3.00E+02	2.87E-04	3.87E-05	6.54E-07	2.16E+01	3.07E+02	2.98E-04
1.00E+03	3.60E-04	7.03E-05	1.05E-06	2.16E+01	3.07E+02	2.98E-04
3.00E+03	3.89E-04	1.39E-04	1.38E-06	2.17E+01	3.10E+02	2.98E-04
1.00E+04	4.26E-04	4.19E-04	2.06E-06	2.18E+01	3.13E+02	3.00E-04
3.00E+04	4.65E-04	1.16E-03	3.02E-06	2.20E+01	3.21E+02	3.05E-04
1.00E+05	5.31E-04	2.84E-03	4.34E-06	2.29E+01	3.44E+02	3.17E-04
3.00E+05	6.11E-04	5.35E-03	7.61E-06	2.47E+01	3.74E+02	3.48E-04
1.00E+06	7.66E-04	9.76E-03	2.68E-05	2.99E+01	3.87E+02	4.25E-04
3.00E+06	1.01E-03	1.42E-02	8.13E-05	4.45E+01	3.95E+02	6.34E-04
1.00E+07	1.23E-03	1.81E-02	1.15E-04	9.64E+01	4.37E+02	1.31E-03
3.15E+07	1.58E-03	2.68E-02	1.19E-04	2.64E+02	7.31E+02	3.85E-03

U-235 Thermal

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U235	U236	Pa231			U235	U236	Pa231
1.00E+01	1.00E+00	9.96E-09	4.84E-08			1.00E+00	9.96E-09	4.84E-08
3.00E+01	1.00E+00	2.97E-08	4.84E-08			1.00E+00	2.97E-08	4.84E-08
1.00E+02	1.00E+00	9.91E-08	4.84E-08			1.00E+00	9.91E-08	4.84E-08
3.00E+02	1.00E+00	2.97E-07	4.84E-08			1.00E+00	2.97E-07	4.84E-08
1.00E+03	1.00E+00	9.91E-07	4.84E-08			1.00E+00	9.91E-07	4.84E-08
3.00E+03	1.00E+00	2.97E-06	4.84E-08			1.00E+00	2.97E-06	4.84E-08
1.00E+04	1.00E+00	9.91E-06	4.84E-08			1.00E+00	9.91E-06	4.84E-08
3.00E+04	1.00E+00	2.97E-05	4.84E-08			1.00E+00	2.97E-05	4.84E-08
1.00E+05	9.99E-01	9.91E-05	4.84E-08			1.00E+00	9.91E-05	4.84E-08
3.00E+05	9.98E-01	2.97E-04	4.84E-08			9.99E-01	2.97E-04	4.84E-08
1.00E+06	9.93E-01	9.91E-04	4.84E-08			9.97E-01	9.88E-04	4.82E-08
3.00E+06	9.80E-01	2.97E-03	4.85E-08			9.90E-01	2.94E-03	4.80E-08
1.00E+07	9.34E-01	9.91E-03	4.87E-08			9.67E-01	9.58E-03	4.71E-08
3.15E+07	8.06E-01	3.12E-02	4.93E-08			9.00E-01	2.81E-02	4.44E-08

Irradiation Time "t" s	Total Fission Product Dose			Total Fissionable Material Dose		
	TEDE Rem	TODE(thy) Rem	Public TEDE Rem	TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	4.28E-01	7.77E-02	1.21E-03	5.74E-05	2.17E-01	2.65E-09
3.00E+01	2.20E+00	5.47E-01	6.98E-03	5.74E-05	5.22E-01	2.65E-09
1.00E+02	5.22E+00	1.21E+00	1.71E-02	5.74E-05	1.11E+00	2.65E-09
3.00E+02	8.33E+00	2.17E+00	3.26E-02	5.74E-05	1.81E+00	2.65E-09
1.00E+03	1.04E+01	3.87E+00	4.99E-02	5.74E-05	2.42E+00	2.65E-09
3.00E+03	1.17E+01	8.16E+00	6.11E-02	5.74E-05	2.51E+00	2.65E-09
1.00E+04	1.36E+01	2.62E+01	8.50E-02	5.75E-05	2.54E+00	2.65E-09
3.00E+04	1.55E+01	7.43E+01	1.25E-01	5.77E-05	2.57E+00	2.66E-09
1.00E+05	1.89E+01	1.84E+02	2.00E-01	6.00E-05	2.69E+00	2.76E-09
3.00E+05	2.33E+01	3.33E+02	3.84E-01	7.61E-05	2.87E+00	3.43E-09
1.00E+06	3.12E+01	5.59E+02	1.41E+00	1.99E-04	4.82E+00	8.60E-09
3.00E+06	4.27E+01	7.57E+02	4.24E+00	6.51E-04	1.06E+01	2.76E-08
1.00E+07	5.02E+01	8.37E+02	5.81E+00	2.10E-03	1.35E+01	8.80E-08
3.15E+07	5.57E+01	9.47E+02	5.50E+00	6.47E-03	1.17E+01	2.71E-07

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
1.17E+00	2.30E+01	8.23E+00		4.28E-01	2.17E-01	1.21E-03
2.27E-01	9.15E+00	1.43E+00		2.20E+00	5.47E-01	6.98E-03
9.58E-02	4.12E+00	5.86E-01		5.22E+00	1.21E+00	1.71E-02
6.00E-02	2.30E+00	3.06E-01		8.33E+00	2.17E+00	3.26E-02
4.80E-02	1.29E+00	2.00E-01		1.04E+01	3.87E+00	4.99E-02
4.26E-02	6.13E-01	1.64E-01		1.17E+01	8.16E+00	6.11E-02
3.67E-02	1.91E-01	1.18E-01		1.36E+01	2.62E+01	8.50E-02
3.23E-02	6.73E-02	7.99E-02		1.55E+01	7.43E+01	1.25E-01
2.64E-02	2.72E-02	4.99E-02		1.89E+01	1.84E+02	2.00E-01
2.14E-02	1.50E-02	2.60E-02		2.33E+01	3.33E+02	3.84E-01
1.60E-02	8.94E-03	7.12E-03		3.12E+01	5.59E+02	1.41E+00
1.17E-02	6.60E-03	2.36E-03		4.27E+01	7.57E+02	4.24E+00
9.95E-03	5.97E-03	1.72E-03		5.02E+01	8.37E+02	5.81E+00
8.97E-03	5.28E-03	1.82E-03		5.57E+01	9.47E+02	5.50E+00

U-235 Thermal

Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
U235	U236	Pa231			U235	U236	Pa231
1.00E+00	9.96E-12	4.84E-08			1.00E+00	9.96E-12	4.84E-08
1.00E+00	2.97E-11	4.84E-08			1.00E+00	2.97E-11	4.84E-08
1.00E+00	9.91E-11	4.84E-08			1.00E+00	9.91E-11	4.84E-08
1.00E+00	2.97E-10	4.84E-08			1.00E+00	2.97E-10	4.84E-08
1.00E+00	9.91E-10	4.84E-08			1.00E+00	9.91E-10	4.84E-08
1.00E+00	2.97E-09	4.84E-08			1.00E+00	2.97E-09	4.84E-08
1.00E+00	9.91E-09	4.84E-08			1.00E+00	9.91E-09	4.84E-08
1.00E+00	2.97E-08	4.84E-08			1.00E+00	2.97E-08	4.84E-08
1.00E+00	9.91E-08	4.84E-08			1.00E+00	9.91E-08	4.84E-08
1.00E+00	2.97E-07	4.84E-08			1.00E+00	2.97E-07	4.84E-08
1.00E+00	9.91E-07	4.84E-08			1.00E+00	9.91E-07	4.84E-08
1.00E+00	2.97E-06	4.85E-08			1.00E+00	2.97E-06	4.85E-08
1.00E+00	9.91E-06	4.87E-08			1.00E+00	9.91E-06	4.87E-08
1.00E+00	3.12E-05	4.93E-08			1.00E+00	3.12E-05	4.93E-08

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	4.28E-04	7.77E-05	1.21E-06	5.74E-05	2.17E-01	2.65E-09
3.00E+01	2.20E-03	5.47E-04	6.98E-06	5.74E-05	5.22E-01	2.65E-09
1.00E+02	5.22E-03	1.21E-03	1.71E-05	5.74E-05	1.11E+00	2.65E-09
3.00E+02	8.33E-03	2.17E-03	3.26E-05	5.74E-05	1.81E+00	2.65E-09
1.00E+03	1.04E-02	3.87E-03	4.99E-05	5.74E-05	2.42E+00	2.65E-09
3.00E+03	1.17E-02	8.16E-03	6.11E-05	5.74E-05	2.51E+00	2.65E-09
1.00E+04	1.36E-02	2.62E-02	8.50E-05	5.75E-05	2.54E+00	2.65E-09
3.00E+04	1.55E-02	7.43E-02	1.25E-04	5.75E-05	2.57E+00	2.65E-09
1.00E+05	1.89E-02	1.84E-01	2.00E-04	5.78E-05	2.69E+00	2.66E-09
3.00E+05	2.33E-02	3.33E-01	3.85E-04	5.81E-05	2.87E+00	2.68E-09
1.00E+06	3.13E-02	5.61E-01	1.41E-03	5.96E-05	4.85E+00	2.74E-09
3.00E+06	4.31E-02	7.65E-01	4.28E-03	6.40E-05	1.08E+01	2.92E-09
1.00E+07	5.20E-02	8.66E-01	6.01E-03	7.95E-05	1.45E+01	3.55E-09
3.15E+07	6.19E-02	1.05E+00	6.11E-03	1.27E-04	1.45E+01	5.50E-09

U235 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.2E+00	1.2E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01
3.0E+01	2.3E-01	2.3E+00	9.6E+00	9.6E+00	9.6E+00	9.6E+00	9.6E+00
1.0E+02	9.6E-02	9.6E-01	4.5E+00	4.5E+00	4.5E+00	4.5E+00	4.5E+00
3.0E+02	6.0E-02	6.0E-01	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00
1.0E+03	4.8E-02	4.8E-01	2.1E+00	2.1E+00	2.1E+00	2.1E+00	2.1E+00
3.0E+03	4.3E-02	4.3E-01	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
1.0E+04	3.7E-02	3.7E-01	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
3.0E+04	3.2E-02	3.2E-01	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
1.0E+05	2.6E-02	2.6E-01	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
3.0E+05	1.5E-02	1.5E-01	1.5E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
1.0E+06	7.1E-03	7.1E-02	7.1E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
3.0E+06	2.4E-03	2.3E-02	2.3E-01	4.6E-01	4.6E-01	4.6E-01	4.6E-01
1.0E+07	1.7E-03	1.7E-02	1.7E-01	3.5E-01	3.5E-01	3.5E-01	3.5E-01
3.2E+07	1.8E-03	1.7E-02	1.6E-01	3.4E-01	3.4E-01	3.4E-01	3.4E-01

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Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	U236						U237					
1.00E+01	3.19E-03	5.01E-04	7.41E-06	1.65E-03	2.21E-03	7.75E-08	2.81E-02	4.42E-03	6.32E-05	7.24E-11	1.64E-02	3.07E-15
3.00E+01	1.73E-02	3.81E-03	4.73E-05	1.65E-03	4.31E-03	7.78E-08	1.75E-01	3.99E-02	4.82E-04	2.15E-10	3.83E-02	9.09E-15
1.00E+02	4.16E-02	8.36E-03	1.16E-04	1.67E-03	8.33E-03	7.84E-08	4.08E-01	8.70E-02	1.18E-03	7.24E-10	7.98E-02	3.07E-14
3.00E+02	6.69E-02	1.49E-02	2.23E-04	1.72E-03	1.31E-02	8.04E-08	6.44E-01	1.55E-01	2.30E-03	2.15E-09	1.30E-01	9.09E-14
1.00E+03	8.34E-02	2.66E-02	3.43E-04	1.89E-04	1.73E-02	8.75E-09	7.97E-01	2.74E-01	3.53E-03	7.24E-09	1.75E-01	3.07E-13
3.00E+03	9.35E-02	5.68E-02	4.19E-04	2.38E-03	1.79E-02	1.08E-07	8.92E-01	5.65E-01	4.25E-03	2.15E-08	1.86E+01	9.09E-13
1.00E+04	1.08E-01	1.84E-01	5.80E-04	4.06E-03	1.81E-02	1.78E-07	1.02E+00	1.76E+00	5.75E-03	7.24E-08	2.03E-01	3.07E-12
3.00E+04	1.23E-01	5.25E-01	8.55E-04	8.75E-03	1.83E-02	3.78E-07	1.17E+00	4.87E+00	8.33E-03	2.15E-07	2.47E-01	9.09E-12
1.00E+05	1.50E-01	1.30E+00	1.38E-03	2.45E-02	1.86E-02	1.04E-06	1.42E+00	1.19E+01	1.33E-02	6.88E-07	3.90E-01	2.93E-11
3.00E+05	1.83E-01	2.34E+00	2.61E-03	6.28E-02	2.03E-02	2.64E-06	1.73E+00	2.16E+01	2.57E-02	1.84E-06	7.48E-01	7.81E-11
1.00E+06	2.37E-01	3.88E+00	9.31E-03	1.43E-01	3.31E-02	6.02E-06	2.29E+00	3.73E+01	9.49E-02	4.30E-06	1.60E+00	1.82E-10
3.00E+06	3.19E-01	5.36E+00	2.79E-02	2.00E-01	7.15E-02	8.38E-06	3.12E+00	5.25E+01	2.87E-01	6.17E-06	2.49E+00	2.62E-10
1.00E+07	3.96E-01	6.62E+00	3.94E-02	2.06E-01	9.50E-02	8.63E-06	3.90E+00	6.52E+01	4.05E-01	6.99E-06	2.78E+00	3.01E-10
3.15E+07	5.14E-01	9.44E+00	4.08E-02	2.06E-01	9.50E-02	8.63E-06	5.07E+00	9.37E+01	4.19E-01	9.00E-06	2.78E+00	3.95E-10

Irradiation Time "t" s	Fission Products TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	TODE(BS) Rem	Public TEDE Rem
	Th232					
1.00E+01	2.91E-04	4.48E-05	5.12E-07	1.59E-03	1.85E-04	7.21E-09
3.00E+01	8.04E-04	1.04E-04	1.27E-06	4.62E-03	2.44E-04	1.68E-08
1.00E+02	2.08E-03	2.09E-04	2.89E-06	1.49E-02	3.43E-04	4.97E-08
3.00E+02	3.30E-03	3.26E-04	5.03E-06	4.25E-02	4.38E-04	1.37E-07
1.00E+03	3.86E-03	4.96E-04	7.47E-06	1.19E-01	5.08E-04	3.81E-07
3.00E+03	4.03E-03	8.77E-04	9.91E-06	2.33E-01	5.19E-04	7.41E-07
1.00E+04	4.25E-03	2.36E-03	1.52E-05	2.93E-01	5.27E-04	9.46E-07
3.00E+04	4.48E-03	6.07E-03	2.19E-05	2.97E-01	5.35E-04	9.83E-07
1.00E+05	4.83E-03	1.39E-02	2.84E-05	2.99E-01	5.42E-04	1.09E-06
3.00E+05	5.18E-03	2.31E-02	3.93E-05	3.08E-01	5.56E-04	1.40E-06
1.00E+06	5.66E-03	3.56E-02	9.45E-05	3.35E-01	6.74E-04	2.33E-06
3.00E+06	6.39E-03	4.66E-02	2.47E-04	3.86E-01	1.07E-03	4.15E-06
1.00E+07	7.12E-03	5.31E-02	3.39E-04	4.43E-01	1.76E-03	6.16E-06
3.15E+07	8.15E-03	6.61E-02	3.46E-04	4.55E-01	3.58E-03	6.70E-06

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Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U236	U237	Th232			U236	U237	Th232
1.00E+01	1.00E+00	3.46E-08	1.44E-06			1.00E+00	3.46E-08	1.44E-06
3.00E+01	1.00E+00	1.04E-07	1.44E-06			1.00E+00	1.04E-07	1.44E-06
1.00E+02	1.00E+00	3.46E-07	1.44E-06			1.00E+00	3.46E-07	1.44E-06
3.00E+02	1.00E+00	1.04E-06	1.44E-06			1.00E+00	1.04E-06	1.44E-06
1.00E+03	1.00E+00	3.46E-06	1.44E-06			1.00E+00	3.46E-06	1.44E-06
3.00E+03	1.00E+00	1.04E-05	1.44E-06			1.00E+00	1.04E-05	1.44E-06
1.00E+04	1.00E+00	3.44E-05	1.44E-06			1.00E+00	3.44E-05	1.44E-06
3.00E+04	1.00E+00	1.02E-04	1.44E-06			1.00E+00	1.02E-04	1.44E-06
1.00E+05	1.00E+00	3.27E-04	1.44E-06			1.00E+00	3.27E-04	1.44E-06
3.00E+05	9.99E-01	8.74E-04	1.44E-06			9.99E-01	8.74E-04	1.44E-06
1.00E+06	9.97E-01	2.03E-03	1.44E-06			9.98E-01	2.03E-03	1.44E-06
3.00E+06	9.90E-01	2.83E-03	1.44E-06			9.95E-01	2.82E-03	1.43E-06
1.00E+07	9.66E-01	2.92E-03	1.46E-06			9.83E-01	2.87E-03	1.43E-06
3.15E+07	8.96E-01	2.92E-03	1.47E-06			9.47E-01	2.77E-03	1.39E-06

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	3.19E-03	5.01E-04	7.41E-06	1.65E-03	2.21E-03	7.75E-08
3.00E+01	1.73E-02	3.81E-03	4.73E-05	1.65E-03	4.31E-03	7.78E-08
1.00E+02	4.16E-02	8.36E-03	1.16E-04	1.67E-03	8.33E-03	7.84E-08
3.00E+02	6.69E-02	1.49E-02	2.23E-04	1.72E-03	1.31E-02	8.04E-08
1.00E+03	8.34E-02	2.66E-02	3.43E-04	1.89E-04	1.73E-02	8.75E-09
3.00E+03	9.36E-02	5.68E-02	4.19E-04	2.38E-03	1.81E-02	1.08E-07
1.00E+04	1.08E-01	1.85E-01	5.81E-04	4.06E-03	1.81E-02	1.78E-07
3.00E+04	1.23E-01	5.25E-01	8.56E-04	8.75E-03	1.83E-02	3.78E-07
1.00E+05	1.50E-01	1.30E+00	1.38E-03	2.45E-02	1.87E-02	1.04E-06
3.00E+05	1.84E-01	2.36E+00	2.64E-03	6.28E-02	2.09E-02	2.64E-06
1.00E+06	2.41E-01	3.95E+00	9.49E-03	1.43E-01	3.62E-02	6.00E-06
3.00E+06	3.26E-01	5.48E+00	2.86E-02	1.98E-01	7.78E-02	8.29E-06
1.00E+07	4.01E-01	6.70E+00	3.99E-02	1.99E-01	9.99E-02	8.34E-06
3.15E+07	5.00E-01	9.20E+00	3.98E-02	1.84E-01	9.32E-02	7.73E-06

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
1.03E+02	2.26E+03	1.33E+03		4.84E-03	2.21E-03	7.49E-06
2.64E+01	1.16E+03	2.11E+02		1.89E-02	4.31E-03	4.74E-05
1.16E+01	5.98E+02	8.61E+01		4.33E-02	8.36E-03	1.16E-04
7.29E+00	3.36E+02	4.47E+01		6.86E-02	1.49E-02	2.23E-04
5.98E+00	1.88E+02	2.91E+01		8.36E-02	2.66E-02	3.43E-04
5.21E+00	8.80E+01	2.38E+01		9.59E-02	5.68E-02	4.19E-04
4.47E+00	2.71E+01	1.72E+01		1.12E-01	1.85E-01	5.81E-04
3.80E+00	9.52E+00	1.17E+01		1.32E-01	5.25E-01	8.57E-04
2.86E+00	3.84E+00	7.24E+00		1.75E-01	1.30E+00	1.38E-03
2.03E+00	2.12E+00	3.79E+00		2.47E-01	2.36E+00	2.64E-03
1.30E+00	1.27E+00	1.05E+00		3.84E-01	3.95E+00	9.50E-03
9.54E-01	9.12E-01	3.50E-01		5.24E-01	5.48E+00	2.86E-02
8.34E-01	7.47E-01	2.51E-01		5.99E-01	6.70E+00	3.99E-02
7.30E-01	5.44E-01	2.51E-01		6.85E-01	9.20E+00	3.98E-02

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Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U236	U237	Th232			U236	U237	Th232
1.00E+01	1.00E+00	3.46E-11	1.44E-06			1.00E+00	3.46E-11	1.44E-06
3.00E+01	1.00E+00	1.04E-10	1.44E-06			1.00E+00	1.04E-10	1.44E-06
1.00E+02	1.00E+00	3.46E-10	1.44E-06			1.00E+00	3.46E-10	1.44E-06
3.00E+02	1.00E+00	1.04E-09	1.44E-06			1.00E+00	1.04E-09	1.44E-06
1.00E+03	1.00E+00	3.46E-09	1.44E-06			1.00E+00	3.46E-09	1.44E-06
3.00E+03	1.00E+00	1.04E-08	1.44E-06			1.00E+00	1.04E-08	1.44E-06
1.00E+04	1.00E+00	3.44E-08	1.44E-06			1.00E+00	3.44E-08	1.44E-06
3.00E+04	1.00E+00	1.02E-07	1.44E-06			1.00E+00	1.02E-07	1.44E-06
1.00E+05	1.00E+00	3.27E-07	1.44E-06			1.00E+00	3.27E-07	1.44E-06
3.00E+05	1.00E+00	8.74E-07	1.44E-06			1.00E+00	8.74E-07	1.44E-06
1.00E+06	1.00E+00	2.03E-06	1.44E-06			1.00E+00	2.03E-06	1.44E-06
3.00E+06	1.00E+00	2.83E-06	1.44E-06			1.00E+00	2.83E-06	1.44E-06
1.00E+07	1.00E+00	2.92E-06	1.46E-06			1.00E+00	2.92E-06	1.46E-06
3.15E+07	1.00E+00	2.92E-06	1.47E-06			1.00E+00	2.92E-06	1.47E-06

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	3.19E-06	5.01E-07	7.41E-09	1.65E-03	2.21E-03	7.75E-08
3.00E+01	1.73E-05	3.81E-06	4.73E-08	1.65E-03	4.31E-03	7.78E-08
1.00E+02	4.16E-05	8.36E-06	1.16E-07	1.67E-03	8.33E-03	7.84E-08
3.00E+02	6.69E-05	1.49E-05	2.23E-07	1.72E-03	1.31E-02	8.04E-08
1.00E+03	8.34E-05	2.66E-05	3.43E-07	1.89E-04	1.73E-02	8.75E-09
3.00E+03	9.35E-05	5.68E-05	4.19E-07	2.38E-03	1.79E-02	1.08E-07
1.00E+04	1.08E-04	1.84E-04	5.80E-07	4.06E-03	1.81E-02	1.78E-07
3.00E+04	1.23E-04	5.25E-04	8.55E-07	8.75E-03	1.83E-02	3.78E-07
1.00E+05	1.50E-04	1.30E-03	1.38E-06	2.45E-02	1.86E-02	1.04E-06
3.00E+05	1.83E-04	2.34E-03	2.61E-06	6.28E-02	2.03E-02	2.64E-06
1.00E+06	2.37E-04	3.88E-03	9.31E-06	1.43E-01	3.31E-02	6.02E-06
3.00E+06	3.19E-04	5.36E-03	2.79E-05	2.00E-01	7.15E-02	8.38E-06
1.00E+07	3.96E-04	6.62E-03	3.94E-05	2.06E-01	9.50E-02	8.63E-06
3.15E+07	5.14E-04	9.44E-03	4.08E-05	2.06E-01	9.50E-02	8.63E-06

U236 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.0E+02	2.5E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02
3.0E+01	2.6E+01	1.5E+02	2.7E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02
1.0E+02	1.2E+01	8.6E+01	2.4E+02	2.9E+02	3.0E+02	3.0E+02	3.0E+02
3.0E+02	7.3E+00	6.0E+01	2.1E+02	2.8E+02	2.9E+02	2.9E+02	2.9E+02
1.0E+03	6.0E+00	5.9E+01	2.9E+02	2.9E+02	2.9E+02	2.9E+02	2.9E+02
3.0E+03	5.2E+00	4.3E+01	1.5E+02	2.0E+02	2.1E+02	2.1E+02	2.1E+02
1.0E+04	4.5E+00	3.4E+01	9.7E+01	1.2E+02	1.2E+02	1.2E+02	1.2E+02
3.0E+04	3.8E+00	2.4E+01	5.0E+01	5.6E+01	5.7E+01	5.7E+01	5.7E+01
1.0E+05	2.9E+00	1.3E+01	1.9E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01
3.0E+05	2.0E+00	6.2E+00	7.7E+00	7.9E+00	8.0E+00	8.0E+00	8.0E+00
1.0E+06	1.1E+00	3.0E+00	3.4E+00	3.5E+00	3.5E+00	3.5E+00	3.5E+00
3.0E+06	3.5E-01	2.2E+00	2.5E+00	2.5E+00	2.5E+00	2.5E+00	2.5E+00
1.0E+07	2.5E-01	2.0E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00
3.2E+07	2.5E-01	2.0E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00	2.4E+00

U-238 Reference Doses

Irradiation Time "t" s	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem
	U238						Pu239					
1.00E+01	1.79E-04	2.89E-05	3.79E-07	1.68E-05	1.06E-04	4.91E-10	5.70E-01	1.73E-01	1.89E-03	1.88E-06	1.35E-01	3.04E-11
3.00E+01	1.09E-03	2.53E-04	2.99E-06	3.60E-05	2.43E-04	7.13E-10	1.50E+00	4.57E-01	5.07E-02	5.63E-06	3.38E-01	9.14E-11
1.00E+02	2.52E-03	5.53E-04	7.30E-06	1.35E-04	5.00E-04	2.05E-09	3.61E+00	1.20E+00	1.33E-02	1.86E-05	7.78E-01	3.04E-10
3.00E+02	3.96E-03	9.88E-04	1.41E-05	6.66E-04	8.02E-04	1.04E-08	6.03E+00	2.73E+00	2.73E-02	5.39E-05	1.38E+00	9.06E-10
1.00E+03	4.92E-03	1.81E-03	2.15E-05	4.84E-03	1.07E-03	8.09E-08	8.13E+00	6.83E+00	4.32E-02	1.63E-04	1.93E+00	2.95E-09
3.00E+03	5.51E-03	4.00E-03	2.58E-05	2.61E-02	1.12E-03	4.52E-07	9.92E+00	1.74E+01	5.21E-02	3.82E-04	2.03E+00	8.49E-09
1.00E+04	6.35E-03	1.31E-02	3.50E-05	8.42E-02	1.23E-03	1.47E-06	1.28E+01	5.10E+01	7.15E-02	8.23E-04	2.06E+00	2.67E-08
3.00E+04	7.34E-03	3.69E-02	5.20E-05	1.07E-01	1.81E-03	1.87E-09	1.69E+01	1.30E+02	1.12E-01	1.87E-03	2.11E+00	7.81E-08
1.00E+05	9.16E-03	9.04E-02	8.75E-05	1.08E-01	3.89E-03	1.88E-06	2.46E+01	3.23E+02	2.11E-01	5.51E-03	2.28E+00	2.58E-07
3.00E+05	1.13E-02	1.61E-01	1.72E-04	1.08E-01	9.92E-03	1.89E-06	3.38E+01	6.30E+02	5.02E-01	1.59E-02	2.99E+00	7.70E-07
1.00E+06	1.49E-02	2.64E-01	6.25E-04	1.08E-01	3.13E-02	1.94E-06	5.01E+01	1.15E+03	2.25E+00	5.23E-02	7.77E+00	2.57E-06
3.00E+06	2.04E-02	3.63E-01	1.88E-03	1.11E-01	9.25E-02	2.06E-06	7.46E+01	1.63E+03	7.19E+00	1.57E-01	2.22E+01	7.70E-06
1.00E+07	2.53E-02	4.45E-01	2.65E-03	1.20E-01	3.00E-01	2.50E-06	9.58E+01	2.01E+03	1.03E+01	5.20E-01	3.80E+01	2.57E-05
3.15E+07	3.27E-02	6.27E-01	2.74E-03	1.47E-01	9.33E-01	3.83E-06	1.28E+02	2.87E+03	1.06E+01	1.64E+00	6.42E+01	8.09E-05

Irradiation Time "t" s	Fission Products TEDE Rem	Fission Products TODE(thy) Rem	Public TEDE Rem	Fissionable Material TEDE Rem	Fissionable Material TODE(BS) Rem	Public TEDE Rem
	U234					
1.00E+01	1.08E-03	1.48E-04	2.48E-06	2.46E-04	5.19E-03	1.04E-08
3.00E+01	4.89E-03	9.38E-04	1.27E-05	2.46E-04	5.80E-03	1.04E-08
1.00E+02	1.27E-02	2.15E-03	3.20E-05	2.46E-04	6.87E-03	1.04E-08
3.00E+02	2.11E-02	3.95E-03	6.27E-05	2.46E-04	8.22E-03	1.04E-08
1.00E+03	2.64E-02	7.12E-03	9.72E-05	2.46E-04	9.42E-03	1.04E-08
3.00E+03	2.92E-02	1.50E-02	1.21E-04	2.46E-04	9.58E-03	1.04E-08
1.00E+04	3.32E-02	4.95E-02	1.71E-04	2.46E-04	9.67E-03	1.04E-08
3.00E+04	3.77E-02	1.45E-01	2.55E-04	2.46E-04	9.67E-03	1.04E-08
1.00E+05	4.62E-02	3.80E-01	4.21E-04	2.46E-04	9.83E-03	1.04E-08
3.00E+05	5.80E-02	7.54E-01	9.05E-04	2.46E-04	1.05E-02	1.04E-08
1.00E+06	8.12E-02	1.43E+00	3.81E-03	2.46E-04	1.61E-02	1.04E-08
3.00E+06	1.17E-01	2.11E+00	1.21E-02	2.47E-04	3.33E-02	1.05E-08
1.00E+07	1.51E-01	2.73E+00	1.72E-02	2.50E-04	4.37E-02	1.06E-08
3.15E+07	2.05E-01	4.14E+00	1.79E-02	2.62E-04	4.39E-02	1.11E-08

U-238

Initial mass = 1 g, Fluence Rate = 1E13 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U238	Pu239	U234			U238	Pu239	U234
1.00E+01	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
3.00E+01	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
1.00E+02	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
3.00E+02	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
1.00E+03	1.00E+00	1.20E-09	7.76E-09			1.00E+00	1.20E-09	7.76E-09
3.00E+03	1.00E+00	3.90E-08	7.76E-09			1.00E+00	3.90E-08	7.76E-09
1.00E+04	1.00E+00	7.68E-07	7.76E-09			1.00E+00	7.68E-07	7.76E-09
3.00E+04	1.00E+00	6.38E-05	7.76E-09			1.00E+00	6.38E-05	7.76E-09
1.00E+05	1.00E+00	2.57E-04	7.76E-09			1.00E+00	2.57E-04	7.76E-09
3.00E+05	9.99E-01	8.09E-04	7.76E-09			1.00E+00	8.09E-04	7.76E-09
1.00E+06	9.97E-01	2.74E-03	7.76E-09			9.99E-01	2.74E-03	7.75E-09
3.00E+06	9.92E-01	8.27E-03	7.76E-09			9.96E-01	8.24E-03	7.73E-09
1.00E+07	9.73E-01	2.76E-02	7.76E-09			9.86E-01	2.72E-02	7.65E-09
3.15E+07	9.17E-01	8.70E-02	7.76E-09			9.58E-01	8.33E-02	7.43E-09

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.79E-04	2.89E-05	3.79E-07	1.68E-05	1.06E-04	4.91E-10
3.00E+01	1.09E-03	2.53E-04	2.99E-06	3.60E-05	2.43E-04	7.13E-10
1.00E+02	2.52E-03	5.53E-04	7.30E-06	1.35E-04	5.00E-04	2.05E-09
3.00E+02	3.96E-03	9.88E-04	1.41E-05	6.66E-04	8.02E-04	1.04E-08
1.00E+03	4.92E-03	1.81E-03	2.15E-05	4.84E-03	1.07E-03	8.09E-08
3.00E+03	5.51E-03	4.00E-03	2.58E-05	2.61E-02	1.12E-03	4.52E-07
1.00E+04	6.36E-03	1.31E-02	3.50E-05	8.42E-02	1.23E-03	1.47E-06
3.00E+04	8.42E-03	4.52E-02	5.91E-05	1.07E-01	1.94E-03	1.88E-09
1.00E+05	1.55E-02	1.73E-01	1.42E-04	1.07E-01	4.48E-03	1.88E-06
3.00E+05	3.87E-02	6.70E-01	5.78E-04	1.07E-01	1.23E-02	1.89E-06
1.00E+06	1.52E-01	3.41E+00	6.77E-03	1.08E-01	5.25E-02	1.94E-06
3.00E+06	6.35E-01	1.37E+01	6.11E-02	1.11E-01	2.75E-01	2.11E-06
1.00E+07	2.63E+00	5.51E+01	2.82E-01	1.31E-01	1.34E+00	3.14E-06
3.15E+07	1.07E+01	2.39E+02	8.90E-01	2.77E-01	6.44E+00	1.06E-05

TEDE Mass,g	TODE Mass, g	Public TEDE Mass,g		TEDE rem	Max TODE rem	Public TEDE rem
2.55E+03	4.72E+04	2.64E+04		1.96E-04	1.06E-04	3.79E-07
4.43E+02	1.97E+04	3.35E+03		1.13E-03	2.53E-04	2.99E-06
1.89E+02	9.05E+03	1.37E+03		2.65E-03	5.53E-04	7.30E-06
1.08E+02	5.06E+03	7.11E+02		4.62E-03	9.88E-04	1.41E-05
5.12E+01	2.76E+03	4.63E+02		9.76E-03	1.81E-03	2.16E-05
1.58E+01	1.25E+03	3.80E+02		3.16E-02	4.00E-03	2.63E-05
5.52E+00	3.81E+02	2.74E+02		9.05E-02	1.31E-02	3.65E-05
4.34E+00	1.11E+02	1.69E+02		1.15E-01	4.52E-02	5.91E-05
4.07E+00	2.89E+01	6.96E+01		1.23E-01	1.73E-01	1.44E-04
3.42E+00	7.46E+00	1.72E+01		1.46E-01	6.70E-01	5.80E-04
1.92E+00	1.47E+00	1.48E+00		2.60E-01	3.41E+00	6.78E-03
6.70E-01	3.64E-01	1.64E-01		7.46E-01	1.37E+01	6.11E-02
1.81E-01	9.07E-02	3.55E-02		2.76E+00	5.51E+01	2.82E-01
4.57E-02	2.09E-02	1.12E-02		1.09E+01	2.39E+02	8.90E-01

U-238

Initial mass = 1 g, Fluence Rate = 1E10 $cm^{-2}s^{-1}$

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U238	Pu239	U234			U238	Pu239	U234
1.00E+01	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
3.00E+01	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
1.00E+02	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
3.00E+02	1.00E+00	0.00E+00	7.76E-09			1.00E+00	0.00E+00	7.76E-09
1.00E+03	1.00E+00	1.20E-12	7.76E-09			1.00E+00	1.20E-12	7.76E-09
3.00E+03	1.00E+00	3.90E-11	7.76E-09			1.00E+00	3.90E-11	7.76E-09
1.00E+04	1.00E+00	7.68E-10	7.76E-09			1.00E+00	7.68E-10	7.76E-09
3.00E+04	1.00E+00	6.38E-08	7.76E-09			1.00E+00	6.38E-08	7.76E-09
1.00E+05	1.00E+00	2.57E-07	7.76E-09			1.00E+00	2.57E-07	7.76E-09
3.00E+05	1.00E+00	8.09E-07	7.76E-09			1.00E+00	8.09E-07	7.76E-09
1.00E+06	1.00E+00	2.74E-06	7.76E-09			1.00E+00	2.74E-06	7.76E-09
3.00E+06	1.00E+00	8.27E-06	7.76E-09			1.00E+00	8.27E-06	7.76E-09
1.00E+07	1.00E+00	2.76E-05	7.76E-09			1.00E+00	2.76E-05	7.76E-09
3.15E+07	1.00E+00	8.70E-05	7.76E-09			1.00E+00	8.70E-05	7.76E-09

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	1.79E-07	2.89E-08	3.79E-10	1.68E-05	1.06E-04	4.91E-10
3.00E+01	1.09E-06	2.53E-07	2.99E-09	3.60E-05	2.43E-04	7.13E-10
1.00E+02	2.52E-06	5.53E-07	7.30E-09	1.35E-04	5.00E-04	2.05E-09
3.00E+02	3.96E-06	9.88E-07	1.41E-08	6.66E-04	8.02E-04	1.04E-08
1.00E+03	4.92E-06	1.81E-06	2.15E-08	4.84E-03	1.07E-03	8.09E-08
3.00E+03	5.51E-06	4.00E-06	2.58E-08	2.61E-02	1.12E-03	4.52E-07
1.00E+04	6.35E-06	1.31E-05	3.50E-08	8.42E-02	1.23E-03	1.47E-06
3.00E+04	7.34E-06	3.69E-05	5.20E-08	1.07E-01	1.81E-03	1.87E-09
1.00E+05	9.17E-06	9.05E-05	8.76E-08	1.07E-01	3.89E-03	1.88E-06
3.00E+05	1.13E-05	1.61E-04	1.73E-07	1.07E-01	9.92E-03	1.89E-06
1.00E+06	1.51E-05	2.67E-04	6.31E-07	1.08E-01	3.14E-02	1.94E-06
3.00E+06	2.10E-05	3.76E-04	1.94E-06	1.11E-01	9.27E-02	2.06E-06
1.00E+07	2.79E-05	5.00E-04	2.93E-06	1.20E-01	3.01E-01	2.50E-06
3.15E+07	4.38E-05	8.76E-04	3.66E-06	1.47E-01	9.39E-01	3.84E-06

U238 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	2.6E+03	1.4E+04	2.7E+04	3.0E+04	3.0E+04	3.0E+04	3.0E+04
3.0E+01	4.4E+02	3.4E+03	1.1E+04	1.3E+04	1.4E+04	1.4E+04	1.4E+04
1.0E+02	1.9E+02	1.3E+03	3.1E+03	3.6E+03	3.7E+03	3.7E+03	3.7E+03
3.0E+02	1.1E+02	4.7E+02	7.1E+02	7.5E+02	7.5E+02	7.5E+02	7.5E+02
1.0E+03	5.1E+01	9.4E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+03	1.6E+01	1.9E+01	1.9E+01	1.9E+01	1.9E+01	1.9E+01	1.9E+01
1.0E+04	5.5E+00	5.9E+00	5.9E+00	5.9E+00	5.9E+00	5.9E+00	5.9E+00
3.0E+04	4.3E+00	4.7E+00	4.7E+00	4.7E+00	4.7E+00	4.7E+00	4.7E+00
1.0E+05	4.1E+00	4.6E+00	4.6E+00	4.7E+00	4.7E+00	4.7E+00	4.7E+00
3.0E+05	3.4E+00	4.6E+00	4.6E+00	4.7E+00	4.7E+00	4.7E+00	4.7E+00
1.0E+06	1.5E+00	4.5E+00	4.6E+00	4.6E+00	4.6E+00	4.6E+00	4.6E+00
3.0E+06	1.6E-01	4.2E+00	4.5E+00	4.5E+00	4.5E+00	4.5E+00	4.5E+00
1.0E+07	3.5E-02	3.2E+00	4.1E+00	4.2E+00	4.2E+00	4.2E+00	4.2E+00
3.2E+07	1.1E-02	1.1E+00	3.3E+00	3.4E+00	3.4E+00	3.4E+00	3.4E+00

I. EXAMPLE CALCULATIONS

Calculations were made as described in this document using Microsoft Excel spreadsheets. A spreadsheet for each fissionable material and type of fission (thermal and non-thermal) were prepared. Independent verification of data entries used in this calculation was performed by the reactor staff.

Example calculations of the following are provided:

1. Number of fission product atoms produced during irradiation (t)
2. Activity of fission products after production and decay (t + T)
3. Released activity and airborne concentrations of fission products in dry and wet experimental conditions
4. Fission product TEDE and Thyroid TODE inside the reactor building
5. Fission product TEDE to members of the public
6. Fissionable material TEDE and Bone Surface TODE inside the reactor building
7. Fissionable material TEDE to members of the public
8. Average mass of fissionable material
9. Experiment fission rate
10. Possession mass
11. Fueled experiment definition
12. Example experiment

Due to the number of calculations made, example calculations example calculations are made for U-235 and the mass number (A) of 133 for the thermal fission of 1 g of U-235 at a fluence rate of 1 E13 cm^{-2} s^{-1}. Decay chain data and U-235 fission yields are provided on the next page for A =133. It is noted that there are 6 decay chains with 3 pathways leading to I-133 production. Calculated activity results are compared to those made using Nuclear Analysis 1.0.

U-235 Irradiation Example Summary

ENTER DATA BELOW - Read "Directions" tab first					FIXED DATA - DO NOT CHANGE	
Material =	*U235*	Select from "Fission Yields" tab			fission rate (f/s)=	1.50E+13
Neutron energy=	*thermal*	Enter "thermal" or "fast"			Vol (ml) =	2.40E+09
A =	*235*	Half Life,s =	*2.22E+16*	U235	k vent (1/s) =	1.18E-04
Mass (g) =	*1.00E+00*	Activity, Ci =	1.60E-02		Evacuation Time (h) =	5.00E-02
Flux (1/cm2/s) =	*1.00E+13*	Mass Limit, g =	7.41E+03		Public Time (h) =	24
Irrad sec =	*1.73E+05*	Maximum irrad sec is 3.15E7			X/Q (s/m3) =	2.15E-03
Decay sec =	*3.60E+03*				wind m/s=	1
Fission Sigma (b) =	*5.85E+02*	Refer to "Sigma" tab			Sigma (cm2) =	5.85E-22
Activation Sigma (b) =	98.7	Refer to "Sigma" tab			Act Sigma (cm2) =	9.87E-23
Sample decay sec =	1.58E+09	Assumed shelf life of 50 y prior to irradiation			Atoms =	2.56E+21
OUTPUT ACTIVITY and DOSE SUMMARY					Dose rate correction =	1.03E+00
Fission Products Conditions	**Bay Effective Dose in Rem**	**Bay Organ* Dose in Rem**	**Public Effective Dose in Rem***	**Public Effective Dose with Dilution from R63 in Rem***	Bay cloud correction =	0.1
					D	**1-R**
All Noble Gas	1.78E-01		9.23E-02	4.23E-03	1	1
All Bromines	1.46E-02		8.61E-05	3.94E-06	1	0.1
All Iodines	6.98E+00	2.77E+02	1.09E-01	4.97E-03	1	0.1
All Particulates	1.57E+00	*Thyroid	1.51E-05	6.91E-07	1.00E-02	0.0003
All fission products	**8.75E+00**	**2.77E+02**	**2.01E-01**	**9.20E-03**		
Fissionable Materials	**Bay Effective Dose in Rem**	**Bay Organ* Dose in Rem**	**Public Effective Dose in Rem***	**Public Effective Dose with Dilution from R63 in Rem***		
Fissionable Materials	**5.67E-05**	**1.78E-01**	**2.65E-09**	**1.21E-10**	0.01	0.0003
		* Bone Surfaces				
All nuclides	**8.75E+00**	**2.77E+02**	**2.01E-01**	**9.20E-03**		

Nuclide	Initial uCi	Decay uCi
Kr83m	6.6E+06	5.9E+06
Kr85m	9.1E+06	7.8E+06
Kr85	4.3E+02	4.4E+02
Kr87	1.6E+07	9.2E+06
Kr88	1.9E+07	1.5E+07
Kr89	1.8E+07	3.4E+01
Kr90	2.1E+07	6.0E-27
Kr91	1.4E+07	1.3E-119
Kr92	6.8E+06	0.0E+00
Kr93	2.0E+06	0.0E+00
Kr94	3.5E+05	0.0E+00
Kr95	2.9E+04	0.0E+00
Kr96	1.5E+05	0.0E+00
Kr97	1.2E+02	0.0E+00
Xe131m	1.8E+03	1.8E+03
Xe133m	2.4E+05	2.4E+05
Xe133	3.8E+06	3.8E+06
Xe135m	9.6E+06	7.7E+06
Xe135	4.9E+07	4.6E+07
Xe137	2.4E+07	4.8E+02
Xe138	2.5E+07	1.3E+06
Xe139	2.0E+07	1.0E-20
Xe140	1.5E+07	3.1E-73
Xe141	5.1E+06	0.0E+00
Xe142	1.8E+06	0.0E+00
Xe143	2.1E+05	0.0E+00
Xe144	2.5E+04	0.0E+00
Xe145	2.9E+02	0.0E+00

Nuclide	Initial uCi	Decay uCi
Te131	1.0E+07	2.2E+06
Sb131	1.0E+07	1.7E+06
Te131m	1.5E+06	1.5E+06
Te132	4.9E+06	4.8E+06
Te133m	1.4E+07	6.5E+06
Te133	1.5E+07	1.9E+06
Te134	3.0E+07	1.1E+07
I-129	9.5E+03	9.7E+03
I131	2.9E+06	2.9E+06
I132	7.9E+06	7.1E+06
I133	2.5E+07	2.5E+07
I134	8.4E+07	4.8E+07
I135	5.0E+07	4.5E+07
Br83	5.1E+06	3.9E+06
Br84	1.1E+07	3.0E+06
Br84m	6.8E+04	6.6E+01
Br85	5.0E+06	2.8E+00
Br86	7.8E+06	2.7E-13
Br87	8.3E+06	3.5E-13
Br88	6.7E+06	5.7E-60
Br89	4.4E+06	2.2E-240
Br90	2.2E+06	0.0E+00
Br91	9.1E+05	0.0E+00
Br92	1.1E+05	0.0E+00
Br93	1.3E+04	0.0E+00
Br96	7.7E+00	0.0E+00
All Particulates	2.8E+09	8.8E+08
All nuclides	3.3E+09	1.1E+09
Fissionable material	2.2E+00	4.3E+00

Decay Chains and Data for A = 133:

1. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133m to Xe-133
2. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133
3. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133m to Xe-133
4. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133
5. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133m to Xe-133
6. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133

Nuclide	Half-life (s)	Yield per 100 fissions for U-235	Decay Constant (1/s)	Branching Decay Fraction
Sn133	1.44E+00	1.38E-01	4.81E-01	1 (B)
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729 (B,m)
Te133m	3.32E+03	2.99E+00	2.09E-04	0.175 (IT)
Te133	7.44E+02	1.15E+00	9.32E-04	1 (B)
I133	7.49E+04	1.65E-01	9.26E-06	0.0285 (B,m)
Xe133m	1.89E+05	1.89E-03	3.66E-06	1 (IT)
Xe133	4.53E+05	6.66E-04	1.53E-06	1 (B)
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729
Te133m	3.32E+03	2.99E+00	2.09E-04	0.175
Te133	7.44E+02	1.15E+00	9.32E-04	1
I133	7.49E+04	1.65E-01	9.26E-06	0.9715 (B)
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729
Te133m	3.32E+03	2.99E+00	2.09E-04	0.825 (B)
I133	7.49E+04	1.65E-01	9.26E-06	0.0285
Xe133m	1.89E+05	1.89E-03	3.66E-06	1
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.1729
Te133m	3.32E+03	2.99E+00	2.09E-04	0.825
I133	7.49E+04	1.65E-01	9.26E-06	0.9715
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.8271 (B)
Te133	7.44E+02	1.15E+00	9.32E-04	1
I133	7.49E+04	1.65E-01	9.26E-06	0.0285
Xe133m	1.89E+05	1.89E-03	3.66E-06	1
Xe133	4.53E+05	6.66E-04	1.53E-06	1
Sn133	1.44E+00	1.38E-01	4.81E-01	1
Sb133	1.50E+02	2.26E+00	4.62E-03	0.8271
Te133	7.44E+02	1.15E+00	9.32E-04	1
I133	7.49E+04	1.65E-01	9.26E-06	0.9715
Xe133	4.53E+05	6.66E-04	1.53E-06	1

Where, (B) is beta minus decay, B,m) is beta minus decay to isomer, (IT) is isomeric transition

1. N(t) calculation results for mass (A) of 133 from the fission of 1 g of U-235 by a thermal fluence rate of 1 E13 cm^{-2} s^{-1} are as follows:

N(t) evaluated at a production time, t, of 1.73 E5 seconds (or 2 days) gives:
N(1.73E5s) = 4.30 E10 atoms of Sn-133
N(1.73E5s) = 6.72E11+1.1E13+8.42E13 + 1.85E14+1.84E13+3.01E14 =
2.81E14+3.19E14 = 6.00 E14 atoms of Te-133
N(1.73E5s) = 5.32E13+8.71E14+6.66E15+1.48E16 +2.13E15+2.51E14+4.11E15+3.15E16+
1.47E15+2.41E16+1.48E16 = 2.45E16+3.59E16+4.04E16 = 1.01 E17 atoms of I-133

The 3 pathways leading to I-133 are:

A: Sn-133 to Sb-133 toTe-133m to Te-133 to I-133
B: Sn-133 to Sb-133 toTe-133m to I-133
C: Sn-133 to Sb-133 to Te-133 to I-133

e.g. individual summations of precursors leading to I-133 for time "t" of 1.73 E5 seconds are shown below:

A: Initial atoms of Sn-133 appearing as atoms of I-133 +
Initial atoms of Sb-133 appearing as atoms of I-133 +
Initial atoms of Te-133m appearing as atoms of I-133 +
Initial atoms of Te-133 appearing as atoms of I-133 +
Initial atoms of I-133 appearing as atoms of I-133 =

5.32E+13
+8.71E+14
+6.66E+15
+1.48E+16
+2.13E+15
Subtotal = 2.45 E16

B: Initial atoms of Sn-133 appearing as atoms of I-133 +
Initial atoms of Sb-133 appearing as atoms of I-133 +
Initial atoms of Te-133m appearing as atoms of I-133 =

2.51E+14
+4.11E+15
+3.15E+16
Subtotal = 3.59 E16

Note that I-133 contribution to itself is not added since it was included in pathway A

C: Initial atoms of Sn-133 appearing as atoms of I-133 +
Initial atoms of Sb-133 appearing as atoms of I-133 +
Initial atoms of Te-133 appearing as atoms of I-133 =

1.47E+15
+2.41E+16
+1.48E+16
Subtotal = 4.04E16

Note that I-133 contribution to itself is included in pathway A, but not in pathways B and C.

N(t) calculation results for mass (A) of 133 from the fission of 1 g of U-235 by a thermal fluence rate of 1 E13 cm^{-2} s^{-1} are as follows for t = 1.73E5 seconds:

Nuclide	N(1.73E5s) at end of production with no decay time from individual chain members Atoms							Total Atoms for All Chains
Sn133	4.30E+10	4.48E+12	1.72E+13	6.72E+11	5.32E+13	1.18E+12	2.65E+11	4.30E+10
Sb133		7.33E+13	2.81E+14	1.10E+13	8.71E+14	1.93E+13	4.33E+12	7.78E+13
Te133m			2.15E+15	8.42E+13	6.66E+15	1.48E+14	3.33E+13	2.45E+15
Te133				1.85E+14	1.48E+16	3.37E+14	7.83E+13	6.00E+14
I133					2.13E+15	4.88E+13	1.14E+13	1.01E+17
Xe133m						3.63E+13	1.16E+13	2.40E+15
Xe133							1.52E+13	9.22E+16
Sn133	4.30E+10	4.48E+12	1.72E+13	6.72E+11	5.32E+13	4.53E+13		
Sb133		7.33E+13	2.81E+14	1.10E+13	8.71E+14	7.42E+14		
Te133m			2.15E+15	8.42E+13	6.66E+15	5.69E+15		
Te133				1.85E+14	1.48E+16	1.30E+16		
I133					2.13E+15	1.89E+15		
Xe133						1.52E+13		
Sn133	4.30E+10	4.48E+12	1.72E+13	2.51E+14	5.59E+12	1.27E+12		
Sb133		7.33E+13	2.81E+14	4.11E+15	9.16E+13	2.08E+13		
Te133m			2.15E+15	3.15E+16	7.02E+14	1.59E+14		
I133				2.13E+15	4.88E+13	1.14E+13		
Xe133m					3.63E+13	1.16E+13		
Xe133						1.52E+13		
Sn133	4.30E+10	4.48E+12	1.72E+13	2.51E+14	2.16E+14			
Sb133		7.33E+13	2.81E+14	4.11E+15	3.53E+15			
Te133m			2.15E+15	3.15E+16	2.71E+16			
I133				2.13E+15	1.89E+15			
Xe133					1.52E+13			
Sn133	4.30E+10	4.48E+12	1.84E+13	1.47E+15	3.34E+13	7.75E+12		
Sb133		7.33E+13	3.01E+14	2.41E+16	5.47E+14	1.27E+14		
Te133			1.85E+14	1.48E+16	3.37E+14	7.83E+13		
I133				2.13E+15	4.88E+13	1.14E+13		
Xe133m					3.63E+13	1.16E+13		
Xe133						1.52E+13		
Sn133	4.30E+10	4.48E+12	1.84E+13	1.47E+15	1.29E+15			
Sb133		7.33E+13	3.01E+14	2.41E+16	2.12E+16			
Te133			1.85E+14	1.48E+16	1.30E+16			
I133				2.13E+15	1.89E+15			
Xe133					1.52E+13			

In the table presented as an example, the atom population calculations shown indication the atoms from one member that produce atoms as another member. For a 7 member decay chain, the following is listed:

Nuclide	1	2	…	5	…	7
1	N1 from N1	N2 from N1		N5 from N1		N7 from N1
2		N2 from N2		N5 from N2		N7 form N2
3				N5 from N3		N7 from N3
4				N5 form N4		N7 from N4
5				N5 from N5		N7 from N5
6						N7 from N6
7						N7 from N7

If there is a branching fraction, each pathway leading to the material of interest is considered. For example, pathways leading to I-133 are shown in the 5th column of the 1st and 2nd pathways and the 4th column in the 3rd, 4th, 5th and 6th pathways. I-133 atoms are summed as follows:

- In the first pathway, I-133 is produced and calculated in the 5th column
- The second pathway is the same as the first, and therefore in not included.
- The third pathway is different form the first as shown in the 4th column. I-133 production to itself was already calculated in the 5th column of the first pathway and is not included (2.13E15 atoms).
- The fourth pathway is the same as the third and is therefore not included
- The fifth pathway is different than the first and third pathways as shown in the fourth column. . I-133 production to itself was already calculated in the 5th column of the first pathway and is not included (2.13E15 atoms).
- The sixth pathway is the same as the fifth and therefore is not included.

The atom populations change for each pathway. Totals at time "t" are:

4.30 E10 atoms of Sn-133
6.00E14 atoms of Te-133
1.01 E17 atoms of I-133

By comparison, Nuclear Analysis 1.0 results at time "t" are:

4.29E10 atoms of Sn-133
6.63E14 atoms of Te-133
8.79E16 atoms of I-133

Differences are ~ 12% or less and may be attributable to differences in half-lives, cross-sections, and branching fractions from difference references.

2. A(t + T) calculation results for mass (A) of 133 from the fission of 1 g of U-235 by a thermal fluence rate of 1 E13 cm^{-2} s^{-1} follow for t = 1.73 E5 seconds and T = 3600 seconds are as follows:

e.g. I-133 activity calculation:

N(t+T) = N(1.73E5 + 3600) =

I-133 produced from the decay of Sn-133+Sb-133+Te-133m+Te-133+ the decay of I-133 initially produced

N(1.73E5 + 3600) =

4.82E+08+
8.72E+11+
1.70E+14+
5.65E+14+
9.75E+16=
9.82 E16 atoms

A(t + T) = λN(t + T) = (9.26E-6/s)(9.82E16 atoms)(1 decay/atom)(1 uCi / 3.7E4 dps)
= 2.46 E7 uCi of I-133

For all nuclides with A = 133, A(t + T) activity in uCi are calculated to be:

Sn133	0.00E+00 uCi
Sb133	5.79E-01 uCi
Te133m	6.55E+06 uCi
Te133	1.90E+06 uCi
I133	2.46E+07 uCi
Xe133m	2.44E+05 uCi
Xe133	3.79E+06 uCi

By comparison, Nuclear Analysis 1.0 gives the following activities:

Sb-133	8.05E-1 uCi
Te-133m	5.79 E6 uCi
Te-133	1.95 E6 uCi
I-133	2.13 E7uCi
Xe-133	3.32 E6 uCi

Results are within 20%.

Nuclide	N(1.73E5s + 3600s) at end of production with decay time from individual chain members Atoms							Total Atoms for All Chains
Sn133	0.00E+00	2.59E+03	3.67E+09	1.69E+08	4.82E+08	1.88E+05	6.87E+02	0.00E+00
Sb133		4.64E+06	6.65E+12	3.06E+11	8.72E+11	3.40E+08	1.25E+06	4.64E+06
Te133m			1.16E+15	5.40E+13	1.70E+14	7.10E+10	2.76E+08	1.16E+15
Te133				2.10E+13	5.65E+14	3.98E+11	2.13E+09	7.53E+13
I133					9.75E+16	9.35E+13	6.20E+11	9.82E+16
Xe133m						2.37E+15	3.14E+13	2.47E+15
Xe133							9.16E+16	9.17E+16
Sn133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Sb133		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Te133m			0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Te133				0.00E+00	0.00E+00	0.00E+00		
I133					0.00E+00	0.00E+00		
Xe133						2.13E+16		
Sn133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Sb133		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Te133m			0.00E+00	0.00E+00	0.00E+00	0.00E+00		
I133				3.47E+16	3.33E+13	2.21E+11		
Xe133m					8.37E+14	1.11E+13		
Xe133						2.03E+14		
Sn133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Sb133		0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Te133m			0.00E+00	0.00E+00	0.00E+00			
I133				0.00E+00	0.00E+00			
Xe133					3.25E+16			
Sn133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Sb133		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Te133			1.12E+13	3.01E+14	2.12E+11	1.13E+09		
I133				3.91E+16	3.75E+13	2.49E+11		
Xe133m					9.54E+14	1.26E+13		
Xe133						2.35E+14		
Sn133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Sb133		0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Te133			0.00E+00	0.00E+00	0.00E+00			
I133				0.00E+00	0.00E+00			
Xe133					3.72E+16			

3. Released activity and airborne concentrations of fission products in dry experimental conditions initially in the reactor bay C(t + T):

Initial concentration, C(t+T), in the reactor bay is given by the following:

$$C(t+T) = A_D(t+T) / V = A_D(t+T) / 2.4\ E9\ ml$$

where, V of 2 E9 ml is the estimated reactor bay free air volume (approximate)
D = 1 for iodines and noble gases and 0.01 for particulates

For A of 133 produced by the fission of 1 g of U-235 by thermal neutrons at a fluence rate of 1 E13 cm^{-2} s^{-1} in the reactor bay are calculated to be as follows for t = 1.73E5 s and T = 3600 s:

	Released Activity To Bay uCi	Released Concentration in Bay uCi/ml
Sn133	0.00E+00	0.00E+00
Sb133	5.79E-03	2.41E-12
Te133m	6.55E+04	2.73E-05
Te133	1.90E+04	7.90E-06
I133	2.46E+07	1.02E-02
Xe133m	2.45E+05	1.02E-04
Xe133	3.79E+06	1.58E-03

e.g reactor bay uCi/ml for I-133:

C(t+T) = (2.46 E7 uCi / 2.4 E9 ml)(1) = 1.02 E-2 uCi/ml

For iodines and noble gases, D = 1

For particulates, the D = 0.01

4. TEDE and Thyroid TODE estimates inside the reactor building from fission products:

Time-integrated concentrations, uCi-h/ml, and dose conversion factors, DCF, and exposure time, τ, are used to calculate personnel doses to personnel in the reactor bay.

Time-integrated exposure for the reactor bay is calculated as follows:

$$\int_0^{\tau} C(t+T)e^{(-k\tau')}d\tau' = \frac{C(t+T)}{k}\left[1-e^{(-k\tau)}\right]$$

where, k = λ + v and
v is the confinement ventilation mode air removal rate constant
v = 1.18 E-4 s^{-1} or 0.425 h^{-1} at a 600 cfm confinement exhaust rate
τ is 0.05 hours for occupational workers

Time-integrated exposure in public areas is further reduced by removal of halogens and particulates by the confinement filters and by atmospheric dispersion. This gives the following equation for time-integrated exposure:

$$\frac{\mu Ci\ h}{ml} = \frac{C(t+T)}{k}(1-e^{-k\tau})(1-R)(7.6\times10^{-3})\ \ F$$

where,

- C(t+T) is in uCi/ml
- k is in h^{-1}
- τ is exposure time of 24 hours for the public
- R = 0.9 for halogens, R = 0.9997 for particulates, and R = 0 for noble gases
- F is the volumetric stack exhaust rate in confinement = 0.283 m^3/s, converted from 600 cfm
- 7.6 E-3 s/m^3 is the most limiting atmospheric dispersion parameter (i.e. X/Q) which was evaluated at a stack height of 30 m and a distance of 150 m and a receptor height of 30 m for Class F weather stability at a wind speed of 1 m/s. This X/Q value is associated with meeting emergency action levels given in the facility emergency plan.

Dose to occupational workers and members of the public is determined as follows:

Dose = (Time-Integrated Exposure)(DCF)

where, Dose is in rem = (uCi-h/ml) * (rem/h per uCi/ml)

Dose Conversion Factor (DCF) is rem/h per uCi/ml taken from 10CFR20 Appendix B

For halogens and particulates:

$$\text{Effective DCF for workers} = \frac{(5 \text{ rem} / 2000 \text{ h})}{[\text{10CFR20 Appendix B Table 1 air concentration in uCi/ml}]}$$

$$\text{Effective DCF for public} = \frac{(0.05 \text{ rem} / 8760 \text{ h})(2)}{[\text{10CFR20 Appendix B Table 2 air concentration in uCi/ml}]}$$

For noble gases:

$$\text{Effective DCF for workers} = \frac{(5 \text{ rem} / 2000 \text{ h})}{[\text{10CFR20 Appendix B Table 1 air concentration in uCi/ml}]}$$

$$\text{Effective DCF for public} = \frac{(0.1 \text{ rem} / 8760 \text{ h})}{[\text{10CFR20 Appendix B Table 2 air concentration in uCi/ml}]}$$

For radioiodines:

$$\text{Thyroid DCF for workers} = \frac{(50 \text{ rem} / 2000 \text{ h})}{[\text{10CFR20 Appendix B Table 1 air concentration in uCi/ml}]}$$

DCF were based on limiting values given in 10CFR20 Appendix B.

For A of 133 produced by the fission of 1 g of U-235 by thermal neutrons at a fluence rate of 1 E13 cm^{-2} s^{-1} doses in the reactor bay are calculated to be as follows for t = 1.73E5 s and T = 3600 s and τ of 180 s (0.05 h):

Dry Sample (example)

Te-133: $\text{Rem} = \frac{[7.9\text{E-}6 \text{ uCi/ml} * (1 - e^{-0.189}) * 5 \text{ rem}]}{[3.78 \text{ per h} * 2000 \text{ h} * 3\text{E-}5 \text{ uCi/ml}]} = 3.6\text{E-}5 \text{ rem (effective)}$

I-133: $\text{Rem} = \frac{[1.02\text{E-}2 \text{ uCi/ml} * (1 - e^{-0.0229}) * 50 \text{ rem}]}{[0.458 \text{ per h} * 2000 \text{ h} * 1 \text{ E-}7 \text{ uCi/ml}]} = 1.27 \text{ E2 rem to thyroid}$

Xe-133: $\text{Rem} = \frac{[1.58\text{E-}3 \text{ uCi/ml} * (1 - e^{-0.0215}) * 5 \text{ rem}]}{[0.431 \text{ per h} * 2000 \text{ h} * 1\text{E-}4 \text{ uCi/ml}]} = 1.96\text{E-}3 \text{ rem (effective)}$

5. TEDE estimates for members of the public from fission products:

Time-integrated concentrations, uCi-h/ml, and dose conversion factors, DCF, exposure time, τ, filter retention, and atmospheric dispersion are used to calculate doses to members of the public.

For A of 133 produced by the fission of 1 g of U-235 by thermal neutrons at a fluence rate of 1 E13 cm^{-2} s^{-1} doses to the public are calculated to be as follows for t = 1.73E5 s and T = 3600 s and τ of 8.64E4 s (24 hours):

Dry Sample (example)

Te-133: Rem = $\frac{[7.9E\text{-}6 \text{ uCi/ml} * (1 - e^{-90.7}) * 0.05 \text{ rem}(2)]}{[3.78 \text{ per h} * 8760 \text{ h} * 8E\text{-}8 \text{ uCi/ml}]}$ *(0.0003)(7.6E-3)(0.283) = 1.92E-10 rem

I-133: Rem = $\frac{[1.02E\text{-}2 \text{ uCi/ml} * (1 - e^{-11.0}) * 0.05 \text{ rem}(2)]}{[0.458 \text{ per h} * 8760 \text{ h} * 1 E\text{-}9 \text{ uCi/ml}]}$ *(0.1)(7.6E-3)(0.283) = 5.49 E-2 rem

Xe-133: Rem = $\frac{[1.58E\text{-}3 \text{ uCi/ml} * (1 - e^{-10.3)} * 0.1 \text{ rem}]}{[0.431 \text{ per h} * 8760 \text{ h} * 5E\text{-}7 \text{ uCi/ml}]}$ *(1)(7.6E-3)(0.283) = 1.81E-4 rem

Nuclide	Bay uCi-h/ml	Public uCi-h/ml	10 CFR DAC uCi/ml	Part 20 Thyroid DAC uCi/ml	App B EC uCi/ml	Bay TEDE rem	Thyroid TODE rem	Public TEDE rem
Sn133			1E-7		1E-9			
Sb133	8.12E-14	9.13E-20	1E-7		1E-9	2.03E-09		1.04E-15
Te133m	1.33E-06	1.50E-11	4.E-06	2.E-06	2.E-08	7.95E-04	1.66E-02	8.55E-09
Te133	3.60E-07	1.35E-12	3.E-05	9.E-06	8.E-08	3.60E-05	9.99E-04	1.92E-10
I133	5.06E-04	4.81E-06	4.E-07	1.E-07	1.E-09	3.38E+00	1.27E+02	5.49E-02
Xe133m	5.04E-06	5.01E-07	1.E-04		6.E-07	1.26E-04		9.52E-06
Xe133	7.83E-05	7.91E-06	1.E-04		5.E-07	1.96E-03		1.81E-04

6. TEDE and Bone Surface TODE estimates inside the reactor building from fissionable material:

Fission Products Conditions	Bay Effective Dose in Rem	Bay Organ* Dose in Rem	Public Effective Dose in Rem*
All Noble Gas	1.78E-01		9.23E-02
All Bromines	1.46E-02		8.61E-05
All Iodines	6.98E+00	2.77E+02	1.09E-01
All Particulates	1.57E+00	*Thyroid	1.51E-05
All fission products	**8.75E+00**	**2.77E+02**	**2.01E-01**
Fissionable Materials	**Bay Effective Dose in Rem**	**Bay Organ* Dose in Rem**	**Public Effective Dose in Rem***
Fissionable Materials	**5.67E-05**	**1.78E-01**	**2.65E-09**
		* Bone Surfaces	
All nuclides	**8.75E+00**	**2.77E+02**	**2.01E-01**

			10 CFR 20 App B			
	Released	Reactor	CEDE	CDE	CEDE	CDE
Nuclide	uCi	uCi/ml	uCi/ml	uCi/ml	rem	rem
U236	1.10E-04	4.57E-14	2.E-11	5.00E-10	2.83E-07	1.13E-07
U235	2.17E-02	9.02E-12	2.E-11	5.00E-10	5.58E-05	2.23E-05
Th231	2.17E-02	9.02E-12	3.E-06		3.72E-10	
Pa231	2.29E-05	9.56E-15	2.E-12	6.00E-13	5.91E-07	1.97E-05
			Internal Dose =		5.67E-05	4.21E-05

TEDE = 5.67E-5 + 0.178 + 1.46E-2 + 6.98 + 1.57 =8.75 rem

TODE = 4.21E-5 +0.178 = 0.178 rem to the bone surfaces

U-235 CEDE in rem

$$= [9.02E\text{-}12 \text{ uCi/ml}/2E\text{-}11 \text{ uCi/ml}]*[5 \text{ rem}/2000 \text{ hours}]*\frac{[1-\exp(-0.425*.05)]}{0.425}$$

= 5.58E-5 rem

U-235 CDE in rem

$$= [9.02E\text{-}12 \text{ uCi/ml}/5E\text{-}10 \text{ uCi/ml}]*[50 \text{ rem}/2000 \text{ hours}]*\frac{[1-\exp(-0.425*.05)]}{0.425}$$

= 2.23E-5 rem

7. **TEDE estimates for members of the public from fissionable material:**

Fission Products Conditions	Bay Effective Dose in Rem	Bay Organ* Dose in Rem	Public Effective Dose in Rem*
All Noble Gas	1.78E-01		9.23E-02
All Bromines	1.46E-02		8.61E-05
All Iodines	6.98E+00	2.77E+02	1.09E-01
All Particulates	1.57E+00	*Thyroid	1.51E-05
All fission products	**8.75E+00**	**2.77E+02**	**2.01E-01**
Fissionable Materials	**Bay Effective Dose in Rem**	**Bay Organ* Dose in Rem**	**Public Effective Dose in Rem***
Fissionable Materials	**5.67E-05**	**1.78E-01**	**2.65E-09**
		* Bone Surfaces	
All nuclides	**8.75E+00**	**2.77E+02**	**2.01E-01**

			10 CFR 20 App B		
	Released	Public	EC		CEDE
Nuclide	uCi	uCi/ml	uCi/ml		rem
U236	1.10E-04	1.37E-17	6.E-14		1.32E-11
U235	2.17E-02	2.71E-15	6.E-14		2.60E-09
Th231	2.17E-02	2.71E-15	9.E-09		1.73E-14
Pa231	2.29E-05	2.87E-18	6.E-15		2.76E-11
			Internal Dose =		2.64E-09
		All Noble Gas		DDE =	9.23E-02
		All Bromines		CEDE =	8.61E-05
		All Iodines		CEDE =	1.09E-01
		All Particulates		CEDE =	1.51E-05
		All fission products		TEDE =	2.01E-01
		All nuclides		TEDE =	2.01E-01

U-236 CEDE in rem

$$= = [1.37E\text{-}17 \text{ uCi/ml}/6E\text{-}14 \text{ uCi/ml}]*[0.1 \text{ rem}/8760 \text{ hours}]*\frac{[1-\exp(-0.425*24)]}{0.425}$$

$$= 1.32 \text{ E-}11\text{rem}$$

CEDE for all fissionable materials = 2.65E-9 rem

TEDE for all nuclides = 2.65E-9 + 9.23E-2 + 8.61E-5 + 0.109 + 1.51E-5 = 0.201 rem

8. Mass Calculations:

Irradiation conditions are for 1 g of U-235 and fluence rate of 1E13 cm-2s-1

Irradiation Time "t" s	Mass at Time "t" g	Mass at Time "t" g	Mass at Time "t" g			Average Mass, g Over "t"	Average Mass, g Over "t"	Average Mass, g Over "t"
	U235	U236	Pa231			U235	U236	Pa231
1.00E+01	1.00E+00	9.96E-09	4.84E-08			1.00E+00	9.96E-09	4.84E-08
3.00E+01	1.00E+00	2.97E-08	4.84E-08			1.00E+00	2.97E-08	4.84E-08
1.00E+02	1.00E+00	9.91E-08	4.84E-08			1.00E+00	9.91E-08	4.84E-08
3.00E+02	1.00E+00	2.97E-07	4.84E-08			1.00E+00	2.97E-07	4.84E-08
1.00E+03	1.00E+00	9.91E-07	4.84E-08			1.00E+00	9.91E-07	4.84E-08
3.00E+03	1.00E+00	2.97E-06	4.84E-08			1.00E+00	2.97E-06	4.84E-08
1.00E+04	1.00E+00	9.91E-06	4.84E-08			1.00E+00	9.91E-06	4.84E-08
3.00E+04	1.00E+00	2.97E-05	4.84E-08			1.00E+00	2.97E-05	4.84E-08
1.00E+05	9.99E-01	9.91E-05	4.84E-08			1.00E+00	9.91E-05	4.84E-08
3.00E+05	9.98E-01	2.97E-04	4.84E-08			9.99E-01	2.97E-04	4.84E-08
1.00E+06	9.93E-01	9.91E-04	4.84E-08			9.97E-01	9.88E-04	4.82E-08
3.00E+06	9.80E-01	2.97E-03	4.85E-08			9.90E-01	2.94E-03	4.80E-08
1.00E+07	9.34E-01	9.91E-03	4.87E-08			9.67E-01	9.58E-03	4.71E-08
3.15E+07	8.06E-01	3.12E-02	4.93E-08			9.00E-01	2.81E-02	4.44E-08

U-235 mass remaining after 1 year:

$$M(t) = M(0)e^{-kt}$$

Total removal rate constant, k =

(9.28E-16 s-1+(98.7b+585b)(1E-24 cm2/b)(1E13 cm-2s-1))+(ln(2)/(3.15e7*7.038E8 y)

k = 6.84 E-9 s-1

M(1y) = 1g * exp(-6.84E-9*3.15e7) = 0.806 g

U-235 average mass over 1 y:

$$M_{average}(t) = \frac{M(0)[1 - e^{(-kt)}]}{kt}$$

$M_{average}$ = $\frac{1g*[1-exp(-6.84E-9*3.15E7)]}{(6.84E-9)(3.15E7)}$ = 0.900 g

U-236 is an activation product of U-235:

$$M^{j}(t) = \frac{AN(t)}{N_a}$$

U-236 activity is calculated at 1 y (3.15E7 s) to be 2.0 uCi

U-236 mass = $\frac{\text{(2uCi) (3.7E4 dps / uCi) (236 g / mole)}}{\text{(9.28E-16 1/s)(6.022E23 atoms / mole)}}$

U-236 mass at 1 y = 0.0312 g from activation of 1 g of U-235

Pa-231 is a decay product of U-235:

Pa-231 activity is calculated at 1 y (3.15E7 s) to be 4.57E-5 uCi uCi

Pa-231 mass = $\frac{\text{(2.34E-3uCi) (3.7E4 dps / uCi) (231 g / mole)}}{\text{(6.738E-13 1/s)(6.022E23 atoms / mole)}}$

Pa-231 mass at 1 y = 4.93E-8 g from decay of 1 g of U-235

Average mass of activation and decay products:

$$M^{j}_{average}(t) = \frac{M^{j}(t)}{M(0)} M_{average}(t)$$

Average U-236 mass = (0.312 g) (0.90 g / 1 g) = 2.81E-2 g

Average Pa-231 mass = (4.93E-8g) (0.90 g / 1 g) = 4.44E-8 g

9. Experiment Limit:

U-235 Thermal Fission Data at fluence rate of 1 E13 $cm^{-2}s^{-1}$:

Irradiation Time "t" s	Total Fission Product Dose TEDE Rem	TODE(thy) Rem	Public TEDE Rem	Total Fissionable Material Dose TEDE Rem	TODE(BS) Rem	Public TEDE Rem
1.00E+01	4.28E-01	7.77E-02	1.21E-03	5.74E-05	2.17E-01	2.65E-09
3.00E+01	2.20E+00	5.47E-01	6.98E-03	5.74E-05	5.22E-01	2.65E-09
1.00E+02	5.22E+00	1.21E+00	1.71E-02	5.74E-05	1.11E+00	2.65E-09
3.00E+02	8.33E+00	2.17E+00	3.26E-02	5.74E-05	1.81E+00	2.65E-09
1.00E+03	1.04E+01	3.87E+00	4.99E-02	5.74E-05	2.42E+00	2.65E-09
3.00E+03	1.17E+01	8.16E+00	6.11E-02	5.74E-05	2.51E+00	2.65E-09
1.00E+04	1.36E+01	2.62E+01	8.50E-02	5.75E-05	2.54E+00	2.65E-09
3.00E+04	1.55E+01	7.43E+01	1.25E-01	5.77E-05	2.57E+00	2.66E-09
1.00E+05	1.89E+01	1.84E+02	2.00E-01	6.00E-05	2.69E+00	2.76E-09
3.00E+05	2.33E+01	3.33E+02	3.84E-01	7.61E-05	2.87E+00	3.43E-09
1.00E+06	3.12E+01	5.59E+02	1.41E+00	1.99E-04	4.82E+00	8.60E-09
3.00E+06	4.27E+01	7.57E+02	4.24E+00	6.51E-04	1.06E+01	2.76E-08
1.00E+07	5.02E+01	8.37E+02	5.81E+00	2.10E-03	1.35E+01	8.80E-08
3.15E+07	5.57E+01	9.47E+02	5.50E+00	6.47E-03	1.17E+01	2.71E-07

U235 Time,s	Mass Limits (g) at fluence rates 1.E+13	1.E+12	1.E+11	≤ 1.E10	1.E+09	1.E+07	1.E+04
1.0E+01	1.2E+00	1.2E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01
3.0E+01	2.3E-01	2.3E+00	9.6E+00	9.6E+00	9.6E+00	9.6E+00	9.6E+00
1.0E+02	9.6E-02	9.6E-01	4.5E+00	4.5E+00	4.5E+00	4.5E+00	4.5E+00
3.0E+02	6.0E-02	6.0E-01	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00
1.0E+03	4.8E-02	4.8E-01	2.1E+00	2.1E+00	2.1E+00	2.1E+00	2.1E+00
3.0E+03	4.3E-02	4.3E-01	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
1.0E+04	3.7E-02	3.7E-01	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
3.0E+04	3.2E-02	3.2E-01	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
1.0E+05	2.6E-02	2.6E-01	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
3.0E+05	1.5E-02	1.5E-01	1.5E+00	1.7E+00	1.7E+00	1.7E+00	1.7E+00
1.0E+06	7.1E-03	7.1E-02	7.1E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00
3.0E+06	2.4E-03	2.3E-02	2.3E-01	4.6E-01	4.6E-01	4.6E-01	4.6E-01
1.0E+07	1.7E-03	1.7E-02	1.7E-01	3.5E-01	3.5E-01	3.5E-01	3.5E-01
3.2E+07	1.8E-03	1.7E-02	1.6E-01	3.4E-01	3.4E-01	3.4E-01	3.4E-01

$$\textit{Total Dose}(\varphi,t)\ \textit{per g} = D_{FP} + D_{FM} + \Sigma_j\,[D^j_{FP} + D^j_{FM}]$$

$$M^{Limit} = \frac{Dose\ \ Limit}{Total\ \ Dose(\varphi,t)per\ \ g}$$

U-235 mass limit at 1 y:

Reactor building TEDE limit = 0.5 rem / (55.7+6.5E-3) rem per g = 9.0 E-3 g
Reactor building TODE limit = 5 rem / 947 rem per g = 5.3 E-3 g
Public TEDE limit = 0.01 rem / (5.5+2.71E-7) rem per g = 1.8 E-3 g

Limit is 1.8 E-3 g

10. Possession Limit:

U-235 Reference data:

Nuclide	uCi	10CFR37 Cat 2 uCi		Cat 2 Fraction
Sr90	1.20E+06	2.70E+08		4.44E-03
Cs137	5.54E+05	2.70E+07		2.05E-02
Pm147	3.79E+06	1.08E+10		3.51E-04
			Q Reference =	2.53E-02

Pa-231 Reference data:

Nuclide	uCi	10CFR37 Cat 2 uCi	Notes	Cat 2 Fraction
Sr90	2.88E+03	2.70E+08	No production of:	
Cs137	1.10E+03	2.70E+07	Se75, Gd153,	1.07E-05
Pm147	6.28E+03	1.08E+10	Am241, Cm244	4.07E-05
			Ir192, Pu238	5.82E-07
			Yt169, Tu170	0.00E+00
			Ra226, Co60	5.19E-05

U-236 Reference data:

Nuclide	uCi	10CFR37 Cat 2 uCi	Notes	Cat 2 Fraction
Sr90	7.73E+03	2.70E+08	No production of:	
Cs137	4.02E+03	2.70E+07	Se75, Gd153,	2.86E-05
Pm147	3.07E+04	1.08E+10	Am241, Cm244	1.49E-04
			Ir192, Pu238	2.84E-06
			Yt169, Tu170	0.00E+00
			Ra226, Co60	1.80E-04

Other 10 CFR Part 37 nuclides are not present.

Fraction of 10 CFR Part 37 activity (Q) was calculated at the maximum irradiation time of 1 year for the reference fluence rate and reference mass of 1 g for each i^{th} fissionable material considered and compared to the respective activity limits A^{Limit} to give Q:

$$Q = \sum_i \frac{(A_i \; per \; g)(M_i)}{A_i^{Limit}}$$

Q = (0.0253/g)(1) + (5.19E-5/g)(4.93E-8)+(1.80E-4/g)(0.0312) = 0.026 per g

Mass Limit, M = 1 / (Q per g) = 1/ 0.026 = 38g

70% of 38 g = 26 g

11. Example Experiment

Irradiation of 1 g of a natural uranium standard for 24 hours at a fluence rate of 5E12 $cm^{-2}s^{-1}$

Evaluation for meeting the fueled experiments is made using mass limits at for 24 hours at a fluence rate of 5E12 $cm^{-2}s^{-1}$

U-235 Data:

U235	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.1E+00	1.1E+01	2.3E+01	2.3E+01
3.0E+01	2.1E-01	2.1E+00	9.6E+00	9.6E+00
1.0E+02	8.9E-02	8.9E-01	4.5E+00	4.5E+00
3.0E+02	5.6E-02	5.6E-01	2.8E+00	2.8E+00
1.0E+03	4.5E-02	4.5E-01	2.1E+00	2.1E+00
3.0E+03	4.0E-02	4.0E-01	2.0E+00	2.0E+00
1.0E+04	3.5E-02	3.5E-01	2.0E+00	2.0E+00
3.0E+04	3.0E-01	3.0E-01	1.9E+00	1.9E+00
1.0E+05	2.5E-02	2.5E-01	1.9E+00	1.9E+00
3.0E+05	1.4E-02	1.4E-01	1.4E+00	1.7E+00
1.0E+06	7.1E-03	7.1E-02	7.1E-01	1.0E+00
3.0E+06	2.4E-03	2.3E-02	2.3E-01	4.6E-01
1.0E+07	1.7E-03	1.7E-02	1.7E-01	3.5E-01
3.2E+07	1.8E-03	1.7E-02	1.6E-01	3.4E-01

U-238 Data:

U238	Mass Limits (g) at fluence rates			
Time,s	1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+01	1.0E+02	1.0E+02	1.0E+02	1.0E+02
1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
3.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
1.0E+03	5.1E+01	9.4E+01	1.0E+02	1.0E+02
3.0E+03	1.6E+01	1.9E+01	1.9E+01	1.9E+01
1.0E+04	5.5E+00	5.9E+00	5.9E+00	5.9E+00
3.0E+04	4.3E+00	4.7E+00	4.7E+00	4.7E+00
1.0E+05	4.1E+00	4.6E+00	4.6E+00	4.7E+00
3.0E+05	3.4E+00	4.6E+00	4.6E+00	4.7E+00
1.0E+06	1.5E+00	4.5E+00	4.6E+00	4.6E+00
3.0E+06	1.6E-01	4.2E+00	4.5E+00	4.5E+00
1.0E+07	3.5E-02	3.2E+00	4.1E+00	4.2E+00
3.2E+07	1.1E-02	1.1E+00	3.3E+00	3.4E+00

U-234 Data:

U234 Time,s	Mass Limits (g) at fluence rates 1.0E+13	1.0E+12	1.0E+11	≤ 1.E10
1.0E+01	3.1E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+01	3.0E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+02	2.9E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+02	2.8E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+03	2.7E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+03	2.6E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+04	2.6E+00	3.1E+00	3.1E+00	3.1E+00
3.0E+04	2.5E+00	3.1E+00	3.1E+00	3.1E+00
1.0E+05	2.3E+00	3.0E+00	3.1E+00	3.1E+00
3.0E+05	1.9E+00	3.0E+00	3.1E+00	3.1E+00
1.0E+06	7.9E-01	2.9E+00	3.1E+00	3.1E+00
3.0E+06	1.1E-01	2.8E+00	3.1E+00	3.1E+00
1.0E+07	2.6E-02	1.8E+00	3.1E+00	3.1E+00
3.2E+07	8.8E-03	7.1E-01	3.0E+00	3.1E+00

Using data given above from Table 3.8-1, the following calculation is made:

Time, s = (24h)(3600 s/h) = 8.64E4 s. Data at 1E5 s is used for this evaluation since the mass allowed remains the same or decreases with time. Linear interpolation of mass limits at 1E5 s gives the following for a fluence rate of 5E12 $cm^{-2}s^{-1}$ at 1E5 s and a mass of 1 g:

Nuclide	Natural Fraction	Fluence Rate Mass Limit, g 1.00E+12	5.00E+12	1.00E+13	Mass g	Mass Fraction
U234	5.50E-05	3	2.69E+00	2.3	5.50E-05	2.05E-05
U235	7.20E-03	0.25	1.50E-01	0.025	7.20E-03	4.80E-02
U238	9.93E-01	4.6	4.38E+00	4.1	9.93E-01	2.27E-01
						2.75E-01

From Table 3.8-2, 1 g of natural U exceeds the non-fueled experiment mass threshold (210> 1):

Nuclide	Natural Fraction	Fluence Rate Mass Limit, g 1.00E+12	5.00E+12	1.00E+13	Mass g	Mass Fraction
U234	5.50E-05	4.00E-03	3.56E-03	3.00E-03	5.50E-05	1.55E-02
U235	7.20E-03	3.30E-04	1.98E-04	3.30E-05	7.20E-03	3.64E+01
U238	9.93E-01	5.40E-03	5.71E-03	6.10E-03	9.93E-01	1.74E+02
						2.10E+02

Experiment is allowed as a fueled experiment since the sum of fractions of 0.275 is less than 1 by Table TS 3.8-1 and exceeds a value of 1 by Table TS 3.8-2.

J. Comparison of Calculations to Nuclear Analysis 1.0

Results for atom populations from the equations and data described above were compared to those made using "Nuclear Analysis 1.0" (Ref 21).

The Nuclear Analysis 1.0 computer code uses similar data and equations to those described above and also include removal by neutron activation.

To verify the computer code was working correctly, a reported case from the user manual was executed and compared to results for a test case from the equations presented above.

Nuclide	**t = 2 hour N (atoms)**					
Sr-92	2.24E+14	Reported case	Mass =	45	mg	
Y-92	6.19E+13	Reported case		Flux =	1.00E+13	cm-2 s-1
				Decay, T =	7200	s
Sr-92	2.24E+14	Test case		Irrad, t =	7200	s
Y-92	5.73E+13	Test case		Fis Mat	U235	

The same example was then executed and compared for an irradiation time of 2 hours with decay time of 18 hours, or a total time of 20 hours.

Nuclide	**2h uCi**	**4h uCi**	**6h uCi**	**12h uCi**	**16h uCi**	**20h uCi**
REPORTED CASE:						
Sr-92	4.30E+05	2.58E+05	1.55E+05	3.33E+04	1.20E+04	4.30E+03
Y-92	9.10E+04	1.66E+05	1.75E+05	1.00E+05	5.60E+04	2.93E+04
TEST CASE:						
Sr-92	4.30E+05	2.58E+05	1.55E+05	3.34E+04	1.20E+04	4.31E+03
Y-92	8.43E+04	1.64E+05	1.76E+05	1.01E+05	5.70E+04	2.98E+04
Error %	-7.36E+00	-1.20E+00	5.71E-01	1.01E+00	1.02E+00	1.02E+00

Note: e.g. 2h = t of 2 hours and T of 0 hours, 16 h = t of 2 hours and T of 14 hours

Activities of those nuclides that gave the higher doses were compared for thermal fission of U-235. A total of 50 nuclides were evaluated at a short irradiation time of 1000 seconds and a long irradiation time of 1E6 seconds.

Comparison of the data indicates the calculated values for most nuclides exceed those given determined from Nuclear Analysis 1.0. The main reason for this difference is the reference used for branching fraction and half-life data. The same reference was used for individual fission yields.

- Branching fraction used in Nuclear Analysis 1.0 was taken from the "Table of Radioactive Isotopes: Eight Edition", E. Browne, RB Firestone, VS Shirley, eds. John Wiley & Sons, pub, 1986.

- Decay constant data used in Nuclear Analysis 1.0 was taken from the "Table of Radioactive Isotopes: Eight Edition", E. Browne, RB Firestone, VS Shirley, eds. John Wiley & Sons, pub, 1986 and from Evaluation and Compilation of Fission Product Yields, T.R. England and B.F. Rider, Los Alamos National Laboratory, October, 1994, LA-UR 94-3106 ENDF 349.

- Branching fraction and decay constant data for the calculated values was taken from "Nuclear Energy Agency (NEA) Publication 6287 "Joint Evaluated Fission and Fusion Project Report 20" (JEFF 3.1-3.1.1 Radioactive Decay Data and Fission Yield Sub-Library), MA Kellett, O. Bersillon, RW Mills, eds., OECD pub, 2009.

- Fission yield data was taken from Evaluation and Compilation of Fission Product Yields, T.R. England and B.F. Rider, Los Alamos National Laboratory, October, 1994, LA-UR 94-3106 ENDF 349, for the calculated and Nuclear Analysis 1.0.

As an example of affect that the decay branching fraction has consider the mass chain of A = 133. JEFF Report 20 and Nuclear Analysis 1.0 has the following decay branching fractions:

	JEFF Report 20			**Nuclear Analysis 1.0**		
Nuclide	**B-**	**B-,m**	**IT**	**B-**	**B-,m**	**IT**
Sn-133	1			1		
Sb-133	0.8271	0.1729		1		
Te-133m	0.825		0.175	0.83		0.17
Te-133	1			1		
I-133	0.9715	0.0285		1		
Xe-133m			1			1
Xe-133	1			1		

From the JEFF Report 20 decay branching fractions, there are 6 decay pathways:

7. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133m to Xe-133
8. Sn-133 to Sb-133 to Te-133m to Te-133 to I-133 to Xe-133
9. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133 m to Xe-133
10. Sn-133 to Sb-133 to Te-133m to I-133 to Xe-133
11. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133m to Xe-133
12. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133

From the Nuclear Analysis 1.0 decay branching fractions, there are 4 decay pathways:

5. Sn-133 to Sb-133 to Te-133 to I-133 to Xe-133
6. Te-133m to Te-133 to I-133 to Xe-133
7. Te-133m to I-133 T0 Xe-133
8. Xe-133m to Xe-133

A comparison of the results between the equations used in this calculation for the 4 and 6 pathway and the 4 pathway Nuclear Analysis 1.0 decay branching fractions for two cases:

Case A: t = 1.73E5 s, T = 0 s

	Calculated Atoms		**Nuclear Analysis 1.0 Atoms**
Nuclide	**6 pathway**	**4 pathway**	**4 pathway**
Sn-133	4.3E10	4.3E10	4.29E10
Sb-133	7.78E13	7.77E13	7.75E13
Te-133m	2.45E15	2.15E15	2.14E15
Te-133	6.0E14	6.52E14	6.63E14
I-133	1.01E17	1.03E17	8.79E16
Xe-133m	2.41E15	3.62E13	3.61E13
Xe-133	9.23E16	9.45E16	7.98E16

Case B: t = 1.000 E3 s, T = 1.000 E3 s

	Calculated Atoms		**Nuclear Analysis 1.0 Atoms**
Nuclide	**6 pathway**	**4 pathway**	**4 pathway**
Sn-133	0	0	0
Sb-133	7.59E11	7.57E11	7.57E11
Te-133m	3.76E14	3.28E14	3.28E14
Te-133	1.2E14	1.61E14	1.68E14
I-133	4.29E14	5.18E14	5.05E14
Xe-133m	4.06E11	2.81E11	2.81E11
Xe-133	1.24E12	5.07E12	4.3E12

Nuclear Analysis 1.0 does not list an B-,m decay branching fraction for Sb-133 or I-133, which affects the atom calculations for Te-133m , Te-133, I-133, Xe-133m and Xe-133. The B- and IT decay branching fraction for Te-133m are different. Fission yields and half-lives used were similar.

Two cases were compared for activities and radiation dose for 50 nuclides produced by the thermal fission of U-235 as described below. Data for the two cases is provided on the following pages for 2 cases:

CASE 1:

Calculated activities have median and average values of approximately 1.3 times and 1.7 times of those determined by Nuclear Analysis 1.0 at t = 1E3 seconds (based on occupational whole body dose)

Ratio of Calculated to Nuclear Analysis 1.0 for:	**T = 0 s**	**T = 1E3 s**
Median	1.467	1.219
Minimum	0.584	0.294
Maximum	6.753	10.03
Average	1.707	1.612

CASE 2:

Calculated activities have median and average values of approximately 1.6 times and 1.7 times of those determined by Nuclear Analysis 1.0 at t = 1E6 seconds (based on occupational TEDE)

Ratio of Calculated to Nuclear Analysis 1.0 for:	**T = 0 s**
Median	1.59E+00
Minimum	4.07E-01
Maximum	4.61E+00
Average	1.69E+00

Fission product dose comparisons by thermal fission of 1 g of U-235 at a neutron fluence rate of 1 E13 $cm^{-2}s^{-1}$:

Time, s	**Calculated rem**	**Nuclear Analysis rem**	**Limiting Dose Category**	**Calculated vs Nuclear Analysis**
t=1E3, T=0	2.06E2	1.48E2	Effective	1.39
t=1E3, T=1E3	3.86E1	2.60E1	Dose-Equivalent	1.48
t=1E6, T=0	5.68E2	4.41E2	Effective Dose-Equivalent	1.29

Summary of Comparison

The JEFF Report 20 (Ref 6) decay branching fractions are more recent and differ from those used in Nuclear Analysis 1.0. As a result, decay chain pathways are different which in turn causes a difference in the calculated atom populations and activities.

For the limiting cases compared above, nuclide activities in this calculation are higher by less than a factor of 2 on average than those determined by Nuclear Analysis 1.0 whether based on activity or dose considerations.

Neutron energy =	**Thermal**					
Target =	**U235**		**Mass =**	**1.00E+00**	**g**	
Fluence rate =	**1.00E+13**	**cm-2s-1**				
Irradiation time, t =	**1.00E+03**	**s**	**Decay time, T =**	**1.00E+03**	**s**	
	Calcuated		**Nuclear Analysis 1.0**		**Calculated vs Nuclear**	
	A(t)	**A(t+T)**	**A(t)**	**A(t+T)**	**Analysis 1.0**	
Nuclide	**uCi**	**uCi**	**uCi**	**uCi**	**A(t)**	**A(t+T)**
Ga74	1.27E+03	3.79E+02	9.53E+02	3.02E+02	1.34E+00	1.25E+00
As79	2.53E+05	7.20E+04	1.29E+05	3.73E+04	1.96E+00	1.93E+00
Se84	3.05E+06	8.82E+04	3.33E+06	1.01E+05	9.16E-01	8.73E-01
Rb88	6.18E+05	8.98E+05	2.82E+05	5.62E+05	2.19E+00	1.60E+00
Rb90	3.64E+07	4.65E+05	2.03E+07	3.05E+05	1.79E+00	1.52E+00
Sr91	8.32E+05	8.77E+05	4.38E+05	4.67E+05	1.90E+00	1.88E+00
Sr93	3.11E+07	6.59E+06	1.96E+07	4.13E+06	1.59E+00	1.60E+00
Y93	3.69E+05	4.37E+05	2.39E+05	4.19E+05	1.55E+00	1.04E+00
Zr95	5.85E+03	1.11E+04	1.32E+03	2.67E+03	4.44E+00	4.15E+00
Zr97	7.35E+05	7.27E+05	2.76E+05	2.73E+05	2.66E+00	2.66E+00
Mo99	8.47E+04	8.56E+04	7.03E+04	7.23E+04	1.20E+00	1.18E+00
Mo101	3.27E+07	1.50E+07	1.15E+07	5.21E+06	2.84E+00	2.88E+00
Tc101	1.16E+07	1.72E+07	4.01E+06	5.96E+06	2.90E+00	2.89E+00
Mo102	2.04E+07	7.40E+06	1.11E+07	3.99E+06	1.83E+00	1.86E+00
Tc102	2.20E+07	7.46E+06	1.11E+07	4.00E+06	1.98E+00	1.87E+00
Ru105	1.29E+05	2.35E+05	6.74E+04	1.27E+05	1.92E+00	1.85E+00
Ag113	1.03E+03	1.40E+03	1.76E+03	1.97E+03	5.84E-01	7.13E-01
Sn125m	9.31E+04	2.77E+04	2.98E+04	8.83E+03	3.12E+00	3.13E+00
Sn129	1.34E+06	7.54E+03	1.14E+06	9.24E+03	1.18E+00	8.16E-01
Sb130m	8.10E+06	2.04E+06	1.20E+06	2.03E+05	6.75E+00	1.00E+01
Sn130	4.47E+06	2.00E+05	4.57E+06	2.01E+05	9.77E-01	9.96E-01
Ba141	1.85E+07	1.01E+07	1.08E+07	5.96E+06	1.71E+00	1.70E+00
La141	5.68E+05	1.22E+06	2.90E+05	6.75E+05	1.96E+00	1.80E+00
Ce145	1.54E+07	3.83E+05	1.56E+07	3.77E+05	9.86E-01	1.02E+00
Pr149	4.33E+06	2.93E+04	4.33E+06	2.88E+04	9.99E-01	1.02E+00
Nd152	6.82E+05	2.48E+05	6.81E+05	2.47E+05	1.00E+00	1.01E+00
Pm152	5.04E+05	3.54E+05	5.07E+05	3.51E+05	9.95E-01	1.01E+00
Pm153	5.52E+05	7.22E+04	5.53E+05	7.13E+04	9.99E-01	1.01E+00
Sb131	4.00E+06	2.52E+06	4.00E+06	2.48E+06	1.00E+00	1.01E+00
Te131m	7.85E+03	9.47E+03	5.60E+03	5.57E+03	1.40E+00	1.70E+00
Te131	9.15E+05	5.77E+05	9.99E+05	1.80E+06	9.16E-01	3.21E-01
I131	7.94E+02	1.53E+03	4.05E+02	1.90E+03	1.96E+00	8.04E-01
Te132	2.80E+04	3.43E+04	3.80E+04	5.03E+04	7.38E-01	6.82E-01
I132	7.82E+03	9.81E+03	7.36E+03	1.05E+04	1.06E+00	9.34E-01
Te133m	2.53E+06	2.12E+06	2.28E+06	1.85E+06	1.11E+00	1.15E+00
Te133	7.07E+06	3.03E+06	7.91E+06	4.24E+06	8.94E-01	7.15E-01
I133	6.43E+04	1.07E+05	5.27E+04	1.26E+05	1.22E+00	8.52E-01
Te134	7.26E+06	5.51E+06	6.77E+06	5.14E+06	1.07E+00	1.07E+00
I134	2.75E+06	3.45E+06	1.33E+06	2.31E+06	2.07E+00	1.49E+00
I135	1.42E+06	1.40E+06	7.27E+05	7.15E+05	1.95E+00	1.96E+00
Br84m	5.78E+04	8.43E+03	5.79E+04	8.44E+03	9.98E-01	9.99E-01
Br84	2.49E+06	1.97E+06	8.07E+05	8.14E+05	3.09E+00	2.41E+00
Br85	4.88E+06	9.64E+04	3.19E+06	6.53E+04	1.53E+00	1.48E+00
Kr87	2.08E+06	1.87E+06	1.35E+06	1.24E+06	1.54E+00	1.51E+00
Kr88	1.24E+06	1.17E+06	8.91E+05	8.40E+05	1.39E+00	1.39E+00
Kr89	1.78E+07	4.57E+05	1.78E+07	4.60E+05	1.00E+00	9.93E-01
Xe133	4.71E+01	4.71E+01	3.29E+01	1.75E+02	1.43E+00	2.69E-01
Xe135	4.85E+04	6.11E+04	1.86E+04	3.90E+04	2.61E+00	1.57E+00
Xe137	2.30E+07	1.19E+06	2.39E+07	1.22E+06	9.64E-01	9.73E-01
Xe138	1.42E+07	6.29E+06	1.43E+07	6.30E+06	9.95E-01	9.99E-01

Neutron energy =	**Thermal**				
Target =	**U235**		**Mass =**	**1.00E+00**	**g**
Fluence rate =	**1.00E+13**	**cm-2s-1**			
Irradiation time =	**1.00E+06**	**s**	**Decay time =**	**0.00E+00**	**s**

Nuclide	**Calcuated A(t) uCi**	**Nuclear Analysis 1.0 A(t) uCi**	**Calculated vs Nuclear Analysis A(t)**
Ga74	1.83E+03	1.34E+03	1.36E+00
As79	3.57E+05	1.80E+05	1.98E+00
Se84	3.14E+06	3.41E+06	9.21E-01
Rb88	3.33E+07	1.37E+07	2.43E+00
Rb90	3.70E+07	2.05E+07	1.80E+00
Sr91	4.55E+07	2.36E+07	1.93E+00
Sr93	3.95E+07	2.46E+07	1.61E+00
Y93	3.96E+07	2.51E+07	1.58E+00
Zr95	1.43E+07	3.11E+06	4.61E+00
Zr97	6.45E+07	2.41E+07	2.68E+00
Mo99	2.83E+07	2.19E+07	1.29E+00
Mo101	6.03E+07	2.08E+07	2.90E+00
Tc101	6.18E+07	2.08E+07	2.97E+00
Mo102	3.19E+07	1.72E+07	1.86E+00
Tc102	3.46E+07	1.72E+07	2.01E+00
Ru105	6.72E+06	3.44E+06	1.95E+00
Ag113	3.75E+04	5.66E+04	6.62E-01
Kr90	2.14E+07	1.99E+07	1.07E+00
Sn129	1.35E+06	1.04E+06	1.30E+00
Kr91	1.36E+07	1.36E+07	9.98E-01
Sn130	4.68E+06	4.75E+06	9.84E-01
Ba141	4.04E+07	2.35E+07	1.72E+00
La141	4.72E+07	2.35E+07	2.01E+00
Ce145	1.58E+07	1.59E+07	9.92E-01
Pr149	4.35E+06	4.33E+06	1.01E+00
Nd152	1.07E+06	1.06E+06	1.01E+00
Pm152	1.08E+06	1.07E+06	1.01E+00
Pm153	6.34E+05	6.29E+05	1.01E+00
Sb131	1.04E+07	1.02E+07	1.02E+00
Cs138	4.60E+07	2.63E+07	1.75E+00
Te131	1.06E+07	1.06E+07	1.00E+00
I131	1.27E+07	6.73E+06	1.89E+00
Te132	1.28E+07	1.27E+07	1.00E+00
I132	2.17E+07	1.27E+07	1.71E+00
Cs137	1.79E+04	1.82E+04	9.86E-01
Te133	1.51E+07	1.42E+07	1.06E+00
I133	3.18E+07	1.49E+07	2.14E+00
Te134	3.02E+07	2.80E+07	1.08E+00
I134	8.41E+07	3.00E+07	2.80E+00
I135	4.99E+07	2.53E+07	1.97E+00
Kr85	2.78E+03	6.84E+03	4.07E-01
Br84	1.09E+07	3.48E+06	3.13E+00
Br85	4.99E+06	3.23E+06	1.54E+00
Kr87	1.58E+07	8.26E+06	1.91E+00
Kr88	1.92E+07	1.01E+07	1.90E+00
Kr89	1.83E+07	1.82E+07	1.00E+00
Xe133	2.44E+07	1.11E+07	2.20E+00
Xe135	5.25E+07	1.15E+07	4.57E+00
Xe137	2.43E+07	2.50E+07	9.72E-01
Xe138	2.55E+07	2.54E+07	1.00E+00

COMPARISON FOR FISSIONABLE MATERIALS

Calculated Data

Production time, s	Primary FM Mass, g	Decay FM Mass, g	Activation FM Mass, g	Decay from AP Mass, g
	U235	Pa231	U236	
1.00E+06	9.93E-01	4.84E-08	9.91E-04	
3.00E+06	9.79E-01	4.84E-08	2.97E-03	
1.00E+07	9.34E-01	4.87E-08	9.90E-03	
50 y		4.84E-08		
	Am241	Np237	Am242	
3.15E+06	9.80E-01	7.58E-02	5.40E-04	
9.45E+06	9.35E-01	7.58E-02	5.40E-04	
3.15E+07	8.14E-01	7.58E-02	5.40E-04	
50y		7.58E-02		
	Pu241	Am241	Pu242	
1.00E+06	9.84E-01		3.76E-03	
3.00E+06	9.53E-01		1.13E-02	
1.00E+07	8.53E-01		3.76E-02	
15y		5.16E-01		
	Pu239		Pu240	
1.00E+06	9.89E-01		3.11E-03	
3.00E+06	9.68E-01		9.34E-03	
1.00E+07	8.96E-01		3.11E-02	
	Np237		Np238	
1.00E+06	9.98E-01		4.20E-04	
3.00E+06	9.95E-01		4.29E-04	
1.00E+07	9.84E-01		4.29E-04	
	Cm245	Pu241		
50 y decay=		1.51E-03		
	Pu240	U236	Pu241	Am241
1.00E+06	9.97E-01	4.92E-01	2.86E-03	2.19E-06
3.00E+06	9.91E-01	4.92E-01	8.56E-03	2.00E-05
1.00E+07	9.72E-01	4.92E-01	2.84E-02	2.18E-04
50 y		4.92E-01		

FM is Fissionable Material. AP is Activation Product.

COMPARISON FOR FISSIONABLE MATERIALS

Nuclear Analysis Data Production time, s	Primary FM Mass, g	Decay FM Mass, g	Activation FM Mass, g	Decay from AP Mass, g
	U235	Pa231	U236	
1.00E+06	9.93E-01	4.84E-08	9.90E-04	
3.00E+06	9.79E-01	4.84E-08	2.95E-03	
1.00E+07	9.34E-01	4.84E-08	9.60E-03	
50 y		4.84E-08		
	Am241	Np237	Am242	
3.15E+06	9.80E-01	7.57E-02	4.49E-04	
9.45E+06	9.43E-01	7.57E-02	4.32E-04	
3.15E+07	8.25E-01	7.57E-02	3.78E-04	
50y		7.57E-02		
	Pu241	Am241	Pu242	
1.00E+06	9.84E-01		3.59E-03	
3.00E+06	9.55E-01		1.06E-02	
1.00E+07	8.58E-01		3.36E-02	
15y		5.07E-01		
	Pu239		Pu240	
1.00E+06	9.89E-01		2.70E-03	
3.00E+06	9.69E-01		8.00E-03	
1.00E+07	9.02E-01		2.55E-02	
	Np237		Np238	
1.00E+06	9.98E-01		4.37E-04	
3.00E+06	9.95E-01		4.46E-04	
1.00E+07	9.83E-01		4.41E-04	
	Cm245	Pu241		
50 y decay=		1.51E-03		
	Pu240	U236	Pu241	Am241
1.00E+06	9.97E-01	4.92E-01	2.89E-03	2.43E-06
3.00E+06	9.91E-01	4.92E-01	8.51E-03	2.02E-05
1.00E+07	9.71E-01	4.92E-01	2.66E-02	2.07E-04
50 y		4.92E-01		

FM is Fissionable Material. AP is Activation Product.

Results from Nuclear Analysis and this calculation are in good agreement for most of the nuclides tested. Most deviations are within 5% except for Am-242 produced from activation of Am-241. In that case, the activated material mass is a small fraction of the mass being activated, i.e. 4E-4 g of Am-242 is small compared to 0.825 g of Am-241.