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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-8010

CRITERIA FOR MONITORING AND METHODS FOR SUMMATION OF INTERNAL AND EXTERNAL OCCUPATIONAL DOSES

A. INTRODUCTION

In the revised 10 CFR Part 20, "Standards for Protection Against Radiation," 10 CFR 20.1201 establishes radiation dose limits for occupationally exposed adults. These limits apply to the sum of the dose received from external exposure and the dose from internally deposited radioactive material. In 10 CFR 20.1201(a)(1), annual limits are prescribed: (a) 5 rems total effective dose equivalent or (b) 50 rems total dose to any single organ or tissue (other than the lens of the eye), whichever is more limiting. The "total effective dose equivalent" is defined as the sum of the "deep-dose equivalent" (for external exposures) and the "committed effective dose equivalent" (for internal exposures). The annual organ dose limit of 50 rems specified in 10 CFR 20.1201(a)(1)(ii) applies to the sum of the "deep-dose equivalent" and the "committed dose equivalent" to any individual organ or tissue. The requirements are in 10 CFR 20.1202 for summing external and internal doses to demonstrate compliance with the dose limits of 10 CFR 20.1201. The occupational dose limits for minors in 10 CFR 20.1207 are 10% of the dose limit for adults, and 10 CFR 20.1208 establishes a dose limit for the embryo/fetus of 0.5 rem during the entire pregnancy.

Monitoring of an individual's external exposure is required by 10 CFR 20.1502(a) if the external occupational dose is likely to exceed 10% of the dose limit appropriate for the individual (i.e., 10% of the limit for the adult, minor, and declared pregnant woman). External monitoring is also required by 10 CFR 20.1502(a)(3) for any individual entering a high or very high radiation area.

Monitoring of the intake of radioactive material is required by 10 CFR 20.1502(b) if the intake is likely to exceed 0.1 ALI (annual limit on intake) for the adult worker or the committed effective dose equivalent is likely to exceed 0.05 rem for the occupationally exposed minor or declared pregnant woman.

This guide is being developed to provide acceptable criteria that may be used by licensees to determine whether monitoring is needed and to provide methods for calculating and summing external and internal doses to demonstrate compliance with the dose limits in 10 CFR 20.1201(a)(1) for adults and 10 CFR 20.1207 for minors.

Any information collection activities mentioned in this draft regulatory guide are contained as requirements in 10 CFR Part 20, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 20 have been cleared under OMB Clearance No. 3150-0014.

B. DISCUSSION

Summation of external and internal doses is required in 10 CFR 20.1201 when both external and internal monitoring of an individual is required to meet 10 CFR 20.1502(a) and (b). The requirement for summation applies to the occupationally exposed adult and minor and to the embryo/fetus of a declared pregnant woman.

The requirements for summation of external and internal doses specified in 10 CFR 20.1202(a) are not applicable to doses to the lens of the eye, the skin, or the extremities. Only external dose is considered in evaluating the shallow-dose equivalent, extremity dose, and the eye dose equivalent.

C. REGULATORY POSITION

1. MONITORING

The criterion in 10 CFR 20.1502 of likely to exceed 10% of the applicable limits triggers the requirement for monitoring the external dose, monitoring the intake of radioactive material, or both. For external dose monitoring, 10 CFR 20.1502(a) requires the use of individual monitoring devices. Individual monitoring devices are not required for monitoring intake.

The monitoring thresholds are specified as percentages of the dose limits for several types of doses and categories of occupationally exposed individuals. The thresholds apply separately to each external dose type

(i.e., deep-dose equivalent, shallow-dose equivalent, eye dose equivalent, and extremity dose equivalent) and each internal dose type (i.e., committed effective dose equivalent and organ-specific committed dose equivalent). In determining whether the monitoring threshold of 10% of the annual limit on intake is likely to be exceeded, intake by all pathways (inhalation, ingestion, and through the skin) must be considered. The categories of workers include occupationally exposed adults, occupationally exposed minors, and declared pregnant women (for evaluating the dose to the embryo/fetus).

1.1 Establishing Categories of Workers for Monitoring

The monitoring requirements in 10 CFR 20.1502 apply to each individual who is occupationally exposed. However, it is not necessary that a separate determination be made for each individual. If groups or categories of workers are exposed to similar radiological conditions, a single determination may cover all individuals in the group. For simplicity, licensees may establish routine operational guidelines for categories of workers who will be monitored. For example, licensees may establish criteria or procedures for monitoring based on anticipated area access or work functions. For workers or groups of workers who receive occupational dose but are not monitored, the licensee should maintain a written record or explanation for not providing monitoring. Statements provided in the license application are adequate.

1.2 Evaluation of Likely Annual Occupational Dose

Evaluation of the likelihood of exposures exceeding the monitoring threshold should be based on the potential occupational dose to the individual for the year. Doses that may have been received during the year from employment by another licensee are not included in the determination of monitoring requirements. The requirements in 10 CFR 20.1502 refer to each licensee. Each licensee makes the determination independently. It would not be appropriate to base the monitoring requirements at one licensee's facility on exposure conditions at a different licensee's facility. Rather, the need for monitoring at a facility should be based on the exposure conditions at that facility.

Comparisons to previous dosimetric or bioassay data may be considered. Surveys of dose rates and estimates of occupancy times may be used to estimate expected external doses. Average airborne radionuclide concentrations and the expected duration of exposure may be used to estimate radionuclide intakes.

Guidance on estimating potential intakes is being developed in a proposed Revision 1 to Regulatory Guide 8.25 (DG-8003, "Air Sampling in the Workplace"). The potential for unlikely exposures and accident conditions need not be considered because these events, by definition, are not likely.

If respirators are used, the concentrations to be used for evaluating the need for monitoring are those of the ambient atmosphere before credit is taken for respiratory protection factors. If monitoring (bioassay) were dependent on the corrected air concentration (after dividing by the protection factor), it would be equivalent to assuming that the intended protection factor was correct without further verification.

1.3 Change in Exposure Conditions

If an individual's exposure conditions change during the year (either in work area radiological conditions or job assignments), the need to provide individual monitoring should be reevaluated.

If monitoring is determined to be required for a worker (when it had previously been determined to be unnecessary), the determination of the individual's dose must include all previous occupational exposures during that year. This retrospective determination must be done in order to actually record the dose received by the individual in that year. The limits in 10 CFR Part 20 are annual limits, and thus dose records must include all occupational dose contributions during the year. If doses must be estimated when individual monitoring was not provided, the licensee should use the best information available, for example, survey results, historical monitoring results, monitoring of other workers during similar work, or whatever information is available.

For example, an unmonitored individual's work assignment is changed from periodic delivery of supplies to a restricted area to performing maintenance activities within a radiation area. Under this new job assignment, if the licensee determines that the worker's dose is likely to exceed the monitoring threshold, past unmonitored exposure arising from the worker's delivery activities in the restricted area must be estimated.

Similarly, if reevaluation of a monitored individual's anticipated annual occupational dose indicates the dose is likely to be below 10% of the limits, monitoring may be terminated.

1.4 Monitoring Performed But Not Required by 10 CFR 20.1502

Individual monitoring may be conducted for reasons other than those noted in 10 CFR 20.1502. The results of monitoring not required by the individual monitoring requirements of 10 CFR 20.1502 are not subject to the summation requirements of 10 CFR 20.1202 and the recording requirements of 10 CFR 20.2106. However, as a regular practice, licensees should routinely record all individual monitoring results on each individual's dose record. This practice, while not required, is preferred by the NRC staff.

Surveys and monitoring results that serve as confirmatory measures are not subject to the individual dose recordkeeping requirements of 10 CFR 20.2106(a) provided such results confirm that actual individual doses are less than 10% of the limits. An example of confirmatory monitoring is an individual's annual bioassay measurement used as confirmation of the adequacy of airborne control measures. Another example is placing monitoring devices, such as thermoluminescence dosimeters (TLDs), on a sample of workers to provide a confirmation that doses are not above those anticipated.

1.5 Detection Sensitivity

The criteria for monitoring do not necessarily establish required levels of detection sensitivity, e.g., the lower limit of detection (LLD). For example, it may not be feasible to actually confirm intakes of 10% of the ALI, particularly for bioassay measurements of some transuranic elements. Therefore, monitoring thresholds should not be considered requirements on the sensitivity of a particular measurement.

2. DETERMINATION OF EXTERNAL DOSES

There are four types of external dose for which limits are included in 10 CFR 20.1201: whole body, skin, eye, and extremity. According to the definitions in 10 CFR 20.1003, the deep-dose equivalent to the whole body is measured at a tissue depth of 1 cm (1000 mg/cm^2), eye dose equivalent at 0.3 cm (300 mg/cm^2), and shallow-dose equivalent to the skin or extremities at 0.007 cm (7 mg/cm^2).

The external dose component needed for evaluating the total effective dose equivalent under 10 CFR 20.1201(a) is the deep-dose equivalent. Also, the deep-dose equivalent is the external dose component that is summed with the internal dose component (when summation is required) for demonstrating

compliance with the 50-rem annual dose limit for any single organ or tissue (other than the lens of the eye).

2.1 Placement of Individual Monitoring Devices

External dose is typically determined by the use of individual monitoring devices, such as film badges and thermoluminescence dosimeters (TLDs). The device for monitoring the whole body dose should be placed so as to provide a measurement of the maximum dose received by the whole body during the year (10 CFR 20.1201(c)). When the whole body is exposed fairly uniformly, the individual monitoring device is typically worn on the front of the trunk of the body between the head and waist.

If the radiation dose is not uniform, causing a specific body part to receive a higher dose than the rest of the body, the individual monitoring device should be placed near that part of the body likely to receive the highest dose. For example, if the dose rate to the head of an individual is higher than the dose rate to the trunk of the body, a monitoring device should be located on or close to the head so as to measure the dose received by the head. If the location of the highest dose cannot be predicted, the use of more than one badge should be considered. The maximum dose is the one that should be recorded.

New forms (Forms 4 and 5) for recording and reporting worker's doses under the revised 10 CFR Part 20 are being developed. See DG-8007, a proposed Revision 1 to Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data." Appendix A to this guide discusses the calculation of internal and external doses for NRC Form 5.

If postexposure data indicate that the maximum dose was not measured by the individual monitoring device, a survey should be conducted to evaluate the actual dose. The results of the survey should be used to correct (or substantiate) the measured dose.

2.2 Dose from Airborne Radioactive Material

In some situations, airborne radioactive material may significantly contribute to the externally received dose. For some radionuclides, such as noble gases, the external dose from submersion in the airborne activity is more controlling than the internal dose received from inhalation. In Table 1 in Appendix B to §§ 20.1001 - 20.2401, under the column heading "Class," the word "submersion" is used to denote this situation. (Further explanation is

provided in footnotes 1 and 2 of Appendix B to §§ 20.1001 - 20.2401.) For these radionuclides, the annual limit on intake (ALI) and derived air concentration (DAC) values are based on the external exposure. If an appropriate individual monitoring device is used to assess the deep-dose equivalent, no additional dose assessments are needed for evaluating the external exposure contribution from airborne radioactive materials. Guidance on determining the external dose from airborne radioactive material is being developed (see Draft Regulatory Guide DG-8005, "Assessing External Radiation Doses from Airborne Radioactive Materials").

3. DETERMINATION OF COMMITTED EFFECTIVE DOSE EQUIVALENT

The internal dose component needed for evaluating the total effective dose equivalent is the committed effective dose equivalent. The committed effective dose equivalent is the 50-year effective dose equivalent that results when radioactive material is taken into the body, whether through inhalation, ingestion, absorption through the skin, accidental injection, or introduction through a wound. The contributions from these modes of intake are added over the yearly time period for which the total committed effective dose equivalent is being evaluated. The regulatory requirements for determining the internal dose are in 10 CFR 20.1204.

3.1 Intake by Inhalation

ALI values have been established for individual radionuclides and are presented in Table 1 in Appendix B to §§ 20.1001 - 20.2401. The ALI values for inhalation, presented in Column 2 in Table 1, correspond to a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue, whichever is more limiting. If the ALI value presented in Table 1 is limited by the 50-rem committed dose equivalent, the controlling organ is listed directly below the ALI value. The ALI value based on the 5-rem committed effective dose equivalent is listed in parentheses directly below the organ name. If an ALI is listed in parentheses, that value should be used to calculate committed effective dose equivalent. The committed effective dose equivalent may be calculated using the estimated radionuclide intakes by the following equation.

$$H_{i,E,50} = 5000\ mrem\ x\ \frac{I_i}{ALI_{i,E,50}} \qquad Equation\ 1$$

where

$H_{i,E,50}$ = Committed effective dose equivalent from radionuclide i (mrem)

I_i = Intake (in μCi) of radionuclide i by inhalation during the calendar year

$ALI_{i,E,50}$ = Value in μCi of the stochastic inhalation ALI (based on the committed effective dose equivalent) from Column 2 of Table 1 in Appendix B to §§ 20.1001 - 20.2401

While this equation is strictly correct for particle distribution with a 1-micron aerodynamic median diameter, the NRC allows its use for any particle size distribution. The NRC allows adjustment of ALIs to account for particle size, but only with prior approval from the NRC (10 CFR 1204(c)).

$H_{i,E,50}$ may also be calculated from exposures expressed in terms of DAC-hours, but only if the DACs for each of the radionuclides represents a stochastic value. Nonstochastic DACs cannot be used. If any of the radionuclides have a nonstochastic DAC, the intakes should be calculated and Equation 1 should be used.

3.2 Intake by Oral Ingestion

If monitoring of an individual's intake is required by 10 CFR 20.1502(b), the licensee must assess the intake from all pathways (inhalation, ingestion, and through the skin) and must include the internal exposure in the individual's dose records (10 CFR 20.1202(c)). If oral ingestion has occurred,* the methods for determining the committed effective dose equivalent are similar to the methods used for estimation of inhalation dose. If the amount of radioactive material ingested is known, the oral ingestion ALIs from Column 1 of Table 1 in Appendix B to §§ 20.1001 - 20.2401 may be used. The following equation may be used for this determination.

*The revised 10 CFR Part 20 assumes that there is no intentional ingestion of radionuclides in the workplace. For this reason, there are no drinking water concentration limits for occupational exposure. The oral ALI may be used to evaluate doses from inadvertent ingestion.

$$H_{i,E,50} = 5000\ mrem\ x\ \frac{I_i}{ALI_{i,E,50,oral}} \qquad Equation\ 2$$

where

$H_{i,E,50}$ = Committed effective dose equivalent from radionuclide i (in mrem)

I_i = Intake (in μCi) of radionuclide i by oral ingestion during the calendar year

$ALI_{i,E,50,oral}$ = Value (in μCi) of the oral ingestion ALI for the committed effective dose equivalent from Column 1 of Table 1 in Appendix B to §§ 20.1001 - 20.2401

The oral ingestion ALI may also be used to evaluate doses from material presumed to have been inhaled but that appears from bioassay measurements to be metabolized as though ingested.

Some radionuclides in Appendix B to §§ 20.1001 - 20.2401 do not have ALI values listed, indicating that the external exposure is controlling. These radionuclides may be excluded from the determination of the internal dose from oral ingestion.

4. DETERMINATION OF ORGAN-SPECIFIC COMMITTED DOSE EQUIVALENTS

The internal dose component needed for demonstrating compliance with the dose limit specified in 10 CFR 20.1201(a)(1)(ii) is the organ-specific committed dose equivalent. The organ-specific committed dose equivalent is calculated for an individual organ. Weighting factors are not used. To determine compliance, it is necessary to add the organ-specific committed dose equivalent to the external deep-dose equivalent. Organ-specific committed dose equivalents need be calculated only if the committed effective dose equivalent exceeds 1.2 rems. Guidance is being developed on this subject and has been issued for public comment as Draft Regulatory Guide DG-8007, "Instructions for Recording and Reporting Occupational Radiation Exposure Data."

4.1 Use of Federal Guidance Report No. 11

The preferred method for calculating organ-specific committed dose equivalent is to use the factors in Federal Guidance Report No. 11.* The organ-specific exposure-to-dose conversion factors presented in Table 2.1 (for inhalation) and Table 2.2 (for ingestion) of Federal Guidance Report No. 11 provide acceptable data for calculating individual organ doses based on intakes.

4.2 Use of Nonstochastic ALIs from Part 20

It is also possible to calculate organ-specific committed dose equivalents for those radioactive materials for which nonstochastic ALIs are given in 10 CFR Part 20. (Nonstochastic ALIs are those in which the organ is identified underneath the ALI in Part 20, Appendix B.) The equation is:

$$H_{i,T,50} = 50\ rems\ x\ \frac{I_i}{ALI_{i,T,50}} \qquad Equation\ 3$$

where

$H_{i,T,50}$ = Committed dose equivalent (in rems) to tissue or organ T from radionuclide i

I_i = Intake (in μCi) of radionuclide i by inhalation during the calendar year

$ALI_{i,T,50}$ = Value (in μCi) of the nonstochastic inhalation ALI (based on the organ-specific committed dose equivalent) from Column 2 of Table 1 in Appendix B to §§ 20.1001 - 20.2401

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

This draft guide has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an accept-

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*Environmental Protection Agency, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Federal Guidance Report No. 11, EPA-520/1-88-020, 1988. This report may be purchased ($35.00 paperback, $9.00 microfiche) from the National Technical Information Service, Springfield, VA 22161. For information and credit card sales, call (703) 487-4650.

able alternative method for complying with specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for new licenses or license renewals and for evaluating compliance with 10 CFR 20.1001-20.2401.

APPENDIX A

EXAMPLE OF THE CALCULATION AND SUMMATION OF INTERNAL AND EXTERNAL DOSES

This example illustrates the calculation of dose information needed for NRC Form 5, "Occupational Exposure History." An NRC Form 5 with the data calculated in this example is shown to illustrate how to fill out the form. In this example, it is assumed the individual was exposed to external radiation and received an intake by inhalation of five airborne radionuclides.

Deep-Dose Equivalent (Whole Body)

The licensee provided individual monitoring for the deep-dose equivalent (1-cm depth) based on the likelihood of exceeding 500 mrem deep-dose equivalent. In this example, the sum of the dosimeter readings for the year is assumed to be 1435 mrem of low-LET radiation (gamma). Neutron dose, which is entered separately on Form 5, is zero because neutrons were not present and no neutron monitoring was provided. It would also be acceptable to enter "NM" for not monitored.

Eye Dose Equivalent

The licensee provided monitoring for eye dose equivalent because the dose to the eye was likely to exceed 1500 mrem. The dose measured on a dosimeter worn on the trunk at a depth of 0.3 cm was 1700 mrem total for the year. This value is entered on Form 5.

Shallow-Dose Equivalent

The shallow-dose equivalent to the skin or extremities must be monitored if the shallow-dose equivalent is likely to exceed 5000 mrem in the year. In this example, the licensee concluded at the start of the year that the shallow-dose equivalent was not likely to exceed 5000 mrem, and, therefore, monitoring of the shallow-dose equivalent was not required by 10 CFR 20.1502. Nevertheless, the licensee provided shallow-dose equivalent monitoring because the dosimeter supplier automatically provided a shallow-dose equivalent reading on all badges. The annual monitored total of the shallow-dose equivalent

is 1850 mrem, confirming that monitoring of the shallow-dose equivalent was not necessary. The licensee could enter "NM," meaning not monitored, on Form 5 because monitoring of shallow-dose equivalent was not required by 10 CFR 20.1502. However, in this case, the licensee decided, for the sake of completeness, to enter the value of 1850 mrem as the shallow-dose equivalent in the skin column, but he entered "NM" under shallow-dose equivalent to the extremities because no extremity monitoring was provided. The licensee also could have entered 1850 mrem on the basis that the extremities received about the same dose as the dosimeters located on the trunk, or could leave the box blank. Any of those entries are acceptable. A value of zero should not be entered if no monitoring was provided. Any numerical value, including zero, should signify a measured or estimated dose.

Radionuclide Intakes

The intake of each radionuclide must be entered separately. The solubility class of each radionuclide must be specified. The intake mode, inhalation (H) in this case, must also be entered. Based on air sampling data, worker stay times, and respirator protection factors when applicable, the licensee calculated the intakes from inhalation (H) shown in Table A.1 using this equation:

$$I = \frac{A/V \times B \times T}{RPF} \qquad \text{Equation A.1}$$

Where:
- I = intake in microcuries
- A = activity on the filter of the air sample in microcuries
- V = total volume of air sampled in milliliters (Note that the ratio A/V is equal to the concentration in microcuries per milliliter.)
- B = the worker's breathing rate of 20,000 ml/min
- t = duration of the worker's exposure in minutes
- RPF = respirator protection factor, dimensionless

Table A.1. WORKER INTAKES

Radionuclide	Solubility Class	Intake Mode	Intake (microcuries)
U-238	D	H	0.022
U-235	D	H	0.0031
U-234	D	H	0.060
Cs-137	D	H	1.87
Ce-144	Y	H	2.07

All the data in Table A.1 must be entered on Form 5.

Committed Effective Dose Equivalent

The committed effective dose equivalent from each radionuclide is calculated by Equation 1 as described in Regulatory Position 3.1. The data used in Equation 1 are shown in Table A.2.

Table A.2. CALCULATION OF COMMITTED EFFECTIVE DOSE EQUIVALENT

Radionuclide and class	Intake, I_i (microcuries)	$ALI_{i,E,50}$ (microcuries)	CEDE (mrem)
U-238 (D)	0.022	2	55
U-235 (D)	0.0031	2	8
U-234 (D)	0.060	2	150
Cs-137 (D)	1.87	200	47
Ce-144 (Y)	2.07	10	1035
Sum			1295

All the data in Table A.2 except the data in the ALI column must be entered on Form 5.

Total Effective Dose Equivalent

The total effective dose equivalent is the sum of the deep-dose equivalent and the sum of the committed effective dose equivalent from all radionuclides. In this case, the total effective dose equivalent is 1435 + 1295 mrem = 2730 mrem.

Organ-Specific Committed Dose Equivalents

The organ-specific committed dose equivalents must be calculated because the committed effective dose equivalent exceeds 1200 mrem. The organ dose factors in Federal Guidance Report No. 11* should be used. The organ dose factors from Table 2.1 of that report are reproduced in Table A.3.

Table A.3. ORGAN DOSE FACTORS FROM FEDERAL GUIDANCE REPORT NO. 11

	Dose Per Unit Intake (Sv/Bq)					
Radionuclide	Gonad	Breast	Lung	R Marrow	B Surface	Thyroid
U-238 (D)	2.23E-8	2.23E-8	2.80E-7	6.58E-7	9.78E-6	2.22E-8
U-235 (D)	2.37E-8	2.37E-8	2.95E-7	6.58E-7	1.01E-5	2.37E-8
U-234 (D)	2.50E-8	2.50E-8	3.18E-7	6.98E-7	1.09E-5	2.50E-8
Cs-137(D)	8.78E-9	7.84E-9	8.82E-9	8.30E-9	7.94E-9	7.93E-9
Ce-144(Y)	2.39E-10	3.48E-10	7.91E-7	2.88E-9	4.72E-9	2.92E-10

To calculate the organ-specific committed dose equivalent, multiply the intake by the organ dose factor and a conversion factor to convert to mrem and microcuries. The equation is:

$$H_{T,i,50} = I_i \times DCF_{T,i} \times 3.7 \times 10^9 \frac{\text{mrem-Bq}}{\mu\text{Ci-Sv}} \qquad \text{Equation A.2}$$

Where

$H_{T,i,50}$ = 50-year committed dose to organ or tissue T from radionuclide i, in mrem

I_i = the intake of radionuclide i, in microcuries

$DCF_{T,i}$ = the organ dose factor for organ or tissue T from radionuclide i, in Sv/Bq

The results are shown in Table A.4.

*Environmental Protection Agency, "Limiting Values of Radionuclide Intake Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Federal Guidance Report No. 11, EPA-520/1-88-020, 1988. This report may be purchased ($35.00 paperback, $9.00 microfiche) from the National Technical Information Service, Springfield, VA 22161. For information and credit card sales, call (703) 487-4650.

Table A.4. CALCULATED ORGAN-SPECIFIC COMMITTED DOSE EQUIVALENT (mrem)

Radionuclide	Intake (μCi)	Organ-Specific Committed Dose Equivalent (mrem)					
		Gonad	Breast	Lung	R Marrow	B Surface	Thyroid
U-238(D)	0.022	1.8	1.8	22.8	53.6	796.1	1.8
U-235(D)	0.0031	0.3	0.3	3.4	7.6	115.9	0.3
U-234(D)	0.060	5.5	5.5	70.6	155.0	2419.8	5.5
Cs-137(D)	1.87	60.6	54.2	61.0	57.4	54.9	54.9
Ce-144(Y)	2.07	1.8	2.7	6058.3	22.1	36.2	2.2
Sum		70.	65.	6216.	296.	3423.	64.

The dose to the "remainder" is not calculated or used because it does not represent a real dose to a real organ.

Organ Dose

The organ dose to the most exposed organ is the sum of the deep-dose equivalent and the committed dose equivalent to the organ with the largest dose. In this case, the deep-dose equivalent is 1435 mrem. The lung is the organ with the highest committed dose equivalent (6216 mrem). The organ dose is the sum, 7651 mrem, which is entered on Form 5.

NRC FORM 5
10 CFR PART 20

OCCUPATIONAL EXPOSURE RECORD FOR 1. MONITORING YEAR 1993

IDENTIFICATION DATA

2. NAME AND ADDRESS OF REPORTING LICENSEE	3. NRC LICENSE NUMBER(S)	4. NAME OF MONITORED INDIVIDUAL (LAST, FIRST, INITIAL)	5. SEX	
XYZ Corporation Bigtown, USA 98765	SNM-44	Smith, John Q.	☒ MALE ☐ FEMALE ☐ EMBRYO/FETUS	
		6. SOCIAL SECURITY NUMBER: 123-45-6789	7. OTHER IDENTIFICATION TYPE: NA	8. DATE OF BIRTH: 11-18-42 / 9. DATE OF DECLARATION: NA

DOSE EQUIVALENT DATA

10. MONITORING PERIODS (MO/DA - MO/DA)	11. DEEP DOSE EQUIVALENT (WHOLE BODY) a. neutron	b. low LET	12. RADIONUCLIDE a. symbol	b. class	13. INTAKE a. pCi or DAC-hrs	b. mode	14. COMMITTED EFFECTIVE DOSE EQUIVALENT	18. COMMITTED DOSE EQUIVALENT a. dose	b. organ	19. ORGAN DOSE (11a+11b+18a)	20. TOTAL EFFECTIVE DOSE EQUIVALENT a. routine	b. other	21. EYE DOSE EQUIV	22. SHALLOW DOSE EQUIVALENT a. skin	b. extremities	c. code
1/1 - 12/31	0	1.435	U-238	D	0.022 µCi	H	0.055	NA	NA	NA	NA	NA	1.700	1.850	NM	NA
			U-235	D	0.003 µCi	H	0.008	NA	NA	NA	NA	NA				
			U-234	D	0.060 µCi	H	0.150	NA	NA	NA	NA	NA				
			Cs-137	D	1.87 µCi	H	0.047	NA	NA	NA	NA	NA				
			Ce-144	Y	2.07 µCi	H	1.035	NA	NA	NA	NA	NA				
			Sum	NA	NA	NA	1.295	6.216	LG	7.651	2.730	0				
CURRENT MONITORING YEAR TOTALS AT THIS FACILITY							15. 1.295	6.216	LG	7.651	23a. 2.730	23b. 0	26. 1.700	29. 1.850	32a. NM	UL
CURRENT MONITORING YEAR TOTALS AT OTHER FACITIES							16. 0	0		0	24a. 0	24b. 0	27. 0	30 0	32b. NM	UR
CURRENT MONITORING YEAR TOTALS AT ALL FACILITIES							17. 1.295	6.216	LG	7.651	25a. 2.730	25b. 0	28. 1.700	31. 1.850	32c. NM	LL
															32d. NM	LR
PRIOR MONITORING YEARS AT THIS FACILITY 33. DATE THIS EMPLOYMENT BEGAN 1/1/93											34a. 2.730	34b. 0				

35. SIGNATURE OF LICENSEE DESIGNEE	36. DATE
[signature]	1/4/94

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REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. The regulatory analysis prepared for 10 CFR Part 20, "Standards for Protection Against Radiation" (56 FR 23360), provides the regulatory basis for this guide and examines the costs and benefits of the rule as implemented by the guide. A copy of the "Regulatory Analysis for the Revision of 10 CFR Part 20" (PNL-6712, November 1988), is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW., Washington, DC, as an enclosure to Part 20.

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