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Annual Radiological Environmental Monitoring Program Report for the Three Mile Island, Unit 2, Independent Spent Fuel Storage Installation

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Idaho National Engineering and Environmental Laboratory

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ABSTRACT

This report presents the results of the 2000 Radiological Environmental Monitoring Program conducted in accordance with 10 CFR 72.44 for the Three Mile Island, Unit 2, Independent Spent Fuel Storage Installation. A description of the facility and the monitoring program is provided. The results of monitoring the two predominant radiation exposure pathways, potential airborne radioactivity releases and direct radiation exposure, indicate the facility operation has not contributed to any increase in the estimated maximum potential dose commitment to the general public.

SUMMARY

The purpose of this report is to present the results of the Radiological Environmental Monitoring Program (REMP) conducted during 2000 for the Three Mile Island, Unit 2, (TMI-2), Independent Spent Fuel Storage Installation (ISFSI). The first shipment of TMI-2 core debris was received and stored at the ISFSI on March 31, 1999. Nine additional shipments were received and stored at the ISFSI during 2000.

The REMP was implemented from January through December 2000. Results of the loose surface radioactive contamination surveys indicated no increase in either gross beta or Cs-137 radioactivity attributed to the facility operation. The results of the airborne radioactivity sampling did not indicate releases of airborne particulate radioactivity from the loaded Horizontal Storage Modules (HSM). The results of the thermoluminescent dosimetry network did not indicate an increase in radiation levels above ambient background attributed to the facility operation.

The monitoring program results support the conclusion reached in the Final Environmental Impact Statement that operation of the facility would not result in a significant dose commitment to the Maximum Exposed Individual.

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INTRODUCTION

The Three Mile Island, Unit 2, Independent Spent Fuel Storage Installation (TMI-2 ISFSI) is a spent fuel dry storage facility designed for interim storage of the TMI-2 core debris. The TMI-2 ISFSI, located within the Idaho Nuclear Technology and Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory (INEEL) as shown in Figure 1, is operated by Bechtel BWXT Idaho, LLC for the Department of Energy (DOE). The TMI-2 ISFSI was licensed on March 19, 1999 by the Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 72 for authorization to receive, possess, store, and transfer spent fuel and fuel debris, resulting from the 1979 TMI-2 accident, for a twenty-year term.[1, 2]

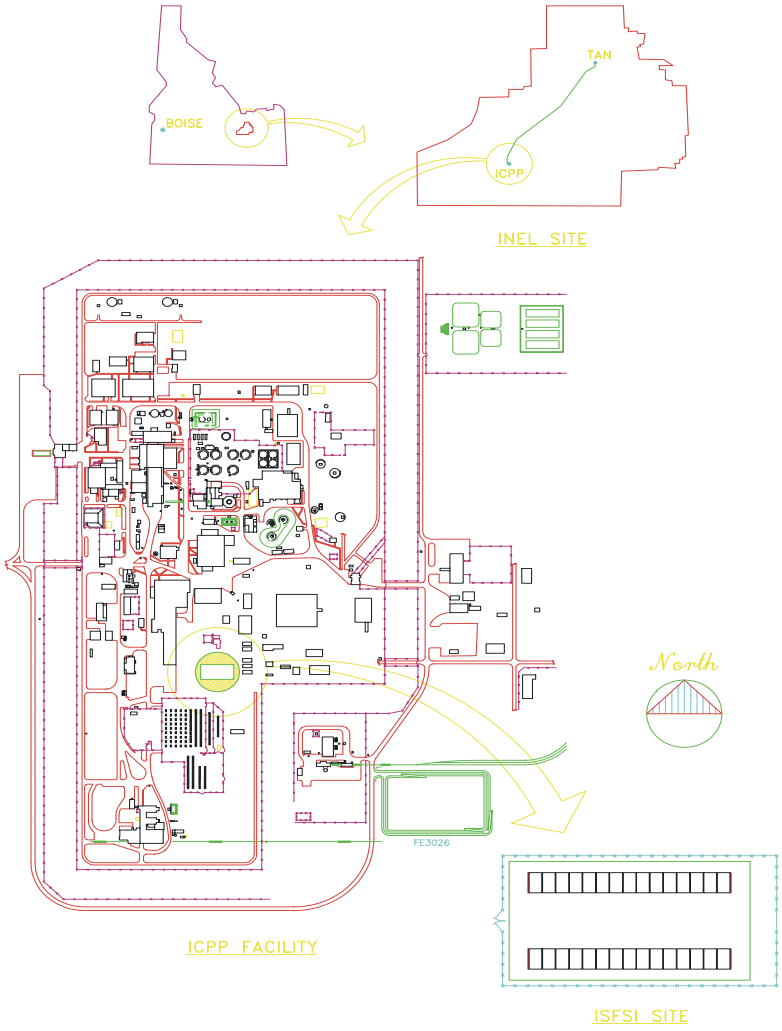

Figure 1. Location of the TMI-2 ISFSI.

The TMI-2 ISFSI is a modified NUHOMS spent fuel storage system, designated NUHOMS-12T. Each of the thirty NUHOMS-12T modules within the facility provide for the horizontal dry storage of up to twelve TMI-2 stainless steel canisters inside a dry shielded canister (DSC) which is placed inside a concrete horizontal storage module (HSM). The NUHOMS-12T modification includes venting of the DSC through high efficiency particulate air (HEPA) grade filters during storage. The vent system allows for release of hydrogen gas, generated due to radiolysis, and monitoring and/or purging of the system during operation.

The TMI-2 core debris, which has been stored in stainless steel canisters in a fuel pool at the Test Area North (TAN) site within the INEEL, is in the process of being transferred to the TMI-2 ISFSI for interim storage. A Settlement Agreement entered into by the State of Idaho, the Department of Energy, and the Department of the Navy in October 1995 established a schedule for commencing core debris transfers by March 31, 1999, and completing such transfers by June 1, 2001.[3] The first core debris transfer was completed on March 31, 1999. Nine additional transfers were completed during 2000; a summary of which is provided in Table 1.

Table 1. TMI-2 Core Debris Transfer/Storage Status as of December 31, 2000.

DSC No.	HSM No.	Storage Date
2	16	March 31, 1999
3	17	July 10, 2000
4	20	October 14, 2000
5	22	October 27, 2000
11	24	November 6, 2000
8	27	November 19, 2000
10	28	November 29, 2000
9	21	December 7, 2000
7	26	December 16, 2000
13	25	December 21, 2000

A Radiological Environmental Monitoring Program (REMP) was developed for the TMI-2 ISFSI and implemented in accordance with 10 CFR 72.44. This report presents the REMP results during the TMI-2 ISFSI operation in 2000.

PROGRAM DESCRIPTION

The REMP is designed to monitor the two predominant radiation exposure pathways inherent with the facility design: potential airborne radioactivity releases and direct radiation. The airborne radioactivity release pathway is monitored using a combination of loose surface radioactive contamination surveys and periodic airborne radioactivity sampling. The direct radiation exposure pathway is monitored using thermoluminescent dosimetry (TLD) located along the outer perimeter fence of the TMI-2 ISFSI.

Loose surface radioactive contamination surveys are performed at the vent and purge ports of each DSC as well as the drain port of each loaded HSM. The survey frequency is monthly during the first year, quarterly during the second through fifth years, and annually thereafter. The survey frequency for each DSC and loaded HSM begins after DSC insertion into the HSM. The frequency coincides with the radiation monitoring surveillance schedule required by the TMI-2 ISFSI Technical Specifications.[4] Sample media is analyzed for gross beta radioactivity. Depending on the amount of gross beta radioactivity detected, gamma isotopic analysis is either performed for each sample or for an annual sample composite. The presence of Cs-137 is determined and quantified during the gamma isotopic analysis with a required Lower Limit of Detection (LLD) no greater than 5 nCi.

Twenty-two TLD stations are located and maintained along the outer perimeter fence of the TMI-2 ISFSI. Four additional TLD stations are maintained outside occupied buildings (CPP-665 and CPP-666) within 100 meters of the TMI-2 ISFSI. The TLD station locations are noted in Figure 2. Dosimetry is changed out on a monthly frequency. The minimum detectable dose demonstrated is no greater than 10 mrem.

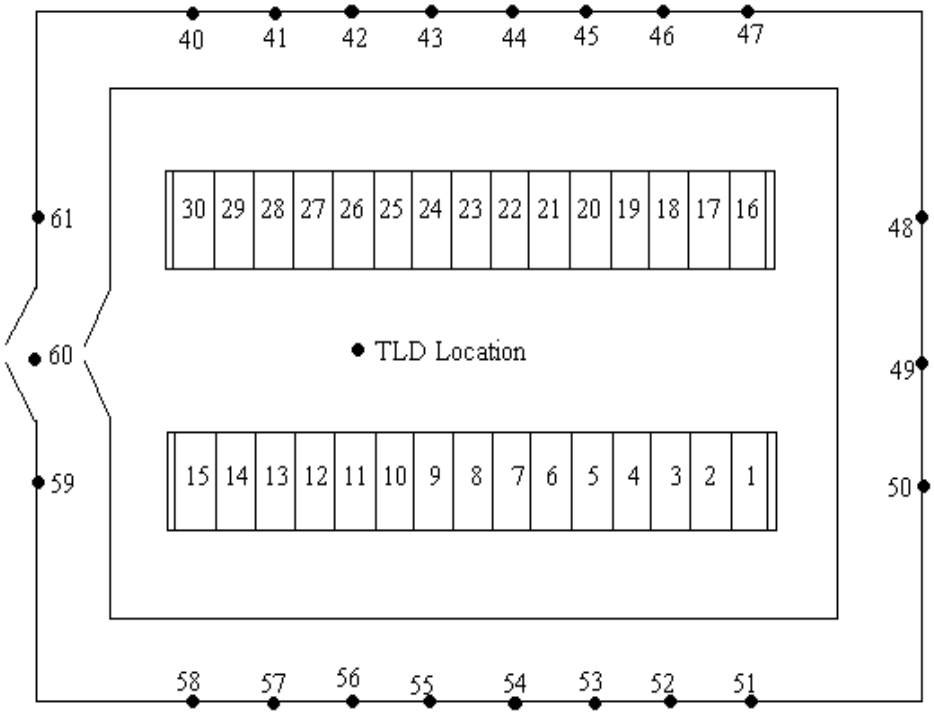

Figure 2. TMI-2 ISFSI TLD Station Locations.

A low-volume air sampler is used to collect a minimum of 5.5E5 liters of air particulate during a seven-day period either during each HSM loading or monthly during periods when no HSM loading operations are occurring. The air sampler is located inside the inner perimeter fence of the TMI-2 ISFSI in the most predominant wind direction from either the HSM being loaded or the center of the facility. Each air particulate sample is analyzed for gross beta radioactivity with an LLD no greater than 0.01 pCi/m^3. Depending on the amount of gross beta radioactivity detected, gamma isotopic analysis is either performed for each air particulate sample or for an annual sample composite. The presence of Cs-137 is determined and quantified during the gamma isotopic analysis with a required Lower Limit of Detection (LLD) no greater than 0.01 pCi/m^3.

RESULTS

Nine additional shipments of TMI-2 core debris were received and loaded into HSM's during 2000. The highest annual individual occupational exposure received at the TMI-2 ISFSI was 10 mrem. The annual collective occupational radiation exposure received at the TMI-2 ISFSI was 0.066 person-rem. Contact radiation levels on the front doors, rear panel doors, and end shield walls are measured either within the first twenty-four hours or seven days following the HSM loading, or during monthly or quarterly scheduled surveillances. The highest radiation levels were all less than or equal to 2 mrem/h, 5 mrem/h, and 1 mrem/h respectively; well below the respective Technical Specification limits. The highest radiation levels measured on the purge and vent port filter housings during monthly DSC hydrogen gas sampling operations are summarized in Table 2. All loaded HSM's are posted as Radioactive Material Areas. HSM rear panel doors are also posted as Radiation Areas.

Table 2. Highest Detected Radiation Summary for Loaded HSM's (mrem/h).

HSM No.	Filter Housing Dose Rate*
16	< 1
17	50
20	100**
22	140**
24	30
27	15
28	5
21	5
26	35
25	40

* Includes Compton scatter contribution from inside the HSM. ** Includes 1 to 2 mrem/h neutron.

The highest loose surface contamination survey results for the purge, vent, and drain ports are summarized in Table 3. With one exception, all analytical gross beta results were less than the Minimum Detectable Activity (MDA) calculated in accordance with NUREG-1507.[5] During the first monthly surveillance of HSM 17 on July 31, 2000, 150 dpm/100 cm^2 of loose surface contamination was detected (1E-4 +/- 1E-5 uCi/sample of Cs-137) at the vent port. Results of a confirmation survey indicated gross beta activity was less than MDA with no detectable Cs-137 activity. The elevated gross beta and Cs-137 radioactivity was attributed to the resuspension of residual fallout and naturally occurring radioactivity contained in vegetation and soil, during the range fires that occurred at the INEEL during the monitoring period.[6]

The gamma isotopic results for the purge, vent, and drain port composite samples from each HSM are summarized in Table 4 in units of radioactivity per sample. Fission and activation product radioactivity was qualitatively identified in the HSM 16 and 17 composite samples. The analytical system used had a calculated LLD of 5E-4 nCi/sample. Since the purge, vent, and drain port samples were composited in one sample, which made identification of the suspect sample media difficult, HSM's 16 and 17 were resurveyed on February 5, 2001. The confirmatory survey results are presented in Table 5. The results are again attributed to the resuspension of radioactivity during the range fires.

Table 3. TMI-2 ISFSI Port Survey Gross Beta/Alpha Results (dpm/100 cm^2).

HSM No.*	Gross Beta	Gross Alpha
16	< 26	< 18
17	< 28**	< 21
20	< 23	< 17
22	< 28	< 21
24	< 28	< 21
27	< 23	< 17
28	< 22	< 19

* HSM's 21, 26, and 25 not included since environmental sampling schedule is not implemented until month following HSM loading. ** Confirmation survey result.

Table 4. TMI-2 ISFSI Port Survey Gamma Isotopic Results.

HSM No.*	Cs-137 Radioactivity
16	Qualitative identification of Co-60, Cs-137, and Mn-54
17	Qualitative identification of Cs-137 and Mn-54
20	No radionuclides identified
22	No radionuclides identified
24	No radionuclides identified
27	No radionuclides identified
28	No radionuclides identified

*HSM's 21, 26, and 25 not included since environmental sampling schedule is not implemented until month following HSM loading.

Table 5. HSM 16 and 17 Confirmation Survey Results (nCi/sample).

HSM No.	Port	Cs-137 Radioactivity
16	Purge	7.2E-3 +/- 1.1E-3
	Vent	<1.1E-2
	Drain	<9.6E-2
17	Purge	<1.2E-2
	Vent	<4.1E-3
	Drain	<1.1E-2

TLD results for the TMI-2 ISFSI are presented in Table 6 in units of mrem/d. Monthly standard deviations were generally 0.1 mrem/d. Analysis of variance results indicated monthly variances were different than the pre-operational baseline variance measured in March 1999. T-test results indicated monthly mean TLD responses were significantly lower than the pre-operational baseline mean every month due to implementation of a new environmental dosimeter and processing system in June 1999.[7] It was also noted that mean TLD responses for locations in the southwest corner of the TMI-2 ISFSI were generally the highest with a mean response of 0.8 mrem/d (locations 56, 57, and 58). This is attributed to direct radiation from outdoor mixed waste storage areas in CPP-1617, which are located 200 meters from the TMI-2 ISFSI, during the monitoring period. All other TLD locations had mean responses of 0.6 to 0.7 mrem/d. The mean response of TLD's located in the two buildings within the 100 meter perimeter of the TMI-2 ISFSI were not significantly different than those at the perimeter fence.

Table 6. TMI-2 ISFSI TLD Results (mrem/d).

LCTN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
40	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.7	0.6	0.6
41	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6
42	0.7	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.6
43	0.7	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.5	0.6	0.5	0.6
44	0.7	0.6	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.6	0.5	0.6
45	0.7	0.6	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.5	0.6
46	0.7	0.6	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.8	0.6	0.6
47	0.7	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.6
48	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.6
49	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.6
50	0.8	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6
51	0.8	0.7	0.7	0.7	0.6	0.7	0.6	0.6	0.6	0.8	0.6	0.7
52	0.9	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.6	0.7
53	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.8	0.7	0.7
54	0.9	0.7	0.7	0.8	0.7	0.7	0.7	0.6	0.7	0.8	0.7	0.7
55	0.9	0.8	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7
56	1.0	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.8
57	0.9	0.8	0.7	0.8	0.7	0.8	0.7	0.7	0.7	0.9	0.8	0.8
58	1.0	0.8	0.8	0.9	0.7	0.8	0.8	0.7	0.8	0.9	0.7	0.8
59	0.8	0.8	0.7	0.8	0.7	0.7	0.8	0.7	0.7	0.8	0.6	0.8
60	0.8	0.7	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.6	0.7
61	0.8	0.7	0.6	0.7	0.6	0.7	0.7	0.6	0.6	0.8	0.6	0.7
Mean	0.8	0.7	0.6	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.7
62	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.5
63	0.7	0.5	0.4	0.5	0.4	0.5	0.5	0.4	0.4	0.5	0.4	0.5
64	0.7	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.7	0.8	0.5	0.8
65	0.8	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.6	0.6
Mean	0.7	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.5	0.6	0.5	0.6

Air sampling results for the TMI-2 ISFSI are presented in Table 7. The required LLD of 0.01 pCi/m^3 for gross beta radioactivity was not demonstrated during January and February. Radioanalytical count times used were based on MDA's required to detect 10% of the Derived Air Concentrations of either Sr-90 or Pu-239, not environmental Cs-137 concentrations. This procedure non-compliance was presented in the 1999 REMP report, but not noticed and corrected until February 2000. Adjustments to variables necessary to achieve a lower LLD were made for implementation during the remainder of 2000.[8] The required LLD was also changed to 1E-2 pCi/m^3 to be consistent with USNRC guidance.[9]

Table 7. TMI-2 ISFSI Air Sample Results (pCi/m^3).

Sample Date	Gross Beta
January	0.06*
February	0.03**
March	0.01
April	0.02
May	0.01
June	0.01
July	0.02
August	0.02
September	0.01
October	0.01, 0.01
November	0.01, 0.03, 0.02
December	0.03, 0.02, 0.02

* Result was greater than the required MDA due to insufficient sample volume, and greater than three standard deviations above the INEEL preoperational baseline (0.04). ** Greater than the required MDA due to insufficient sample volume.

Gamma spectroscopy results of the air sample composite indicated no identified radionuclides. The required LLD of 0.01 pCi/m^3 was achieved with a calculated LLD of 0.5 pCi/sample for the analytical system and a composite air sample volume of 9.5E3 m^3; hence 1E-4 pCi/m^3.

DISCUSSION

With the one exception to achieving the required LLD for two airborne gross beta radioactivity measurements, the TMI-2 ISFSI REMP was conducted in accordance with established procedures. There was no loss of monitoring data impacting estimation of the potential dose commitment to the general public. There were no changes in sampling locations during the monitoring period. There were no deviations from the established sampling schedule. Three criteria associated with the air sampling program were changed in February 2000; air sample volume, sample count time, and the LLD to be achieved.

The loose surface radioactive contamination surveying and airborne radioactivity sampling results indicate there has been no measurable release of radioactive material from the DSC's stored in the HSM's at the ISFSI. Radioanalytical results are not significantly different from pre-operational results as well as those projected in the Final Environmental Impact Statement (EIS).[10]

The radiation dosimetry results indicate there has been no measurable increase in ambient background radiation levels outside the TMI-2 ISFSI perimeter fence attributed to storage of the TMI-2 core debris, however the results do indicate an influence from an outdoor mixed waste storage facility adjacent to the ISFSI. The absence of any significant increase in radiation levels outside the TMI-2 ISFSI perimeter fence is also supported by conclusions reached in the EIS.

Calibration and quality control of instrumentation used for gross beta analysis of surface contamination and airborne radioactivity sample media is maintained in accordance with procedures used by the INEEL Radiological Control Program.[11] Radioactive sources used for instrumentation calibration and quality control are traceable to the National Institute of Standards and Technology (NIST). The radioanalytical program does not participate in either an intracomparison or intercomparison program.

The dosimetry processor participated in the twelfth environmental dosimetry intercomparison program conducted by the DOE Environmental Measurements Laboratory (EML) during 2000, but intercomparison results have not yet been reported by EML.

The radioanalytical laboratory that provides gamma spectroscopy services for composite sample analysis participated in a regularly scheduled intercomparison program conducted by the EML. The intercomparison results for the sample geometry used for composite samples of surface contamination survey and air sample media conducted during 2000 are published.[12, 13] The results are summarized in Table 8. A description of the evaluation criteria can be found at the EML website (www.eml.doe.gov). The evaluation results for Cs-137 identification indicate the INEEL was conservative in their reporting by 4.9% to 14.7%.

Table 8. Gamma Spectroscopy Intercomparison Results for June and December 2000 (Bq/filter).

Radionuclide	INEEL Value (Error)	EML Value (Error)	INEEL/EML	Evaluation
Co-57	5.6 (0.1)	5.31 (0.22)	1.055	Acceptable
Co-57	5.6 (0.1)	5.31 (0.22)	1.055	Acceptable
Co-60	5.4 (0.2)	5.32 (0.26)	1.015	Acceptable
Co-60	5.4 (0.2)	5.32 (0.26)	1.015	Acceptable
Cs-137	6.4 (0.1)	6.1 (0.3)	1.049	Acceptable
Cs-137	6.4 (0.1)	6.1 (0.3)	1.049	Acceptable
Mn-54	28.1 (0.5)	27.2 (0.8)	1.033	Acceptable
Mn-54	28.1 (0.5)	27.2 (0.8)	1.033	Acceptable
Co-57	16.3 (1.8)	14.55 (0.46)	1.120	Acceptable
Co-60	9.3 (1.0)	8.43 (0.48)	1.103	Acceptable
Cs-137	8.5 (0.9)	7.41 (0.36)	1.147	Acceptable
Mn-54	47.9 (1.2)	43.2 (1.3)	1.109	Acceptable

It can be concluded from the results of the TMI-2 ISFSI REMP that airborne radioactivity releases and direct radiation exposure from the facility during 2000 did not contribute to any increase in the estimate of maximum potential dose commitment to the general public. The effective dose equivalent to the Maximum Exposed Individual reported in the EIS is 2.7E-3 mrem/y.

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