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U.S. DOE, RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT, PROPOSED RULE, 58 FEDERAL REGISTER 56 - (USED AS A REFERENCE IN OU5 RI REPORT APPENDIX A)

03/25/93

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REPORT

DEPARTMENT OF ENERGY

10 CFR Part 834

[Docket No. EH-RM-93-834]

Radiation Protection of the Public and the Environment

AGENCY: U.S. Department of Energy.

ACTION: Notice of proposed rulemaking and public hearing.

SUMMARY: The U.S. Department of Energy (DOE) is proposing its primary standards for the protection of the public and environment against radiation. The requirements would be applicable to the control of radiation exposures to the public and to the environment from normal operations under the control of DOE and DOE contractor personnel.

This proposed rule covers four basic areas relating to radiation protection of the public and the environment. It establishes dose limits for exposure of members of the public to radiation and requires the reporting of doses above specified levels. In addition, it requires the assessment of all releases of radioactive material and all doses and potential doses to the public from DOE activities to ensure that they are managed in accordance with the Department's "as low as is reasonably achievable" (ALARA) policy. It provides requirements for the management of radioactive materials in liquid waste discharges, in soil columns, and in selected solid waste containing radioactive materials and requires sites to establish ground water protection programs. It provides requirements for decontamination, survey, management, storage, disposal, and release of buildings, land, equipment, personal property containing residual radioactive material. It requires an Environmental Radiological Protection Program (ERPP) for each DOE activity to set forth the program, plans, and other processes to protect the public from exposures to radiation. In particular, it requires effluent monitoring and environmental surveillance programs as part of the ERPP.

DATES: Written comments (10 copies) should be submitted to the address listed below by June 22, 1993. A hearing will be held on May 13, 1993, beginning at 9 a.m. Requests to speak at the hearing must be submitted on or before May 10, 1993.

ADDRESSES: Written comments (10 copies) and requests to speak at the hearing should be addressed to: Ben McRae, U.S. Department of Energy, Office of General Counsel, GC-31, Docket No. EH-RM-93-834, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-3012.

A hearing will be held at 9 a.m. on May 13, 1993 at: U.S. Department of Energy, Germantown, Auditorium Building, 19901 Germantown Road (Route 118), Germantown, MD 20874.

Written comments and the hearing transcript may be examined between 9 a.m. and 4 p.m., Monday through Friday, except Federal Holidays, in the U.S. Department of Energy, Freedom of Information Reading Room, room 1E-190, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-6020.

FOR FURTHER INFORMATION CONTACT: For legal questions, contact: Ben McRae, U.S. Department of Energy, GC-31, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-6975.

For technical questions, contact: Andrew Wallo III, or Harold T. Peterson, Jr., U.S. Department of Energy, EH-232 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-2409.

For procedural questions concerning participation in the public hearing or submission of written comments, contact: Andi Kasarsky at (202) 586-3012.

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I. Background

The DOE owns numerous facilities where production, research, development, and other operations and activities involving radioactive material and radiation are carried out. Radiation protection requirements for these facilities and operations are, for the most part, established through DOE Orders under the authority of the Atomic Energy Act of 1954, as amended (Pub. L. 83-703).

Recently, the DOE has undertaken a thorough review of operations at its nuclear facilities. In particular, the DOE has been examining the performance of its contractors in achieving the goals of protecting the public health and safety and the environment. As a result of its review, the DOE is taking steps to improve its ability to enforce its nuclear safety and radiation protection requirements.

It is DOE's objective to operate its facilities and to conduct its activities so that radiation exposures to members of the public are maintained within acceptable limits and to control

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exposures to residual radioactive material through the management of real and personal property. Moreover, DOE strives to operate its facilities in a manner that limits exposures to members of the public so that resultant doses are as far below the limits as is reasonably achievable and that DOE facilities have the capabilities, consistent with the types of operations conducted, to monitor routine and non-routine releases, and to assess doses and potential health impacts to members of the public from such releases.

In addition to providing protection to members of the public, it is DOE's objective to protect the environment from residual radioactive material to the extent practical so that ecosystems and national resources will be protected for future generations.

On February 8, 1990, the DOE issued the Order DOE 5400.5, "Radiation Protection of the Public and the Environment." Order DOE 5400.5 superseded those portions of Order DOE 5480.1A, "Environmental Protection, Safety, and Health Program for DOE Operations" of 8–31–81, chapter XI, that addressed public and environmental radiation protection standards and control practices. The DOE is proposing to promulgate, through this rulemaking, its primary standards for protection of the public and the environment against radiation which are presently found in DOE 5400.5. The proposed rule differs from DOE 5400.5 essentially in format rather than substance. Certain elements of Order DOE 5400.1, "General Environmental Protection Program," applicable to radiation protection, have also been included in the proposed rule.

System of Dose Limitations

A significant element of the Order DOE 5400.5 is the implementation of the recommendations of the International Commission on Radiological Protection (ICRP) contained in ICRP Publications 26 and the recommended dosimetric models and data base contained in ICRP Publication 30. In these reports and related guidance, the ICRP recommended a system of dose limitations that has been adopted and implemented by essentially all countries with nuclear programs. A significant feature of the ICRP dose limitation system is that compliance with the specified dose limits is not, by itself, satisfactory. The doses to workers and to the public must also be kept as low as is reasonably achievable (ALARA).

The dose calculation method is based on the recognition of two basic types of radiation-induced health effects—"non-stochastic" (or "deterministic") and "stochastic" (or "probabilistic"). Non-stochastic health-effects do not occur unless a threshold dose is exceeded. Such health-effects include cataracts, ablation of the thyroid, and sterility. One objective of the radiation protection system is to prevent these health-effects by limiting the radiation dose to less than the threshold dose level associated with these effects. The ICRP stated in Publication 26: "* * * non-stochastic effects will be prevented by applying a dose equivalent limit of 50 rem (0.5 Sv) in a year to all tissues except the lens, for which the Commission recommends a limit of 30 rem (0.3 Sv) in a year." In both the Order on radiation protection of the public and the environment (DOE 5400.5) and this proposed rule, there is no need to provide requirements for protection of the public from non-stochastic health-effects because the DOE has set limits for protection of the public against stochastic effects that are well below the threshold for non-stochastic health-effects. As long as this dose limit is not exceeded, there should be no non-stochastic health-effects.

Stochastic health-effects are probabilistic; the likelihood of their occurrence is assumed to be proportional to the radiation dose, and the severity of the effect is not dose-dependent. For example, cancer is considered to be the predominant stochastic health-effect of radiation exposure, and it is assumed that the greater the dose, the greater the risk (probability) of developing cancer. There is considerable uncertainty in estimating the probability of radiation-induced cancer, owing to the dearth of information on the induction of health-effects in humans exposed to low doses and low dose rates. Since epidemiological data cannot exclude the existence of a threshold for stochastic effects, such as cancer, the possibility that there may be no risk at low dose levels cannot be ruled out.

Notwithstanding the possibility of a threshold effect, in order to ensure the protection of the public and the environment and in setting the radiation protection standards in this proposed rule, the Department assumes that the severity of each type of stochastic (random) health effect, e.g., cancer and genetic disease, is independent of dose and that within the range of exposures normally encountered by the public, the relationship between dose and the probability of a stochastic health effect is without threshold (i.e., it is assumed that any exposure, no matter how low, can cause health effects). On the basis of these assumptions, DOE is requiring that the ALARA process be employed at its facilities. DOE and DOE contractor operations will be conducted in a manner that will ensure that doses to members of the general public and releases of radioactive material to the environment will be ALARA and do not exceed established dose or release limits.

In recommending an annual effective dose equivalent (EDE) limit of 100 mrem (1 mSv), the ICRP concluded that risks associated with this limit were within the public's general "level of acceptance" for everyday risks which was in the range of 10^{-6} to 10^{-5} per year (ICRP 1977). The risk of stochastic effects to workers and to members of the public are further reduced by restricting doses to levels that are as low as is reasonably achievable (ALARA) below the dose limits. Data from DOE operating experience verifies that the maximum doses to members of the public living near facilities which are operated with ALARA considerations, are consistently a small fraction of the 100 mrem (1 mSv) annual limit.

DOE is aware that the ICRP has recently revised the recommendations of ICRP Publication 26 and issued them in ICRP Publication 60. The Department believes it is neither prudent nor necessary to consider these recommendations in this proposal. The recommendations contained in ICRP Publication 60 for protection of the public are not significantly different from those in ICRP Publication 26. The recommended allowable dose for a member of the public in ICRP Publication 60 is expressed in terms of a 5 year increment (i.e., 500 mrem (5 mSv) in 5 years) which is effectively equivalent to the 100 mrem (1 mSv) in a year dose recommended in ICRP Publication 26. However, there are differences in the methods used to calculate dose. It is anticipated that these recommendations will be considered by an interagency committee. It would therefore be premature for DOE to unilaterally consider them at this time. DOE intends to evaluate the recommendations contained in ICRP Publication 60 and to consider possible adjustments in its radiation protection standards following the completion of the interagency review.

Public Dose Limits

The primary public dose limits include consideration of all exposure modes from all routine DOE activities (including remedial actions). The dose limit is expressed as an effective dose equivalent (EDE), a term developed by the ICRP for their risk-based radiation protection system, which requires the risk-based weighted summation of doses

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and dose commitments to various organs of the body. The dose limit and other limitations do not include dose received from background radiation or radiation dose received by a patient from diagnostic or therapy treatment.

The DOE is not alone in its effort to update its radiation protection standard. The NRC has adopted the ICRP system of dose limitations and has promulgated revisions of its standards for protection against radiation (10 CFR part 20) to reflect the ICRP recommendations. The EPA utilized elements of the ICRP system in its Federal Guidance "Radiation Protection Guidance to Federal Agencies for Occupational Exposures" of January 1987, Federal Guidance Report No. 11 "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" of September 1988, and in the subpart of its 40 CFR part 61 dealing with emissions of radionuclides under the National Air Emissions Standards for Hazardous Air Pollutants (NESHAPs) published December 1989. It also permitted use of the system as an alternative to its standards in subpart A of 40 CFR part 191. Thus, this proposed rule is consistent with DOE Orders as well as regulations of other Federal agencies in adopting and implementing the ICRP recommendations with respect to the system of dose limitations.

Ground Water Protection and Control of Effluents

The U.S. General Accounting Office (GAO) issued a report titled "Nuclear Energy: Environmental Issues at DOE's Nuclear Defense Facilities," GAO/RCED-86-192, September 8, 1986. The report contained a recommendation that the DOE "* * * establish a ground water and soil protection strategy. Such a strategy should reflect DOE policy on the extent ground water and soil can become contaminated and include specific guidelines, to the extent practical, to protect ground water and soil around DOE facilities." In response to this recommendation, Order DOE 5400.1, November 9, 1988, required each DOE field organization to prepare a ground water protection management plan, and Order DOE 5400.5, February 8, 1990, included requirements for DOE facilities to establish Best Available Technology (BAT) programs for the treatment of waste streams prior to release as liquid effluents and to phase out the use of soil columns which retain suspended or dissolved radionuclides from radioactive liquid waste streams. These requirements have been retained in this proposed rule.

Environmental Monitoring

Another GAO report ("Environment, Safety, and Health: Environment and Workers Could be Better Protected at Ohio Defense Plants." GAO/RCED-86-61, December 13, 1985) recommended that DOE establish "mandatory" monitoring guidelines for all DOE facilities. Order DOE 5400.1 provides general guidance for the establishment of environmental monitoring programs including effluent monitoring and environmental surveillance for radiological and non-radiological constituents of all media and meteorological monitoring. The Order also requires the establishment of quality assurance and data verification programs and requires each facility to prepare an Environmental Monitoring Plan by November 1991. These requirements, as they apply to radiological monitoring, are included in this proposed rule. In addition, guidance issued January 1991, "DOE Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" supporting DOE 5400.5 and the similar requirements contained in this proposed rule, contains more definitive radiological monitoring specifications for the facility environmental radiological monitoring programs.

Remedial Activities

A major activity at many DOE facilities involves the radiological decontamination of facilities, property, and equipment previously used for nuclear operations. DOE 5400.5 contains general requirements for the radiological decontamination and the release of such material and property, and includes some specific minimum requirements with the primary goal being to reduce all exposures and potential exposures of the general public to levels that are as low as is reasonably achievable. This proposed rule contains criteria for the release of such materials and property, and includes some specific minimum requirements with the primary goal being to reduce all exposures and potential exposures of the general public to levels that are as low as is reasonably achievable.

II. Nature of Proposed Rule and Rationale

A. Radiation Protection Principles and Dose Limitation

General

Subpart B of the proposed rule contains requirements for a system of dose limitation that is consistent with the recommendations contained in ICRP Publications 26 and 30 for members of the general public. The proposed system continues the use of DOE requirements for the application of the ALARA process to activities involving exposures to radioactive material and radiation. The ALARA process is also a principal element of the ICRP dose limitation system.

The proposed rule includes the requirement that radiation exposures to individuals in the general public from all radiation sources and exposure pathways combined from routine DOE activities would not exceed an EDE of 100 mrem (1 mSv) in a year (§ 834.101(a)(2)). This dose limit is significantly lower than the 500 mrem (5 mSv) in a year whole body dose equivalent limit contained in the current Federal guidance for protection of the public.[1] Because this primary dose limit applies to all radiation sources and pathways combined (other than background sources) and the DOE ALARA process applies (§ 834.101(a)(1)), the Department expects doses from its operation to be no more than a small fraction of the 100 mrem (1 mSv) in a year EDE limit. Current monitoring programs have demonstrated the success of the ALARA process in lowering doses to levels that are well below the dose limit. The estimated maximum EDE to any individual member of the public for 1988, from DOE activities, was less than 10 mrem (0.1 mSv). Furthermore, data indicated that for most sites (29 of 35) the maximum estimated doses to individuals were less than 1 mrem (0.01mSv). EPA also evaluated air emissions from DOE operations when it promulgated its National Air Emission Standards for Hazardous Air Pollutants (NESHAPs) for radionuclides emissions from DOE facilities (40 CFR part 61, subpart H) on December 15, 1989. After reviewing data on emissions from DOE facilities during 1986, EPA concluded that DOE facilities were controlling air emissions to levels that limited maximum annual individual doses below 10 mrem (0.1 mSv) EDE and that this dose level provided an ample margin of safety for release to the air pathway. EPA concluded that risks of radiation-induced fatal cancer to 98% of

[1] On May 13, 1960 (25 FR 4402), and September 26, 1961 (25 FR 9057), the former Federal Radiation Council (FRC) guidance to Federal agencies for protection of the public and workers were issued. New recommendations for protection of workers, adopting ICRP-26 recommendations, were developed through EPA and approved by the President on January 27, 1987 (52 FR 28822). The FRC guidance for the general public has not yet been updated.

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the individuals in the general public within 50 miles (80 km) of the sites were less than 1 in 1,000,000. The DOE believes that recent data from its operating facilities, such as those cited above, demonstrate that the dose limitation system in this proposed rule represents an effective method of regulating radiation exposures to the public and to the environment from its facilities.

The public dose limits in § 834.101 apply to doses from exposures to radiation sources from routine DOE activities, including doses that occur during the conduct of remedial actions. Radionuclides, including source, byproduct, and special nuclear material and naturally occurring and accelerator produced radioactive material (NARM) used at DOE facilities are subject to these limitations. The dose limits also apply to the doses to individuals who are exposed to radiation or contamination by radionuclides at properties subsequent to remedial action and release of the property. Radioactive waste-handling operations, including disposal, storage, transport, and packaging, are subject to the requirements of the proposed rule. DOE facilities and operations, in some instances, are subject to the regulatory requirements of the NRC and the EPA (e.g., 10 CFR parts 60 [high-level waste repository] and 72 [spent-fuel storage] and 40 CFR parts 61 [all DOE facilities], 191 [disposal of high-level waste], and 192 [UMTRA sites]). The Waste Isolation Pilot Plant, for purposes of this part, is considered to be a disposal facility subject to this part and 40 CFR part 191. It is Departmental policy that DOE facilities and operations will comply fully with the requirements of those and other applicable regulatory requirements.

In addition to the general reporting requirements (e.g., annual environmental reports), the proposed rule contains a requirement (§ 834.7) for notification to DOE Headquarters, in particular DOE–EH, if combined annual releases from any facility are causing, or might cause, doses to individual members of the general public to exceed 10 mrem (0.1 mSv) EDE in a year. This reporting requirement is not intended as a limit, but rather an action level that will act to alert DOE to activities that might cause doses that are a significant fraction of the overall dose limit. It will provide a mechanism by which DOE can identify and resolve potential problems in a timely manner to ensure that the dose to any member of the public is ALARA. Similarly, a reporting value for collective dose of 100 person-rem (1 person-Sv) is proposed to provide a timely notification before collective doses become substantial. Such notifications would be made in a timely manner, but within one month of determination of the occurrence, in any case. All reports, notifications, and records developed pursuant to this proposed rule would present data in the units used, or required, in the applicable regulation or DOE Directive. Conventional units would be presented, with appropriate Standard Internationale (SI) units in parentheses following the conventional units.

The ALARA process is required for situations that have potential doses below these reporting levels. The reporting level is the level at which DOE will take special or additional actions to review. The reporting level of 10 mrem (0.1 mSv) EDE in a year was selected because it represents a small fraction (e.g., 10%) of the primary EDE limit for essentially all radiation sources. Intrinsically, the uncertainties in dose estimates are high for doses an order of magnitude below the EDE limit. The uncertainties increase greatly for dose estimates on the order of 1 mrem (0.01 mSv) in a year. Thus, 1 mrem (0.01 mSv) in a year would not be appropriate for the reporting level because it would require considerably more frequent reporting for doses which have greater uncertainties and thereby diluting DOE oversight resources. DOE believes that the routine audit and oversight activity is adequate for doses two orders of magnitude below (e.g., 1% of) the primary EDE limit.

The collective dose reporting requirement was similarly selected. At annual collective dose below 100 person-rem (1 person-Sv) in a year, DOE believes that routine oversight activities are adequate, but above 100 person-rem (1 person-Sv) in a year, special oversight might be useful.

Neither the reporting level of 10 mrem (0.1 mSv) in a year for individuals, nor the 100 person-rem (1 person-Sv) in a year for collective dose, should be confused with "below regulatory concern" (BRC) considerations. DOE has not addressed the use of the BRC concept in this proposed rule. The BRC concept establishes levels of radiation that are associated with such small health risk that further regulatory efforts to reduce these levels are unwarranted because the diversion of associated resources from more critical public protection issues alone exceed the benefits to public health achieved by further regulation and the cost of the regulatory effort. In this proposed rule DOE requires that all releases and doses be reviewed and assessed under the ALARA process.

For purposes of determining compliance with the reporting requirements of 40 CFR parts 302 and 355, releases of source, by-product, and special nuclear material which occur from DOE activities are considered to be "Federally permitted" releases if they do not exceed the limits specified in this part and the operations and releases are in compliance with DOE policies, guidelines, and requirements specified in plans prepared and approved in accordance with this part.

Temporary increases. Situations could occur that would require (for short periods of time) exposure of individual members of the general public in excess of the 100 mrem (1 mSv) EDE in a year limit, but not more than 500 mrem (5 mSv) EDE in the year. Provisions for such a situation are contained in the proposed rule (§ 834.101(b)). If the need can be justified, DOE may approve a temporary higher limit than the 100 mrem (1 mSv) EDE annual limit. An example of such a situation would be a remedial action project which, in the long term, will benefit the general public in the area, but which, in the short term (during remedial action), might cause unavoidable higher doses to individuals. The Department expects requests for increases to the primary dose limit to be rare. The actions must be clearly justified and still would be subject to the ALARA process.

Other limits. In addition to the primary dose limit and requirements for the ALARA process, DOE proposes several pathway and source-specific limits. These include: 10 mrem (0.1 mSv) in a year from airborne effluent (§ 834.102(a)(2)); 25 mrem (0.25 mSv) in a year from all waste handling, storage, and disposal activities (§ 834.109(a)(2)); and radon flux 20 pCi (0.7 Bq)/m^2-sec where radium-226 residues are accepted for storage or disposal, 3 pCi(0.1 Bq)/L at a facility where sources of radon are handled, and concentration of 0.5 pCi/L (0.02 Bq/L) at boundary of the site (§ 834.102(a) (3),(4), and (5)). In general, these additional requirements are consistent with other Federal requirements. In addition, limits for radon and its decay products in air are provided in terms of Working Levels (WL) and concentrations in air rather than dose limits and are addressed independently.

DOE has adopted the public community drinking water standards in 40 CFR part 141, "Interim Primary Drinking Water Regulations, Promulgation of Regulations on Radionuclides," (Safe Drinking Water Act), for DOE drinking water systems (§ 834.103(a) (2),(3), and (4)). It is DOE

policy that the level of protection provided to persons consuming water from a public drinking water supply operated by DOE directly or through a contractor, be equivalent to that provided to the public for non-DOE operated systems. The proposed rule would require that liquid effluents from DOE activities be controlled to ensure that public or private drinking water systems downstream of DOE facilities are not caused to exceed the dose limits in 40 CFR part 141, as a result of DOE operations (§ 834.103(a)(5)).

Implementation

All DOE operations, with the exception of those under the jurisdiction of the Director of Naval Nuclear Propulsion Programs (who is also the Deputy Assistant Secretary for Naval Reactors within DOE), would be required to comply with the dose limits and ALARA requirements of this proposed rule. Section 309 of the Department of Energy Organization Act (Public Law 95–91), Executive Order 12344, and Public Law 98–525 establish the responsibilities and authority of the Director, Naval Nuclear Propulsion Program over all facilities and activities which comprise the Program, a joint Navy-DOE organization solely responsible for military application of nuclear energy in connection with naval warship propulsion. Pursuant to the purpose and direction of these actions, the standards, regulations, and requirements prescribed by the Director continue to apply to Program facilities and activities in lieu of this proposed rule.

DOE facilities will be designed and operated so that doses to members of the public do not exceed the dose limits and other requirements of the proposed rule. However, compliance with these limits is not sufficient to comply with the proposed rule because doses must be reduced as far below these limits as is practicable through the ALARA process. Selected limits and reporting levels in the proposed rule are summarized in Table 1 of this preamble. Compliance with the dose limits will be verified and demonstrated through a combination of measurements, monitoring and calculations to evaluate doses. The proposed rule requires reporting of these data each year in the Annual Environmental Report. While the standards in this proposed rule are not intended to apply to accidents with regard to planning or the design of facilities or their control systems, doses from accidental releases at a subject facility are to be included in that facilities dose assessments for the purpose of evaluating and assessing compliance with this proposed rule and would be reported in the Annual Environmental Reports.

Interim strategy. If the DOE activity cannot comply with the rule within 180 days of the effective date of the rule, an interim strategy to implement the rule requirements to the extent practicable and to provide a plan and schedule for achieving compliance would be required. These items would be submitted to DOE for approval and incorporated into the ERPP. The interim strategy would be required to:

(1) Document the reasons compliance cannot be achieved within the 180 days;

(2) Evaluate and alternative measures which might be taken;

(3) Analyze the effects of non-compliance on members of the public and the environment; and

(4) Provide an interim strategy and schedule for compliance.

Dose evaluations. Data developed to demonstrate that DOE operations comply with applicable standards and requirements should be correct and representative. Accordingly, this proposed rule requires that calculations of dose to the public from exposures resulting from both routine and unplanned activities be performed using standard EPA or DOE dose conversion factors or analytical models prescribed in regulations applicable to DOE operations. Doses to members of the public in the vicinity of DOE activities would be evaluated and documented to demonstrate compliance with the dose limits of this rule and to assess exposures of the public from unplanned events. Collective doses to the public within 50 miles (80 km) of the site boundary would be evaluated and documented at least annually.

Analytical models used for dose evaluations would be appropriate for characteristics of emissions (e.g., gas, liquid, or particle; depositing or non-depositing; buoyant or non-buoyant); mode of release (e.g., stack or vent; crib or pond; surface water or sewer; continuous or intermittent); environmental transport medium (e.g., air or water); and exposure pathway (e.g., inhalation; ingestion of food, water, or milk; direct radiation). Information on dispersion (transport and diffusion) in the environment, demography, land use (including the location and number of dairy and slaughter animals), food supplies, and exposure pathways used in the dose calculations would be appropriate to evaluate actual and potential doses in the environs of DOE facilities. Such information would be updated as necessary to document significant changes that could affect dose evaluations. Dose evaluation models that are codified, approved, or accepted by regulatory or other authorities, such as those codes approved for demonstrating compliance with 40 CFR part 61, subpart H, would be used where appropriate.

Committed dose conversion factors. Radionuclides taken into the body, generally by exposure modes whereby the radionuclide is ingested or inhaled, will continue to irradiate the body as long as they exist and are retained by the body. The dose delivered to a body over the lifetime of the individual from a single intake of a radionuclide is the committed dose. Tables of committed dose conversion factors would be used, as appropriate, based upon the ICRP reference man model, and the committed dose is the dose integrated over an interval of 50 years.

External dose conversion factors. The doses from exposure to external radiation from radionuclide concentrations in air and in water that result from submersion or from exposure to contaminated plane surfaces would be estimated, using the ICRP reference man model and appropriate dosimetry factors. However, for demonstrating compliance with DOE dose limits, external doses may be determined using data from direct measurements with appropriate instrumentation if doses obtained with the direct measurements are found to be at least as accurate as those determined by analytical model evaluations.

Derived concentration guides (DCG). DCG values are presented as reference values in appendix A for each of three exposure modes: inhalation of air containing the radionuclide; submersion in a semi-infinite cloud of air containing the radionuclide; and ingestion of water containing the radionuclide. The DCG tables may be used to evaluate only the three exposure modes upon which they are based.

Other methods and alternatives. Methods and alternatives other than those discussed above and as prescribed in applicable regulations would be submitted to DOE for approval. DOE may approve the alternative method, if appropriate.

Parametric considerations. Dose limits for members of the general public, from routine operation of a DOE activity, would be expressed as a dose received by the individuals during the year (if, for example, the exposure is external to the body) or the committed dose received by the individual over a period of 50 years from radionuclides taken into the body during the year. The limits should not be interpreted as dose

policy that the level of protection provided to persons consuming water from a public drinking water supply operated by DOE directly or through a contractor, be equivalent to that provided to the public for non-DOE operated systems. The proposed rule would require that liquid effluents from DOE activities be controlled to ensure that public or private drinking water systems downstream of DOE facilities are not caused to exceed the dose limits in 40 CFR part 141, as a result of DOE operations (§ 834.103(a)(5)).

Implementation

All DOE operations, with the exception of those under the jurisdiction of the Director of Naval Nuclear Propulsion Programs (who is also the Deputy Assistant Secretary for Naval Reactors within DOE), would be required to comply with the dose limits and ALARA requirements of this proposed rule. Section 309 of the Department of Energy Organization Act (Public Law 95–91), Executive Order 12344, and Public Law 98–525 establish the responsibilities and authority of the Director, Naval Nuclear Propulsion Program over all facilities and activities which comprise the Program, a joint Navy-DOE organization solely responsible for military application of nuclear energy in connection with naval warship propulsion. Pursuant to the purpose and direction of these actions, the standards, regulations, and requirements prescribed by the Director continue to apply to Program facilities and activities in lieu of this proposed rule.

DOE facilities will be designed and operated so that doses to members of the public do not exceed the dose limits and other requirements of the proposed rule. However, compliance with these limits is not sufficient to comply with the proposed rule because doses must be reduced as far below these limits as is practicable through the ALARA process. Selected limits and reporting levels in the proposed rule are summarized in Table 1 of this preamble. Compliance with the dose limits will be verified and demonstrated through a combination of measurements, monitoring and calculations to evaluate doses. The proposed rule requires reporting of these data each year in the Annual Environmental Report. While the standards in this proposed rule are not intended to apply to accidents with regard to planning or the design of facilities or their control systems, doses from accidental releases at a subject facility are to be included in that facilities dose assessments for the purpose of evaluating and assessing compliance with this proposed rule and would be reported in the Annual Environmental Reports.

Interim strategy. If the DOE activity cannot comply with the rule within 180 days of the effective date of the rule, an interim strategy to implement the rule requirements to the extent practicable and to provide a plan and schedule for achieving compliance would be required. These items would be submitted to DOE for approval and incorporated into the ERPP. The interim strategy would be required to:

(1) Document the reasons compliance cannot be achieved within the 180 days;

(2) Evaluate and alternative measures which might be taken;

(3) Analyze the effects of non-compliance on members of the public and the environment; and

(4) Provide an interim strategy and schedule for compliance.

Dose evaluations. Data developed to demonstrate that DOE operations comply with applicable standards and requirements should be correct and representative. Accordingly, this proposed rule requires that calculations of dose to the public from exposures resulting from both routine and unplanned activities be performed using standard EPA or DOE dose conversion factors or analytical models prescribed in regulations applicable to DOE operations. Doses to members of the public in the vicinity of DOE activities would be evaluated and documented to demonstrate compliance with the dose limits of this rule and to assess exposures of the public from unplanned events. Collective doses to the public within 50 miles (80 km) of the site boundary would be evaluated and documented at least annually.

Analytical models used for dose evaluations would be appropriate for characteristics of emissions (e.g., gas, liquid, or particle; depositing or non-depositing; buoyant or non-buoyant); mode of release (e.g., stack or vent; crib or pond; surface water or sewer; continuous or intermittent); environmental transport medium (e.g., air or water); and exposure pathway (e.g., inhalation; ingestion of food, water, or milk; direct radiation). Information on dispersion (transport and diffusion) in the environment, demography, land use (including the location and number of dairy and slaughter animals), food supplies, and exposure pathways used in the dose calculations would be appropriate to evaluate actual and potential doses in the environs of DOE facilities. Such information would be updated as necessary to document significant changes that could affect dose evaluations. Dose evaluation models that are codified, approved, or accepted by regulatory or other authorities, such as those codes approved for demonstrating compliance with 40 CFR part 61, subpart H, would be used where appropriate.

Committed dose conversion factors. Radionuclides taken into the body, generally by exposure modes whereby the radionuclide is ingested or inhaled, will continue to irradiate the body as long as they exist and are retained by the body. The dose delivered to a body over the lifetime of the individual from a single intake of a radionuclide is the committed dose. Tables of committed dose conversion factors would be used, as appropriate, based upon the ICRP reference man model, and the committed dose is the dose integrated over an interval of 50 years.

External dose conversion factors. The doses from exposure to external radiation from radionuclide concentrations in air and in water that result from submersion or from exposure to contaminated plane surfaces would be estimated, using the ICRP reference man model and appropriate dosimetry factors. However, for demonstrating compliance with DOE dose limits, external doses may be determined using data from direct measurements with appropriate instrumentation if doses obtained with the direct measurements are found to be at least as accurate as those determined by analytical model evaluations.

Derived concentration guides (DCG). DCG values are presented as reference values in appendix A for each of three exposure modes: inhalation of air containing the radionuclide; submersion in a semi-infinite cloud of air containing the radionuclide; and ingestion of water containing the radionuclide. The DCG tables may be used to evaluate only the three exposure modes upon which they are based.

Other methods and alternatives. Methods and alternatives other than those discussed above and as prescribed in applicable regulations would be submitted to DOE for approval. DOE may approve the alternative method, if appropriate.

Parametric considerations. Dose limits for members of the general public, from routine operation of a DOE activity, would be expressed as a dose received by the individuals during the year (if, for example, the exposure is external to the body) or the committed dose received by the individual over a period of 50 years from radionuclides taken into the body during the year. The limits should not be interpreted as dose

rates per se, especially not in the sense of instantaneous dose rates.

Calculated doses should be as realistic as practicable. Consequently, the individuals subject to the greatest exposure would be identified, to the extent practicable, so that the highest dose might be determined. Dose limits apply to actual or committed doses to real individuals. Consequently, all factors germane to dose determination should be applied. Alternatively, if available data are not sufficient to evaluate these factors, the assumed parametric values would be sufficiently conservative so that it is unlikely that individuals would actually receive a dose that would exceed the dose calculated using the values assumed. Parametric values used in performing dose calculations would be recorded and included with the calculations.

Collective public dose in the environs of a site with multiple emission points may be estimated using the assumption that all emissions occur from a single point centrally located on the site.

The assumption of a single point of emission may be used to calculate public dose for the maximally exposed individuals if the emission points can be combined in accordance with EPA guidance. This assumption may be used provided the procedures do not result in significant underestimates of doses and that the locations of the emission points are close to one another relative to the location of the receptor. Otherwise, the public dose to the maximally exposed individuals should be determined taking into consideration the actual locations of emissions on the site with respect to the offsite locations.

Demonstration of Compliance With the Dose Limits

The proposed rule would require the submission to and the approval by DOE of an Environmental Radiation Protection Plan (ERPP) for a DOE activity. DOE activities will be conducted in compliance with the specifications in these approved site-specific plans. These site-specific specifications will be used to determine when compliance is achieved. Compliance with the dose limits of the proposed, and concentration limits in specific plans, would be demonstrated by documentation of an appropriate combination of measurements and calculations to evaluate potential doses and releases. These data and results of evaluations would be presented in the Annual Environmental Report. The Annual Environmental Report also will contain the status of compliance with other requirements of this rule.

Supplemental documents. The dose conversion factors and derived concentrations needed to make dose evaluations to meet DOE requirements are provided in the proposed rule and in three supplemental documents: EPA-520/1-88-020, Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration Factors for Inhalation, Submersion, and Ingestion;" DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" and DOE/EH-0071, "Internal Dose Conversion Factors for Calculation of Dose to the Public." The dose conversion factors in these documents provide the primary basis for determining compliance with this proposed rule. Compared to previous DOE DCG tables, the table of DCGs in the proposed rule has been expanded considerably to present all classes of uptake and retention.

EPA models. The use of AIRDOS/RADRISK, CAP-88, or AIRDOS-PC models is prescribed by EPA in 40 CFR part 61, subpart H, to evaluate potential doses from airborne releases. In some instances, other models may be deemed more appropriate (e.g., predicts more realistic dose values) for estimating doses from DOE operations. Thus, two evaluations of doses from airborne pathways could be required: One to satisfy 40 CFR part 61 requirements and one for DOE purposes using contemporary dosimetry and site-specific parameters. However, wherever possible, DOE elements should minimize such duplicative analyses. If an alternative model or approach is necessary to develop the required data for demonstrating compliance with 40 CFR part 61, the operator of the DOE facilities should obtain EPA approval for use of the appropriate alternatives.

B. Liquid Waste

General

In addition to the dose limitation system for members of the public established in subpart B of the proposed rule, controls on the release of liquid wastes are imposed in subpart C to reduce the potential for radiological contamination of natural resources such as land, ground and surface water, and ecosystems. The proposed rule would require that the Best Available Technology (BAT) be used for selected liquid waste discharges (§§ 834.201(a)(2) and 834.203(a)(2)).

Section 301(b) of the Clean Water Act (CWA) states * * * for pollutants identified in subparagraphs (C), (D), and (F) of this paragraph effluent limitations for categories and classes of point sources, other than publicly owned treatment works, which shall require application of the best available technology economically achievable (BAT) for such category or class, which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants, as determined in accordance with regulations issued by the Administrator pursuant to section 304(b)(2) of this Act * * *. This statement is the basis for requiring BAT under the CWA. Section 304(b)(2) of the CWA further states that a discharger must identify, in terms of amounts of constituents and chemical, physical, and biological characteristics of pollutants, the degree of effluent reduction attainable through the application of the best control measures and practices achievable including treatment techniques, process and procedure innovations, operating methods, and other alternatives for classes and categories of point sources * * *; and * * * specify factors to be taken into account in determining the best measures and practices available to comply * * * Factors relating to the assessment of best available technology shall take into account the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, non-water quality environmental impact (including energy requirements), and such other factors as the Administrator deems appropriate * * *.

On the basis of section 304 of the CWA, the EPA established regulations (40 CFR part 125) which require the incorporation of Best Available Technology (BAT) control into National Pollutant Discharge Elimination System (NPDES) Permits required for a facility to discharge into public waters.

The NPDES "permitting system," with its requirement of the application of BAT, applies to DOE facilities discharging nonradioactive pollutants or pollutants with a nonradioactive component into public waters. Since DOE has the responsibility for regulating the discharge of radioactive pollutants into public waters, DOE determined that it was appropriate to have an equivalent requirement of the application of BAT to the discharge of radioactive pollutants into public waters.

Additional limitations. To protect aquatic animal organisms, § 834.205 of the proposed rule includes a dose limit of 1 rad/day (0.01 Gray/day), based on recommendations of the NCRP (NCRP Report No. 109, 1991). As an added

protection to ensure that discharges to public waters do not contain insoluble quantities that might settle in sediment in waterways, the proposed rule would require that concentrations of alpha and beta-gamma emitting radionuclides in settleable solids be less than 5 pCi/gram (0.2 Bq/gram) and 50 pCi/gram (2 Bq/gram), respectively (§ 834.201(a)(3) (i) and (ii)). The ALARA provisions of the proposed rule would be applicable to all discharges and concentrations and settleable solids would be as low as is practicable.

Implementation. Standards for liquid effluents are driven by the DOE ALARA policy and the objective to minimize contamination in the environment to the extent practicable. The proposed rule adopts the BAT as the appropriate level of treatment for liquid wastes containing radioactive material and provides that the use of soil columns be phased out at the earliest practicable time (§ 834.202(a)). Technical and economic considerations are included in determining the BAT. Radioactive waste streams that would otherwise contain radionuclide concentrations of more than the derived concentration guide (DCG) reference values at the point of discharge to a surface waterway are required to implement BAT treatment to further reduce the concentration. BAT treatment also may be required for waste streams with concentrations of radionuclides that are less than the DCGs, if they do not conform to other requirements of the proposed rule. BAT treatment is provided to protect ground water and to prevent radionuclide buildup in soil. DCG values in Appendix A of the proposed rule are not necessarily considered "acceptable" discharge limits. They are provided for the purposes of addressing the need to conduct BAT analyses and to aid in performing dose estimates. The ALARA provisions of this proposed rule are applicable to all liquid discharges containing radioactive material derived from DOE operations, including those that are less than the DCG values and meet BAT requirements.

The operating organization subject to the rule will submit to DOE for approval, within 90 days of the effective date of this rule, a plan and schedule to install waste treatment systems in existing facilities, if justified by a BAT analysis, to permit compliance at the earliest practicable time. The plan will include an ALARA section on tritium, if that isotope is a component of the effluent stream. DOE may make modifications of the proposed BAT plan and schedule or may direct the operating organization to make such modifications, or appropriate, updates. BAT plans will be incorporated into the Environmental Radiological Protection Program (ERPP) (see § 834.401). If the operation of the facility:

(1) Exceeds the reporting requirements specified in § 834.201(2) (e.g., doses to the public exceed 10 mrem (0.1 mSv)/year) and the water pathway is a significant contributor to that dose; or

(2) Does not conform to the ground-water protection requirements in § 834.210, BAT analyses would be conducted.

DCGs are used only as screening values (not discharge limits) for considering BAT requirements for these discharges. In all cases, the ALARA provisions of this part are applicable to all discharges and potential doses to the public.

Phaseout of soil columns. The use of soil columns to retain, by sorption or ion exchange, suspended or dissolved radionuclides from liquid waste streams would be discontinued in favor of an acceptable alternative disposal means (§ 834.202(a)). DOE activities that currently discharge liquids containing radioactive materials to soil columns, would have or develop a DOE approved plan and schedule for implementing acceptable alternate disposal to allow phase out of the soil columns. Interim strategies that include continued use of soil columns may be approved by DOE if alternatives to the use of soil columns would, on balance, be detrimental to the environment or the health and safety of the public. The BAT selection process would be applied to all those processes that will continue, as an interim control measure, to discharged liquid wastes containing process-derived radionuclides to soil columns for indefinite periods. These requirements are intended to prevent the buildup of contamination in soils and ground water and to protect the environment from the spread of contamination from burial trenches and pits.

New or increased discharges of radionuclides in liquid waste to inactive receptors would not be permitted. Contaminated soil columns, drainage systems, and ground water to which contaminated liquid discharges have been discontinued would be managed or decontaminated in accordance with the requirements in the proposed rule and other applicable regulations. Liquid discharges, even though uncontaminated, are prohibited in inactive release areas to prevent the further spread of radionuclides previously deposited.

Tritium. There is no practicable control technology available for removing tritium from dilute liquid waste streams. Therefore this proposed rule does not require that BAT be applied to the control of tritium in liquid effluents. Rather, process alternatives that reduce the amount of tritium entering the liquid waste streams would be identified and evaluated in accordance with the DOE ALARA policy (§ 834.215). Tritium decay in transit in confined ground water may be an acceptable alternative to direct release to the atmosphere or to surface waters. The proposed rule requires operating organizations, within 180 days of the effective date of the final rule, to develop a description and summary of the alternatives considered in the control of tritium releases and to submit it to DOE for approval. The plan may be incorporated into documentation necessary to fulfill waste management planning requirements for the specific facility (e.g., the Ground-Water Protection Management Plan), and reevaluated annually and updated as necessary.

Discharges to sanitary sewers. Provisions in the proposed rule for regulating the releases of liquid wastes to public sanitary sewer systems (§ 834.203) are designed to be generally consistent with requirements imposed by the NRC on its licensees. The BAT selection process would be implemented to reduce discharge concentrations if liquid wastes discharged from DOE activities into sanitary sewerage contain radionuclides at concentrations which, averaged monthly, would otherwise be greater than five times the DCG values for liquids at the point of discharge. When more than one radionuclide is present, the total ratio (sum of the fractions) of the average concentrations for each radionuclide to its respective DCG value would otherwise exceed five. Neither the DCG concentrations in appendix A nor the above five-times DCG concentration limit noted above are necessarily considered acceptable discharge limits. All discharges would be evaluated in accordance with the ALARA process and meet the other criteria and requirements including those stated below. The proposed rule also would require operators to ensure that the total annual discharge of residual radioactive material associated with DOE operations to the sanitary sewer system will not cause exposures to members of the general public that will result in doses that exceed a small fraction of the basic annual dose limit (§ 834.203(a)(4)). Further, the total quantity of radionuclides which may be released in a year to a public sewer system, from a DOE activity, is limited

to 5 Ci (185 GBq) of tritium, 1 Ci (37 GBq) of carbon-14, and 1 Ci (37 GBq) of all other radionuclides (§ 834.203(a)(3)). Discharges to public sewers would be coordinated with the operators of the waste water treatment works.

Discharges of radionuclides to government-owned sewer systems are not subject to the annual quantity limits or the concentration limits which are applicable when the discharge is to a public sewer system, but ALARA considerations still would be required (§ 834.203(b)). Liquid wastes containing concentrations or quantities of radioactive materials that, when averaged monthly, are greater than the limits for discharge into public sewer systems may be discharged into a chemical or sanitary sewerage system (e.g., systems with drain fields excepted) if the system is owned by the Federal Government. However, ALARA process requirements are applicable. Such a sewerage system would provide liquid waste treatment prior to discharge to surface waters in accordance with the requirements of proposed § 834.201(a). Sludge containing radioactive material from the operation of the government-owned sewerage system would be disposed in accordance with the appropriate requirements for solid waste (§ 834.203(b)(2)).

Demonstration of Compliance—Liquid Waste

The selection of the BAT treatment would be based on a BAT analysis prepared by the site operator. The specific plans and schedules for preparing BAT analyses and submitting them to DOE for approval is required will be documented in the BAT plan. The final analyses would be completed in accordance with the schedule in the BAT plan. To ensure that BAT analyses are of good quality and generally consistent in content, a "Guidance Manual for Implementing BAT Analyses" required under the proposed rule has been prepared and is provided as supplementary guidance. The final BAT analysis and selected BAT alternative would require approval by DOE. The BAT treatment alternative selected as a result of the analyses would be designed and operated in accordance with approved designed specification and plans.

Plans for the phaseout of soil columns would be incorporated into waste management plans for the site, or its equivalent, and would be part of the ERPP. The phaseout should be completed at the earliest practical time, and the schedule would require the approval of Program Offices. Phaseout plans would be included in the waste management plans prepared for the site and would be reviewed and updated annually.

Data would be collected and calculations completed to demonstrate that sites are complying with the dose limit for native aquatic animal organisms. These data would be reported in the site Annual Environmental Reports required by the proposed rule. Similarly, data to demonstrate that the sedimentation concentration limits are being achieved would be reported in the Annual Environmental Reports. It is expected that the quantity of radionuclides and settleable solids in effluent streams at most DOE facilities will be very small. If settleable solids are so low that the levels are below detection, periodic environmental sampling would be conducted to ensure that current operations are not contributing significantly to the buildup of residual radioactive material in sediment.

The Department considers protection of the ground water an important element of environmental protection and radiation protection programs. The proposed rule would require each site to prepare a Ground Water Protection Management Plan (§ 834.401(e)) and to implement ground water protection programs in compliance with these plans. The plans should be consistent with applicable Federal and State requirements and must be approved by DOE.

C. Residual Radioactive Material

Releases and Evaluations

Subpart D of the proposed rule contains DOE requirements for the release of property containing residual radioactive material. The proposed rule includes criteria that property containing residual radioactive material from DOE activities must meet if it is to be released from DOE control. These criteria are consistent with the dose limitation system established in the proposed rule. The criteria require that current and future use of the property be assessed and evaluated; authorized limits be established for release actions or remedial actions; and any releases of property be documented.

ALARA. The proposed rule would require that doses to the public from residual radioactive material must be as low as is reasonably achievable below the primary dose limits. A remedial action goal should be to return the levels of residual radioactive material to near-background levels. The Department realizes that in certain cases this may not be practical or even possible. The proposed rule would require that all releases of property be assessed and the ALARA process applied no matter how small the dose. DOE, as with the general dose limitation system, has established a graded level of control and oversight to ensure that doses to the public are low.

The proposed rule would require that assessments of potential doses associated with releases be specific to the particular release being considered. While the proposed rule is limited to regulation of radionuclides, responsible persons should be aware of coincident non-radioactive contaminants and their possible impacts. When non-radioactive contaminants are present coincident with residual radioactive material, decontamination or remedial measures should be rational and effective considering the hazards of both materials and in compliance with other applicable regulations governing such material.

Limits for Residual Radioactive Material

Authorized limits and, where appropriate, supplemental limits would be required to be developed for the release of property. DOE must review and approve authorized limits before properties with residual radioactive material are released to members of the general public for unrestricted use. Supplemental guidance for derivation and selection of these limits would be provided by DOE. The limits would be selected to ensure that doses to individuals using the property under "actual" and "likely use" scenarios[2] will be well below the primary dose limit specified in proposed 834.101(a)(2) and should be on the order of a few mrem in a year, or less, for continuous exposure. To the extent practicable, property to be released for use where close contact is likely, would have no measurable contamination.

The evaluation also would consider the "worst plausible" use[3] of the property over the long term. Allowable doses for release of the properties calculated under this type of scenarios may be a relatively large fraction of the general dose limit if the probability of

[2] *Actual* and *likely use* scenarios are those that have a fairly high probability of occurring. These represent expected use of the property. As a general guide, it should include scenarios that are plausible, unlikely to substantially underestimate the dose, and have a reasonable chance of occurring within at least the first 50 years. Scenarios that are not expected to occur for at least 100 years after release of the property normally need not be considered as likely use.

[3] The *worst plausible use* represents a scenario that is credible over the long term. The period of assessment may extend beyond several hundred years and the probability of the scenario ever occurring must be considered in the review.

the scenario occurring is relatively low. In cases where the probability of the worst plausible scenario is high and reasonably certain, potential doses associated with the release would be limited to a relatively small fraction of the 100 mrem (1 mSv) in a year dose limit.

Specific assessments would estimate collective dose to the public when such doses are potentially significant. In such situations, collective doses also would be considered under the ALARA process and in the establishment of authorized limits.

Documentation. Persons responsible for the decontamination and release of property with residual radioactive material subject to this proposed rule would ensure that the property to be released has been assessed and potential impacts are appropriately documented. The proposed rule would require evaluation of the historical use of property (including land, structures, equipment and recyclable material) prior to release to determine if it has been subjected to radiological contamination. The required documentation would include a description of the property; a description of the survey characterizing the property and the results, its radiological condition; and the quantity and disposition of the waste resulting from the decontamination effort. The documentation would also include the date of the last radiation survey; the identity of the organization and the individual who performed the monitoring operation; the type and identification number of monitoring instruments; the results of the monitoring operation; and the identity of the recipient of the released property. Documentation would be submitted to DOE for review and approval. DOE would ensure that information regarding the release of property is made available to interested parties and archived, as appropriate. Copies of these records would be made available for public review and would be archived in accordance with applicable records management directives.

Surface and volume activity in property. Specific requirements for volumes and surfaces (except for soil contamination) are not delineated in the proposed rule. DOE is presently considering in coordination with other agencies, additional requirements and may propose such requirements in the future. However, the requirements in subpart D are applicable to such material.

The proposed rule would require that property, including equipment, structures, and recyclable material contaminated or potentially having contaminated or potentially contaminated surfaces (e.g., radioactivity per unit surface area) or contaminated in depth, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit of mass) be surveyed to characterize the surface or mass concentration of radioactive material present in the material and evaluated in accordance with the ALARA criteria. Such materials may be released only if the authorized limits established for release of the material and survey techniques used to characterize the property are approved by DOE. Non-recyclable materials would be subject to the same requirements; however, development of authorized limits through the ALARA process would consider appropriate pathways based on expected fate of the material. The assessment of individual doses and collective doses would be conducted with appropriate models and dose conversion factors consistent with the requirements of this part and with associated guidance documents.

Soil. Authorized limits for radionuclides in soil will be developed by using survey data to characterize the site, and calculations and models will be used to predict potential doses to the users. Consistent with the general principles provided in proposed subpart D, the concentrations permitted by the authorized limits should ensure that doses to the general public are only a small fraction of the primary dose limit. The Department has developed a model, (the computer code RESRAD), and guidance manual ("A Manual for Implementing Residual Radioactive Material Guidelines," DOE/CH/8901, June 1989), for deriving soil criteria, conducting decontamination efforts, and applying the ALARA process. While other models and approaches are permitted, field elements would identify the differences and rationale for using other approaches in their analyses. The subject model and RESRAD code only consider individual dose; collective dose estimates must be developed using other procedures.

Experience to date indicates that potential doses from release of properties under these criteria, derived authorized limits, and procedures have resulted in low potential doses to the public. Cleanup of 47 properties in New York State by the DOE Formerly Utilized Sites Remedial Action Program (FUSRAP) has been reviewed. The procedures used in the RESRAD Code and associated implementation manual were employed to derive a soil concentration for depleted uranium that would produce a worst case dose of 100 mrem (1 mSv) in a year. It was estimated that this concentration was approximately 120 pCi (4.4 Bq) of uranium/gram of soil. DOE worked with the State and EPA and determined, on the basis of ALARA, that an acceptable authorized limit would be:

(1) Average soil concentrations over any 10 meter by 10 meter area should not exceed 35 pCi (1.3 Bq) of depleted uranium/g of soil; and

(2) 100 pCi/g (4 Bq/g) should not be exceeded over any 1 square meter area.

The cleanup of 47 properties accomplished under this standard were evaluated. The average maximum potential dose from post-remedial action use of the subject properties was less than 1 mrem (0.01 mSv) per year (less than 0.3% of the typical background dose received by someone living in the United States).

The proposed rule would adopt the soil criteria for radium which is provided in 40 CFR part 192 as limits for remedial actions at properties having soil contaminated with these materials. The 40 CFR part 192 standards were derived for the cleanup of properties in the vicinity of uranium mill tailings piles; EPA developed them consistent with the ALARA process. Therefore, when they are applied to the cleanup of uranium mill tailing sites, the requirement for applying the ALARA process during planning or development of the authorized limit already has been achieved. The ALARA process has many site-specific elements, so when these limits are applied to other uses, the ALARA process must be considered in the establishment of the authorized limits and during the implementation of the action. The Department considered requiring the derivation of soil limits for residual radium or thorium consistent with the process required for all other radionuclides, but opted to be consistent with the EPA guidelines and require an additional measure of protection by making the ALARA process applicable. DOE is requesting comments on the continued use of the concentration limits in 40 CFR part 192 with the added requirement for the ALARA process. Field verification of radon emanation rates would be in accordance with the requirements of 40 CFR part 61.

Indoor radon-222. The proposed rule would require that the objective of remedial actions conducted on any occupied or habitable structures would be to make a reasonable effort to reduce residual radioactive material levels such that an annual average (or equivalent) radon decay product concentration would not exceed 0.02 WL, including

background, in the structure. In any case, the radon decay product concentration would not exceed 0.03 WL, including background, in such structures as a result of residual radioactive material.

The requirements of proposed subpart D apply to both DOE-owned facilities and to private properties that are being prepared by DOE for release. Real properties owned by DOE are subject to the requirements of section 120(h) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended, concerning hazardous substances, and to any other applicable Federal, State, and local requirements. The requirements of 40 CFR part 192 are applicable to properties remediated by DOE under Title I of the Uranium Mill Tailings Radiation Control Act (UMTRA).

Specific Numerical Limits for Surface Activity

Both DOE 5400.5, February 8, 1990, and the "DOE Guidelines for Residual Radioactive Material," March 1987, utilized the values listed in Table 2 of this preamble for maximum contamination levels permitted for release of property having residual radioactive material on its surface. The values were used as "upper limit" standards for the unrestricted release of structures, equipment, personal property and recyclable material. These values were selected to be consistent with the requirements of the NRC guidance in its publications "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material," July 1982, and with NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," June 1974. In addition to the requirements to meet these maximum contamination levels, the DOE guidance required that the ALARA process be used to bring the concentrations as far below these levels as is practical.

The Department has not included the values in Table 2 in this proposed rule. DOE and other Federal agencies are presently investigating alternatives to Table 2. The Department believes that potential doses associated with release of material at these levels are low, as are assumed risks, especially when the ALARA process is applied in addition to the contamination limits, as DOE has required in its existing Order, DOE 5400.5. However, the values in Table 2 are not internally consistent. They provide levels of protection that vary by orders of magnitude even among radionuclides in a category. Consequently, DOE is seeking comments on the continued use of the values in this table or alternative approaches. The Department, with NRC and EPA, is investigating risk-based approaches to surface contamination limits. The approach in the proposed rule would require the derivation of authorized limits for the release of property that will ensure potential doses to users of the property are low. If risk-based levels are established, should the limits be provided by radionuclide or in categories such as those provided in Table 2? Should separate limits be provided for removable and fixed contamination? What time periods are appropriate for assessing impacts for exposures associated with contaminated building or equipment surfaces?

DOE is seeking comments on mass contamination limits for structures, equipment, and recyclable material. The current DOE requirements and the proposed rule would require reviews of the action, including application of the ALARA process to establish authorized limits for release. DOE is requesting comments on the following: Should DOE establish tables of maximum concentrations (i.e., upper limits) that must not be exceeded or generic release limits that could apply to all sites? Or should the final rule and DOE guidance provide requirements, including scenarios, and parameters that each facility must use to derive authorized limits similar to what is provided in the proposed rule for soil contamination?

The proposed rule would require that all sub-surface contamination, such as contamination in depth (i.e., mass contamination), be assessed and authorized limits be determined, consistent with the principles set forth in proposed subpart D. Comments are requested on the DOE policy, in general, on the release for unrestricted use of personal property containing residual radioactive material (e.g., office furniture, tools, and other reusable items).

Supplemental Limits

Unrestricted use. If special specific property circumstances indicate that the criteria in proposed § 834.305 or authorized limits established for a given property are not appropriate for any portion of that property, then a request may be made to apply supplemental limits. Any supplemental limits would achieve the criteria set forth in proposed § 834.301 for both current and potential unrestricted uses of a property. Supplemental limits may be applied to any portion of a property if, on the basis of a specific property analysis, it is demonstrated that certain aspects of the property were not considered in the development of the established authorized limits for the entire property; and as a result, the established limits either do not provide adequate protection or are unnecessarily restrictive and costly.

The responsible operating organization would document the decision that the subject guidelines or authorized limits are not appropriate and that the alternative action selected will provide adequate protection and allow unrestricted use of the site giving due consideration to health and safety, the environment, costs, and public policy considerations. Prior to release, the approval for specific supplemental limits would be obtained from DOE as specified in proposed § 834.310. The request for supplemental limits must be accompanied by those materials required for the justification as specified in this section. DOE also would be responsible for coordination with the State and local government regarding the limits or exceptions and associated restrictions as appropriate.

Restricted use. Supplemental limits with restrictions on the use may be applied to any portion of the property when it is established that the authorized limits cannot reasonably be achieved and that restrictions on use of the property are necessary. It would be demonstrated that the supplemental limit is justified and that the restrictions will protect members of the public within the basic dose limits of the proposed rule and will comply with the requirements for control of residual radioactive material. Such supplemental limits must be approved by DOE prior to release. The operator and DOE would be responsible for implementing the administrative controls and the cognizant Federal, State, or local authorities should be responsible for enforcing them. The administrative controls include, but are not limited to, periodic monitoring as appropriate; appropriate shielding; physical barriers to prevent access; and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.

Justification for Supplemental Limits

Documentation of need. The proposed rule would permit the use of supplemental limits when the specific criteria specified in § 834.310 are met. The need for supplemental limits would be documented by the contractor on a case-by-case basis using specific property data. Every reasonable effort

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would be made to minimize the use of supplemental limits.

Reporting Level

Approval of authorized limits, survey procedures, certification of radiological condition of released property and oversight of the ALARA process are the responsibility of DOE. DOE, through its audit program, will overview all of these activities. The proposed rule would require notification to DOE if any authorized limits will potentially cause an EDE to exceed 10 mrem (0.1 mSv) in a year or collective dose to exceed 100 person-rem (1 person Sv) in a year. These values represent neither acceptable nor unacceptable doses. They are simply reporting limits that will help DOE concentrate its regulatory and oversight resources on activities of interest, and respond in a timely manner.

Control of Residual Radioactive Material

Property containing residual radioactive material not releasable and residues resulting from the decontamination of property would be managed in accordance with proposed subpart D and with appropriate DOE waste management regulation and directives. Additional requirements for disposal and storage of remedial action residues, primarily those where radium-226 and its decay products represent the significant mode of exposure of the public, are provided below. The disposition of residues from remedial actions associated with inactive uranium mill tailings sites implemented by DOE under Public Law 95–604 is subject to the requirements of 40 CFR part 192. The requirements in § 834.411 are included in the proposed rule to ensure that management of similar materials not subject to 40 CFR part 192 provide equal or greater levels of protection. They include requirements for interim storage, interim management and disposal of such materials.

Storage and disposal of residual radioactive material. Wastes resulting from decontamination projects or containing residual radioactive material may be disposed or stored at existing DOE waste disposal and storage facilities. These facilities are regulated under specific DOE requirements and, in some cases, by EPA or NRC regulations. If residual radioactive material from activities governed by this proposed rule is disposed or stored at such facilities, it will be regulated under the requirements of regulations applicable to the sites and any applicable section of this proposed rule.

The proposed rule includes specific requirements for storage and disposal of radium and thorium residues from decontamination and remedial actions. These requirements are consistent with requirements in 40 CFR part 192 for the management of radium residues from remedial actions at uranium mill tailings sites. In addition to the radon flux limits contained in 40 CFR part 192 and subpart Q of 40 CFR part 61, this proposed rule includes radon concentration limits. These limits are provided to be consistent with past practices of the Department in regulating radon exposures and to provide further assurance that doses associated with radon releases will be minimized. The proposed rule provides requirements for assessing potential effects over the long term (greater than 1,000 years) and to provide special protection against intrusion for residues with unusually high concentrations of radium. Reviewers are requested to comment on the need for such additional limits considering that EPA has reviewed radon-220 emissions from DOE storage and disposal sites under the Clean Air Act (CAA) and has determined that a flux rate of 20 pCi (0.7 Bq)m^{2}sec provides adequate protection with an ample margin of safety.

D. Environmental Radiological Protection Program

All DOE activities would be managed in accordance with an Environmental Radiological Protection Program (ERPP) for the operation. An ERPP would be comprised of the plans, programs, and other procedures or processes by which the DOE activity will protect the general public and the environment. An ERPP would include:

a. ALARA Program;
b. BAT Plan;
c. Ground-Water Protection Management Plan;
d. Environmental Monitoring Plan, including:
(1) Effluent monitoring;
(2) Environmental surveillance;
(3) Meteorological data; and
(4) Preoperational study;
e. Waste Plan; and
f. Quality Assurance Program.

An ERPP would be submitted to DOE for review and approval within 90 days of the effective date of the final rule and updated annually or sooner if there is a change in the activity or operation. The rule would require that the submitted ERPP be approved, revised, or rejected by DOE within 180 days of the effective date of the final rule.

ALARA program. An ALARA program would address the potential radiological impact of the operation on the public and the environment and be approved by DOE. The approved program would include requirements for contractors or DOE personnel to implement the ALARA process for all DOE activities and facilities that cause public doses and releases to the environment. An ALARA program would include requirements for documenting ALARA decisions as well as implementing the ALARA process. ALARA requirements in the proposed rule are for protection of the public and environment; application of the ALARA process for the limitation of occupational exposures at DOE operations are addressed in proposed 10 CFR part 835 (56 FR 64334).

In addition to the considerations discussed below, the ALARA process and associated decisions conducted for the protection of the public and environment should consider the impact on workers. It is not appropriate to ignore large increases in occupational doses in order to achieve small potential reductions in public exposures and visa versa. Both individual exposures and collective exposures over time must be considered. A quantitative cost-benefit analysis (e.g., optimization) could be performed, given the results of the considerations required by the proposed rule. However, the parameters needed to evaluate the cost-benefit analyses are difficult to quantify, and evaluations themselves can be expensive. Furthermore, the evaluations include many additional assumptions, judgments, and limitations that are often difficult to reflect as uncertainties in the analyses. Therefore, considering that most analyses for DOE operations that evaluate potential exposures of the public involve low radiation dose increments (i.e., levels that represent a small fraction of the dose limits and assumed small fraction of acceptable risks), qualitative and semi-quantitative analyses are often acceptable bases for ALARA judgments. The bases for such judgments would be documented in accordance with the requirements of the approved ALARA program. More detailed analyses should be considered if the decisions might result in doses that approach or are a significant fraction of the dose limit. Quantitative analyses also may be necessary if other regulations or statutes, such as the National Environmental Policy Act, require them.

An ERPP would be required to contain an ALARA Program to control releases of radioactive materials and exposures to radiation at levels as low as is reasonably achievable. The extent of the ALARA efforts and evaluations should reflect the magnitude of the potential doses to the maximum dose exposed individual member of the

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public and the collective dose to all persons within 50 miles of the site of the DOE activity. An ALARA Program would include, as appropriate:

(1) A statement of commitment to use the ALARA process;

(2) A description of the means to be used to implement the ALARA process;

(3) A process for documenting ALARA decisions;

(4) A training program for the staff on implementation of the ALARA process; and

(5) A listing and evaluation of specific factors considered in arriving at ALARA position, including, as appropriate:

(i) The maximum dose to members of the public;

(ii) The collective dose to the population;

(iii) Applicable alternative processes, such as alternative treatments of discharge streams, operating methods, or controls;

(iv) Doses for each alternative evaluated;

(v) Cost for each of the alternatives evaluated;

(vi) An examination of the changes in cost among alternatives; and

(vi) Changes in societal impact associated with process alternatives, e.g., differential doses from various pathways of exposure.

Interim guidance "DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5" was distributed March 8, 1990. The interim guidance is equally applicable for the proposed rule to assist those who must prepare an ALARA Program. The guidance suggests a step-by-step logical procedure to arrive at ALARA judgments.

BAT plan. An ERPP would contain a BAT Plan for those activities conducted at a site for which the proposed rule requires a determination whether to use the BAT for processing liquid waste. A BAT Plan would:

(1) Document the analysis of whether the BAT is required and, if required,

(2) Document the BAT results of (or schedule for) the selection process; and

(3) (Where selected) set forth the schedule for installing the BAT.

BAT selection. Selection of the BAT for a specific application will be made from among candidate alternative treatment technologies which are identified by an evaluation process that includes factors related to technology, economics, and public policy considerations. Factors that are to be considered in selecting BAT, at a minimum, will include: The age of equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; the cost of achieving such effluent reduction; non-water quality environmental impact (including energy requirements); safety considerations; and policy considerations. BAT analyses are difficult to express quantitatively because the factors do not have a common denominator. However, consideration of these factors should permit qualitative evaluations which will support judgments. A report "Best Available Technology (BAT) Guidance Manual, Application of BAT for Liquid Effluent Releases at Department of Energy Facilities," is being drafted and will be available for those who are responsible for making BAT decisions.

Ground-water protection management plan. Each DOE operation would implement a ground-water protection program and would describe the program in a Ground-water Protection Management Plan. This proposed rule would require Ground Water Protection Management Program to be developed and implemented. While the requirements of this proposed rule are generally limited to the control, measurement, and evaluation of radionuclides and radioactive material, it is not appropriate or effective to separate radiological and non-radiological elements of the management programs for ground water protection. Therefore, to the extent possible, the Ground Water Protection Management Plan should address both. However, only the radiation-related portion of the plan is subject to this proposed rule. Each plan would be reviewed and approved by DOE. The plan must consider relevant Federal and State requirements and must include a monitoring program to characterize ground water at DOE sites. The proposed rule would require that the ERPP contain a Ground-Water Protection Management Plan that would:

(1) Address the potential for radiological and, where appropriate, non-radiological contamination of the ground water by a DOE activity;

(2) Document the quality and quantity of ground water;

(3) Identify possible sources of contamination;

(4) Describe strategies for controlling contamination, including preventive and remediation measures to comply with applicable Federal environmental laws and regulations: and

(5) Describe measures for monitoring the ground-water.

Environmental monitoring plan (EMP). Demonstrations of compliance with requirements of this proposed rule generally will be based upon calculations that make use of information obtained from monitoring and surveillance programs. Subpart E of the proposed rule delineates the requirements of the EMP. The abilities to detect, quantify, and adequately respond to unplanned releases of radioactive material to the environment also rely on in-place effluent monitoring, monitoring of environmental transport and dispersal conditions, and assessment capabilities. This will enable DOE to develop useful data and to collect and analyze pertinent information on unplanned releases in a timely manner. It is the intent of DOE that the monitoring and surveillance programs for the DOE activities, facilities, and locations be of high quality. Although some differences result from specific site or specific activity conditions, uniformity in the methods and performance criteria used to obtain the information will be achieved to the extent practicable.

To ensure that the effluent monitoring and environmental surveillance programs are of good quality at all DOE facilities and sites, requirements and recommendations are provided in the proposed rule and in supplemental guidance for implementation of effluent and environmental monitoring programs. The ERPP would be required to contain an EMP that provides for effluent monitoring to obtain representative measurements of the quantities and concentrations of pollutants in liquid and airborne discharges and environmental surveillance to monitor the effects, if any, of a DOE activity on members of the public, the environment and natural resources.

An EMP would be required to set forth:

(1) The elements of the plan to determine compliance with the requirements of the proposed rule and other applicable Federal environmental laws and regulations;

(2) The rationale and design criteria for each element;

(3) The extent and frequency of monitoring and measurements;

(4) Procedures for laboratory analyses;

(5) Implementation procedures;

(6) Meteorological data; and

(7) For a new facility or new activity at an existing facility, a preoperational study.

Effluent monitoring, in an ERPP, would be required to:

(1) Measure quantities and concentrations of pollutants in liquid and airborne discharges from a DOE activity;

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(2) Collect samples in a manner and frequency sufficient to characterize the effluent streams from a DOE activity; and

(3) Analyze samples to the extent necessary.

Environmental surveillance, in an ERPP, would be required to:

(1) Establish background levels of pollutants;

(2) Determine the location and magnitude of concentrations of pollutants from a DOE activity;

(3) Evaluate the effects on the public and the environment of pollutants from a DOE activity;

(4) Utilize monitoring stations on the basis of the type of emission, meteorology, climatology, topography, geography, population distribution, land use, and other relevant considerations;

(5) Collect and analyze samples in a manner and frequency sufficient to characterize the emissions from a DOE activity and their effects; and

(6) Verify whether any unexpected or undetected releases occur.

Meteorological data, collected in accordance with an EMP, would be required to:

(1) Characterize atmospheric transport and dispersion conditions in the vicinity of a DOE activity;

(2) Describe meteorological conditions including precipitation, temperature, wind speed, wind direction, and atmospheric stability that are important to surveillance; and

(3) Support assessment of routine and non-routine emissions.

Preoperational study. A preoperational study would be required to:

(1) Begin at least one year prior to the start-up of a new activity;

(2) Characterize existing physical, chemical, and biological conditions that could be affected;

(3) Establish background levels of radioactive and, as appropriate, chemical components;

(4) Characterize pertinent environment and ecological parameters; and

(5) Identify potential pathways for human exposure or environmental impact.

Waste plan. An ERPP would be required to contain a Waste Plan to manage, dispose, and store radioactive waste, including low-level waste, high-level waste, transuranic waste, spent nuclear fuel, and residual radioactive material.

A Waste Plan for a DOE activity would be required by the proposed rule to:

(1) Provide for controls to ensure compliance with this part and applicable Federal statutes and regulations;

(2) Describe the means used to limit access to waste;

(3) Describe the interim and long-term strategies for dealing with waste;

(4) Describe the administrative safeguards; and

(5) Describe the mechanism for cooperating with State and local officials.

(6) Describe the process for releasing property contaminated or potentially contaminated with residual radioactive material.

Quality assurance program. An ERPP would be required by the proposed rule to contain a Quality Assurance Program that includes:

(1) Organizational responsibility;

(2) Program design;

(3) Procedures;

(4) Field quality design;

(5) Laboratory quality control;

(6) Human factors;

(7) Recordkeeping;

(8) Chain-of-custody procedures;

(9) Audits;

(10) Performance reporting; and

(11) Independent data verification.

TABLE 1.—DOSE AND CONCENTRATION LIMITS [1] AND REPORTING LEVELS

Reference	Limiting value	Exposure mode	Comment
834.101(b) Primary dose (EDE) limit.	100 mrem in a year	Exposed individual, all sources and pathways.	Excludes background and medical exposures.
834.7 Reporting requirement	10 mrem in a year	Exposed individual, all DOE sources and pathways.	Doses and collective doses exceeding these value must be reported to DOE–EH.
	100 person-rem in a year	All DOE sources, pathways, and exposures to persons within 80-km.	
834.101(b) Temporary exemption, maximum EDE.	500 mrem in a year	Exposed individual, all DOE sources and pathways.	Exemption from primary limit only permitted under special circumstances, justified, and approved by DOE–EH.
834.102(a)(2) Air pathway only EDE limit.	10 mrem in a year	Exposed individual, DOE sources only through air pathway.	Excludes radon.
834.102(a) Radon limits	20 pCi $m^{-2}sec^{-1}$	Average flux rate over area of disposal or storage site.	As an alternative, compliance may be demonstrated by showing EDE ≤10 mrem in a year EDE to the exposed individual.
	3 pCi l^{-1}	Maximum concentration at any point on boundary.	
	0.5 pCi l^{-1}	Average concentration at site boundary or beyond.	
834.103(a) Drinking water EDE limit.	4 mrem in a year	From drinking water at the tap.	
	Ra-226 and Ra-228 5×10^{-9}μCi ml^{-1} and gross alpha, excluding uranium, 1.5×10^{-8}μCi ml^{-1}.		
834.110(a) Waste management EDE limits.	25 mrem in a year	Exposed individual, all pathways associated with waste management.	Radon regulated separately, see 834.102, 834.306, and 834.311.

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TABLE 1.—DOSE AND CONCENTRATION LIMITS[1] AND REPORTING LEVELS—Continued

Reference	Limiting value	Exposure mode	Comment
834.201(a) Liquid waste controls	All discharges controlled by ALARA and if >DCGs, must be reduced by BAT.	Liquid discharges at release point.	
834.201(a)(3) Settleable solids	5 pCi y^{-1} alpha, 50 pCi y^{-1} beta-gamma.	Settleable solids in effluent at discharge point.	
834.203(a) Sanitary sewerage limits.	5xDCG and annual total of 5 Ci H-3, 1 Ci C-14, 1 Ci others combined.	Discharges to sewer	Potential doses must be a small fraction of the primary EDE limit.
834.205 Aquatic animal organisms	1 rad day^{-1}	Limit applies to water on-site as well as water off-site.	

[1] All doses must be as far below the applicable limits as is reasonably achievable.

TABLE 2.—SURFACE CONTAMINATION GUIDELINES

Radionuclides[2]	Allowable total residual surface contamination (dpm/100 cm^2)[1]		
	Average[3 4]	Maximum[4 5]	Removable[4 6]
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	100	300	20
Th-Natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay product, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.[7]	5,000	15,000	1,000

[1] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[2] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[3] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[4] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[5] The maximum contamination level applies to an area of not more than 100 cm^2.

[6] The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area, should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[7] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

III. Procedural Requirements

A. Review Under Executive Order 12291

Executive Order 12291, entitled "Federal Regulation," requires that rules be reviewed to determine whether they are "major rules." DOE has determined that this notice does not involve a major rule and does not require a Regulatory Impact Analysis statement because its promulgation will not result in:

(1) An annual effect on the economy of $100 million or more;

(2) A major increase in the costs or prices for consumers, individual industries, Federal, State, or local government agencies or geographic regions; or

(3) A significant, adverse effect on competition, employment, investment, productivity, innovation, or ability of U.S.-based enterprises to compete in domestic or export markets.

Although not a major rule, DOE has considered the benefits and costs associated with the proposed rule. The proposed rule provides a base for the establishment of radiation protection programs for the public and the environment. The proposed rule is a regulatory base upon which DOE will build a program of compliance, inspection, and enforcement. DOE believes it will greatly enhance the Department's ability to carry out the mandate of the Price-Anderson Ammendments Act of 1988 (PAAA) and the Atomic Energy Act of 1954 (AEA), as amended. It will provide a set of requirements that have been promulgated by law, thereby permitting enforcement under Federal statutes.

Most of the requirements contained in this proposed rule are the same as those contained in Department Orders, including DOE 5400.5 and DOE 5400.1, which were issued February 1990 and November 1988, respectively. Contractors already are required to comply with most of the requirements of this proposed rule under those Orders. Therefore, compliance with the proposed rule is not expected to have any significant incremental cost over current costs.

The promulgation of the proposed rule does have implicit additional costs for the establishment of a radiation protection enforcement program. It is expected that costs, as associated with this proposed rule, will represent only marginal additional overall cost to the current oversight and inspection programs.

The Department was unable to arrive at any alternatives to this action that could achieve the same regulatory goal at lower cost. Therefore, no alternatives were considered.

Pursuant to section 3(c) of E.O. 12291, this rule was submitted to the Director of the Office of Management and Budget. The Director has concluded his review under that Executive Order.

B. Review Under the Regulatory Flexibility Act

This proposed rule was reviewed under the "Regulatory Flexibility Act of 1980," Public Law 96-354, which

requires a regulatory flexibility analysis for any rule that is likely to have significant economic impact on a substantial number of small entities. DOE certifies that this proposed rule will not have a significant economic impact on a substantial number of small entities. Therefore, no analysis has been prepared.

C. Review Under the Paperwork Reduction Act

The proposed information and reporting requirements in part 834 are not substantially different from existing reporting requirements contained in DOE directives and required by DOE contracts with prime contractors covered by this proposed rule. DOE will submit the collection of any new information requests concerning the proposed rule to the Office of Management and Budget for approval in accordance with the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 *et seq.*, and the procedures implementing that Act, 5 CFR part 1320 *et seq.*

D. Review Under the National Environmental Policy Act

The DOE has reviewed the promulgation of 10 CFR part 384 under the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*) and the Council on Environmental Quality regulations for implementing NEPA. The Department has completed an Environmental Assessment and, on the basis of that information, has made a finding of no significant impact for this proposed rule. Copies of the Environmental Assessment are available for review at the DOE Freedom of Information Reading Room, the location of which is given in the ADDRESSES section of this notice. Comments on this finding of no significant impact should be provided to DOE at the address above.

E. Review Under Executive Order 12612

Executive Order 12612, 52 FR 41685 (October 30, 1987) requires that regulations, rules, legislation, and any other policy actions be reviewed for any substantial direct effects on States, on the relationship between the Federal government and the States, or in the distribution of power and responsibilities among the various levels of government. If there are any substantial direct effects, then the Executive Order requires the preparation of a federalism assessment. This proposed rule, when promulgated, will not have a substantial direct effect on the institutional interests or traditional functions of States.

IV. Public Comment Procedures

A. Written Comments

Interested persons are invited to participate by submitting data, views, or arguments with respect to all or any portion of this proposed rule. Ten copies of written comments should be submitted to the address indicated in the "ADDRESSES" section of this notice. All public comments received will be available for inspection in the DOE Freedom of Information Reading Room, room 1E-190, 1000 Independence Avenue SW., Washington, DC 20585, between the hours of 9 a.m. and 4 p.m., Monday through Friday, except on Federal holidays. All written comments received by June 22, 1993 will be considered prior to publication of the final rule. Any information considered to be confidential must be so identified and submitted in writing, one copy only. DOE reserves the right to determine the confidential status of the information and to treat it according to its determination.

DOE is interested in comments concerning the potential costs and benefits of this regulation, either to the general public, DOE contractors, or DOE. DOE is particularly interested in comments that discuss whether or not DOE may be subjecting its contractors to additional costs that are not contemplated by existing contractual relations or the PAAA. Comments concerning this subject should address the specific nature and scope of additional costs to which contractors will be subjected and explain why these concerns are not already addressed in the current contractual relationship or PAAA. Furthermore, DOE is interested in any comments which address the overall cost-effectiveness of the measures mandated in this proposal.

B. Public Hearing

1. Requests to speak at the hearing (May 13, 1993) must be submitted to the address or phone number indicated in the ADDRESSES section of this notice and received by DOE by May 10, 1993. Requests for oral presentations should contain a telephone number where the requestor may be contacted prior to the hearing. Speakers are requested to bring 10 copies of their statement to the DOE hearing.

2. Oral comments presented at the hearing will be limited to 10 minutes. A longer statement may be submitted for inclusion in the record. To the extent practicable, an oral presentation should summarize the views anticipated to be set forth in the written comments on the proposed rule and, in particular, should indicate what, if any, changes should be made in the proposed rule.

3. Conduct of the hearing. DOE reserves the right to select the persons to be heard at the hearing (in the event there are more requests to be heard than time allows), to schedule their respective presentations, and to establish the procedures governing the conduct of the hearing. The length of each presentation is limited to 10 minutes. The hearing begins at 9 a.m.

A DOE official will be designated to preside at the hearing. This will not be a judicial-type hearing. Questions may be asked only by those conducting the hearing.

Any additional procedural rules will be announced at the hearing. The entire record of the rulemaking, including the transcript, will be retained by DOE and made available for inspection in the DOE Freedom of Information Reading Room, 1E-190, 1000 Independence Avenue SW., Washington, DC 20585, between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Transcripts may be purchased from the court reporter.

List of Subjects in 10 CFR Part 834

Radiation protection, Nuclear safety, Health and safety, Radioactive material, Reporting and recordkeeping requirements.

For the reasons set forth in the preamble, title 10, chapter III, of the Code of Federal Regulations is proposed to be amended by adding a new part 834 as set forth below.

Issued in Washington, DC, on March 10, 1993.

Peter N. Brush,

Acting Assistant Secretary, Environment, Safety, and Health.

PART 834—RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT

Subpart A—General Provisions

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834.302 Authorized limits.
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834.310 Supplemental limits.
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Subpart E—Environmental Radiological Protection Program

834.401 Composition of the Environmental Radiological Protection Program (ERPP).

Appendix A to Part 834—Derived Concentration Guides for Air and Water

Table A–1a Derived Concentration Guides (DCGs) for Members of the Public from Ingested Water and Inhalation Resulting in an EDE of 100 mrem/yr. [μCi]
Table A–1b Derived Concentration Guides (DCGs) for Members of the Public from Ingested Water and Inhalation Resulting in an EDE of 1 mSv/yr. [Bq]
Table A–2 Alternative Absorption Factors and Lung Retention Classes for Specific Compounds.
Table A–3 Derived Concentration Guides (DCGs) for Members of the Public for External Exposure During Immersion in an Infinite Hemispherical Cloud of uniform Concentration Resulting in an EDE of 100 mrem/yr. [Ci and Bq]

Authority: 42 U.S.C. 2201, 7191.

Subpart A—General Provisions

§ 834.1 Scope.

(a) *General.* The requirements in this part govern activities conducted by, or for, DOE that might result in the release of radioactive material, the exposure of members of the public to radiation, or contamination of the environment with radionuclides from DOE activities.

(b) *Exclusions.* The requirements in this part do not apply to:

(1) Activities that are regulated through a license by the U.S. Nuclear Regulatory Commission (NRC), or by a State under an Agreement with the NRC; or

(2) Activities conducted under the authority of the Director, Office of Naval Reactors, as described in Public Law 98–525.

§ 834.2 Definitions.

(a) As used in this part:

Act means the Atomic Energy Act, as amended.

ALARA means "As Low As is Reasonably Achievable" which is an approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public, and releases of radioactive material to the environment at levels as low as is practicable, taking into account social, technical, economic, practical, and public policy considerations. As used in this part, ALARA is not a dose limit, but rather a process which has the objective of attaining doses as far below the applicable limit of this part as is reasonably achievable.

ALARA Process means a logical procedure for evaluating alternative operations, processes, and other measures, taking into account factors that relate to societal, technological, economic, practical, and public policy considerations in order to make a judgment with respect to what constitutes ALARA.

Background means:

(1) Naturally occurring radioactive materials;

(2) Cosmic and natural terrestrial radiation;

(3) Global fallout;

(4) Radon in concentrations or levels commonly found in buildings or the environment, independent of regulated activities; and

(5) Radiation from consumer products containing nominal amounts of radioactive material.

Best Available Technology (BAT) means the preferred technology for a particular activity, selected from among others after taking into account factors related to technology, economics, public policy, and other parameters. As used in this part, the BAT is not a specific level of treatment, but is the conclusion of a selection process that includes several alternatives.

BAT Selection Process means the evaluation of candidate alternative technologies in order to select the BAT after considering: technology; economics; the age of equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; other quality environmental impact (including energy requirements); safety considerations; and policy considerations.

Derived Concentration Guide (DCG) means the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem, 0.1 rem (1 mSv) to reference man. DCGs do not consider decay products when the parent radionuclide is the cause of the exposure.

DOE Activity means an activity taken for, or by, DOE that has the potential to release radioactive material to the environment and result in the exposure of members of the public or the environment to radiation or radioactive material. The activity may be, but is not limited to, design, construction, operation, or decommissioning. To the extent appropriate, the activity may involve a single DOE facility, or a combination of facilities and operations, possibly including an entire site.

Effluent Monitoring means the collection and analysis of samples or measurements of liquid and gaseous effluent for purposes of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.

Environmental Surveillance means the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures to members of the public, and assessing effects, if any, on the local environment.

Members of the Public means persons who are not occupationally associated with a DOE activity.

Nonstochastic (or deterministic) Effects means biological effects, the severity of which, in affected

individuals, varies with the magnitude of the dose above a threshold value.

Person means any individual; corporation; partnership; firm; association; trust; estate; public or private institution; group; Government Agency; any State or political subdivision of, or any political entity within a State; any foreign government or nation or other entity and any legal successor, representative, agent or agency of the foregoing; provided that person does not include the Department of Energy.

Protective Action Guides (PAG) means projected numerical dose values established by EPA, DOE, or States for individuals in the population. These values may trigger protective actions that would reduce or avoid the projected dose.

Radioactivity means the property or characteristic of radioactive material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

Reference Man means a hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus (ICRP Publication 23). These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult from ionizing radiation to a common base. The "reference man" is assumed to inhale 8400 cubic meters of air in a year and to ingest 730 liters of water in a year for the derivation of DCGs.

Remedial Action means those actions consistent with a permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances.

Residual Radioactive Material means any radioactive material which is in or on soil, air, water, equipment, or structures as a consequence of past operations or activities.

Settleable Solids means those solids suspended in waste water that are determined to be settleable using standard methods for examination of water and waste water.

Sewage means waste matter that passes through sewers.

Sewer means an artificial conduit, usually underground, for carrying off waste water and refuse.

Sewerage means a system of sewers.

Soil Column means an in situ volume of soil down through which liquid wastes percolate from ponds, cribs, seepage basins, or trenches.

Stochastic Effects means biological effects, the probability, rather than the severity, of which is a function of the magnitude of the radiation dose without threshold; i.e., stochastic effects are random in nature.

(b) As used in this part to describe various aspects of radiation dose:

Absorbed Dose means the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray). (1 rad=0.01 gray.)

Collective Dose Equivalent and Collective Effective Dose Equivalent mean the sums of the dose equivalents or effective dose equivalents of all individuals in a specified population. Collective dose equivalent and collective effective dose equivalent are expressed in units of person-rem (or person-sievert). For purposes of this part, the collective dose equivalent and collective effective dose equivalent refer to the population within 50 miles (80 km) of the site boundary.

Committed Dose Equivalent means the predicted dose equivalent to a tissue or organ over a 50-year period after an intake of a radionuclide into the body. It does not include dose contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert). (1 rem=0.01 Sv.)

Committed Effective Dose Equivalent means the sum of the committed dose equivalents to various organs or tissues in the body from an intake of a radionuclide into the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).

Deep Dose Equivalent means the dose equivalent at a depth of 1 cm, in tissue, from external exposure.

Dose Equivalent means the product of absorbed dose in rad (or gray) in tissue, a quality factor, and all other modifying factors at the location of interest. Dose equivalent is expressed in units of rem (or sievert).

Effective Dose Equivalent (EDE) means the sum of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. The total EDE is the sum of the EDE (or deep dose equivalent, if dosimeter data are used) from exposures to radiation sources external to the body during the year plus the committed EDE from radionuclides taken into the body during the year. For purposes of this rule, a 50-year time interval may be assumed for determining committed dose. Effective dose equivalent is expressed in units of rem (or sievert).

Public Dose means the dose received by member(s) of the public from exposure to radiation and to radioactive material released by a DOE facility or operation, whether the exposure is within a DOE site boundary or offsite. It does not include doses received from occupational exposures, doses received from "background" radiation, doses received as a patient from medical practices, or doses received from consumer products.

Quality Factor means the principal modifying factor used to calculate the dose equivalent from the absorbed dose (the absorbed dose is multiplied by the appropriate quality factor). Typical quality factors for various types of radiation are:

Radiation type	Quality factor
X-rays, gamma rays, beta particles, positrons, and electrons (including tritium)	1
Neutrons, <10 keV	3
Neutrons, >10 keV	10
Protons and other single-charged particles of unknown energy with rest-mass > one atomic mass unit	10
Alpha particles and other multiple-charged particles (and particles of unknown charge) of unknown energy	20

Weighting Factor means tissue-specific factor representing the fraction of the total health risk resulting from uniform, whole-body irradiation attributable to that particular tissue. Weighting factors are given below by organ or tissue type:

Organ or tissue	Weighting factor
Gonads	0.25
Breasts	0.15
Red Bone Marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder [1]	0.30

[1] "Remainder" means the five other organs with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, or upper and lower large intestine, but excluding skin, lens of the eye, and extremities). The weighting factor for each of these organs is 0.06. A weighting factor of 0.01 shall be used for skin.

Working Level (WL) means the potential alpha energy concentrations of radon decay products in 1 liter of air, without regard to the degree of equilibrium, that will result in the

eventual emission of 1.3×10^5 MeV of alpha particle energy.

(c) Terms defined in the Act and not defined in this part are used consistent with the meanings given in the Act.

(d) As used in this part, words in the singular also include the plural and words in the masculine gender also include the feminine and vice versa, as the case may be.

§ 834.3 General rule.

(a) No person or DOE personnel shall take, or cause to be taken, any action inconsistent with the requirements of:

(1) This part;

(2) Any program, plan, schedule, or other process established by this part; or

(3) Any applicable Federal statute or regulation concerning the exposure of members of the public to radiation or contaminating the environment with radioactive material.

(b) With respect to a particular DOE activity, the person in charge of the activity shall be responsible for implementation of, and compliance with, the requirements of this part.

(c) Where there is no contractor in charge of a DOE activity, DOE shall act to ensure implementation of, and compliance with, the requirements of this part.

(d) Nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety.

§ 834.4 Enforcement.

The requirements in this part are subject to enforcement by all appropriate means, including the imposition of civil and criminal penalties in accordance with the provisions of proposed rule 10 CFR part 820.

§ 834.5 Environmental Radiological Protection Program.

A DOE activity shall be conducted in accordance with the Environmental Radiological Protection Program (ERPP) for the activity, as prepared and approved pursuant to subpart E of this part, including any modifications made or directed by DOE.

§ 834.6 Interim strategy.

(a) If the person in charge of a DOE activity cannot comply with a requirement of this part within [180 DAYS OF THE EFFECTIVE DATE OF THE FINAL RULE], the person shall submit to DOE an interim strategy for implementing the requirement to the extent practicable and a plan and schedule for achieving compliance with the requirement.

(b) An interim strategy shall:

(1) Document the reasons compliance cannot be achieved;

(2) Evaluate any alternative interim measures; and

(3) Analyze the effects of non-compliance on members of the public and the environment.

(c) An interim strategy, plan, and schedule for complying with a requirement shall:

(1) Be submitted to DOE within [90 DAYS OF THE EFFECTIVE DATE OF THE FINAL RULE];

(2) Be considered approved 120 days after its submission unless approved or rejected by DOE at an earlier date; and

(3) Include any modifications made or directed by DOE.

§ 834.7 Reporting.

(a) A person in charge of a DOE activity shall submit to DOE:

(1) An annual environmental report that sets forth actual levels of releases of radioactive materials and exposures to radiation for which this part establishes requirements;

(2) A report that sets forth any release of radioactive materials or exposure to radiation that exceeds or potentially exceeds the limits established by this part, within one month of determination of the occurrence; and

(3) A report that sets forth any occurrence (including the release of property) that contributes, or potentially contributes, an annual EDE greater than 10 mrem or a collective EDE greater than 100 person-rem, within one month of determination of the occurrence; and

(b) The person in charge of a DOE activity shall identify potential sources of man-made radiation other than the DOE activity and shall report to DOE if the annual combined EDE from the DOE activity and other sources does, or could exceed 100 mrem (1 mSv).

§ 834.8 Records.

Complete and accurate records as necessary to substantiate compliance with the requirements of this part shall be maintained for each DOE activity.

§ 834.9 Accidents.

(a) Actual releases and associated doses due to accidents, or other unanticipated causes, from a DOE activity shall be included in dose assessments to evaluate and demonstrate compliance of that activity with this part.

(b) Dose limits in this part are not applicable to planning and design activities related to accident conditions, where controls of exposures cannot be maintained.

§ 834.10 Dose evaluations.

(a) In calculating dose to the public from exposures resulting from both routine and unplanned activities:

(1) Standard EPA or DOE dose conversion factors or analytical models prescribed in statutes or regulations applicable to a DOE activity or direct measurements shall be used;

(2) Estimates of doses to members of the public in the vicinity of DOE activities shall be evaluated and documented to demonstrate compliance with the dose limits of this part and to assess exposures of the public from unplanned events;

(3) Estimates of collective doses to the public within 50 miles (80 km) of the site boundary shall be evaluated and documented at least annually;

(4) Analytical models used for dose evaluations shall be appropriate for characteristics of emissions (e.g., gas, liquid, or particle; depositing or non-depositing; buoyant or non-buoyant); mode of release (e.g., stack or vent; crib or pond; surface water or sewer; continuous or intermittent); environmental transport medium (e.g., air or water); and exposure pathway (e.g., inhalation; ingestion of food, water, or milk; direct radiation);

(5) Information on dispersion (transport and diffusion) in the environment, demography, land use (including the location and number of dairy and slaughter animals), food supplies, and exposure pathways used in the dose calculations shall be appropriate to evaluate actual and potential doses in the environs of DOE facilities; and

(6) Information shall be updated as necessary to document significant changes that could affect dose evaluations.

(b) In determining compliance with dose limits for members of the general public from routine operation of a DOE activity:

(1) Dose shall be expressed as an EDE received by the individuals during the year for external exposures and as the committed dose (EDE) received by the individual over a period of 50 years from radionuclides taken into the body during the year;

(2) Dose estimates shall be as realistic as practicable;

(3) To the extent practicable, individuals subject to the greatest exposure shall be identified so that the maximum dose might be evaluated; and

(4) All factors germane to dose determination shall be applied.

(c) If available data are not sufficient to evaluate the factors important to performing dose estimates:

(1) The assumed parametric values shall be sufficiently conservative so that it is unlikely that individuals would actually receive a dose that would exceed the dose calculated using the values assumed; and

(2) Parametric values used in performing dose calculations shall be recorded and included with the calculations.

(d)(1) To demonstrate compliance with the requirements of this part:

(i) Tables of committed dose conversion factors shall be used, as appropriate, based upon the reference man model, and the committed dose is the dose integrated over an interval of 50 years;

(ii) Doses from exposure to external radiation from radionuclide concentrations in air and in water that result from submersion or from exposure to contaminated plane surfaces shall be estimated, using the reference man model and appropriate dosimetry factors;

(iii) External doses may be determined using data from direct measurements with appropriate instrumentation if doses obtained with the direct measurements are found to be at least as accurate as those determined by analytical model evaluations;

(iv) Derived Concentration Guides (DCG) values in appendix A of this part for each of three exposure modes (inhalation of air containing the radionuclide; submersion in a semi-infinite cloud of air containing the radionuclide; and ingestion of water containing the radionuclide) shall be used to evaluate only the three exposure modes upon which they are based.

(2) Methods and alternatives other than those discussed in paragraph (d)(1) of this section or prescribed in applicable statutes or regulations shall be submitted to DOE for approval.

§ 834.11 ALARA compliance.

Exposure to radiation, release of radioactive material, and other radiological contamination from a DOE activity shall be deemed to comply with ALARA if the activity is:

(a) Evaluated pursuant to an ALARA program: and

(b) Conducted in accordance with the ALARA program for the activity, as approved and modified by DOE.

Subpart B—Radiation Dose and Concentration Limits and Reporting Levels for Protection of the Public and the Environment

§ 834.101 Public dose and concentration limits.

(a) *Primary dose limit.* A DOE activity shall be conducted in a manner such that the exposure of members of the public to radiation shall:

(1) Comply with ALARA; and

(2) Not cause an effective dose equivalent (EDE) greater than 100 mrem (1 mSv) from all sources and pathways of the activity and in combination with reasonably expected exposures from all other sources—excluding dose from radon and its decay products, dose received by a patient from medical sources of radiation used for diagnostic or therapeutic purposes, dose from consumer products, and dose from background radiation.

(b) *Higher limits.* DOE may authorize temporary dose limits for members of the public in excess of (EDE) 100 mrem (1 mSv) in a year, but not in excess of (EDE) 500 mrem (5 mSv). A request for a temporary authorization shall:

(1) Be submitted as soon as practicable when the need is recognized and, where possible, before the dose limit is exceeded;

(2) Document the need, discuss the alternatives considered, provide an ALARA evaluation, and demonstrate a reasonable assurance the increase will be short-term in nature; and

(3) Show that the annual average lifetime exposure to any member of the public will be less than 100 mrem (1 mSv), evaluated under reasonable exposure scenarios—excluding dose from radon and its decay products, dose received by a patient from medical sources of radiation used for diagnostic or therapeutic purposes, dose from background radiation.

§ 834.102 Airborne emissions only, all DOE sources of radionuclides.

(a) A DOE activity shall be conducted in a manner such that the release to the atmosphere of radioactive materials from the activity or in combination with other DOE activities shall:

(1) Comply with ALARA; and

(2) Not cause an EDE in excess of 10 mrem (0.1 mSv) in a year—excluding dose from radon and its decay products and from background;

(3) Not cause average radon-222 flux rates to exceed 20 pCi (0.7 Bq)/m^2/sec where radium-226 residues are accepted for storage or disposal;

(4) Not cause outdoor boundary concentrations of radon to exceed 3 pCi (0.1 Bq)/L above background at a facility where significant sources of radon are handled; and

(5) Not cause average radon concentration at outdoor boundary of a facility or any offsite location to exceed 0.5 pCi (0.02 Bq)/L above background.

(b) Reserved.

§ 834.103 Drinking water.

(a) The drinking water system for a DOE activity shall be managed in a manner that:

(1) Complies with ALARA;

(2) Shall not cause a person consuming the water to receive an EDE greater than 4 mrem (0.04 mSv) in a year;

(3) Shall not cause combined radium-226 and radium-228 to exceed 5×10^{-9}µCi (1.5×10^{-4}Bq)/mL;

(4) Shall not cause gross alpha activity (including radium-226 but excluding radon and uranium) to exceed 1.5×10^{-8}µCi (5.6×10^{-4}Bq)/mL; and

(5) Shall not cause private or public drinking water systems downstream of the facility discharge to exceed the drinking water radiological limits in 40 CFR part 141.

(b) Reserved.

§ 834.104 [Reserved]

§ 834.105 [Reserved]

§ 834.106 [Reserved]

§ 834.107 [Reserved]

§ 834.108 [Reserved]

§ 834.109 Radioactive waste.

(a) A DOE activity shall be conducted in a manner such that exposure of any member of the public to radiation or radioactive waste from the handling, disposal, storage, transport, and packaging of low-level waste, high-level waste, transuranic waste, spent nuclear fuel, naturally occurring or activated radioactive material (NARM), and residual radioactive material:

(1) Complies with ALARA; and

(2) Does not exceed an EDE of 25 mrem (0.25 mSv) in a year from all pathways.

(b) Reserved.

Subpart C—Control of Liquid Discharges Containing Radioactive Material

§ 834.201 Liquid discharge.

(a) A DOE activity shall be managed in a manner such that liquid release of radioactive materials from the activity shall:

(1) Comply with ALARA; and

(2) Be treated by the BAT if:

(i) The surface waters otherwise would contain, at the point of discharge to surface waters and prior to dilution, annual average concentrations of radioactive material greater than the DCG values in liquids in appendix A to this part; or

(ii) The total annual EDE to the public would otherwise exceed 10 mrem (0.1 mSv) and the liquid discharge

contributes a significant portion of that dose; or

(iii) The activity does not operate in conformance with the ground-water protection plan for the activity.

(3) Not result in the release of settleable solids to natural waterways if the concentration of radioactive material in the solids in the waste stream exceeds:

(i) 5 pCi (0.2 Bq) per gram of settleable solids for alpha-emitting radionuclides; or

(ii) 50 pCi (2 Bq) per gram of settleable solids for beta-gamma-emitting radionuclides.

(b) For purposes of this section, if more than one type of radionuclide A, B, ...N are present in concentrations C_A, C_B, ...C_N, and if the applicable DCG's are DCG_A, DCG_B, ...DCG_N respectively, then the concentration shall be limited so that the following relationship exists:

$$(C_A/DCG_A)+(C_B/DCG_B)+...+(C_N/DCG_N)\leq 1$$

where: DCG_i is the derived concentration guide value for radionuclide i.

(c) Selected BAT alternatives shall be implemented in accordance with the approved schedules in the BAT Plan.

(d) The BAT process shall be used in the design and construction of new facilities and activities.

§ 834.202 Discharges of liquid waste to aquifers and phaseout of soil columns.

(a) The use of soil columns in connection with a DOE activity to retain, by absorption or ion exchange, suspended or dissolved radionuclides from liquid waste streams shall be discontinued as soon as practicable and no new or increased discharges to active or virgin soil columns shall be permitted.

(b) Soil columns, drainage systems, ground water, and any other areas to which releases of radioactive material in liquids from a DOE activity has been discontinued, shall be managed or decontaminated in a manner that:

(1) Complies with ALARA; and

(2) Prohibits any liquid discharges, including uncontaminated liquids, that could further spread previously deposited radioactive material through the soil column or directly impact ground water.

§ 834.203 Discharges to sanitary sewerage.

(a) A DOE activity shall be conducted in a manner such that the concentration of radionuclides in liquid wastes discharged from the activity into sanitary sewerage shall:

(1) Comply with ALARA;

(2) Be treated by the BAT to reduce the concentration level to less than five times the DCG values for liquids (appendix A to this part) if the average monthly level otherwise would be greater than five times the DCG value at the point of discharge; and

(3) Not result in an annual discharge (above background) into public sewers in excess of:

(i) 5 Ci (200 GBq) of hydrogen-3;

(ii) 1 Ci (37 GBq) of carbon-14; and

(iii) 1 Ci (37 GBq) of all other radionuclides.

(4) Be evaluated through pathway analyses or environmental surveillance to verify that the total annual discharge of radioactive material to the sanitary sewer system will not cause members of the public to receive incremental doses from that source more than a few mrem in a year.

(b) The discharge liquid wastes from a DOE activity into a chemical or sanitary sewerage system owned by the Federal Government shall not be subject to the requirements of § 834.203(a) (2) and (3) of this part if:

(1) The system provides treatment in accordance with an approved interim strategy prior to discharge of liquid wastes to surface waters; and

(2) Sludge from the system is disposed in accordance with all applicable Federal regulations.

(c) A discharge from a DOE activity to a public sewer shall be coordinated with the operators of the waste water treatment works.

§ 834.204 [Reserved]

§ 834.205 Native aquatic animal organisms.

A DOE activity shall be conducted in such a manner that the absorbed dose to a native aquatic animal organism (e.g., fish, crustaceans, mollusks, and benthic invertebrates) shall not exceed 1 rad (0.01 gray) per day from exposure to radioactive material in liquid wastes discharged to natural waterways.

§ 834.206 [Reserved]

§ 834.207 [Reserved]

§ 834.208 [Reserved]

§ 834.209 [Reserved]

§ 834.210 Ground water protection.

(a) A DOE activity shall be conducted in a manner that:

(1) Radiological contamination of the ground water complies with ALARA; and

(2) Protects the ground water from radiological and non-radiological contamination in accordance with the Ground Water Protection Management Plan applicable to the activity.

(b) Reserved.

§ 834.211 [Reserved]

§ 834.212 [Reserved]

§ 834.213 [Reserved]

§ 834.214 [Reserved]

§ 834.215 Tritium.

(a) A DOE activity shall be conducted in a manner that releases of tritium from the facility to the environment by application of the ALARA process to ensure that doses are as low as is reasonably achievable.

(b) Releases of tritium shall not be considered in determining whether a BAT is required by this subpart or in applying the BAT selection process.

Subpart D—Release of Property Having Residual Radioactive Material

§ 834.301 Release of property containing residual radioactive material.

(a) No property contaminated, or potentially contaminated, with residual radioactive material shall be released from a DOE facility unless:

(1) The property is assessed to demonstrate that doses to the public from use of the property will comply with ALARA;

(2) Doses to the public from exposures to the property will not exceed the primary or supplemental limits authorized by DOE pursuant to this subpart;

(3) The property is surveyed to determine mass contamination, removable surface radioactive material, and total surface radioactive material (including contamination present on and under any coating); and

(4) DOE approves documentation that:

(i) Describes the item;

(ii) Describes its radiological history;

(iii) States the DOE-approved criteria for release of the property;

(iv) Describes the survey of the item, including the date, the identity of the surveyor, the type and identification number of the instruments used, and the results of the survey;

(v) Indicates the radiological condition of the property;

(vi) Indicates the quantity and disposition of the waste resulting from any decontamination effort; and

(vii) Identifies the recipient of the property.

(b) Reserved.

§ 834.302 Authorized limits.

(a) DOE may authorize limits for the release of property containing residual radioactive material.

(b) In evaluating and approving authorized limits, DOE shall consider:

(1) The nature of the property and its potential use;

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(2) The potential dose to an individual in:

(i) The actual and likely use scenario to ensure that potential doses are not likely to exceed a small fraction of the applicable dose limits in this part; and

(ii) The worst plausible use scenario to ensure that potential doses are not likely to exceed the applicable dose limits in this part;

(3) The collective dose to the affected population; and

(4) Where close contact is likely, the ability and need to decontaminate the property to ensure that there is no measurable contamination.

§ 834.303 [Reserved]

§ 834.304 [Reserved]

§ 834.305 Soil.

(a) Authorized limits for radium-226 and radium-228 shall be less than 5 pCi/gram (0.2 Bq/gram) in the first 15 cm of the surface layer and 15 pCi/gram (0.56 Bq/gram) in any subsequent 15 cm subsurface layer.

(b) Authorized limits for all other radionuclides in soil shall be derived using approved models in accordance with the requirements of this subpart.

§ 834.306 Radon.

(a) Remedial actions shall be conducted on habitable and occupied structures with the objective to reduce residual radioactive material levels such that an annual average radon-222 decay product concentration will not exceed 0.02 WL, including background, in the structure.

(b) In any case, the radon decay product shall not exceed 0.03 WL, including background, in such structures as a result of residual radioactive material.

§ 834.307 [Reserved]

§ 834.308 [Reserved]

§ 834.309 [Reserved]

§ 834.310 Supplemental limits.

(a) DOE may authorize, for a particular DOE activity, supplemental limits for the release of property containing residual radioactive material in lieu of any general limits authorized under this subpart, if:

(1) Remedial action consistent with authorized limits would pose a clear and present risk of injury to workers or members of the public, notwithstanding reasonable measures to avoid or reduce risk;

(2) Remedial action consistent with authorized limits, even after all reasonable mitigative measures have been taken, would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected properties, now or in the future;

(3) It is determined that the scenarios or assumptions used to establish the authorized limits do not apply to the property or portion of the property identified, or where more appropriate scenarios or assumptions indicate that other limits are applicable or appropriate for protection of the public and the environment;

(4) The cost of remedial action for contaminated soil is unreasonably high relative to long-term benefits and where the residual material does not pose a clear present or future risk after taking necessary control measures; or

(5) There is no feasible remedial action that can achieve the authorized limits.

(b) A supplemental limit shall achieve the dose and ALARA requirements of this part for any current or future use of the property and shall contain any restriction necessary to achieve the objectives of this part.

§ 834.311 Control of residual radioactive material.

(a) Control and stabilization features for the interim storage of residual radioactive material shall be designed to meet the applicable dose limits for an effective life of 25 years at a minimum and, to the extent practicable, 50 years. Where applicable, the control shall limit radon-222 concentrations in the atmosphere above facility surfaces or openings to levels that will not exceed:

(1) An annual average concentration of 30 pCi(1 Bq)/L over the facility or site;

(2) An annual average concentration of 0.5 pCi(0.02 Bq)/L above background at or beyond the boundary of the facility or site; 3 pCi(0.1 Bq)/L at or above any single location accessible by the public, as a result of material stored on the site; and

(3) Flux rates from the storage of radon-producing wastes of 20 pCi(0.7 Bq)/m^2/sec, averaged over the storage unit.

(b) A property may be maintained under an interim management arrangement when the residual radioactive material exceeds authorized limits developed for unrestricted release if:

(1) The residual radioactive material is in inaccessible locations;

(2) The residual contamination would be unreasonably costly to remove; and

(3) When needed, administrative controls are instituted by the operating organization to protect members of the public.

(c)(1) Appropriate administrative and physical controls for the management of storage or disposal activities shall be developed and implemented to limit access and use of onsite material contaminated by residual radioactive material. Requirements for such controls shall be appropriately documented.

(2) Controls shall be designed such that concentrations of radionuclides in the groundwater and quantities of residual radioactive material will not cause the requirements of this part to be exceeded.

(d)(1) Long-term management of residual radioactive material residue from a DOE activity shall be in accordance with this section and DOE approved plans.

(2) Control and stabilization features for uranium, thorium, and their decay products shall be designed, to the extent reasonably achievable, to:

(i) Provide an effective life of 1,000 years with a minimum life of at least 200 years;

(ii) Limit radon-222 emanation to the atmosphere from the wastes to less than an annual average release rate of 20 pCi(0.7 Bq)/m^2/sec; and

(iii) Prevent increases in the annual average radon-222 concentration at or above any location outside the boundary of the controlled area by more than 0.5 pCi(0.02 Bq)/L.

(3) In the development of controls and waste management plans, the impacts of various disposal modes should be addressed beyond the 1,000-year period design requirement.

(4) For wastes containing significant concentrations of radium and thorium, special considerations must be given to intruder prevention.

(5) Before any potentially bio-degradable contaminated wastes are placed in a long-term management facility, such wastes shall be properly conditioned so that the generation and escape of biogenic gases will not cause the emission or dose limits to be exceeded and that bio-degradation within the facility will not result in premature structural failure.

Subpart E—Environmental Radiological Protection Program

§ 834.401 Composition of the Environmental Radiological Protection Program (ERPP).

(a) The contents of an ERPP shall be commensurate with the nature of the DOE activity and the potential risk to the public and the environment from the DOE activity.

(b) With respect to each requirement in this part relating to the permissible levels for releases of radioactive

material, exposures to radiation, and other radioactive contamination, an ERPP shall indicate:

(1) What, if any, existing or anticipated activities are subject to the requirement;

(2) The measures to be used in implementing the requirement; and

(3) The methods to be used in monitoring, reporting, and recording compliance with the requirement.

(c) An ERPP shall contain an ALARA Program to control releases of radioactive materials and exposures to radiation at levels as low as reasonably achievable. An ALARA Program shall include:

(1) A statement of commitment to use the ALARA process;

(2) A description of the means to be used to implement the ALARA process;

(3) A process for documenting ALARA decisions;

(4) A training program for the staff on implementation of the ALARA process; and

(5) A listing and evaluation of specific societal, technological, economic, and public policy factors considered in arriving at ALARA decision, including, as appropriate:

(i) The maximum dose to members of the public;

(ii) The collective dose to the population;

(iii) Applicable alternative processes, such as alternative treatments of discharge streams, operating methods, or controls;

(iv) Doses for each alternative evaluated;

(v) Cost for each of the alternatives evaluated;

(vi) An examination of the changes in cost among alternatives; and

(vii) Societal impact associated with alternatives.

(d) An ERPP shall contain a BAT Plan for each activity for which this part requires a determination whether to use the BAT for processing liquid waste. A BAT Plan shall:

(1) Document the analysis of whether the BAT is required and, if required,

(2) Document the BAT selection process; and

(3) Set forth the schedule for installing the BAT.

(e) An ERPP shall contain a Ground-Water Protection Management Plan that shall:

(1) Address the potential for radiological and, where appropriate, non-radiological contamination of the ground water by a DOE activity;

(2) Document the quality and quantity of ground water;

(3) Identify possible sources of contamination;

(4) Describe strategies for controlling contamination, including preventive and remediation measures to comply with applicable Federal environmental laws and regulations; and

(5) Describe measures for monitoring the ground-water.

(f) An ERPP shall contain an Environmental Monitoring Plan (EMP) that provides for effluent monitoring to obtain representative measurements of the quantities and concentrations of pollutants in liquid and airborne discharges and environmental surveillance to monitor the effects, if any, of a DOE activity on members of the public, the environment and natural resources. The EMP shall set forth:

(1) The elements of the plan to determine compliance with the requirements of this part and other applicable Federal environmental laws and regulations;

(2) The rationale and design criteria for each element;

(3) The extent and frequency of monitoring and measurements;

(4) Procedures for laboratory analyses;

(5) Implementation procedures;

(6) Meteorological data; and

(7) For a new facility or new activity at an existing facility, a preoperational study.

(g) Effluent monitoring, in an EMP, shall:

(1) Measure quantities and concentrations of pollutants in liquid and airborne discharges from a DOE activity;

(2) Collect samples in a manner and frequency sufficient to characterize the effluent streams from a DOE activity; and

(3) Analyze samples to the extent necessary.

(h) Environmental surveillance, in an EMP, shall:

(1) Establish background levels of pollutants;

(2) Determine the location and magnitude of concentrations of pollutants from a DOE activity;

(3) Evaluate the effects on the public and the environment of pollutants from a DOE activity;

(4) Utilize monitoring stations on the basis of the type of emission, meteorology, climatology, topography, geography, population distribution, land use, and other relevant considerations;

(5) Collect and analyze samples in a manner and frequency sufficient to characterize the emissions from a DOE activity and their effects; and

(6) Verify whether any unexpected or undetected releases occur.

(i) Meteorological data, collected in accordance with an EMP, shall:

(1) Characterize atmospheric transport and dispersion conditions in the vicinity of a DOE activity;

(2) Describe meteorological conditions including precipitation, temperature, wind speed, wind direction, and atmospheric stability that are important to surveillance; and

(3) Support assessment of routine and non-routine emissions.

(j) A Preoperational Study, in an EMP, shall:

(1) Begin at least one year prior to the start-up of a new activity;

(2) Characterize existing physical, chemical, and biological conditions that could be affected;

(3) Establish background levels of radioactive and, as appropriate, chemical components;

(4) Characterize pertinent environment and ecological parameters; and

(5) Identify potential pathways for human exposure or environmental impact.

(k) An ERPP shall contain a Waste Plan to manage, dispose, and store radioactive waste, including low-level waste, high-level waste, transuranic waste, spent nuclear fuel, and residual radioactive material. The Waste Plan for a DOE activity shall:

(1) Provide for controls to ensure compliance this part and applicable Federal statutes and regulations;

(2) Describe the means used to limit access to waste;

(3) Describe the interim and long-term strategies for dealing with waste;

(4) Describe the administrative safeguards;

(5) Describ mechanism for cooperating w State and local officials; and

(6) Document any plan for the release of property contaminated, or potentially contaminated, with residual radioactive material, including limits authorized by DOE and the process for ensuring compliance with the plan.

(l) An ERPP shall contain a Quality Assurance Program that includes:

(1) Organizational responsibility;

(2) Program design;

(3) Procedures;

(4) Field quality design;

(5) Laboratory quality control;

(6) Human factors;

(7) Recordkeeping;

(8) Chain-of-custody procedures;

(9) Audits;

(10) Performance reporting; and

(11) Independent data verification.

(m)(1) An ERPP for an existing DOE activity shall be submitted to DOE within [90 DAYS OF THE EFFECTIVE DATE OF THE FINAL RULE].

(2) An ERPP for a new DOE activity shall be submitted to DOE prior to the

initiation of the activity. An update of an existing ERPP may be submitted if the new activity can be integrated into the existing ERPP.

(3) An update of an ERPP shall be submitted to DOE:

(i) Annually;

(ii) Whenever there is a change or addition to the ERPP;

(iii) Within 90 days of the effective date of any modification to this part that should be reflected in the ERPP; or

(iv) Prior to the modification of a DOE activity that is not reflected in the ERPP for that activity.

(4) The initial ERPP or an update shall be considered approved 180 days after its submission, including any modifications made or directed by DOE, unless approved or rejected by DOE at an earlier date.

Appendix A to Part 834—Derived Concentration Guides for Air and Water

1. *Purpose.* The Derived Concentration Guide (DCG) values listed in this appendix are provided as reference values for conducting radiological environmental protection programs at operational DOE facilities and sites. The DCG values in this appendix are not concentration limits or levels of acceptable concentrations for release to the environment. Rather, the concentration values are provided as a tool for estimating potential dose and for determining compliance with other requirements of 10 CFR part 834.

2. *Basis.* The DCG values are presented for each of three exposure modes: (1) Ingestion of water; (2) inhalation of air; and (3) immersion in a semi-infinite cloud of uniform concentration. The DCG values for internal exposure are listed, in the special units of µCi/mL, in Table A-1a (Derived Concentration Guides [DCGs] for Members of the Public from Ingested Water and Inhalation Resulting in an EDE of 100 mrem/yr). The DCGs values are also given in Table A-1b (Derived Concentration Guides [DCGs] for Members of the Public from Ingested Water and Inhalation Resulting in an EDE of 1 mSv/yr) in the SI units of Bq/L for ingestion of water and Bq/m³ for inhalation of air. The values in these two tables are based on a committed effective dose equivalent (EDE) of 100 mrem (1 mSv) for the radionuclide taken into the body by ingestion or inhalation during one year.

Alternative gastrointestinal-tract (GI-tract) absorption factors (f_1) and lung retention classes (noted as D, W, or Y in the Task Group Lung Model used to produce the inhalation dose factors reported in ICRP Publication 30) are listed for specific compounds, by element, in Table A-2 (Alternative Absorption Factors and Lung Retention Classes for Specific Compounds) for cross-referencing with the internal DCGs in Tables A-1a and A-1b. The data in Table A-2 are listed in alphabetical order, by element name. Removal half-times assigned to the compounds with lung retention classes D, W, and Y are 0.5, 50, and 500 days, respectively. The air immersion DCG values shown in Table A-3 (Derived Concentration Guides [DCGs] for Members of the Public for External Exposure During Immersion in an Infinite Hemispherical Cloud of Uniform Concentration Resulting in an EDE of 100 mrem/yr [1 mSv/yr]) are given in both special (µCi/mL) and SI (Bq/m³) units and are based on an effective dose equivalent of 100 mrem (1 mSv) from exposure during one year.

Tables A-1a and A-1b each contain six columns of information: Radionuclide/Chemical Form/Isomer Half-Life; f_1 Value (GI-tract absorption); Ingested Water DCG; Inhaled Air DCG for Lung Retention Class D and Inhaled Air DCG for Lung Retention Class W and Inhaled Air DCG for Lung Retention Class Y. Table A-2 contains five columns of information: Element/Symbol; Atomic Number; compound; f_1 value; and Lung Retention Class. Table A-3 contains four columns of information: Radionuclide; Half-life in units of seconds (s), minutes (min), hours (h), days (d), or years (yr); Air Immersion DCG in units of µCi/mL; Air Immersion DCG in units of Bq/m³.

a. *Exposure Conditions for Ingestion of Water and Inhalation.* Under conditions of continuous exposure, 24 hours per day, 365 days per year, members of the public are assumed to ingest 730 liters of drinking water (2 Liters per day), and to inhale 8400 cubic meters of air (23 cubic meters per day), as given for the "reference man" in ICRP Publication 23. Only single modes of exposure were considered in the calculation of the DCGs—that is, they apply to either inhalation *or* ingestion, not to a combination of both. For ingestion, DCG values are tabulated for all values of f_1, for each radionuclide given in ICRP Publication 30, Parts 1 through 4 and ICRP 48. For inhalation, DCG values are given for all combinations of f_1 and lung retention class (D, W, or Y) given by the ICRP, as tabulated in Table A–2. For radionuclides with multiple f_1 listings, where specific data for an airborne or liquid release are lacking, the f_1 value that results in the most restrictive DCG for ingested water or inhaled air should be used.

b. *Exposure Conditions for Air Immersion.* The air immersion DCGs were for a continuous, unshielded exposure via immersion in a semi-infinite atmospheric cloud. Exposures of members of the general public to concentrations of radionuclides in air are constrained, by consideration of potential stochastic radiation effects (such as, cancer and hereditary effects), to levels that preclude the occurrence of non-stochastic radiation effects (such as, cataracts in the eye and depression of bone marrow activity) which only occur at radiation doses that are factors of 100 or more times the value of 100 mrem/yr associated with the DCGs listed here.

For most of the radionuclides listed in Table A–3, the DCG value is determined by the limit on annual effective dose equivalent. Thus, the few cases where the DCG value is determined by the limit on annual dose equivalent to skin are indicated in the table by an appropriate footnote. Again, the DCGs listed in Table A–3 account only for immersion in a semi-infinite cloud and do not account for inhalation or ingestion exposures. Three classes of radionuclides are included in the air immersion DCGs given in Table A–3, as described below.

(1) *Class 1.* The first class of radionuclides includes selected noble gases and short-lived activation products that occur in gaseous form. For these radionuclides, inhalation doses are negligible compared to the external dose from immersion in an atmospheric cloud.

(2) *Class 2.* The second class of radionuclides includes those for which a DCG value for inhalation has been calculated (using the ICRP inhalation dose equivalent factors), but for which the DCG value for external exposure to a contaminated atmospheric cloud is more restrictive (i.e., results in a lower DCG value). These radionuclides generally have half-lives of a few hours or less, or are eliminated from the body following inhalation sufficiently rapidly to limit the inhalation dose.

(3) *Class 3.* The third class of radionuclides includes selected isotopes with relatively short half-lives that were not considered in ICRP Publication 30. These radionuclides typically have half-lives that are less than 10 minutes, they do not occur as a decay product of a longer-lived radionuclide, or they lack sufficient decay data to permit internal dose calculations. These radionuclides are also typified by a radioactive emission of highly intense, high-energy photons and rapid removal from the body following inhalation.

c. *Application to Mixtures of Radionuclides.* The DCG values are given for individual radionuclides. For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding DCG must not exceed 1.0.

3. *Limitations.* The values given in Tables A–1a, A–1b and A–3 account for only three exposure pathways (ingested water or inhaled air or air immersion) and do not include other potentially significant pathways. When more complex environmental pathways are involved, a more complete pathway analysis is required for calculating public radiation doses resulting from the operation of DOE facilities.

TABLE A–1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
H-3 (Water)		2.E–03	(–[1])	1.E–07 [2]	
H-3 (Elemental)				2.E–02 [2]	
Be-7	5.E–03	1.E–03		5.E–08	4.E–08
Be-10	5.E–03	3.E–05		4.E–10	3.E–11
C-11 (org)		1.E–02		1.E–06	
C-11 (CO)			3.E–06		
C-11 (CO_2)			2.E–06		
C-14 (org)		7.E–05		6.E–09	
C-14 (CO)			4.E–06		
C-14 (CO_2)			5.E–07		
F-18	1.E+00	1.E–03	2.E–07	2.E–07	2.E–07
Na-22	1.E+00	1.E–05	2.E–09		
Na-24	1.E+00	1.E–04	1.E–08		
Mg-28	5.E–01	2.E–05	4.E–09	3.E–09	
Al-26	1.E–02	1.E–05	1.E–10	2.E–10	
Si-31	1.E–02	3.E–04	6.E–08	7.E–08	6.E–08
Si-32	1.E–02	8.E–05	6.E–10	3.E–10	1.E–11
P-32	8.E–01	2.E–05	2.E–09	9.E–10	
P-33	8.E–01	2.E–04	2.E–08	6.E–09	
S-35	8.E–01	3.E–04	4.E–08	5.E–09	
	1.E–01	2.E–04			
S-35 (Gas)			3.E–08		
Cl-36	1.E+00	5.E–05	6.E–09	6.E–10	
Cl-38	1.E+00	7.E–04	1.E–07	1.E–07	
Cl-39	1.E+00	1.E–03	1.E–07	1.E–07	
K-40	1.E+00	7.E–06	9.E–10		
K-42	1.E+00	1.E–04	1.E–08		
K-43	1.E+00	2.E–04	2.E–08		
K-44	1.E+00	9.E–04	2.E–07		
K-45	1.E+00	2.E–03	3.E–07		
Ca-41	3.E–01	1.E–04		9.E–09	
Ca-45	3.E–01	5.E–05		2.E–09	
Ca-47	3.E–01	2.E–05		2.E–09	
Sc-43	1.E–04	2.E–04			5.E–08
Sc-44m	1.E–04	1.E–05			2.E–09
Sc-44	1.E–04	1.E–04			3.E–08
Sc-46	1.E–04	2.E–05			6.E–10
Sc-47	1.E–04	7.E–05			7.E–09
Sc-48	1.E–04	2.E–05			3.E–09
Sc-49	1.E–04	6.E–04			1.E–07
Ti-44	1.E–02	7.E–06	3.E–11	7.E–11	1.E–11
Ti-45	1.E–02	2.E–04	6.E–08	8.E–08	7.E–08
V-47	1.E–02	9.E–04	2.E–07	2.E–07	
V-48	1.E–02	2.E–05	3.E–09	2.E–09	
V-49	1.E–02	2.E–03	8.E–08	4.E–08	
Cr-48	1.E–01	2.E–04	3.E–08	2.E–08	2.E–08
	1.E–02	2.E–04			
Cr-49	1.E–01	8.E–04	2.E–07	2.E–07	2.E–07
	1.E–02	8.E–04			
Cr-51	1.E–01	1.E–03	1.E–07	6.E–08	5.E–08
	1.E–02	1.E–03			
Mn-51	1.E–01	5.E–04	1.E–07	1.E–07	
Mn-52m	1.E–01	9.E–04	2.E–07	2.E–07	
Mn-52	1.E–01	2.E–05	3.E–09	2.E–09	
Mn-53	1.E–01	1.E–03	6.E–08	3.E–08	
Mn-54	1.E–01	5.E–05	2.E–09	2.E–09	
Mn-56	1.E–01	1.E–04	4.E–08	5.E–08	
Fe-52	1.E–01	3.E–05	7.E–09	6.E–09	
Fe-55	1.E–01	2.E–04	5.E–09	1.E–08	
Fe-59	1.E–01	2.E–05	8.E–10	1.E–09	
Fe-60	1.E–01	9.E–07	2.E–11	4.E–11	
Co-55	5.E–02	3.E–05		7.E–09	6.E–09
	3.E–01	4.E–05			
Co-56	5.E–02	1.E–05		7.E–10	5.E–10
	3.E–01	1.E–05			
Co-57	5.E–02	2.E–04		7.E–09	2.E–09
	3.E–01	1.E–04			
Co-58m	5.E–02	2.E–03		2.E–07	2.E–07

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
	3.E-01	2.E-03			
Co-58	5.E-02	5.E-05		3.E-09	2.E-09
	3.E-01	4.E-05			
Co-60m	5.E-02	4.E-02		9.E-06	6.E-06
	3.E-01	4.E-02			
Co-60	5.E-02	1.E-05		4.E-10	8.E-11
	3.E-01	5.E-06			
Co-61	5.E-02	5.E-04		2.E-07	1.E-07
	3.E-01	6.E-04			
Co-62m	5.E-02	1.E-03		4.E-07	4.E-07
	3.E-01	1.E-03			
Ni-56	5.E-02	4.E-05	5.E-09	3.E-09	
Ni-56 (Vapor)			3.E-09		
Ni-57	5.E-02	4.E-05	1.E-08	7.E-09	
Ni-57 (Vapor)			1.E-08		
Ni-59	5.E-02	7.E-04	9.E-09	2.E-08	
Ni-59 (Vapor)			4.E-09		
Ni-63	5.E-02	3.E-04	4.E-09	6.E-09	
Ni-63 (Vapor)			2.E-09		
Ni-65	5.E-02	2.E-04	6.E-08	7.E-08	
Ni-65 (Vapor)			4.E-08		
Ni-66	5.E-02	1.E-05	4.E-09	2.E-09	
Ni-66 (Vapor)			7.E-09		
Cu-60	5.E-01	8.E-04	2.E-07	3.E-07	2.E-07
Cu-61	5.E-01	3.E-04	7.E-08	1.E-07	8.E-08
Cu-64	5.E-01	3.E-04	7.E-08	6.E-08	5.E-08
Cu-67	5.E-01	1.E-04	2.E-08	1.E-08	1.E-08
Zn-62	5.E-01	4.E-05			7.E-09
Zn-63	5.E-01	7.E-04			2.E-07
Zn-65	5.E-01	9.E-06			6.E-10
Zn-69m	5.E-01	1.E-04			2.E-08
Zn-69	5.E-01	2.E-03			3.E-07
Zn-71m	5.E-01	2.E-04			4.E-08
Zn-72	5.E-01	3.E-05			3.E-09
Ga-65	1.E-03	2.E-03	4.E-07	5.E-07	
Ga-66	1.E-03	3.E-05	8.E-09	7.E-09	
Ga-67	1.E-03	2.E-04	3.E-08	3.E-08	
Ga-68	1.E-03	4.E-04	1.E-07	1.E-07	
Ga-70	1.E-03	2.E-03	4.E-07	5.E-07	
Ga-72	1.E-03	3.E-05	8.E-09	7.E-09	
Ga-73	1.E-03	1.E-04	4.E-08	4.E-08	
Ge-66	1.E+00	7.E-04	6.E-08	5.E-08	
Ge-67	1.E+00	1.E-03	2.E-07	2.E-07	
Ge-68	1.E+00	1.E-04	9.E-09	2.E-10	
Ge-69	1.E+00	4.E-04	4.E-08	2.E-08	
Ge-71	1.E+00	1.E-02	1.E-06	1.E-07	
Ge-75	1.E+00	2.E-03	2.E-07	2.E-07	
Ge-77	1.E+00	2.E-04	2.E-08	1.E-08	
Ge-78	1.E+00	7.E-04	5.E-08	5.E-08	
As-69	5.E-01	1.E-03		3.E-07	
As-70	5.E-01	4.E-04		1.E-07	
As-71	5.E-01	1.E-04		1.E-08	
As-72	5.E-01	2.E-05		3.E-09	
As-73	5.E-01	2.E-04		4.E-09	
As-74	5.E-01	4.E-05		2.E-09	
As-76	5.E-01	3.E-05		4.E-09	
As-77	5.E-01	1.E-04		1.E-08	
As-78	5.E-01	2.E-04		5.E-08	
Se-70	8.E-01	4.E-04	9.E-08	1.E-07	
	5.E-02	3.E-04			
Se-73m	8.E-01	2.E-03	4.E-07	3.E-07	
	5.E-02	9.E-04			
Se-73	8.E-01	2.E-04	3.E-08	4.E-08	
	5.E-02	9.E-05			
Se-75	8.E-01	2.E-05	2.E-09	1.E-09	
	5.E-02	8.E-05			
Se-79	8.E-01	2.E-05	2.E-09	1.E-09	
	5.E-02	1.E-04			

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[µCi]

Radionuclide	f_1 value	Ingested water DCG (µCi/mL)	Inhaled air DCG (µCi/mL)		
			D	W	Y
Se-81m	8.E-01	1.E-03	2.E-07	2.E-07	
	5.E-02	7.E-04			
Se-81	8.E-01	2.E-03	5.E-07	6.E-07	
	5.E-02	2.E-03			
Se-83	8.E-01	1.E-03	3.E-07	3.E-07	
	5.E-02	9.E-04			
Br-74m	1.E+00	6.E-04	9.E-08	1.E-07	
Br-74	1.E+00	1.E-03	2.E-07	2.E-07	
Br-75	1.E+00	1.E-03	1.E-07	1.E-07	
Br-76	1.E+00	1.E-04	1.E-08	1.E-08	
Br-77	1.E+00	4.E-04	6.E-08	5.E-08	
Br-80m	1.E+00	6.E-04	4.E-08	3.E-08	
Br-80	1.E+00	2.E-03	4.E-07	5.E-07	
Br-82	1.E+00	8.E-05	1.E-08	9.E-09	
Br-83	1.E+00	2.E-03	2.E-07	2.E-07	
Br-84	1.E+00	9.E-04	1.E-07	2.E-07	
Rb-79	1.E+00	2.E-03	3.E-07		
Rb-81m	1.E+00	7.E-03	8.E-07		
Rb-81	1.E+00	1.E-03	1.E-07		
Rb-82m	1.E+00	3.E-04	4.E-08		
Rb-83	1.E+00	2.E-05	2.E-09		
Rb-84	1.E+00	1.E-05	2.E-09		
Rb-86	1.E+00	1.E-05	2.E-09		
Rb-87	1.E+00	3.E-05	4.E-09		
Rb-88	1.E+00	8.E-04	2.E-07		
Rb-89	1.E+00	2.E-03	3.E-07		
Sr-80	3.E-01	1.E-04	3.E-08		
	1.E-02	1.E-04			3.E-08
Sr-81	3.E-01	7.E-04	2.E-07		
	1.E-02	6.E-04			2.E-07
Sr-82	3.E-01	7.E-06	7.E-10		
	1.E-02	6.E-06			2.E-10
Sr-83	3.E-01	8.E-05	2.E-08		
	1.E-02	6.E-05			8.E-09
Sr-85m	3.E-01	6.E-03	2.E-06		
	1.E-02	6.E-03			2.E-06
Sr-85	3.E-01	7.E-05	6.E-09		
	1.E-02	1.E-04			4.E-09
Sr-87m	3.E-01	1.E-03	3.E-07		
	1.E-02	1.E-03			4.E-07
Sr-89	3.E-01	2.E-05	2.E-09		
	1.E-02	2.E-05			3.E-10
Sr-90	3.E-01	1.E-06	5.E-11		
	1.E-02	1.E-05			9.E-12
Sr-91	3.E-01	6.E-05	1.E-08		
	1.E-02	5.E-05			8.E-09
Sr-92	3.E-01	9.E-05	2.E-08		
	1.E-02	7.E-05			1.E-08
Y-86m	1.E-04	6.E-04		1.E-07	1.E-07
Y-86	1.E-04	3.E-05		8.E-09	7.E-09
Y-87	1.E-04	6.E-05		8.E-09	7.E-09
Y-88	1.E-04	3.E-05		6.E-10	6.E-10
Y-90m	1.E-04	2.E-04		3.E-08	3.E-08
Y-90	1.E-04	1.E-05		2.E-09	1.E-09
Y-91m	1.E-04	4.E-03		6.E-07	4.E-07
Y-91	1.E-04	1.E-05		4.E-10	3.E-10
Y-92	1.E-04	7.E-05		2.E-08	2.E-08
Y-93	1.E-04	3.E-05		7.E-09	6.E-09
Y-94	1.E-04	8.E-04		2.E-07	2.E-07
Y-95	1.E-04	1.E-03		4.E-07	3.E-07
Zr-86	2.E-03	4.E-05	9.E-09	6.E-09	6.E-09
Zr-88	2.E-03	1.E-04	5.E-10	1.E-09	7.E-10
Zr-89	2.E-03	4.E-05	8.E-09	6.E-09	6.E-09
Zr-93	2.E-03	9.E-05	4.E-11	1.E-10	2.E-10
Zr-95	2.E-03	4.E-05	6.E-10	9.E-10	6.E-10
Zr-97	2.E-03	2.E-05	5.E-09	3.E-09	3.E-09
Nb-88	1.E-02	2.E-03		5.E-07	5.E-07
Nb-89 (66 min)	1.E-02	3.E-04		1.E-07	9.E-08

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
Nb-89 (122 min)	1.E-02	1.E-04		4.E-08	4.E-08
Nb-90	1.E-02	3.E-05		6.E-09	6.E-09
Nb-93m	1.E-02	5.E-03		3.E-08	4.E-09
Nb-94	1.E-02	3.E-05		5.E-10	4.E-11
Nb-95m	1.E-02	7.E-05		6.E-09	5.E-09
Nb-95	1.E-02	6.E-05		3.E-09	3.E-09
Nb-96	1.E-02	3.E-05		6.E-09	6.E-09
Nb-97	1.E-02	6.E-04		2.E-07	2.E-07
Nb-98	1.E-02	4.E-04		1.E-07	1.E-07
Mo-90	8.E-01	1.E-04	2.E-08		
	5.E-02	6.E-05			1.E-08
Mo-93m	8.E-01	3.E-04	4.E-08		
	5.E-02	1.E-04			3.E-08
Mo-93	8.E-01	1.E-04	1.E-08		
	5.E-02	6.E-04			4.E-10
Mo-99	8.E-01	5.E-05	6.E-09		
	5.E-02	3.E-05			3.E-09
Mo-101	8.E-01	2.E-03	3.E-07		
	5.E-02	2.E-03			4.E-07
Tc-93m	8.E-01	2.E-03	4.E-07	7.E-07	
Tc-93	8.E-01	9.E-04	2.E-07	2.E-07	
Tc-94m	8.E-01	5.E-04	1.E-07	1.E-07	
Tc-94	8.E-01	2.E-04	4.E-08	6.E-08	
Tc-95m	8.E-01	1.E-04	1.E-08	5.E-09	
Tc-95	8.E-01	3.E-04	5.E-08	5.E-08	
Tc-96m	8.E-01	4.E-03	7.E-07	6.E-07	
Tc-96	8.E-01	5.E-05	7.E-09	5.E-09	
Tc-97m	8.E-01	1.E-04	2.E-08	3.E-09	
Tc-97	8.E-01	9.E-04	1.E-07	1.E-08	
Tc-98	8.E-01	3.E-05	4.E-09	7.E-10	
Tc-99m	8.E-01	2.E-03	4.E-07	6.E-07	
Tc-99	8.E-01	1.E-04	1.E-08	2.E-09	
Tc-101	8.E-01	4.E-03	8.E-07	9.E-07	
Tc-104	8.E-01	8.E-04	2.E-07	2.E-07	
Ru-94	5.E-02	4.E-04	1.E-07	2.E-07	1.E-07
Ru-97	5.E-02	2.E-04	5.E-08	3.E-08	3.E-08
Ru-103	5.E-02	5.E-05	4.E-09	2.E-09	2.E-09
Ru-105	5.E-02	1.E-04	3.E-08	3.E-08	3.E-08
Ru-106	5.E-02	6.E-06	2.E-10	1.E-10	3.E-11
Rh-99m	5.E-02	5.E-04	1.E-07	2.E-07	2.E-07
Rh-99	5.E-02	7.E-05	7.E-09	5.E-09	5.E-09
Rh-100	5.E-02	5.E-05	1.E-08	9.E-09	9.E-09
Rh-101m	5.E-02	2.E-04	3.E-08	2.E-08	2.E-08
Rh-101	5.E-02	6.E-05	1.E-09	2.E-09	4.E-10
Rh-102m	5.E-02	4.E-05	1.E-09	9.E-10	3.E-10
Rh-102	5.E-02	2.E-05	2.E-10	4.E-10	1.E-10
Rh-103m	5.E-02	1.E-02	3.E-06	3.E-06	3.E-06
Rh-105	5.E-02	1.E-04	3.E-08	1.E-08	1.E-08
Rh-106m	5.E-02	2.E-04	6.E-08	9.E-08	8.E-08
Rh-107	5.E-02	2.E-03	6.E-07	6.E-07	6.E-07
Pd-100	5.E-03	4.E-05	4.E-09	3.E-09	4.E-09
Pd-101	5.E-03	4.E-04	7.E-08	8.E-08	7.E-08
Pd-103	5.E-03	2.E-04	1.E-08	1.E-08	8.E-09
Pd-107	5.E-03	1.E-03	5.E-08	2.E-08	9.E-10
Pd-109	5.E-03	6.E-05	1.E-08	1.E-08	1.E-08
Ag-102	5.E-02	2.E-03	4.E-07	5.E-07	5.E-07
Ag-103	5.E-02	1.E-03	2.E-07	3.E-07	3.E-07
Ag-104m	5.E-02	9.E-04	2.E-07	3.E-07	3.E-07
Ag-104	5.E-02	6.E-04	2.E-07	3.E-07	3.E-07
Ag-105	5.E-02	7.E-05	2.E-09	4.E-09	4.E-09
Ag-106m	5.E-02	2.E-05	2.E-09	2.E-09	2.E-09
Ag-106	5.E-02	2.E-03	4.E-07	5.E-07	4.E-07
Ag-108m	5.E-02	2.E-05	4.E-10	6.E-10	6.E-11
Ag-110m	5.E-02	1.E-05	3.E-10	4.E-10	2.E-10
Ag-111	5.E-02	3.E-05	4.E-09	2.E-09	2.E-09
Ag-112	5.E-02	9.E-05	2.E-08	2.E-08	2.E-08
Ag-115	5.E-02	9.E-04	2.E-07	2.E-07	2.E-07
Cd-104	5.E-02	6.E-04	2.E-07	3.E-07	3.E-07

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
Cd-107	5.E-02	6.E-04	1.E-07	1.E-07	1.E-07
Cd-109	5.E-02	1.E-05	1.E-10	3.E-10	3.E-10
Cd-113m	5.E-02	9.E-07	8.E-12	3.E-11	3.E-11
Cd-113	5.E-02	8.E-07	8.E-12	3.E-11	3.E-11
Cd-115m	5.E-02	9.E-06	2.E-10	3.E-10	3.E-10
Cd-115	5.E-02	3.E-05	3.E-09	3.E-09	3.E-09
Cd-117m	5.E-02	1.E-04	3.E-08	4.E-08	3.E-08
Cd-117	5.E-02	1.E-04	3.E-08	4.E-08	3.E-08
In-109	2.E-02	5.E-04	1.E-07	2.E-07	
In-110 (69 min)	2.E-02	4.E-04	1.E-07	1.E-07	
In-110 (5 h)	2.E-02	1.E-04	4.E-08	5.E-08	
In-111	2.E-02	1.E-04	1.E-08	2.E-08	
In-112	2.E-02	6.E-03	2.E-06	2.E-06	
In-113m	2.E-02	1.E-03	3.E-07	5.E-07	
In-114m	2.E-02	9.E-06	1.E-10	2.E-10	
In-115m	2.E-02	4.E-04	1.E-07	1.E-07	
In-115	2.E-02	1.E-06	3.E-12	1.E-11	
In-116m	2.E-02	7.E-04	2.E-07	3.E-07	
In-117m	2.E-02	3.E-04	8.E-08	1.E-07	
In-117	2.E-02	2.E-03	4.E-07	5.E-07	
In-119m	2.E-02	1.E-03	3.E-07	3.E-07	
Sn-110	2.E-02	9.E-05	3.E-08	3.E-08	
Sn-111	2.E-02	2.E-03	5.E-07	6.E-07	
Sn-113	2.E-02	5.E-05	3.E-09	1.E-09	
Sn-117m	2.E-02	5.E-05	5.E-09	3.E-09	
Sn-119m	2.E-02	1.E-04	6.E-09	2.E-09	
Sn-121m	2.E-02	1.E-04	2.E-09	1.E-09	
Sn-121	2.E-02	2.E-04	4.E-08	3.E-08	
Sn-123m	2.E-02	1.E-03	3.E-07	3.E-07	
Sn-123	2.E-02	2.E-05	2.E-09	4.E-10	
Sn-125	2.E-02	1.E-05	2.E-09	8.E-10	
Sn-126	2.E-02	8.E-06	1.E-10	2.E-10	
Sn-127	2.E-02	2.E-04	5.E-08	4.E-08	
Sn-128	2.E-02	3.E-04	6.E-08	9.E-08	
Sb-115	1.E-01	2.E-03	6.E-07		
	1.E-02	2.E-03		7.E-07	
Sb-116m	1.E-01	6.E-04	2.E-07		
	1.E-02	6.E-04		3.E-07	
Sb-116	1.E-01	2.E-03	7.E-07		
	1.E-02	2.E-03		8.E-07	
Sb-117	1.E-01	2.E-03	5.E-07		
	1.E-02	2.E-03		7.E-07	
Sb-118m	1.E-01	2.E-04	5.E-08		
	1.E-02	2.E-04		5.E-08	
Sb-119	1.E-01	4.E-04	1.E-07		
	1.E-02	4.E-04		6.E-08	
Sb-120 (16 min)	1.E-01	5.E-03	1.E-06		
	1.E-02	5.E-03		1.E-06	
Sb-120 (6 d)	1.E-01	3.E-05	5.E-09		
	1.E-02	2.E-05		3.E-09	
Sb-122	1.E-01	2.E-05	5.E-09		
	1.E-02	2.E-05		2.E-09	
Sb-124m	1.E-01	7.E-03	2.E-06		
	1.E-02	7.E-03		1.E-06	
Sb-124	1.E-01	2.E-05	2.E-09		
	1.E-02	1.E-05		6.E-10	
Sb-125	1.E-01	6.E-05	6.E-09		
	1.E-02	5.E-05		1.E-09	
Sb-126m	1.E-01	2.E-03	4.E-07		
	1.E-02	2.E-03		5.E-07	
Sb-126	1.E-01	1.E-05	3.E-09		
	1.E-02	1.E-05		1.E-09	
Sb-127	1.E-01	2.E-05	5.E-09		
	1.E-02	2.E-05		2.E-09	
Sb-128 (9 h)	1.E-01	3.E-05	1.E-08		
	1.E-02	3.E-05		8.E-09	
Sb-128 (10 min)	1.E-01	3.E-03	9.E-07		
	1.E-02	3.E-03		1.E-06	

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TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
Sb-129	1.E-01	8.E-05	2.E-08		
	1.E-02	8.E-05		2.E-08	
Sb-130	1.E-01	5.E-04	2.E-07		
	1.E-02	5.E-04		2.E-07	
Sb-131	1.E-01	5.E-04	9.E-08		
	1.E-02	5.E-04		1.E-07	
Te-116	2.E-01	2.E-04	5.E-08	7.E-08	
Te-121m	2.E-01	2.E-05	9.E-10	1.E-09	
Te-121	2.E-01	9.E-05	1.E-08	7.E-09	
Te-123m	2.E-01	3.E-05	1.E-09	1.E-09	
Te-123	2.E-01	3.E-05	1.E-09	3.E-09	
Te-125m	2.E-01	4.E-05	2.E-09	2.E-09	
Te-127m	2.E-01	2.E-05	1.E-09	6.E-10	
Te-127	2.E-01	2.E-04	5.E-08	4.E-08	
Te-129m	2.E-01	1.E-05	2.E-09	6.E-10	
Te-129	2.E-01	7.E-04	2.E-07	2.E-07	
Te-131m	2.E-01	2.E-05	3.E-09	2.E-09	
Te-131	2.E-01	2.E-04	3.E-08	3.E-08	
Te-132	2.E-01	2.E-05	2.E-09	2.E-09	
Te-133m	2.E-01	2.E-04	3.E-08	3.E-08	
Te-133	2.E-01	9.E-04	1.E-07	1.E-07	
Te-134	2.E-01	7.E-04	1.E-07	1.E-07	
I-120m	1.E+00	3.E-04	5.E-08		
I-120	1.E+00	2.E-04	3.E-08		
I-121	1.E+00	8.E-04	1.E-07		
I-123	1.E+00	3.E-04	4.E-08		
I-124	1.E+00	4.E-06	6.E-10		
I-125	1.E+00	4.E-06	5.E-10		
I-126	1.E+00	2.E-06	3.E-10		
I-128	1.E+00	2.E-03	3.E-07		
I-129	1.E+00	5.E-07	7.E-11		
I-130	1.E+00	3.E-05	5.E-09		
I-131	1.E+00	3.E-06	4.E-10		
I-132m	1.E+00	3.E-04	5.E-08		
I-132	1.E+00	2.E-04	4.E-08		
I-133	1.E+00	1.E-05	2.E-09		
I-134	1.E+00	7.E-04	1.E-07		
I-1353	1.E+00	7.E-05	1.E-08		
Cs-125	1.E+00	2.E-03	3.E-07		
Cs-127	1.E+00	2.E-03	2.E-07		
Cs-129	1.E+00	6.E-04	8.E-08		
Cs-130	1.E+00	3.E-03	4.E-07		
Cs-131	1.E+00	6.E-04	7.E-08		
Cs-132	1.E+00	7.E-05	9.E-09		
Cs-134m	1.E+00	3.E-03	3.E-07		
Cs-134	1.E+00	2.E-06	2.E-10		
Cs-135m	1.E+00	3.E-03	5.E-07		
Cs-135	1.E+00	2.E-05	3.E-09		
Cs-136	1.E+00	1.E-05	2.E-09		
Cs-137	1.E+00	3.E-06	4.E-10		
Cs-138	1.E+00	9.E-04	1.E-07		
Ba-126	1.E-01	2.E-04	4.E-08		
Ba-128	1.E-01	1.E-05	4.E-09		
Ba-131m	1.E-01	1.E-02	3.E-06		
Ba-131	1.E-01	8.E-05	2.E-08		
Ba-133m	1.E-01	7.E-05	2.E-08		
Ba-133	1.E-01	4.E-05	2.E-09		
Ba-135m	1.E-01	9.E-05	3.E-08		
Ba-139	1.E-01	3.E-04	7.E-08		
Ba-140	1.E-01	2.E-05	3.E-09		
Ba-141	1.E-01	7.E-04	2.E-07		
Ba-142	1.E-01	1.E-03	3.E-07		
La-131	1.E-03	1.E-03	3.E-07	4.E-07	
La-132	1.E-03	9.E-05	2.E-08	3.E-08	
La-135	1.E-03	1.E-03	2.E-07	2.E-07	
La-137	1.E-03	3.E-04	2.E-10	6.E-10	
La-138	1.E-03	2.E-05	8.E-12	3.E-11	
La-140	1.E-03	2.E-05	4.E-09	3.E-09	

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TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[µCi]

Radionuclide	f_1 value	Ingested water DCG (µCi/mL)	Inhaled air DCG (µCi/mL)		
			D	W	Y
La-141	1.E-03	1.E-04	2.E-08	3.E-08	
La-142	1.E-03	2.E-04	5.E-08	8.E-08	
La-143	1.E-03	1.E-03	2.E-07	2.E-07	
Ce-134	3.E-04	1.E-05		2.E-09	2.E-09
Ce-135	3.E-04	4.E-05		9.E-09	8.E-09
Ce-137m	3.E-04	7.E-05		1.E-08	9.E-09
Ce-137	3.E-04	1.E-03		3.E-07	3.E-07
Ce-139	3.E-04	1.E-04		2.E-09	2.E-09
Ce-141	3.E-04	5.E-05		2.E-09	1.E-09
Ce-143	3.E-04	3.E-05		4.E-09	4.E-09
Ce-144	3.E-04	7.E-06		6.E-11	3.E-11
Pr-136	3.E-04	2.E-03		6.E-07	5.E-07
Pr-137	3.E-04	1.E-03		4.E-07	3.E-07
Pr-138m	3.E-04	3.E-04		1.E-07	1.E-07
Pr-139	3.E-04	1.E-03		3.E-07	2.E-07
Pr-142m	3.E-04	2.E-03		4.E-07	3.E-07
Pr-142	3.E-04	3.E-05		5.E-09	4.E-09
Pr-143	3.E-04	3.E-05		2.E-09	2.E-09
Pr-144	3.E-04	1.E-03		3.E-07	3.E-07
Pr-145	3.E-04	9.E-05		2.E-08	2.E-08
Pr-147	3.E-04	2.E-03		5.E-07	4.E-07
Nd-136	3.E-04	4.E-04		1.E-07	1.E-07
Nd-138	3.E-04	5.E-05		1.E-08	1.E-08
Nd-139m	3.E-04	1.E-04		4.E-08	3.E-08
Nd-139	3.E-04	2.E-03		8.E-07	7.E-07
Nd-141	3.E-04	4.E-03		2.E-06	1.E-06
Nd-147	3.E-04	4.E-05		2.E-09	2.E-09
Nd-149	3.E-04	3.E-04		6.E-08	6.E-08
Nd-151	3.E-04	2.E-03		5.E-07	4.E-07
Pm-141	3.E-04	2.E-03		4.E-07	4.E-07
Pm-143	3.E-04	1.E-04		1.E-09	2.E-09
Pm-144	3.E-04	4.E-05		3.E-10	3.E-10
Pm-145	3.E-04	3.E-04		5.E-10	4.E-10
Pm-146	3.E-04	4.E-05		1.E-10	1.E-10
Pm-147	3.E-04	1.E-04		5.E-10	4.E-10
Pm-148m	3.E-04	2.E-05		7.E-10	7.E-10
Pm-148	3.E-04	1.E-05		1.E-09	1.E-09
Pm-149	3.E-04	4.E-05		5.E-09	4.E-09
Pm-150	3.E-04	1.E-04		5.E-08	4.E-08
Pm-151	3.E-04	5.E-05		8.E-09	7.E-09
Sm-141m	3.E-04	8.E-04		2.E-07	
Sm-141	3.E-04	2.E-03		4.E-07	
Sm-142	3.E-04	2.E-04		6.E-08	
Sm-145	3.E-04	2.E-04		1.E-09	
Sm-146	3.E-04	7.E-07		1.E-13	
Sm-147	3.E-04	8.E-07		2.E-13	
Sm-151	3.E-04	4.E-04		4.E-10	
Sm-153	3.E-04	5.E-05		7.E-09	
Sm-155	3.E-04	2.E-03		5.E-07	
Sm-156	3.E-04	1.E-04		2.E-08	
Eu-145	1.E-03	4.E-05		5.E-09	
Eu-146	1.E-03	3.E-05		3.E-09	
Eu-147	1.E-03	8.E-05		4.E-09	
Eu-148	1.E-03	3.E-05		8.E-10	
Eu-149	1.E-03	3.E-04		7.E-09	
Eu-150 (12 h)	1.E-03	9.E-05		2.E-08	
Eu-150 (34 yr)	1.E-03	2.E-05		4.E-11	
Eu-152m	1.E-03	7.E-05		2.E-08	
Eu-152	1.E-03	2.E-05		6.E-11	
Eu-154	1.E-03	1.E-05		5.E-11	
Eu-155	1.E-03	1.E-04		3.E-10	
Eu-156	1.E-03	2.E-05		1.E-09	
Eu-157	1.E-03	6.E-05		1.E-08	
Eu-158	1.E-03	5.E-04		1.E-07	
Gd-145	3.E-04	1.E-03	4.E-07	4.E-07	
Gd-146	3.E-04	4.E-05	3.E-10	7.E-10	
Gd-147	3.E-04	5.E-05	1.E-08	8.E-09	
Gd-148	3.E-04	7.E-07	4.E-14	1.E-13	

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TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGs) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
Gd-149	3.E-04	8.E-05	5.E-09	6.E-09	
Gd-151	3.E-04	2.E-04	2.E-09	3.E-09	
Gd-152	3.E-04	9.E-07	5.E-14	2.E-13	
Gd-153	3.E-04	1.E-04	6.E-10	1.E-09	
Gd-159	3.E-04	7.E-05	2.E-08	1.E-08	
Tb-147	3.E-04	2.E-04		8.E-08	
Tb-149	3.E-04	1.E-04		2.E-09	
Tb-150	3.E-04	1.E-04		5.E-08	
Tb-151	3.E-04	1.E-04		2.E-08	
Tb-153	3.E-04	1.E-04		2.E-08	
Tb-154	3.E-04	5.E-05		1.E-08	
Tb-155	3.E-04	2.E-04		2.E-08	
Tb-156m (24 h)	3.E-04	2.E-04		2.E-08	
Tb-156m (5 h)	3.E-04	4.E-04		6.E-08	
Tb-156	3.E-04	3.E-05		3.E-09	
Tb-157	3.E-04	1.E-03		1.E-09	
Tb-158	3.E-04	3.E-05		5.E-11	
Tb-160	3.E-04	2.E-05		5.E-10	
Tb-161	3.E-04	5.E-05		4.E-09	
Dy-155	3.E-04	2.E-04		6.E-08	
Dy-157	3.E-04	5.E-04		2.E-07	
Dy-159	3.E-04	3.E-04		6.E-09	
Dy-165	3.E-04	4.E-04		1.E-07	
Dy-166	3.E-04	2.E-05		2.E-09	
Ho-155	3.E-04	1.E-03		4.E-07	
Ho-157	3.E-04	7.E-03		3.E-06	
Ho-159	3.E-04	6.E-03		2.E-06	
Ho-161	3.E-04	3.E-03		1.E-06	
Ho-162m	3.E-04	2.E-03		6.E-07	
Ho-162	3.E-04	2.E-02		6.E-06	
Ho-164m	3.E-04	3.E-03		7.E-07	
Ho-164	3.E-04	6.E-03		2.E-06	
Ho-166m	3.E-04	2.E-05		2.E-11	
Ho-166	3.E-04	2.E-05		4.E-09	
Ho-167	3.E-04	4.E-04		1.E-07	
Er-161	3.E-04	4.E-04		2.E-07	
Er-165	3.E-04	2.E-03		4.E-07	
Er-169	3.E-04	1.E-04		6.E-09	
Er-171	3.E-04	1.E-04		2.E-08	
Er-172	3.E-04	4.E-05		3.E-09	
Tm-162	3.E-04	2.E-03		7.E-07	
Tm-166	3.E-04	1.E-04		3.E-08	
Tm-167	3.E-04	7.E-05		5.E-09	
Tm-170	3.E-04	3.E-05		5.E-10	
Tm-171	3.E-04	3.E-04		1.E-09	
Tm-172	3.E-04	2.E-05		3.E-09	
Tm-173	3.E-04	1.E-04		3.E-08	
Tm-175	3.E-04	2.E-03		6.E-07	
Yb-162	3.E-04	2.E-03		7.E-07	7.E-07
Yb-166	3.E-04	4.E-05		5.E-09	4.E-09
Yb-167	3.E-04	8.E-03		2.E-06	2.E-06
Yb-169	3.E-04	5.E-05		2.E-09	2.E-09
Yb-175	3.E-04	9.E-05		8.E-09	8.E-09
Yb-177	3.E-04	4.E-04		1.E-07	1.E-07
Yb-178	3.E-04	3.E-04		9.E-08	9.E-08
Lu-169	3.E-04	7.E-05		1.E-08	1.E-08
Lu-170	3.E-04	3.E-05		5.E-09	5.E-09
Lu-171	3.E-04	5.E-05		4.E-09	5.E-09
Lu-172	3.E-04	3.E-05		3.E-09	3.E-09
Lu-173	3.E-04	1.E-04		1.E-09	6.E-10
Lu-174m	3.E-04	8.E-05		8.E-10	5.E-10
Lu-174	3.E-04	1.E-04		5.E-10	4.E-10
Lu-176m	3.E-04	2.E-04		6.E-08	5.E-08
Lu-176	3.E-04	2.E-05		3.E-11	2.E-11
Lu-177m	3.E-04	2.E-05		3.E-10	2.E-10
Lu-177	3.E-04	7.E-05		5.E-09	5.E-09
Lu-178m	3.E-04	2.E-03		4.E-07	4.E-07
Lu-178	3.E-04	1.E-03		3.E-07	3.E-07

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
Lu-179	3.E-04	2.E-04		4.E-08	4.E-08
Hf-170	2.E-03	7.E-05	1.E-08	1.E-08	
Hf-172	2.E-03	3.E-05	4.E-11	1.E-10	
Hf-173	2.E-03	1.E-04	3.E-08	3.E-08	
Hf-175	2.E-03	8.E-05	2.E-09	3.E-09	
Hf-177m	2.E-03	5.E-04	1.E-07	2.E-07	
Hf-178m	2.E-03	7.E-06	6.E-12	2.E-11	
Hf-179m	2.E-03	3.E-05	1.E-09	1.E-09	
Hf-180m	2.E-03	2.E-04	5.E-08	6.E-08	
Hf-181	2.E-03	3.E-05	9.E-10	1.E-09	
Hf-182m	2.E-03	1.E-03	2.E-07	3.E-07	
Hf-182	2.E-03	1.E-05	4.E-12	2.E-11	
Hf-183	2.E-03	5.E-04	1.E-07	1.E-07	
Hf-184	2.E-03	7.E-05	2.E-08	1.E-08	
Ta-172	1.E-03	1.E-03		3.E-07	2.E-07
Ta-173	1.E-03	2.E-04		5.E-08	4.E-08
Ta-174	1.E-03	7.E-04		2.E-07	2.E-07
Ta-175	1.E-03	2.E-04		4.E-08	3.E-08
Ta-176	1.E-03	1.E-04		3.E-08	3.E-08
Ta-177	1.E-03	3.E-04		5.E-08	4.E-08
Ta-178	1.E-03	5.E-04		2.E-07	2.E-07
Ta-179	1.E-03	6.E-04		1.E-08	2.E-09
Ta-180m	1.E-03	6.E-04		2.E-07	1.E-07
Ta-180	1.E-03	4.E-05		1.E-09	6.E-11
Ta-182m	1.E-03	6.E-03		1.E-06	1.E-06
Ta-182	1.E-03	2.E-05		8.E-10	3.E-10
Ta-183	1.E-03	3.E-05		3.E-09	2.E-09
Ta-184	1.E-03	5.E-05		1.E-08	1.E-08
Ta-185	1.E-03	7.E-04		2.E-07	2.E-07
Ta-186	1.E-03	2.E-03		5.E-07	5.E-07
W-176	1.E-02	3.E-04			
	3.E-01	4.E-04	1.E-07		
W-177	1.E-02	6.E-04			
	3.E-01	7.E-04	2.E-07		
W-178	1.E-02	2.E-04			
	3.E-01	2.E-04	5.E-08		
W-179	13.E-02	1.E-02			
	3.E-01	2.E-02	4.E-06		
W-181	1.E-02	4.E-04			
	3.E-01	5.E-04	8.E-08		
W-185	1.E-02	7.E-05			
	3.E-01	1.E-04	2.E-08		
W-187	1.E-02	5.E-05			
	3.E-01	7.E-05	2.E-08		
W-188	1.E-02	1.E-05			
	3.E-01	2.E-05	3.E-09		
Re-177	8.E-01	3.E-03	6.E-07	8.E-07	
Re-178	8.E-01	3.E-03	6.E-07	7.E-07	
Re-181	8.E-01	1.E-04	2.E-08	2.E-08	
Re-182 (64 h)	8.E-01	4.E-05	6.E-09	5.E-09	
Re-182 (12 h)	8.E-01	2.E-04	3.E-08	4.E-08	
Re-184m	8.E-01	6.E-05	7.E-09	1.E-09	
Re-184	8.E-01	6.E-05	8.E-09	3.E-09	
Re-186m	8.E-01	4.E-05	5.E-09	4.E-10	
Re-186	8.E-01	5.E-05	7.E-09	4.E-09	
Re-187	8.E-01	2.E-02	2.E-06	2.E-07	
Re-188m	8.E-01	2.E-03	3.E-07	3.E-07	
Re-188	8.E-01	5.E-05	7.E-09	7.E-09	
Re-189	8.E-01	9.E-05	1.E-08	1.E-08	
Os-180	1.E-02	3.E-03	9.E-07	1.E-06	1.E-06
Os-181	1.E-02	4.E-04	1.E-07	1.E-07	1.E-07
Os-182	1.E-02	6.E-05	1.E-08	1.E-08	9.E-09
Os-185	1.E-02	7.E-05	1.E-09	2.E-09	2.E-09
Os-189m	1.E-02	2.E-03	5.E-07	5.E-07	4.E-07
Os-191m	1.E-02	4.E-04	7.E-08	5.E-08	4.E-08
Os-191	1.E-02	7.E-05	5.E-09	4.E-09	3.E-09
Os-193	1.E-02	4.E-05	1.E-08	7.E-09	6.E-09
Os-194	1.E-02	1.E-05	1.E-10	1.E-10	2.E-11

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGs) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[µCi]

Radionuclide	f_1 value	Ingested water DCG (µCi/mL)	Inhaled air DCG (µCi/mL)		
			D	W	Y
Ir-182	1.E-02	1.E-03	3.E-07	4.E-07	3.E-07
Ir-184	1.E-02	2.E-04	6.E-08	8.E-08	6.E-08
Ir-185	1.E-02	1.E-04	3.E-08	3.E-08	2.E-08
Ir-186	1.E-02	7.E-05	2.E-08	1.E-08	1.E-08
Ir-187	1.E-02	3.E-04	7.E-08	7.E-08	6.E-08
Ir-188	1.E-02	5.E-05	1.E-08	8.E-09	8.E-09
Ir-189	1.E-02	2.E-04	1.E-08	9.E-09	9.E-09
Ir-190m	1.E-02	5.E-03	5.E-07	5.E-07	4.E-07
Ir-190	1.E-02	3.E-05	2.E-09	2.E-09	2.E-09
Ir-192m	1.E-02	9.E-05	2.E-10	5.E-10	4.E-11
Ir-192	1.E-02	3.E-05	6.E-10	9.E-10	5.E-10
Ir-194m	1.E-02	2.E-05	2.E-10	4.E-10	2.E-10
Ir-194	1.E-02	3.E-05	7.E-09	5.E-09	4.E-09
Ir-195m	1.E-02	2.E-04	6.E-08	7.E-08	5.E-08
Ir-195	1.E-02	4.E-04	1.E-07	1.E-07	1.E-07
Pt-186	1.E-02	4.E-04	9.E-08		
Pt-188	1.E-02	5.E-05	4.E-09		
Pt-189	1.E-02	3.E-04	7.E-08		
Pt-191	1.E-02	1.E-04	2.E-08		
Pt-193m	1.E-02	8.E-05	1.E-08		
Pt-193	1.E-02	1.E-03	6.E-08		
Pt-195m	1.E-02	6.E-05	1.E-08		
Pt-197m	1.E-02	4.E-04	1.E-07		
Pt-197	1.E-02	9.E-05	2.E-08		
Pt-199	1.E-02	1.E-03	3.E-07		
Pt-200	1.E-02	3.E-05	8.E-09		
Au-193	1.E-01	3.E-04	6.E-08	5.E-08	4.E-08
Au-194	1.E-01	8.E-05	2.E-08	1.E-08	1.E-08
Au-195	1.E-01	1.E-04	3.E-08	3.E-09	1.E-09
Au-198m	1.E-01	3.E-05	6.E-09	3.E-09	3.E-09
Au-198	1.E-01	3.E-05	9.E-09	4.E-09	4.E-09
Au-199	1.E-01	9.E-05	2.E-08	9.E-09	9.E-09
Au-200m	1.E-01	3.E-05	8.E-09	7.E-09	6.E-09
Au-200	1.E-01	7.E-04	2.E-07	2.E-07	2.E-07
Au-201	1.E-01	2.E-03	5.E-07	6.E-07	5.E-07
Hg-193m (Org)	1.E+00	3.E-04	3.E-08		
	4.E-01	1.E-04			
Hg-193m	2.E-02	9.E-05	2.E-08	2.E-08	
Hg-193m (Vapor)			2.E-08		
Hg-193 (Org)	1.E+00	1.E-03	2.E-07		
	4.E-01	5.E-04			
Hg-193	2.E-02	4.E-04	1.E-07	1.E-07	
Hg-193 (Vapor)			7.E-08		
Hg-194 (Org)	1.E+00	5.E-07	7.E-11		
	4.E-01	1.E-06			
Hg-194	2.E-02	2.E-05	1.E-10	3.E-10	
Hg-194 (Vapor)			7.E-11		
Hg-195m (Org)	1.E+00	1.E-04	1.E-08		
	4.E-01	8.E-05			
Hg-195m	2.E-02	6.E-05	1.E-08	9.E-09	
Hg-195m (Vapor)			9.E-09		
Hg-195 (Org)	1.E+00	1.E-03	1.E-07		
	4.E-01	5.E-04			
Hg-195	2.E-02	4.E-04	8.E-08	8.E-08	
Hg-195 (Vapor)			7.E-08		
Hg-197m (Org)	1.E+00	2.E-04	2.E-08		
	4.E-01	1.E-04			
Hg-197m	2.E-02	8.E-05	2.E-08	1.E-08	
Hg-197m (Vapor)			1.E-08		
Hg-197 (Org)	1.E+00	3.E-04	3.E-08		
	4.E-01	2.E-04			
Hg-197	2.E-02	2.E-04	3.E-08	2.E-08	
Hg-197 (Vapor)			2.E-08		
Hg-199m (Org)	1.E+00	3.E-03	4.E-07		
	4.E-01	2.E-03			
Hg-199m	2.E-02	2.E-03	3.E-07	4.E-07	
Hg-199m (Vapor)			2.E-07		
Hg-203 (Org)	1.E+00	1.E-05	2.E-09		

TABLE A–1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
	4.E–01	2.E–05			
Hg-203	2.E–02	7.E–05	3.E–09	3.E–09	
Hg-203 (Vapor)			2.E–09		
Tl-194m	1.E+00	2.E–03	4.E–07		
Tl-194	1.E+00	7.E–03	1.E–06		
Tl-195	1.E+00	2.E–03	3.E–07		
Tl-197	1.E+00	2.E–03	3.E–07		
Tl-198m	1.E+00	8.E–04	1.E–07		
Tl-198	1.E+00	5.E–04	7.E–08		
Tl-199	1.E+00	2.E–03	2.E–07		
Tl-200	1.E+00	2.E–04	3.E–08		
Tl-201	1.E+00	5.E–04	5.E–08		
Tl-202	1.E+00	9.E–05	1.E–08		
Tl-204	1.E+00	4.E–05	5.E–09		
Pb-195m	2.E–01	2.E–03	5.E–07		
Pb-198	2.E–01	9.E–04	2.E–07		
Pb-199	2.E–01	6.E–04	2.E–07		
Pb-200	2.E–01	9.E–05	1.E–08		
Pb-201	2.E–01	2.E–04	5.E–08		
Pb-202m	2.E–01	3.E–04	7.E–08		
Pb-202	2.E–01	4.E–06	1.E–10		
Pb-203	2.E–01	1.E–04	2.E–08		
Pb-205	2.E–01	6.E–05	3.E–09		
Pb-209	2.E–01	7.E–04	1.E–07		
Pb-210	2.E–01	3.E–08	9.E–13		
Pb-211	2.E–01	3.E–04	2.E–09		
Pb-212	2.E–01	3.E–06	8.E–11		
Pb-214	2.E–01	2.E–04	2.E–09		
Bi-200	5.E–02	8.E–04	2.E–07	2.E–07	
Bi-201	5.E–02	3.E–04	7.E–08	9.E–08	
Bi-202	5.E–02	4.E–04	9.E–08	2.E–07	
Bi-203	5.E–02	7.E–05	2.E–08	1.E–08	
Bi-205	5.E–02	4.E–05	6.E–09	3.E–09	
Bi-206	5.E–02	2.E–05	3.E–09	2.E–09	
Bi-207	5.E–02	3.E–05	4.E–09	8.E–10	
Bi-210m	5.E–02	2.E–06	1.E–11	2.E–12	
Bi-210	5.E–02	2.E–05	9.E–10	6.E–11	
Bi-212	5.E–02	1.E–04	6.E–10	7.E–10	
Bi-213	5.E–02	2.E–04	7.E–10	8.E–10	
Bi-214	5.E–02	6.E–04	2.E–09	2.E–09	
Po-203	1.E–01	7.E–04	2.E–07	2.E–07	
Po-205	1.E–01	6.E–04	9.E–08	2.E–07	
Po-207	1.E–01	2.E–04	6.E–08	7.E–08	
Po-210	1.E–01	8.E–08	1.E–12	1.E–12	
At-207	1.E+00	2.E–04	6.E–09	5.E–09	
At-211	1.E+00	3.E–06	2.E–10	1.E–10	
Rn-220		(3)	(3)	(3)	(3)
Rn-222		(4)	(4)	(4)	(4)
Fr-222	1.E+00	6.E–05	1.E–09		
Fr-223	1.E+00	2.E–05	2.E–09		
Ra-223	2.E–01	2.E–07		2.E–12	
Ra-224	2.E–01	4.E–07		4.E–12	
Ra-225	2.E–01	4.E–07		2.E–12	
Ra-226	2.E–01	1.E–07		1.E–12	
Ra-227	2.E–01	6.E–04		4.E–08	
Ra-228	2.E–01	1.E–07		3.E–12	
Ac-224	1.E–03	5.E–05	9.E–11	1.E–10	1.E–10
Ac-225	1.E–03	1.E–06	1.E–12	2.E–12	1.E–12
Ac-226	1.E–03	4.E–06	9.E–12	1.E–11	1.E–11
Ac-227	1.E–03	1.E–08	2.E–15	7.E–15	1.E–14
Ac-228	1.E–03	6.E–05	4.E–11	1.E–10	1.E–10
Th-226	2.E–04	2.E–04		4.E–10	3.E–10
Th-227	2.E–04	4.E–06		8.E–13	7.E–13
Th-228	2.E–04	4.E–07		5.E–14	4.E–14
Th-229	2.E–04	4.E–08		6.E–15	7.E–15
Th-230	2.E–04	3.E–07		4.E–14	5.E–14
Th-231	2.E–04	1.E–04		1.E–08	1.E–08
Th-232	2.E–04	5.E–08		7.E–15	1.E–14

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
Th-234	2.E-04	1.E-05		5.E-10	4.E-10
Pa-227	1.E-03	1.E-04		3.E-10	2.E-10
Pa-228	1.E-03	3.E-05		5.E-11	3.E-11
Pa-230	1.E-03	2.E-05		1.E-11	8.E-12
Pa-231	1.E-03	1.E-08		9.E-15	1.E-14
Pa-232	1.E-03	4.E-05		1.E-10	2.E-10
Pa-233	1.E-03	4.E-05		2.E-09	1.E-09
Pa-234	1.E-03	7.E-05		2.E-08	2.E-08
U-230	5.E-02	2.E-07	1.E-12	8.E-13	
	2.E-03	1.E-06			6.E-13
U-231	5.E-02	1.E-04	2.E-08	1.E-08	
	2.E-03	1.E-04			1.E-08
U-232	5.E-02	1.E-07	1.E-12	9.E-13	
	2.E-03	2.E-06			2.E-14
U-233	5.E-02	5.E-07	4.E-12	2.E-12	
	2.E-03	5.E-06			9.E-14
U-234	5.E-02	5.E-07	4.E-12	2.E-12	
	2.E-03	6.E-06			9.E-14
U-235	5.E-02	5.E-07	5.E-12	2.E-12	
	2.E-03	5.E-06			9.E-14
U-236	5.E-02	5.E-07	5.E-12	2.E-12	
	2.E-03	6.E-06			9.E-14
U-237	5.E-02	5.E-05	6.E-09	4.E-09	
	2.E-03	5.E-05			4.E-09
U-238	5.E-02	6.E-07	5.E-12	2.E-12	
	2.E-03	6.E-06			1.E-13
U-239	5.E-02	2.E-03	4.E-07	4.E-07	
	2.E-03	2.E-03			4.E-07
U-240	5.E-02	4.E-05	9.E-09	7.E-09	
	2.E-03	3.E-05			6.E-09
U-Natural	5.E-02	6.E-07	5.E-12	2.E-12	
	2.E-03	6.E-06			1.E-13
Np-232	1.E-03	4.E-03		1.E-08	
Np-233	1.E-03	2.E-02		7.E-06	
Np-234	1.E-03	6.E-05		6.E-09	
Np-235	1.E-03	7.E-04		3.E-09	
Np-236 (1.E+5 yr)	1.E-03	2.E-07		1.E-13	
Np-236 (22 h)	1.E-03	1.E-04		2.E-10	
Np-237	1.E-03	3.E-08		2.E-14	
Np-238	1.E-03	4.E-05		4.E-10	
Np-239	1.E-03	5.E-05		5.E-09	
Np-240	1.E-03	6.E-04		2.E-07	
Pu-234	1.E-03	2.E-04		5.E-10	
	1.E-04	3.E-04			
	1.E-05	3.E-04			4.E-10
Pu-235	1.E-03	2.E-02		7.E-06	
	1.E-04	2.E-02			
	1.E-05	2.E-02			6.E-06
Pu-236	1.E-03	1.E-07		8.E-14	
	1.E-04	1.E-06			
	1.E-05	5.E-06			1.E-13
Pu-237	1.E-03	3.E-04		8.E-09	
	1.E-04	3.E-04			
	1.E-05	3.E-04			7.E-09
Pu-238	1.E-03	4.E-08		3.E-14	
	1.E-04	4.E-07			
	1.E-05	5.E-06			4.E-14
Pu-239	1.E-03	4.E-08		3.E-14	
	1.E-04	4.E-07			
	1.E-05	4.E-06			4.E-14
Pu-240	1.E-03	4.E-08 [5]		3.E-14	
	1.E-04	4.E-07			
	1.E-05	4.E-06			4.E-14
Pu-241	1.E-03	2.E-06		1.E-12	
	1.E-04	2.E-05			
	1.E-05	2.E-04			2.E-12
Pu-242	1.E-03	4.E-08		3.E-14	
	1.E-04	4.E-07			

TABLE A-1a.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 100 MREM/YR.—Continued

[μCi]

Radionuclide	f_1 value	Ingested water DCG (μCi/mL)	Inhaled air DCG (μCi/mL)		
			D	W	Y
	1.E-05	5.E-06			4.E-14
Pu-243	1.E-03	4.E-04		9.E-08	
	1.E-04	4.E-04			
	1.E-05	4.E-04			9.E-08
Pu-244	1.E-03	4.E-08		3.E-14	
	1.E-04	4.E-07			
	1.E-05	3.E-06			4.E-14
Pu-245	1.E-03	6.E-05		1.E-08	
	1.E-04	6.E-05			
	1.E-05	6.E-05			1.E-08
Pu-246	1.E-03	1.E-05		6.E-10	
	1.E-04	1.E-05			
	1.E-05	1.E-05			6.E-10
Am-237	1.E-03	2.E-03		7.E-07	
Am-238	1.E-03	1.E-03		1.E-08	
Am-239	1.E-03	1.E-04		3.E-08	
Am-240	1.E-03	6.E-05		7.E-09	
Am-241	1.E-03	4.E-08		3.E-14	
Am-242m	1.E-03	4.E-08		3.E-14	
Am-242	1.E-03	1.E-04		2.E-10	
Am-243	1.E-03	4.E-08		3.E-14	
Am-244m	1.E-03	2.E-03		2.E-08	
Am-244	1.E-03	7.E-05		7.E-10	
Am-245	1.E-03	8.E-04		2.E-07	
Am-246m	1.E-03	2.E-03		5.E-07	
Am-246	1.E-03	9.E-04		2.E-07	
Cm-238	1.E-03	4.E-04		3.E-09	
Cm-240	1.E-03	2.E-06		1.E-12	
Cm-241	1.E-03	3.E-05		8.E-11	
Cm-242	1.E-03	1.E-06		7.E-13	
Cm-243	1.E-03	6.E-08		4.E-14	
Cm-244	1.E-03	7.E-08		5.E-14	
Cm-245	1.E-03	4.E-08		3.E-14	
Cm-246	1.E-03	4.E-08		3.E-14	
Cm-247	1.E-03	4.E-08		3.E-14	
Cm-248	1.E-03	1.E-08		7.E-15	
Cm-249	1.E-03	1.E-03		6.E-08	
Cm-250	1.E-03	2.E-09		1.E-15	
Bk-245	1.E-03	6.E-05		3.E-09	
Bk-246	1.E-03	7.E-05		7.E-09	
Bk-247	1.E-03	3.E-08		2.E-14	
Bk-249	1.E-03	1.E-05		9.E-12	
Bk-250	1.E-03	2.E-04		2.E-09	
Cf-244	1.E-03	8.E-04		1.E-09	1.E-09
Cf-246	1.E-03	1.E-05		2.E-11	2.E-11
Cf-248	1.E-03	5.E-07		3.E-13	2.E-13
Cf-249	1.E-03	3.E-08		2.E-14	3.E-14
Cf-250	1.E-03	7.E-08		5.E-14	6.E-14
Cf-251	1.E-03	3.E-08		2.E-14	3.E-14
Cf-252	1.E-03	1.E-07		9.E-14	8.E-14
Cf-253	1.E-03	1.E-05		5.E-12	4.E-12
Cf-254	1.E-03	6.E-08		5.E-14	4.E-14
Es-250	1.E-03	1.E-03		3.E-09	
Es-251	1.E-03	2.E-04		3.E-09	
Es-253	1.E-03	4.E-06		3.E-12	
Es-254m	1.E-03	9.E-06		2.E-11	
Es-254	1.E-03	5.E-07		3.E-13	
Fm-252	1.E-03	1.E-05		3.E-11	
Fm-253	1.E-03	3.E-05		2.E-11	
Fm-254	1.E-03	8.E-05		2.E-10	
Fm-255	1.E-03	1.E-05		5.E-11	
Fm-257	1.E-03	1.E-06		5.E-13	
Md-257	1.E-03	2.E-04		2.E-10	
Md-258	1.E-03	1.E-06		7.E-13	

[1] A dash indicates no values given for this data category.

[2] The inhalation DCG values allow for an additional 50% absorption through the skin, as described in ICRP Publication No. 30: "Limits for Intakes of Radionuclides by Workers, Part 1. For elemental tritium, the lung dose equivalent is used as the basis for the DCG value shown.

[3] DCGs for Rn-220 are being assessed by DOE. Until the review has been completed and new values issued, the value of 3.E−09 µCi/mL given in Figure A-3 shall be used.

[4] DCGs for Rn-222 are being assessed by DOE. Until the review has been completed and new values issued, the value of 3.E−09 µCi/mL given in Figure A-3 shall be used for Rn-222 releases from DOE facilities.

TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
H-3 (Water)		8.E+04	(1)	4.E+03 [2]	
H-3 (Elemental)				7.E+08 [2]	
Be-7	5.E−03	5.E+04		2.E+03	2.E+03
Be-10	5.E−03	1.E+03		1.E+01	1.E+00
C-11 (Org)		4.E+05		4.E+04	
C-11 (CO)			1.E+05		
C-11 (CO_2)			6.E+04		
C-14 (Org)		3.E+03		2.E+02	
C-14 (CO)			2.E+05		
C-14 (CO_2)			2.E+04		
F-18	1.E+00	5.E+04	6.E+03	8.E+03	7.E+03
Na-22	1.E+00	4.E+02	6.E+01		
Na-24	1.E+00	4.E+03	5.E+02		
Mg-28	5.E−01	7.E+02	1.E+02	1.E+02	
Al-26	1.E−02	4.E+02	6.E+00	8.E+00	
Si-31	1.E−02	1.E+04	2.E+03	3.E+03	2.E+03
Si-32	1.E−02	3.E+03	2.E+01	1.E+01	4.E−01
P-32	8.E−01	7.E+02	8.E+01	3.E+01	
P-33	8.E−01	6.E+03	7.E+02	2.E+02	
S-35	8.E−01	1.E+04	2.E+03	2.E+02	
	1.E−01	8.E+03			
S-35 (Gas)			1.E+03		
Cl-36	1.E+00	2.E+03	2.E+02	2.E+01	
Cl-38	1.E+00	3.E+04	4.E+03	4.E+03	
Cl-39	1.E+00	4.E+04	5.E+03	5.E+03	
K-40	1.E+00	3.E+02	4.E+01		
K-42	1.E+00	5.E+03	4.E+02		
K-43	1.E+00	7.E+03	8.E+02		
K-44	1.E+00	4.E+04	6.E+03		
K-45	1.E+00	6.E+04	1.E+04		
Ca-41	3.E−01	4.E+03		3.E+02	
Ca-45	3.E−01	2.E+03		7.E+01	
Ca-47	3.E−01	8.E+02		8.E+01	
Sc-43	1.E−04	7.E+03			2.E+03
Sc-44m	1.E−04	5.E+02			6.E+01
Sc-44	1.E−04	4.E+03			1.E+03
Sc-46	1.E−04	9.E+02			2.E+01
Sc-47	1.E−04	3.E+03			3.E+02
Sc-48	1.E−04	8.E+02			1.E+02
Sc-49	1.E−04	2.E+04			5.E+03
Ti-44	1.E−02	3.E+02	1.E+00	3.E+00	5.E−01
Ti-45	1.E−02	9.E+03	2.E+03	3.E+03	3.E+03
V-47	1.E−02	3.E+04	7.E+03	8.E+03	
V-48	1.E−02	7.E+02	1.E+02	6.E+01	
V-49	1.E−02	1.E+05	3.E+03	2.E+03	
Cr-48	1.E−01	6.E+03	1.E+03	7.E+02	6.E+02
	1.E−02	6.E+03			
Cr-49	1.E−01	3.E+04	7.E+03	9.E+03	8.E+03
	1.E−02	3.E+04			
Cr-51	1.E−01	4.E+04	4.E+03	2.E+03	2.E+03
	1.E−02	4.E+04			
Mn-51	1.E−01	2.E+04	4.E+03	5.E+03	
Mn-52m	1.E−01	4.E+04	8.E+03	9.E+03	
Mn-52	1.E−01	8.E+02	1.E+02	8.E+01	
Mn-53	1.E−01	5.E+04	2.E+03	1.E+03	
Mn-54	1.E−01	2.E+03	8.E+01	7.E+01	
Mn-56	1.E−01	5.E+03	1.E+03	2.E+03	
Fe-52	1.E−01	1.E+03	3.E+02	2.E+02	
Fe-55	1.E−01	9.E+03	2.E+02	4.E+02	
Fe-59	1.E−01	8.E+02	3.E+01	5.E+01	
Fe-60	1.E−01	3.E+01	6.E−01	2.E+00	
Co-55	5.E−02	1.E+03		3.E+02	2.E+02
	3.E−01	2.E+03			

TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Co-56	5.E-02	5.E+02		3.E+01	2.E+01
	3.E-01	4.E+02			
Co-57	5.E-02	8.E+03		2.E+02	6.E+01
	3.E-01	5.E+03			
Co-58m	5.E-02	6.E+04		8.E+03	6.E+03
	3.E-01	7.E+04			
Co-58	5.E-02	2.E+03		1.E+02	6.E+01
	3.E-01	2.E+03			
Co-60m	5.E-02	2.E+06		3.E+05	2.E+05
	3.E-01	2.E+06			
Co-60	5.E-02	5.E+02		2.E+01	3.E+00
	3.E-01	2.E+02			
Co-61	5.E-02	2.E+04		6.E+03	5.E+03
	3.E-01	2.E+04			
Co-62m	5.E-02	5.E+04		2.E+04	1.E+04
	3.E-01	5.E+04			
Ni-56	5.E-02	2.E+03	2.E+02	1.E+02	
Ni-56 (Vapor)			1.E+02		
Ni-57	5.E-02	2.E+03	4.E+02	3.E+02	
Ni-57 (Vapor)			6.E+02		
Ni-59	5.E-02	3.E+04	3.E+02	6.E+02	
Ni-59 (Vapor)			2.E+02		
Ni-63	5.E-02	1.E+04	1.E+02	2.E+02	
Ni-63 (Vapor)			7.E+01		
Ni-65	5.E-02	9.E+03	2.E+03	3.E+03	
Ni-65 (Vapor)			2.E+03		
Ni-66	5.E-02	5.E+02	1.E+02	6.E+01	
Ni-66 (Vapor)			3.E+02		
Cu-60	5.E-01	3.E+04	8.E+03	1.E+04	9.E+03
Cu-61	5.E-01	1.E+04	3.E+03	4.E+03	3.E+03
Cu-64	5.E-01	1.E+04	3.E+03	2.E+03	2.E+03
Cu-67	5.E-01	5.E+03	7.E+02	5.E+02	4.E+02
Zn-62	5.E-01	2.E+03			3.E+02
Zn-63	5.E-01	3.E+04			6.E+03
Zn-65	5.E-01	4.E+02			2.E+01
Zn-69m	5.E-01	4.E+03			6.E+02
Zn-69	5.E-01	6.E+04			1.E+04
Zn-71m	5.E-01	6.E+03			2.E+03
Zn-72	5.E-01	1.E+03			1.E+02
Ga-65	1.E-03	7.E+04	2.E+04	2.E+04	
Ga-66	1.E-03	1.E+03	3.E+02	3.E+02	
Ga-67	1.E-03	7.E+03	1.E+03	9.E+02	
Ga-68	1.E-03	2.E+04	4.E+03	5.E+03	
Ga-70	1.E-03	7.E+04	2.E+04	2.E+04	
Ga-72	1.E-03	1.E+03	3.E+02	3.E+02	
Ga-73	1.E-03	5.E+03	1.E+03	1.E+03	
Ge-66	1.E+00	3.E+04	2.E+03	2.E+03	
Ge-67	1.E+00	5.E+04	8.E+03	9.E+03	
Ge-68	1.E+00	5.E+03	3.E+02	9.E+00	
Ge-69	1.E+00	1.E+04	1.E+03	7.E+02	
Ge-71	1.E+00	5.E+05	4.E+04	4.E+03	
Ge-75	1.E+00	7.E+04	7.E+03	7.E+03	
Ge-77	1.E+00	9.E+03	9.E+02	5.E+02	
Ge-78	1.E+00	3.E+04	2.E+03	2.E+03	
As-69	5.E-01	5.E+04		1.E+04	
As-70	5.E-01	2.E+04		5.E+03	
As-71	5.E-01	4.E+03		4.E+02	
As-72	5.E-01	9.E+02		1.E+02	
As-73	5.E-01	9.E+03		1.E+02	
As-74	5.E-01	2.E+03		7.E+01	
As-76	5.E-01	1.E+03		1.E+02	
As-77	5.E-01	5.E+03		5.E+02	
As-78	5.E-01	8.E+03		2.E+03	
Se-70	8.E-01	2.E+04	3.E+03	4.E+03	
	5.E-02	1.E+04			
Se-73m	8.E-01	7.E+04	1.E+04	1.E+04	
	5.E-02	4.E+04			
Se-73	8.E-01	7.E+03	1.E+03	1.E+03	

TABLE A–1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
	5.E−02	3.E+03			
Se-75	8.E−01	6.E+02	6.E+01	5.E+01	
	5.E−02	3.E+03			
Se-79	8.E−01	6.E+02	7.E+01	5.E+01	
	5.E−02	5.E+03			
Se-81m	8.E−01	4.E+04	6.E+03	6.E+03	
	5.E−02	3.E+04			
Se-81	8.E−01	9.E+04	2.E+04	2.E+04	
	5.E−02	9.E+04			
Se-83	8.E−01	5.E+04	1.E+04	1.E+04	
	5.E−02	3.E+04			
Br-74m	1.E+00	2.E+04	3.E+03	4.E+03	
Br-74	1.E+00	4.E+04	6.E+03	7.E+03	
Br-75	1.E+00	4.E+04	4.E+03	4.E+03	
Br-76	1.E+00	4.E+03	4.E+02	4.E+02	
Br-77	1.E+00	2.E+04	2.E+03	2.E+03	
Br-80m	1.E+00	2.E+04	2.E+03	1.E+03	
Br-80	1.E+00	9.E+04	2.E+04	2.E+04	
Br-82	1.E+00	3.E+03	4.E+02	3.E+02	
Br-83	1.E+00	7.E+04	6.E+03	6.E+03	
Br-84	1.E+00	3.E+04	5.E+03	6.E+03	
Rb-79	1.E+00	6.E+04	1.E+04		
Rb-81m	1.E+00	3.E+05	3.E+04		
Rb-81	1.E+00	4.E+04	4.E+03		
Rb-82m	1.E+00	1.E+04	2.E+03		
Rb-83	1.E+00	7.E+02	9.E+01		
Rb-84	1.E+00	5.E+02	7.E+01		
Rb-86	1.E+00	6.E+02	7.E+01		
Rb-87	1.E+00	1.E+03	1.E+02		
Rb-88	1.E+00	3.E+04	6.E+03		
Rb-89	1.E+00	7.E+04	1.E+04		
Sr-80	3.E−01	5.E+03	1.E+03		
	1.E−02	4.E+03			1.E+03
Sr-81	3.E−01	3.E+04	7.E+03		
	1.E−02	2.E+04			7.E+03
Sr-82	3.E−01	3.E+02	3.E+01		
	1.E−02	2.E+02			8.E+00
Sr-83	3.E−01	3.E+03	6.E+02		
	1.E−02	2.E+03			3.E+02
Sr-85m	3.E−01	2.E+05	5.E+04		
	1.E−02	2.E+05			8.E+04
Sr-85	3.E−01	3.E+03	2.E+02		
	1.E−02	4.E+03			1.E+02
Sr-87m	3.E−01	5.E+04	1.E+04		
	1.E−02	4.E+04			1.E+04
Sr-89	3.E−01	6.E+02	8.E+01		
	1.E−02	6.E+02			1.E+01
Sr-90	3.E−01	4.E+01	2.E+00		
	1.E−02	5.E+02			3.E−01
Sr-91	3.E−01	2.E+03	5.E+02		
	1.E−02	2.E+03			3.E+02
Sr-92	3.E−01	3.E+03	8.E+02		
	1.E−02	3.E+03			6.E+02
Y-86m	1.E−04	2.E+04		5.E+03	5.E+03
Y-86	1.E−04	1.E+03		3.E+02	3.E+02
Y-87	1.E−04	2.E+03		3.E+02	3.E+02
Y-88	1.E−04	1.E+03		2.E+01	2.E+01
Y-90m	1.E−04	8.E+03		1.E+03	1.E+03
Y-90	1.E−04	5.E+02		6.E+01	5.E+01
Y-91m	1.E−04	1.E+05		2.E+04	1.E+04
Y-91	1.E−04	6.E+02		2.E+01	1.E+01
Y-92	1.E−04	3.E+03		7.E+02	7.E+02
Y-93	1.E−04	1.E+03		3.E+02	2.E+02
Y-94	1.E−04	3.E+04		7.E+03	7.E+03
Y-95	1.E−04	5.E+04		1.E+04	1.E+04
Zr-86	2.E−03	2.E+03	4.E+02	2.E+02	2.E+02
Zr-88	2.E−03	4.E+03	2.E+01	4.E+01	3.E+01
Zr-89	2.E−03	2.E+03	3.E+02	2.E+02	2.E+02

TABLE A–1b.—DERIVED CONCENTRATION GUIDES (DCGs) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Zr-93	2.E−03	3.E+03	1.E+00	6.E+00	6.E+00
Zr-95	2.E−03	2.E+03	2.E+01	3.E+01	2.E+01
Zr-97	2.E−03	7.E+02	2.E+02	1.E+02	1.E+02
Nb-88	1.E−02	7.E+04		2.E+04	2.E+04
Nb-89 (66 min)	1.E−02	1.E+04		4.E+03	3.E+03
Nb-89 (122 min)	1.E−02	5.E+03		2.E+03	1.E+03
Nb-90	1.E−02	1.E+03		2.E+02	2.E+02
Nb-93m	1.E−02	2.E+05		1.E+03	1.E+02
Nb-94	1.E−02	1.E+03		2.E+01	1.E+00
Nb-95m	1.E−02	3.E+03		2.E+02	2.E+02
Nb-95	1.E−02	2.E+03		1.E+02	1.E+02
Nb-96	1.E−02	1.E+03		2.E+02	2.E+02
Nb-97	1.E−02	2.E+04		7.E+03	6.E+03
Nb-98	1.E−02	2.E+04		5.E+03	4.E+03
Mo-90	8.E−01	5.E+03	6.E+02		
	5.E−02	2.E+03			4.E+02
Mo-93m	8.E−01	1.E+04	2.E+03		
	5.E−02	5.E+03			1.E+03
Mo-93	8.E−01	4.E+03	5.E+02		
	5.E−02	2.E+04			2.E+01
Mo-99	8.E−01	2.E+03	2.E+02		
	5.E−02	1.E+03			1.E+02
Mo-101	8.E−01	6.E+04	1.E+04		
	5.E−02	6.E+04			1.E+04
Tc-93m	8.E−01	7.E+04	1.E+04	3.E+04	
Tc-93	8.E−01	3.E+04	6.E+03	9.E+03	
Tc-94m	8.E−01	2.E+04	4.E+03	5.E+03	
Tc-94	8.E−01	9.E+03	2.E+03	2.E+03	
Tc-95m	8.E−01	4.E+03	5.E+02	2.E+02	
Tc-95	8.E−01	1.E+04	2.E+03	2.E+03	
Tc-96m	8.E−01	2.E+05	3.E+04	2.E+04	
Tc-96	8.E−01	2.E+03	3.E+02	2.E+02	
Tc-97m	8.E−01	5.E+03	6.E+02	1.E+02	
Tc-97	8.E−01	4.E+04	4.E+03	5.E+02	
Tc-98	8.E−01	1.E+03	1.E+02	3.E+01	
Tc-99m	8.E−01	9.E+04	1.E+04	2.E+04	
Tc-99	8.E−01	4.E+03	5.E+02	6.E+01	
Tc-101	8.E−01	1.E+05	3.E+04	3.E+04	
Tc-104	8.E−01	3.E+04	7.E+03	8.E+03	
Ru-94	5.E−02	2.E+04	4.E+03	6.E+03	5.E+03
Ru-97	5.E−02	8.E+03	2.E+03	1.E+03	1.E+03
Ru-103	5.E−02	2.E+03	2.E+02	9.E+01	6.E+01
Ru-105	5.E−02	5.E+03	1.E+03	1.E+03	1.E+03
Ru-106	5.E−02	2.E+02	8.E+00	5.E+00	1.E+00
Rh-99m	5.E−02	2.E+04	5.E+03	7.E+03	6.E+03
Rh-99	5.E−02	3.E+03	3.E+02	2.E+02	2.E+02
Rh-100	5.E−02	2.E+03	5.E+02	4.E+02	3.E+02
Rh-101m	5.E−02	6.E+03	1.E+03	7.E+02	7.E+02
Rh-101	5.E−02	2.E+03	4.E+01	7.E+01	1.E+01
Rh-102m	5.E−02	2.E+03	4.E+01	4.E+01	1.E+01
Rh-102	5.E−02	6.E+02	8.E+00	2.E+01	5.E+00
Rh-103m	5.E−02	5.E+05	1.E+05	1.E+05	1.E+05
Rh-105	5.E−02	4.E+03	1.E+03	6.E+02	5.E+02
Rh-106m	5.E−02	9.E+03	2.E+03	3.E+03	3.E+03
Rh-107	5.E−02	1.E+05	2.E+04	2.E+04	2.E+04
Pd-100	5.E−03	1.E+03	1.E+02	1.E+02	1.E+02
Pd-101	5.E−03	1.E+04	3.E+03	3.E+03	3.E+03
Pd-103	5.E−03	8.E+03	6.E+02	4.E+02	3.E+02
Pd-107	5.E−03	4.E+04	2.E+03	7.E+02	3.E+01
Pd-109	5.E−03	2.E+03	6.E+02	5.E+02	4.E+02
Ag-102	5.E−02	7.E+04	2.E+04	2.E+04	2.E+04
Ag-103	5.E−02	4.E+04	9.E+03	1.E+04	1.E+04
Ag-104m	5.E−02	3.E+04	8.E+03	1.E+04	1.E+04
Ag-104	5.E−02	2.E+04	6.E+03	1.E+04	1.E+04
Ag-105	5.E−02	3.E+03	9.E+01	2.E+02	1.E+02
Ag-106m	5.E−02	8.E+02	6.E+01	8.E+01	8.E+01
Ag-106	5.E−02	7.E+04	2.E+04	2.E+04	2.E+04
Ag-108m	5.E−02	7.E+02	2.E+01	2.E+01	2.E+00

TABLE A–1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Ag-110m	5.E−02	5.E+02	1.E+01	2.E+01	8.E+00
Ag-111	5.E−02	1.E+03	1.E+02	8.E+01	8.E+01
Ag-112	5.E−02	3.E+03	7.E+02	9.E+02	8.E+02
Ag-115	5.E−02	3.E+04	8.E+03	7.E+03	7.E+03
Cd-104	5.E−02	2.E+04	6.E+03	1.E+04	1.E+04
Cd-107	5.E−02	2.E+04	5.E+03	5.E+03	4.E+03
Cd-109	5.E−02	4.E+02	4.E+00	1.E+01	1.E+01
Cd-113m	5.E−02	4.E+01	3.E−01	1.E+00	1.E+00
Cd-113	5.E−02	3.E+01	3.E−01	9.E−01	1.E+00
Cd-115m	5.E−02	3.E+02	7.E+00	1.E+01	1.E+01
Cd-115	5.E−02	1.E+03	1.E+02	1.E+02	1.E+02
Cd-117m	5.E−02	5.E+03	1.E+03	2.E+03	1.E+03
Cd-117	5.E−02	5.E+03	1.E+03	2.E+03	1.E+03
In-109	2.E−02	2.E+04	4.E+03	6.E+03	
In-110 (69 min)	2.E−02	2.E+04	4.E+03	5.E+03	
In-110 (5 h)	2.E−02	5.E+03	2.E+03	2.E+03	
In-111	2.E−02	4.E+03	6.E+02	6.E+02	
In-112	2.E−02	2.E+05	6.E+04	6.E+04	
In-113m	2.E−02	5.E+04	1.E+04	2.E+04	
In-114m	2.E−02	4.E+02	6.E+00	9.E+00	
In-115m	2.E−02	2.E+04	4.E+03	4.E+03	
In-115	2.E−02	4.E+01	1.E−01	5.E−01	
In-116m	2.E−02	3.E+04	7.E+03	1.E+04	
In-117m	2.E−02	1.E+04	3.E+03	4.E+03	
In-117	2.E−02	6.E+04	2.E+04	2.E+04	
In-119m	2.E−02	5.E+04	1.E+04	1.E+04	
Sn-110	2.E−02	4.E+03	1.E+03	1.E+03	
Sn-111	2.E−02	8.E+04	2.E+04	2.E+04	
Sn-113	2.E−02	2.E+03	1.E+02	5.E+01	
Sn-117m	2.E−02	2.E+03	2.E+02	1.E+02	
Sn-119m	2.E−02	4.E+03	2.E+02	8.E+01	
Sn-121m	2.E−02	4.E+03	8.E+01	5.E+01	
Sn-121	2.E−02	6.E+03	1.E+03	1.E+03	
Sn-123m	2.E−02	5.E+04	1.E+04	1.E+04	
Sn-123	2.E−02	7.E+02	6.E+01	2.E+01	
Sn-125	2.E−02	5.E+02	8.E+01	3.E+01	
Sn-126	2.E−02	3.E+02	5.E+00	6.E+00	
Sn-127	2.E−02	7.E+03	2.E+03	2.E+03	
Sn-128	2.E−02	1.E+04	2.E+03	3.E+03	
Sb-115	1.E−01	8.E+04	2.E+04		
	1.E−02	8.E+04		3.E+04	
Sb-116m	1.E−01	2.E+04	6.E+03		
	1.E−02	2.E+04		1.E+04	
Sb-116	1.E−01	9.E+04	2.E+04		
	1.E−02	9.E+04		3.E+04	
Sb-117	1.E−01	7.E+04	2.E+04		
	1.E−02	7.E+04		3.E+04	
Sb-118m	1.E−01	6.E+03	2.E+03		
	1.E−02	6.E+03		2.E+03	
Sb-119	1.E−01	2.E+04	4.E+03		
	1.E−02	2.E+04		2.E+03	
Sb-120 (16 min)	1.E−01	2.E+05	4.E+04		
	1.E−02	2.E+05		4.E+04	
Sb-120 (6 d)	1.E−01	1.E+03	2.E+02		
	1.E−02	1.E+03		1.E+02	
Sb-122	1.E−01	9.E+02	2.E+02		
	1.E−02	8.E+02		1.E+02	
Sb-124m	1.E−01	3.E+05	7.E+04		
	1.E−02	3.E+05		5.E+04	
Sb-124	1.E−01	6.E+02	8.E+01		
	1.E−02	6.E+02		2.E+01	
Sb-125	1.E−01	2.E+03	2.E+02		
	1.E−02	2.E+03		5.E+01	
Sb-126m	1.E−01	7.E+04	2.E+04		
	1.E−02	7.E+04		2.E+04	
Sb-126	1.E−01	6.E+02	1.E+02		
	1.E−02	5.E+02		4.E+01	
Sb-127	1.E−01	9.E+02	2.E+02		

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TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
	1.E-02	8.E+02		8.E+01	
Sb-128 (9 h)	1.E-01	1.E+03	4.E+02		
	1.E-02	1.E+03		3.E+02	
Sb-128 (10 min)	1.E-01	1.E+05	3.E+04		
	1.E-02	1.E+05		4.E+04	
Sb-129	1.E-01	3.E+03	8.E+02		
	1.E-02	3.E+03		8.E+02	
Sb-130	1.E-01	2.E+04	6.E+03		
	1.E-02	2.E+04		7.E+03	
Sb-131	1.E-01	2.E+04	4.E+03		
	1.E-02	2.E+04		4.E+03	
Te-116	2.E-01	8.E+03	2.E+03	3.E+03	
Te-121m	2.E-01	8.E+02	3.E+01	4.E+01	
Te-121	2.E-01	3.E+03	4.E+02	3.E+02	
Te-123m	2.E-01	1.E+03	5.E+01	5.E+01	
Te-123	2.E-01	1.E+03	4.E+01	1.E+02	
Te-125m	2.E-01	2.E+03	9.E+01	7.E+01	
Te-127m	2.E-01	7.E+02	4.E+01	2.E+01	
Te-127	2.E-01	8.E+03	2.E+03	2.E+03	
Te-129m	2.E-01	5.E+02	6.E+01	2.E+01	
Te-129	2.E-01	3.E+04	6.E+03	7.E+03	
Te-131m	2.E-01	6.E+02	1.E+02	8.E+01	
Te-131	2.E-01	6.E+03	1.E+03	1.E+03	
Te-132	2.E-01	7.E+02	7.E+01	6.E+01	
Te-133m	2.E-01	7.E+03	1.E+03	1.E+03	
Te-133	2.E-01	3.E+04	5.E+03	5.E+03	
Te-134	2.E-01	3.E+04	4.E+03	5.E+03	
I-120m	1.E+00	1.E+04	2.E+03		
I-120	1.E+00	8.E+03	1.E+03		
I-121	1.E+00	3.E+04	4.E+03		
I-123	1.E+00	1.E+04	2.E+03		
I-124	1.E+00	2.E+02	2.E+01		
I-125	1.E+00	1.E+02	2.E+01		
I-126	1.E+00	7.E+01	1.E+01		
I-128	1.E+00	6.E+04	1.E+04		
I-129	1.E+00	2.E+01	3.E+00		
I-130	1.E+00	1.E+03	2.E+02		
I-131	1.E+00	1.E+02	1.E+01		
I-132m	1.E+00	1.E+04	2.E+03		
I-132	1.E+00	9.E+03	1.E+03		
I-133	1.E+00	5.E+02	8.E+01		
I-134	1.E+00	3.E+04	4.E+03		
I-135	1.E+00	3.E+03	4.E+02		
Cs-125	1.E+00	9.E+04	1.E+04		
Cs-127	1.E+00	7.E+04	9.E+03		
Cs-129	1.E+00	2.E+04	3.E+03		
Cs-130	1.E+00	1.E+05	2.E+04		
Cs-131	1.E+00	2.E+04	3.E+03		
Cs-132	1.E+00	3.E+03	4.E+02		
Cs-134m	1.E+00	1.E+05	1.E+04		
Cs-134	1.E+00	7.E+01	9.E+00		
Cs-135m	1.E+00	1.E+05	2.E+04		
Cs-135	1.E+00	7.E+02	1.E+02		
Cs-136	1.E+00	5.E+02	6.E+01		
Cs-137	1.E+00	1.E+02	1.E+01		
Cs-138	1.E+00	3.E+04	5.E+03		
Ba-126	1.E-01	6.E+03	1.E+03		
Ba-128	1.E-01	5.E+02	2.E+02		
Ba-131m	1.E-01	5.E+05	1.E+05		
Ba-131	1.E-01	3.E+03	7.E+02		
Ba-133m	1.E-01	3.E+03	8.E+02		
Ba-133	1.E-01	2.E+03	7.E+01		
Ba-135m	1.E-01	3.E+03	1.E+03		
Ba-139	1.E-01	1.E+04	3.E+03		
Ba-140	1.E-01	6.E+02	1.E+02		
Ba-141	1.E-01	3.E+04	6.E+03		
Ba-142	1.E-01	5.E+04	1.E+04		
La-131	1.E-03	5.E+04	1.E+04	2.E+04	

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TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
La-132	1.E-03	4.E+03	9.E+02	1.E+03	
La-135	1.E-03	4.E+04	9.E+03	9.E+03	
La-137	1.E-03	1.E+04	6.E+00	2.E+01	
La-138	1.E-03	9.E+02	3.E-01	1.E+00	
La-140	1.E-03	7.E+02	1.E+02	1.E+02	
La-141	1.E-03	4.E+03	8.E+02	1.E+03	
La-142	1.E-03	8.E+03	2.E+03	3.E+03	
La-143	1.E-03	4.E+04	9.E+03	8.E+03	
Ce-134	3.E-04	6.E+02		7.E+01	6.E+01
Ce-135	3.E-04	2.E+03		4.E+02	3.E+02
Ce-137m	3.E-04	3.E+03		4.E+02	3.E+02
Ce-137	3.E-04	5.E+04		1.E+04	1.E+04
Ce-139	3.E-04	5.E+03		7.E+01	6.E+01
Ce-141	3.E-04	2.E+03		6.E+01	5.E+01
Ce-143	3.E-04	1.E+03		2.E+02	1.E+02
Ce-144	3.E-04	3.E+02		2.E+00	1.E+00
Pr-136	3.E-04	8.E+04		2.E+04	2.E+04
Pr-137	3.E-04	4.E+04		1.E+04	1.E+04
Pr-138m	3.E-04	1.E+04		5.E+03	4.E+03
Pr-139	3.E-04	4.E+04		1.E+04	1.E+04
Pr-142m	3.E-04	8.E+04		1.E+04	1.E+04
Pr-142	3.E-04	1.E+03		2.E+02	2.E+02
Pr-143	3.E-04	1.E+03		7.E+01	6.E+01
Pr-144	3.E-04	5.E+04		1.E+04	1.E+04
Pr-145	3.E-04	3.E+03		8.E+02	7.E+02
Pr-147	3.E-04	9.E+04		2.E+04	2.E+04
Nd-136	3.E-04	2.E+04		5.E+03	5.E+03
Nd-138	3.E-04	2.E+03		6.E+02	5.E+02
Nd-139m	3.E-04	5.E+03		2.E+03	1.E+03
Nd-139	3.E-04	9.E+04		3.E+04	3.E+04
Nd-141	3.E-04	2.E+05		6.E+04	5.E+04
Nd-147	3.E-04	1.E+03		8.E+01	7.E+01
Nd-149	3.E-04	1.E+04		2.E+03	2.E+03
Nd-151	3.E-04	7.E+04		2.E+04	2.E+04
Pm-141	3.E-04	6.E+04		2.E+04	2.E+04
Pm-143	3.E-04	5.E+03		5.E+01	6.E+01
Pm-144	3.E-04	1.E+03		1.E+01	1.E+01
Pm-145	3.E-04	1.E+04		2.E+01	2.E+01
Pm-146	3.E-04	2.E+03		4.E+00	4.E+00
Pm-147	3.E-04	5.E+03		2.E+01	1.E+01
Pm-148m	3.E-04	7.E+02		3.E+01	3.E+01
Pm-148	3.E-04	5.E+02		5.E+01	4.E+01
Pm-149	3.E-04	2.E+03		2.E+02	2.E+02
Pm-150	3.E-04	5.E+03		2.E+03	2.E+03
Pm-151	3.E-04	2.E+03		3.E+02	3.E+02
Sm-141m	3.E-04	3.E+04		9.E+03	
Sm-141	3.E-04	6.E+04		2.E+04	
Sm-142	3.E-04	9.E+03		2.E+03	
Sm-145	3.E-04	6.E+03		5.E+01	
Sm-146	3.E-04	3.E+01		6.E-03	
Sm-147	3.E-04	3.E+01		6.E-03	
Sm-151	3.E-04	2.E+04		2.E+01	
Sm-153	3.E-04	2.E+03		3.E+02	
Sm-155	3.E-04	8.E+04		2.E+04	
Sm-156	3.E-04	5.E+03		8.E+02	
Eu-145	1.E-03	2.E+03		2.E+02	
Eu-146	1.E-03	1.E+03		1.E+02	
Eu-147	1.E-03	3.E+03		2.E+02	
Eu-148	1.E-03	1.E+03		3.E+01	
Eu-149	1.E-03	1.E+04		3.E+02	
Eu-150 (12 h)	1.E-03	4.E+03		7.E+02	
Eu-150 (34 yr)	1.E-03	8.E+02		2.E+00	
Eu-152m	1.E-03	3.E+03		6.E+02	
Eu-152	1.E-03	9.E+02		2.E+00	
Eu-154	1.E-03	6.E+02		2.E+00	
Eu-155	1.E-03	4.E+03		1.E+01	
Eu-156	1.E-03	6.E+02		4.E+01	
Eu-157	1.E-03	2.E+03		4.E+02	

TABLE A–1b.—DERIVED CONCENTRATION GUIDES (DCGs) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 mSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Eu-158	1.E–03	2.E+04		5.E+03	
Gd-145	3.E–04	5.E+04	1.E+04	2.E+04	
Gd-146	3.E–04	1.E+03	1.E+01	3.E+01	
Gd-147	3.E–04	2.E+03	4.E+02	3.E+02	
Gd-148	3.E–04	3.E+01	1.E–03	5.E–03	
Gd-149	3.E–04	3.E+03	2.E+02	2.E+02	
Gd-151	3.E–04	7.E+03	6.E+01	1.E+02	
Gd-152	3.E–04	3.E+01	2.E–03	7.E–03	
Gd-153	3.E–04	5.E+03	2.E+01	5.E+01	
Gd-159	3.E–04	3.E+03	7.E+02	5.E+02	
Tb-147	3.E–04	9.E+03		3.E+03	
Tb-149	3.E–04	5.E+03		7.E+01	
Tb-150	3.E–04	5.E+03		2.E+03	
Tb-151	3.E–04	4.E+03		8.E+02	
Tb-153	3.E–04	5.E+03		6.E+02	
Tb-154	3.E–04	2.E+03		4.E+02	
Tb-155	3.E–04	6.E+03		7.E+02	
Tb-156m (24 h)	3.E–04	7.E+03		7.E+02	
Tb-156m (5 h)	3.E–04	2.E+04		2.E+03	
Tb-156	3.E–04	1.E+03		1.E+02	
Tb-157	3.E–04	5.E+04		5.E+01	
Tb-158	3.E–04	1.E+03		2.E+00	
Tb-160	3.E–04	8.E+02		2.E+01	
Tb-161	3.E–04	2.E+03		1.E+02	
Dy-155	3.E–04	9.E+03		2.E+03	
Dy-157	3.E–04	2.E+04		6.E+03	
Dy-159	3.E–04	1.E+04		2.E+02	
Dy-165	3.E–04	1.E+04		4.E+03	
Dy-166	3.E–04	8.E+02		7.E+01	
Ho-155	3.E–04	4.E+04		1.E+04	
Ho-157	3.E–04	3.E+05		1.E+05	
Ho-159	3.E–04	2.E+05		9.E+04	
Ho-161	3.E–04	1.E+05		4.E+04	
Ho-162m	3.E–04	6.E+04		2.E+04	
Ho-162	3.E–04	8.E+05		2.E+05	
Ho-164m	3.E–04	1.E+05		3.E+04	
Ho-164	3.E–04	2.E+05		6.E+04	
Ho-166m	3.E–04	7.E+02		6.E–01	
Ho-166	3.E–04	9.E+02		2.E+02	
Ho-167	3.E–04	2.E+04		5.E+03	
Er-161	3.E–04	2.E+04		6.E+03	
Er-165	3.E–04	7.E+04		2.E+04	
Er-169	3.E–04	4.E+03		2.E+02	
Er-171	3.E–04	4.E+03		9.E+02	
Er-172	3.E–04	1.E+03		1.E+02	
Tm-162	3.E–04	7.E+04		2.E+04	
Tm-166	3.E–04	4.E+03		1.E+03	
Tm-167	3.E–04	3.E+03		2.E+02	
Tm-170	3.E–04	1.E+03		2.E+01	
Tm-171	3.E–04	1.E+04		5.E+01	
Tm-172	3.E–04	9.E+02		1.E+02	
Tm-173	3.E–04	4.E+03		1.E+03	
Tm-175	3.E–04	1.E+05		2.E+04	
Yb-162	3.E–04	7.E+04		3.E+04	2.E+04
Yb-166	3.E–04	1.E+03		2.E+02	2.E+02
Yb-167	3.E–04	3.E+05		7.E+04	6.E+04
Yb-169	3.E–04	2.E+03		7.E+01	6.E+01
Yb-175	3.E–04	3.E+03		3.E+02	3.E+02
Yb-177	3.E–04	2.E+04		4.E+03	4.E+03
Yb-178	3.E–04	1.E+04		4.E+03	3.E+03
Lu-169	3.E–04	3.E+03		4.E+02	4.E+02
Lu-170	3.E–04	1.E+03		2.E+02	2.E+02
Lu-171	3.E–04	2.E+03		2.E+02	2.E+02
Lu-172	3.E–04	1.E+03		1.E+02	1.E+02
Lu-173	3.E–04	5.E+03		4.E+01	2.E+01
Lu-174m	3.E–04	3.E+03		3.E+01	2.E+01
Lu-174	3.E–04	5.E+03		2.E+01	1.E+01
Lu-176m	3.E–04	8.E+03		2.E+03	2.E+03

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TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Lu-176	3.E-04	8.E+02		1.E+00	7.E-01
Lu-177m	3.E-04	8.E+02		1.E+01	7.E+00
Lu-177	3.E-04	3.E+03		2.E+02	2.E+02
Lu-178m	3.E-04	6.E+04		2.E+04	2.E+04
Lu-178	3.E-04	4.E+04		1.E+04	1.E+04
Lu-179	3.E-04	6.E+03		2.E+03	1.E+03
Hf-170	2.E-03	3.E+03	5.E+02	4.E+02	
Hf-172	2.E-03	1.E+03	2.E+00	5.E+00	
Hf-173	2.E-03	5.E+03	1.E+03	1.E+03	
Hf-175	2.E-03	3.E+03	9.E+01	1.E+02	
Hf-177m	2.E-03	2.E+04	5.E+03	8.E+03	
Hf-178m	2.E-03	3.E+02	2.E-01	8.E-01	
Hf-179m	2.E-03	1.E+03	5.E+01	5.E+01	
Hf-180m	2.E-03	8.E+03	2.E+03	2.E+03	
Hf-181	2.E-03	1.E+03	4.E+01	4.E+01	
Hf-182m	2.E-03	4.E+04	8.E+03	1.E+04	
Hf-182	2.E-03	4.E+02	2.E-01	6.E-01	
Hf-183	2.E-03	2.E+04	4.E+03	5.E+03	
Hf-184	2.E-03	3.E+03	7.E+02	6.E+02	
Ta-172	1.E-03	4.E+04		1.E+04	9.E+03
Ta-173	1.E-03	7.E+03		2.E+03	2.E+03
Ta-174	1.E-03	3.E+04		8.E+03	8.E+03
Ta-175	1.E-03	6.E+03		1.E+03	1.E+03
Ta-176	1.E-03	4.E+03		1.E+03	1.E+03
Ta-177	1.E-03	1.E+04		2.E+03	2.E+03
Ta-178	1.E-03	2.E+04		8.E+03	6.E+03
Ta-179	1.E-03	2.E+04		5.E+02	8.E+01
Ta-180m	1.E-03	2.E+04		6.E+03	5.E+03
Ta-180	1.E-03	2.E+03		4.E+01	2.E+00
Ta-182m	1.E-03	2.E+05		5.E+04	4.E+04
Ta-182	1.E-03	9.E+02		3.E+01	1.E+01
Ta-183	1.E-03	1.E+03		1.E+02	9.E+01
Ta-184	1.E-03	2.E+03		5.E+02	4.E+02
Ta-185	1.E-03	3.E+04		7.E+03	6.E+03
Ta-186	1.E-03	8.E+04		2.E+04	2.E+04
W-176	1.E-02	1.E+04			
	3.E-01	1.E+04	5.E+03		
W-177	1.E-02	2.E+04			
	3.E-01	3.E+04	8.E+03		
W-178	1.E-02	6.E+03			
	3.E-01	8.E+03	2.E+03		
W-179	1.E-02	6.E+05			
	3.E-01	6.E+05	2.E+05		
W-181	1.E-02	2.E+04			
	3.E-01	2.E+04	3.E+03		
W-185	1.E-02	3.E+03			
	3.E-01	4.E+03	6.E+02		
W-187	1.E-02	2.E+03			
	3.E-01	3.E+03	8.E+02		
W-188	1.E-02	6.E+02			
	3.E-01	8.E+02	1.E+02		
Re-177	8.E-01	1.E+05	2.E+04	3.E+04	
Re-178	8.E-01	1.E+05	2.E+04	3.E+04	
Re-181	8.E-01	5.E+03	8.E+02	8.E+02	
Re-182 (64 h)	8.E-01	2.E+03	2.E+02	2.E+02	
Re-182 (12 h)	8.E-01	7.E+03	1.E+03	1.E+03	
Re-184m	8.E-01	2.E+03	3.E+02	4.E+01	
Re-184	8.E-01	2.E+03	3.E+02	1.E+02	
Re-186m	8.E-01	2.E+03	2.E+02	1.E+01	
Re-186	8.E-01	2.E+03	3.E+02	2.E+02	
Re-187	8.E-01	6.E+05	8.E+04	9.E+03	
Re-188m	8.E-01	8.E+04	1.E+04	1.E+04	
Re-188	8.E-01	2.E+03	3.E+02	2.E+02	
Re-189	8.E-01	3.E+03	5.E+02	4.E+02	
Os-180	1.E-02	1.E+05	3.E+04	4.E+04	4.E+04
Os-181	1.E-02	2.E+04	4.E+03	4.E+03	4.E+03
Os-182	1.E-02	2.E+03	5.E+02	4.E+02	4.E+02
Os-185	1.E-02	3.E+03	4.E+01	7.E+01	7.E+01

TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Os-189m	1.E-02	8.E+04	2.E+04	2.E+04	2.E+04
Os-191m	1.E-02	1.E+04	3.E+03	2.E+03	2.E+03
Os-191	1.E-02	3.E+03	2.E+02	1.E+02	1.E+02
Os-193	1.E-02	2.E+03	4.E+02	3.E+02	2.E+02
Os-194	1.E-02	6.E+02	4.E+00	5.E+00	7.E-01
Ir-182	1.E-02	4.E+04	1.E+04	1.E+04	1.E+04
Ir-184	1.E-02	8.E+03	2.E+03	3.E+03	2.E+03
Ir-185	1.E-02	5.E+03	1.E+03	1.E+03	9.E+02
Ir-186	1.E-02	2.E+03	7.E+02	6.E+02	5.E+02
Ir-187	1.E-02	1.E+04	3.E+03	3.E+03	2.E+03
Ir-188	1.E-02	2.E+03	4.E+02	3.E+02	3.E+02
Ir-189	1.E-02	6.E+03	4.E+02	4.E+02	3.E+02
Ir-190m	1.E-02	2.E+05	2.E+04	2.E+04	2.E+04
Ir-190	1.E-02	1.E+03	8.E+01	9.E+01	8.E+01
Ir-192m	1.E-02	3.E+03	8.E+00	2.E+01	1.E+00
Ir-192	1.E-02	1.E+03	2.E+01	4.E+01	2.E+01
Ir-194m	1.E-02	6.E+02	8.E+00	2.E+01	9.E+00
Ir-194	1.E-02	1.E+03	3.E+02	2.E+02	2.E+02
Ir-195m	1.E-02	8.E+03	2.E+03	3.E+03	2.E+03
Ir-195	1.E-02	2.E+04	4.E+03	5.E+03	4.E+03
Pt-186	1.E-02	1.E+04	3.E+03		
Pt-188	1.E-02	2.E+03	2.E+02		
Pt-189	1.E-02	1.E+04	3.E+03		
Pt-191	1.E-02	4.E+03	7.E+02		
Pt-193m	1.E-02	3.E+03	5.E+02		
Pt-193	1.E-02	5.E+04	2.E+03		
Pt-195m	1.E-02	2.E+03	4.E+02		
Pt-197m	1.E-02	2.E+04	4.E+03		
Pt-197	1.E-02	3.E+03	9.E+02		
Pt-199	1.E-02	5.E+04	1.E+04		
Pt-200	1.E-02	1.E+03	3.E+02		
Au-193	1.E-01	1.E+04	2.E+03	2.E+03	2.E+03
Au-194	1.E-01	3.E+03	7.E+02	5.E+02	5.E+02
Au-195	1.E-01	5.E+03	1.E+03	1.E+02	4.E+01
Au-198m	1.E-01	1.E+03	2.E+02	1.E+02	1.E+02
Au-198	1.E-01	1.E+03	3.E+02	2.E+02	2.E+02
Au-199	1.E-01	3.E+03	8.E+02	4.E+02	3.E+02
Au-200m	1.E-01	1.E+03	3.E+02	3.E+02	2.E+02
Au-200	1.E-01	3.E+04	6.E+03	7.E+03	6.E+03
Au-201	1.E-01	9.E+04	2.E+04	2.E+04	2.E+04
Hg-193m (Org)	1.E+00	1.E+04	1.E+03		
	4.E-01	4.E+03			
Hg-193m	2.E-02	3.E+03	8.E+02	7.E+02	
Hg-193m (Vapor)			8.E+02		
Hg-193 (Org)	1.E+00	5.E+04	6.E+03		
	4.E-01	2.E+04			
Hg-193	2.E-02	2.E+04	4.E+03	4.E+03	
Hg-193 (Vapor)			3.E+03		
Hg-194 (Org)	1.E+00	2.E+01	3.E+00		
	4.E-01	5.E+01			
Hg-194	2.E-02	9.E+02	4.E+00	1.E+01	
Hg-194 (Vapor)			3.E+00		
Hg-195m (Org)	1.E+00	5.E+03	5.E+02		
	4.E-01	3.E+03			
Hg-195m	2.E-02	2.E+03	5.E+02	3.E+02	
Hg-195m (Vapor)			4.E+02		
Hg-195 (Org)	1.E+00	4.E+04	4.E+03		
	4.E-01	2.E+04			
Hg-195	2.E-02	1.E+04	3.E+03	3.E+03	
Hg-195 (Vapor)			3.E+03		
Hg-197m (Org)	1.E+00	7.E+03	8.E+02		
	4.E-01	4.E+03			
Hg-197m	2.E-02	3.E+03	7.E+02	4.E+02	
Hg-197m (Vapor)			5.E+02		
Hg-197 (Org)	1.E+00	1.E+04	1.E+03		
	4.E-01	7.E+03			
Hg-197	2.E-02	6.E+03	1.E+03	8.E+02	
Hg-197 (Vapor)			8.E+02		

TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Hg-199m (Org)	1.E+00	1.E+05	1.E+04		
	4.E-01	6.E+04			
Hg-199m	2.E-02	6.E+04	1.E+04	2.E+04	
Hg-199m (Vapor)			7.E+03		
Hg-203 (Org)	1.E+00	5.E+02	7.E+01		
	4.E-01	9.E+02			
Hg-203	2.E-02	3.E+03	1.E+02	1.E+02	
Hg-203 (Vapor)			7.E+01		
Tl-194m	1.E+00	7.E+04	1.E+04		
Tl-194	1.E+00	3.E+05	5.E+04		
Tl-195	1.E+00	7.E+04	1.E+04		
Tl-197	1.E+00	8.E+04	1.E+04		
Tl-198m	1.E+00	3.E+04	5.E+03		
Tl-198	1.E+00	2.E+04	3.E+03		
Tl-199	1.E+00	6.E+04	7.E+03		
Tl-200	1.E+00	8.E+03	1.E+03		
Tl-201	1.E+00	2.E+04	2.E+03		
Tl-202	1.E+00	4.E+03	5.E+02		
Tl-204	1.E+00	2.E+03	2.E+02		
Pb-195m	2.E-01	6.E+04	2.E+04		
Pb-198	2.E-01	3.E+04	6.E+03		
Pb-199	2.E-01	2.E+04	6.E+03		
Pb-200	2.E-01	3.E+03	6.E+02		
Pb-201	2.E-01	8.E+03	2.E+03		
Pb-202m	2.E-01	9.E+03	3.E+03		
Pb-202	2.E-01	1.E+02	5.E+00		
Pb-203	2.E-01	5.E+03	9.E+02		
Pb-205	2.E-01	4.E+03	1.E+02		
Pb-209	2.E-01	3.E+04	5.E+03		
Pb-210	2.E-01	1.E+00	4.E-02		
Pb-211	2.E-01	1.E+04	6.E+01		
Pb-212	2.E-01	1.E+02	3.E+00		
Pb-214	2.E-01	9.E+03	7.E+01		
Bi-200	5.E-02	3.E+04	7.E+03	9.E+03	
Bi-201	5.E-02	1.E+04	3.E+03	3.E+03	
Bi-202	5.E-02	2.E+04	4.E+03	7.E+03	
Bi-203	5.E-02	3.E+03	6.E+02	5.E+02	
Bi-205	5.E-02	1.E+03	2.E+02	1.E+02	
Bi-206	5.E-02	7.E+02	1.E+02	8.E+01	
Bi-207	5.E-02	1.E+03	2.E+02	3.E+01	
Bi-210m	5.E-02	6.E+01	6.E-01	6.E-02	
Bi-210	5.E-02	9.E+02	3.E+01	2.E+00	
Bi-212	5.E-02	5.E+03	2.E+01	3.E+01	
Bi-213	5.E-02	8.E+03	3.E+01	3.E+01	
Bi-214	5.E-02	2.E+04	7.E+01	8.E+01	
Po-203	1.E-01	3.E+04	6.E+03	8.E+03	
Po-205	1.E-01	2.E+04	3.E+03	6.E+03	
Po-207	1.E-01	9.E+03	2.E+03	3.E+03	
Po-210	1.E-01	3.E+00	5.E-02	5.E-02	
At-207	1.E+00	6.E+03	2.E+02	2.E+02	
At-211	1.E+00	1.E+02	7.E+00	5.E+00	
Rn-220		(3)	(3)	(3)	(3)
Rn-222		(4)	(4)	(4)	(4)
Fr-222	1.E+00	2.E+03	4.E+01		
Fr-223	1.E+00	6.E+02	7.E+01		
Ra-223	2.E-01	1.E+01		6.E-02	
Ra-224	2.E-01	2.E+01		2.E-01	
Ra-225	2.E-01	2.E+01		6.E-02	
Ra-226	2.E-01	5.E+00		6.E-02	
Ra-227	2.E-01	2.E+04		2.E+03	
Ra-228	2.E-01	4.E+00		1.E-01	
Ac-224	1.E-03	2.E+03	3.E+00	4.E+00	4.E+00
Ac-225	1.E-03	6.E+01	4.E-02	6.E-02	6.E-02
Ac-226	1.E-03	1.E+02	3.E-01	4.E-01	4.E-01
Ac-227	1.E-03	4.E-01	7.E-05	3.E-04	4.E-04
Ac-228	1.E-03	2.E+03	2.E+00	5.E+00	4.E+00
Th-226	2.E-04	6.E+03		1.E+01	1.E+01
Th-227	2.E-04	1.E+02		3.E-02	3.E-02

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TABLE A–1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Th-228	2.E−04	1.E+01		2.E−03	1.E−03
Th-229	2.E−04	2.E+00		2.E−04	3.E−04
Th-230	2.E−04	1.E+01		1.E−03	2.E−03
Th-231	2.E−04	4.E+03		6.E+02	6.E+02
Th-232	2.E−04	2.E+00		3.E−04	4.E−04
Th-234	2.E−04	4.E+02		2.E+01	1.E+01
Pa-227	1.E−03	4.E+03		1.E+01	9.E+00
Pa-228	1.E−03	1.E+03		2.E+00	1.E+00
Pa-230	1.E−03	9.E+02		4.E−01	3.E−01
Pa-231	1.E−03	5.E−01		3.E−04	5.E−04
Pa-232	1.E−03	2.E+03		5.E+00	7.E+00
Pa-233	1.E−03	2.E+03		6.E+01	5.E+01
Pa-234	1.E−03	3.E+03		7.E+02	6.E+02
U-230	5.E−02	6.E+00	5.E−02	3.E−02	
	2.E−03	4.E+01			2.E−02
U-231	5.E−02	5.E+03	7.E+02	5.E+02	
	2.E−03	5.E+03			4.E+02
U-232	5.E−02	4.E+00	4.E−02	3.E−02	
	2.E−03	8.E+01			7.E−04
U-233	5.E−02	2.E+01	2.E−01	6.E−02	
	2.E−03	2.E+02			3.E−03
U-234	5.E−02	2.E+01	2.E−01	6.E−02	
	2.E−03	2.E+02			3.E−03
U-235	5.E−02	2.E+01	2.E−01	7.E−02	
	2.E−03	2.E+02			4.E−03
U-236	5.E−02	2.E+01	2.E−01	7.E−02	
	2.E−03	2.E+02			4.E−03
U–237	5.E−02	2.E+03	2.E+02	2.E+02	
	2.E−03	2.E+03			1.E+02
U-238	5.E−02	2.E+01	2.E−01	7.E−02	
	2.E−03	2.E+02			4.E−03
U-239	5.E−02	7.E+04	2.E+04	2.E+04	
	2.E−03	7.E+04			1.E+04
U-240	5.E−02	1.E+03	3.E+02	3.E+02	
	2.E−03	1.E+03			2.E+02
U-Natural	5.E−02	2.E+01	2.E−01	7.E−02	
	2.E−03	2.E+02			4.E−03
Np-232	1.E−03	2.E+05		4.E+02	
Np-233	1.E−03	8.E+05		3.E+05	
Np-234	1.E−03	2.E+03		2.E+02	
Np-235	1.E−03	3.E+04		1.E+02	
Np-236 (1.E+5 yr)	1.E−03	7.E+00		5.E−03	
Np-236 (22 h)	1.E−03	4.E+03		6.E+00	
Np-237	1.E−03	1.E+00		9.E−04	
Np-238	1.E−03	2.E+03		1.E+01	
Np-239	1.E−03	2.E+03		2.E+02	
Np-240	1.E−03	2.E+04		7.E+03	
Pu-234	1.E−03	9.E+03		2.E+01	
	1.E−04	9.E+03			
	1.E−05	9.E+03			2.E+01
Pu-235	1.E−03	9.E+05		3.E+05	
	1.E−04	9.E+05			
	1.E−05	9.E+05			2.E+05
Pu-236	1.E−03	5.E+00		3.E−03	
	1.E−04	4.E+01			
	1.E−05	2.E+02			4.E−03
Pu-237	1.E−03	1.E+04		3.E+02	
	1.E−04	1.E+04			
	1.E−05	1.E+04			3.E+02
Pu-238	1.E−03	2.E+00		1.E−03	
	1.E−04	2.E+01			
	1.E−05	2.E+02			2.E−03
Pu-239	1.E−03	2.E+00		1.E−03	
	1.E−04	2.E+01			
	1.E−05	2.E+02			2.E−036
Pu-240	1.E−03	2.E+00		1.E−03	
	1.E−04	2.E+01			
	1.E−05	2.E+02			2.E−03

TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Pu-241	1.E-03	8.E+01		5.E-02	
	1.E-04	8.E+02			
	1.E-05	7.E+03			9.E-02
Pu-242	1.E-03	2.E+00		1.E-03	
	1.E-04	2.E+01			
	1.E-05	2.E+02			2.E-03
Pu-243	1.E-03	2.E+04		3.E+03	
	1.E-04	2.E+04			
	1.E-05	2.E+04			3.E+03
Pu-244	1.E-03	2.E+00		1.E-03	
	1.E-04	2.E+01			
	1.E-05	1.E+02			2.E-03
Pu-245	1.E-03	2.E+03		4.E+02	
	1.E-04	2.E+03			
	1.E-05	2.E+03			4.E+02
Pu-246	1.E-03	4.E+02		2.E+01	
	1.E-04	4.E+02			
	1.E-05	4.E+02			2.E+01
Am-237	1.E-03	8.E+04		2.E+04	
Am-238	1.E-03	4.E+04		6.E+02	
Am-239	1.E-03	5.E+03		1.E+03	
Am-240	1.E-03	2.E+03		3.E+02	
Am-241	1.E-03	1.E+00		1.E-03	
Am-242m	1.E-03	2.E+00		1.E-03	
Am-242	1.E-03	4.E+03		8.E+00	
Am-243	1.E-03	1.E+00		1.E-03	
Am-244m	1.E-03	8.E+04		6.E+02	
Am-244	1.E-03	3.E+03		3.E+01	
Am-245	1.E-03	3.E+04		7.E+03	
Am-246m	1.E-03	6.E+04		2.E+04	
Am-246	1.E-03	3.E+04		9.E+03	
Cm-238	1.E-03	2.E+04		1.E+02	
Cm-240	1.E-03	8.E+01		6.E-02	
Cm-241	1.E-03	1.E+03		3.E+00	
Cm-242	1.E-03	5.E+01		3.E-02	
Cm-243	1.E-03	2.E+00		2.E-03	
Cm-244	1.E-03	3.E+00		2.E-03	
Cm-245	1.E-03	1.E+00		1.E-03	
Cm-246	1.E-03	1.E+00		1.E-03	
Cm-247	1.E-03	2.E+00		1.E-03	
Cm-248	1.E-03	4.E-01		3.E-04	
Cm-249	1.E-03	6.E+04		2.E+03	
Cm-250	1.E-03	7.E-02		5.E-05	
Bk-245	1.E-03	2.E+03		1.E+02	
Bk-246	1.E-03	3.E+03		3.E+02	
Bk-247	1.E-03	1.E+00		8.E-04	
Bk-249	1.E-03	5.E+02		3.E-01	
Bk-250	1.E-03	9.E+03		7.E+01	
Cf-244	1.E-03	3.E+04		5.E+01	5.E+01
Cf-246	1.E-03	4.E+02		8.E-01	8.E-01
Cf-248	1.E-03	2.E+01		1.E-02	9.E-03
Cf-249	1.E-03	1.E+00		8.E-04	1.E-03
Cf-250	1.E-03	3.E+00		2.E-03	2.E-03
Cf-251	1.E-03	1.E+00		8.E-04	1.E-03
Cf-252	1.E-03	5.E+00		3.E-03	3.E-03
Cf-253	1.E-03	4.E+02		2.E-01	2.E-01
Cf-254	1.E-03	2.E+00		2.E-03	2.E-03
Es-250	1.E-03	4.E+04		1.E+02	
Es-251	1.E-03	8.E+03		1.E+02	
Es-253	1.E-03	2.E+02		1.E-01	
Es-254m	1.E-03	3.E+02		9.E-01	
Es-254	1.E-03	2.E+01		1.E-02	
Fm-252	1.E-03	5.E+02		1.E+00	
Fm-253	1.E-03	1.E+03		9.E-01	
Fm-254	1.E-03	3.E+03		6.E+00	
Fm-255	1.E-03	5.E+02		2.E+00	
Fm-257	1.E-03	4.E+01		2.E-02	
Md-257	1.E-03	7.E+03		8.E+00	

TABLE A-1b.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FROM INGESTED WATER AND INHALATION RESULTING IN AN EDE OF 1 MSV/YR.—Continued

[Bq]

Radionuclide	f_1 value	Ingested water DCG (Bq/L)	Inhaled air DCG (Bq/m³)		
			D	W	Y
Md-258	1.E-03	5.E+01		3.E-02	

[1] A dash indicates no values given for this data category.
[2] The inhalation DCG values allow for an additional 50% absorption through the skin, as described in ICRP Publication No. 30: "Limits for Intakes of Radionuclides by Workers, Part 1." For elemental tritium, the lung dose equivalent is used as the basis for the DCG value shown.
[3] DCGs for Rn-220 are being assessed by DOE. Until the review has been completed and new values issued, the value of 1.E+02 Bq/m³ given in Figure A-3 shall be used.
[4] DCGs for Rn-222 are being assessed by DOE. Until the review has been completed and new values issued, the value of 1.E+02 Bq/m³ given in Figure A-3 shall be used for Rn-222 releases from DOE facilities.

TABLE A-2.—ALTERNATE ABSORPTION FACTORS AND LUNG RETENTION CLASSES FOR SPECIFIC COMPOUNDS

Element/symbol	Atomic number	Compound	f_1	Lung retention class
Actinium/Ac	89	Oxides, hydroxides	1.E-03	Y.
		Halides, nitrates	1.E-03	W.
		All others	1.E-03	D.
Aluminum/Al	13	Oxides, hydroxides, carbides, halides, nitrates, elemental form.	1.E-02	W.
		All others	1.E-02	D.
Americium/Am	95	All forms	1.E-03	W.
Antimony/Sb	51	Oxides, hydroxides, halides, sulphides, sulphates, nitrates.	1.E-01	D.
		All others	1.E-02	W.
Arsenic/As	33	All forms	5.E-01	W.
Astatine/At	85	All (as a halide)	1.E+00	W or D; dependent upon associated element.
Barium/Ba	56	All forms	1.E-01	D.
Berkelium/Bk	97	All forms	5.E-04	W.
Beryllium/Be	4	Oxides, halides, nitrates	5.E-03	Y.
		All others	5.E-03	W.
Bismuth/Bi	83	All except nitrates	5.E-02	W.
		Nitrates	5.E-02	D.
Bromine/Br	35	Bromides	1.E+00	W or D; dependent upon associated element.
Cadmium/Cd	48	Oxides, hydroxides	5.E-02	Y.
		Sulphates, halides	5.E-02	W.
		All others	5.E-02	D.
Calcium/Ca	20	All forms	3.E-01	W.
Californium/Cf	98	Oxides, hydroxides	1.E-03	Y.
		All others	1.E-03	W.
Carbon/C	6	Oxides	(1)	D.
		Organic (^{11}C)	1.E-02	W.
		Organic (^{14}C)	7.E-05	W.
Cerium/Ce	58	Oxides, hydroxides, fluorides	3.E-04	Y.
		All others	3.E-04	W.
Cesium/Cs	55	All forms	1.E+00	D.
Chlorine/Cl	17	Chloride	1.E+00	W or D; dependent upon associated element.
Chromium/Cr	24	Oxides, hydroxides	1.E-01	Y.
		Halides, nitrates	1.E-01	W.
		All others	1.E-01	D.
		Ingestion[2]		
		Trivalent	1.E-02	
		Hexavalent	1.E-01	
Cobalt/Co	27	Oxides, hydroxides, halides, nitrates	5.E-02	Y.
		All others	5.E-02	W.
		Ingestion only	3.E-01	
Copper/Cu	29	Oxides, hydroxides	5.E-01	Y.
		Sulphites, halides, nitrates	5.E-01	W.
		All forms	5.E-01	D.
Curium/Cm	96	All forms	1.E-03	W.
Dysprosium/Dy	66	All forms	3.E-04	W.
Einsteinium/Es	99	All forms	5.E-04	W.
Erbium/Er	68	All forms	3.E-04	W.
Europium/Eu	63	All forms	1.E-03	W.
Fermium/Fm	100	All forms	5.E-04	W.

TABLE A-2.—ALTERNATE ABSORPTION FACTORS AND LUNG RETENTION CLASSES FOR SPECIFIC COMPOUNDS—Continued

Element/symbol	Atomic number	Compound	f_1	Lung retention class
Fluorine/F	9	Fluoride	1.E+00	Y, W, or D; dependent upon associated element.
Francium/Fr	87	All forms	1.E+00	D.
Gadolinium/Gd	64	Oxides, hydroxides, Fluorides	3.E−04	W.
		All others	3.E−04.	
Gallium/Ga	31	Oxides, hydroxides, carbides, halides, nitrates	1.E−03	W.
		All others	1.E−03	D.
Germanium/Ge	32	Oxides, sulphides, halides	1.E+00	W.
		All others	1.E+00	D.
Gold/Au	79	Oxides, hydroxides	1.E−01	Y.
		Halides, nitrates	1.E−01	W.
		All others	1.E−01	D.
Hafnium/Ga	72	Oxides, hydroxides, halides, carbides, nitrates	2.E−03	W.
		All others	2.E−03	D.
Holmium/Ho	67	All forms	3.E−04	W.
Hydrogen/H	1	Water (^3H)	1.E+00	
Indium/In	49	Oxides, hydroxides, halides	2.E−02	W.
		All others	2.E−02	D.
Iodine/I	53	All forms	1.E+00	D.
Iridium/Ir	77	Oxides, hydroxides	1.E−02	Y.
		Halides, nitrates, metallic form	1.E−02	W.
		All others	1.E−02	D.
Iron/Fe	26	Oxides, hydroxides, halides	1.E−01	W.
		All others	1.E−01	D.
Lanthanum/La	57	Oxides, hydroxides	1.E−03	W.
		All others	1.E−03	D.
Lead/Pb	82	All forms	2.E−01	D.
Lutetium/Lu	71	Oxides, hydroxides, fluorides	3.E−04	Y.
		All others	3.E−04	W.
Magnesium/Mg	12	Oxides, hydroxides, carbides, halides, nitrates	5.E−01	W.
		All others	5.E−01	D.
Manganese/Mn	25	Oxides, hydroxides, halides, nitrates	1.E−01	W.
		All others	1.E−01	D.
Mendelevium/Md	101	All forms	5.E−04	W.
Mercury/Hg	80	Oxides, hydroxides, halides, nitrates, sulphites	2.E−02	W.
		Sulphates, elemental form	2.E−02	D.
		Organic forms	1.E+00	D.
		Vapor		D.
Molybdenum/Mo	42	Oxides, hydroxides, MoS_2	5.E−02	Y.
		All others	8.E−01	D.
		Ingestion[2]		
		MoS_2	5.E−02	
		All others	8.E−01	
Neodymium/Nd	60	Oxides, hydroxides, carbides, fluorides	3.E−04	Y.
		All others	3.E−04	W.
Neptunium/Np	93	All forms	1.E−03	W.
Nickel/Ni	28	Oxides, hydroxides	5.E−02	W.
		All others (vapor)		D.
Niobium/Nb	41	Oxides, hydroxides	1.E−02	Y.
		All others	1.E−02	W.
Osmium/Os	76	Oxides, hydroxides	1.E−02	Y.
		Halides, nitrates	1.E−02	W.
		All others	1.E−02	D.
Palladium/Pd	46	Oxides, hydroxides	5.E−03	Y.
		Nitrates	5.E−03	W.
		All others	5.E−03	D.
Phosphorus/P	15	Phosphates	8.E−01	W. or D; dependent upon associated element.
Platinum/Pt	78	All forms	1.E−02	D.
Plutonium/Pu	94	Oxides, hydroxides	1.E−05	Y.
		Nitrates	1.E−04	W.
		All others. [Note: Use same values for ingestion]	1.E−03	W.
Polonium/Po	84	Oxides, hydroxides, nitrates	1.E−01	W.
		All others	1.E−01	D.
Potassium/K	19	All forms	1.E+00	D.
Praesodymium/Pr	59	Oxides, hydroxides, carbides, fluorides	3.E−04	Y.
		All others	3.E−04	W.
Promethium/Pm	61	Oxides, hydroxides, carbides, fluorides	3.E−04	Y.
		All others	3.E−04	W.
Protactinium/Pa	91	Oxides, hydroxides	1.E−03	Y.

TABLE A-2.—ALTERNATE ABSORPTION FACTORS AND LUNG RETENTION CLASSES FOR SPECIFIC COMPOUNDS—Continued

Element/symbol	Atomic number	Compound	f_1	Lung retention class
		All others	1.E-03	W.
Radium/Ra	88	All forms	2.E-01	W.
Rhenium/Re	75	Oxides, hydroxides, halides, nitrates	8.E-01	W.
		All others	8.E-01	D.
Rhodium/Rh	45	Oxides, hydroxides	5.E-02	Y.
		Halides	5.E-02	W.
		All others	5.E-02	D.
Rubidium/Rb	37	All forms	1.E+00	D.
Ruthenium/Ru	44	Oxides, hydroxides	5.E-02	Y.
		Halides	5.E-02	W.
		All others	5.E-02	D.
Samarium/Sm	62	All forms	3.E-04	W.
Scandium/Sc	21	All forms	1.E-04	Y.
Selenium/Se	34	Oxides, hydroxides, carbides	8.E-01	W.
		All others	8.E-01	D.
		Ingestion only	5.E-02	
Silicon/Si	14	Ceramic forms	1.E-02	Y.
		Oxides, hydroxides, carbides, nitrates	1.E-02	W.
		All others	1.E-02	D.
Silver/Ag	47	Oxides, hydroxides	5.E-02	Y.
		Nitrates, sulphides	5.E-02	W.
		All others, elemental form	1.E-02	D.
Sodium/Na	11	All forms	1.E+00	D.
Strontium/Sr	38	$SrTiO_3$	1.E-02	Y.
		All others (soluble)	3.E-01	D.
Sulfur/S	16	Sulphates, sulphides	1.E-01	W or D; dependent upon associated element
		All inorganic	8.E-01	
		Elemental form	1.E-01	W.
		Gases	1.E+00	D.
Tantalum/Ta	73	Oxides, hydroxides, halides, carbides, nitrates, nitrides.	1.E-03	Y.
		All others	1.E-03	W.
Technetium/Tc	43	Oxides, hydroxides, halides, nitrates	8.E-01	W.
		All others	8.E-01	D.
Tellurium/Te	52	Oxides, hydroxides, nitrates	2.E-01	W.
		All others	2.E-01	D.
Terbium/Tb	65	All forms	3.E-04	W.
Thallium/Tl	81	All forms	1.E+00	D.
Thorium/Th	90	Oxides, hydroxides	2.E-04	Y.
		All others	2.E-04	W.
Thulium/Tm	69	All forms	3.E-04	W.
Tin/Sn	50	Oxides, hydroxides, halides, nitrates, sulphides, $Sn_3(PO_4)_4$.	2.E-02	W.
		All others	2.E-02	D.
Titanium/Ti	22	$SrTiO_3$	1.E-02	Y.
		Oxides, hydroxides, carbides, halides, nitrates	1.E-02	W.
		All others	1.E-02	D.
Tungsten/W	74	Ingestion/Tungstic acid	1.E-02	
		All others	3.E-01	
Uranium/U	92	UO_2, U_3O_8	2.E-03	Y.
		UO_3, tetravalent compounds	5.E-02	W.
		UF_6, uranyl compounds	5.E-02	D.
Vanadium/V	23	Oxides, hydroxides, carbides, halides	1.E-02	W.
		All others	1.E-02	D.
Ytterbium/Yb	70	Oxides, hydroxides, fluorides	3.E-04	Y.
	.....	All others	3.E-04	W.
Yttrium/Y	39	Oxides, hydroxides	1.E-04	Y.
	All others	1.E-04	W..	
Zinc/Zn	30	All forms	5.E-01	Y.
Zirconium/Zr	40	Carbides	2.E-03	Y.
		Oxides, hydroxides, halides, nitrates	2.E-03	W.
		All others	2.E-03	D.

[1] A dash indicates no data for the value shown.
[2] For ingestion, no lung retention classes are listed.

TABLE A-3.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FOR EXTERNAL EXPOSURE DURING IMMERSION IN AN INFINITE HEMISPHERICAL CLOUD OF UNIFORM CONCENTRATION RESULTING IN AN EDE OF 100 MREM/YR (1 MSV/YR)

[Ci and Bq]

Radionuclide	Half-life	Air immersion DCG	
		(μ Ci/mL)	(Bq/m³)
C-11	20.48 min	2.E-08	7.E+02
N-13	9.97 min	2.E-08	7.E+02
N-16	7.13 s	3.E-09	1.E+02
O-15	122.24 s	2.E-08	7.E+02
F-18 [1]	109.74 min	2.E-08	7.E+02
Na-24 [1]	15.00 h	4.E-09	1.E+02
Mg-27 [2]	9.458 min	2.E-08	7.E+02
Al-28 [2]	2.240 min	1.E-08	4.E+02
Cl-38 [1]	37.21 min	1.E-08	4.E+02
Ar-37	35.02 d	1.E-02	4.E+08
Ar-39	269 yr	4.E-06 [3]	1.E+05
Ar-41	1.827 h	1.E-08	4.E+02
K-43 [1]	22.6 h	2.E-08	2.E+02
Ca-49 [2]	8.719 min	5.E-09	2.E+02
Sc-44 [1]	3.927 h	9.E-09	3.E+02
Sc-46m [2]	18.72 s	2.E-07	7.E+03
Ti-45 [1]	3.08 h	2.E-08	7.E+02
Ti-51 [2]	5.752 min	5.E-08	2.E+03
V-52 [2]	3.75 min	1.E-08	4.E+02
Cr-49 [1]	42.09 min	2.E-08	7.E+02
Mn-52m [1]	21.4 min	8.E-09	3.E+02
Mn-56 [1]	2.5785 h	1.E-08	4.E+02
Mn-57 [2]	1.47 min	2.E-07	7.E+03
Co-60m [1]	10.47 min	4.E-06	1.E+05
Ni-57 [1,4]	36.08 h	1.E-08	4.E+02
Ni-65 [1,5]	2.530 h	3.E-08	1.1E+03
Cu-61 [1]	3.408 h	2.E-08	7.E+02
Cu-62 [2]	9.74 min	2.E-08	7.E+02
Ga-66 [1]	9.40 h	7.E-09	3.E+02
Ga-68 [1]	68.0 min	2.E-08	7.E+02
Ga-72 [1]	14.1 h	7.E-09	3.E+02
Se-73 [1]	7.15 h	2.E-08	7.E+02
Br-77 [1]	57.04 h	6.E-08 [6]	2.E+03
Br-80 [1]	17.4 min	2.E-07	7.E+03
Br-82 [1]	35.30 h	7.E-09	3.E+03
Br-84 [1]	31.80 min	1.E-08	4.E+02
Br-85 [2]	172 s	2.E-07	7.E+03
Kr-79	35.04 h	8.E-08	3.E+03
Kr-81	2.1E+05 yr	2.E-06	4.E+04
Kr-83m	1.83 h	2.E-04	7.E+06
Kr-85	10.72 yr	3.E-06 [3]	1.E+05
Kr-85m	4.48 h	1.E-07	4.E+03
Kr-87	76.8 min	2.E-08	7.E+02
Kr-88	2.84 h	9.E-09	3.E+02
Kr-89	3.16 min	1.E-08	4.E+02
Kr-90	32.32 s	1.E-08	4.E+02
Rb-81 [1]	4.58 h	3.E-08	1.E+03
Rb-82 [2]	1.25 min	2.E-08	7.E+02
Rb-88 [1]	17.8 min	3.E-08	1.E+03
Rb-89 [1]	15.44 min	9.E-09	3.E+02
Rb-90 [2]	147 s	8.E-09	3.E+02
Rb-90m [2]	258 s	5.E-09	2.E+02
Sr-85m [1]	67.66 min	9.E-08	3.E+03
Sr-87m [1]	2.805	6.E-08	2.E+03
Sr-92 [1]	2.71 h	1.E-08	4.E+02
Sr-93 [2]	7.3 min	8.E-09	3.E+02
Y-86 [1]	14.74 h	5.E-09	2.E+02
Y-90m [1]	3.19 h	3.E-08 [6]	1.E+03
Y-91m [1]	49.71 min	4.E-08	1.E+03
Nb-90 [1]	14.60 h	4.E-09	1.E+02
Nb-94	6.26 min	4.E-06	1.E+05
Nb-97 [1]	72.1 min	3.E-08	1.E+03
Nb-97m [1]	60 s	3.E-08	1.E+03
Mo-91 [2]	15.49 min	2.E-08	7.E+02
Mo-101 [1]	14.61	1.E-08	4.E+02
Tc-95 [1]	20.0 h	2.E-08	7.E+02
Tc-96m [1]	51.5 min	5.E-07	3.E+04

TABLE A-3.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FOR EXTERNAL EXPOSURE DURING IMMERSION IN AN INFINITE HEMISPHERICAL CLOUD OF UNIFORM CONCENTRATION RESULTING IN AN EDE OF 100 MREM/YR (1 MSV/YR)—Continued

[Ci and Bq]

Radionuclide	Half-life	Air immersion DCG	
		(μ Ci/mL)	(Bq/m³)
Tc-99m [1]	6.02 h	1.E-07	4.E+03
Tc-101 [1]	14.2 min	6.E-08	2.E+03
Ru-105 [1]	4.44 h	2.E-08	7.E+02
Rh-105m [2]	45 s	7.E-07	3.E+04
Rh-108	29.92 s	8.E-08	3.E+03
Ag-108 [2]	2.37 min	7.E-07	3.E+04
Ag-109m [2]	39.6 s	4.E-06	1.E+05
Ag-110 [2]	24.57 s	4.E-07	1.E+04
Cd-111m [2]	48.7 min	7.E-08	3.E+03
Cd-117 [1]	2.49 h	2.E-08	7.E+02
Cd-117m [1]	3.36 h	9.E-09	3.E+02
In-113m [1]	1.658 h	8.E-08	3.E+03
In-114 [2]	71.9 s	5.E-07	2.E+04
In-116m [1]	54.15 min	8.E-09	3.E+02
In-117 [1]	43.8 min	3.E-08	1.E+03
Sb-117 [1]	2.80 h	1.E-07	4.E+03
Sb-126m [1]	19.0 min	1.E-08	4.E+02
Sb-129 [1]	4.40 h	1.E-08	4.E+02
Te-133 [1]	12.45 min	2.E-08	7.E+02
Te-133 [1]	55.4 min	8.E-09	3.E+02
Te-134 [1]	42.8 min	2.E-08	7.E+02
I-122 [2]	3.62 min	2.E-08	7.E+02
I-128 [1]	24.99 min	2.E-07	7.E+03
I-132 [1]	2.30 h	8.E-09	3.E+02
I-134 [1]	52.6 min	7.E-09	3.E+02
I-135 [1]	6.6.1 h	1.E-08 [6]	4.E+02
I-136 [2]	83 s	7.E-09	3.E+02
Xe-122	20.1 h	3.E-07	1.E+04
Xe-123	2.4 h	3.E-08	1.E+03
Xe-125	16.8 h	8.E-08	3.E+03
Xe-127	36.406 d	7.E-08	3.D+03
Xe-129m	8.89 d	8.E-07	3.E+04
Xe-131m	11.84 d	2.E-06	7.E+04
Xe-133	5.245 d	5.E-07	2.E+04
Xe-133m	2.19 d	6.E-07	2.E+04
Xe-135	9.11 h	8.E-08	3.E+03
Xe-135m	15.36 min	5.E-08	2.E+03
Xe-137	3.83 min	9.E-08	3.E+03
Xe-138	14.13 min	2.E-08	7.E+02
Cs-126 [2]	1.64 min	2.E-08	7.E+02
Cs-129 [1]	32.06 h	8.E-08 [6]	3.E+03
Cs-138 [1]	32.2 min	8.E-09	3.E+02
Cs-139 [2]	9.40 min	5.E-08	2.E+03
Ba-137 [2]	2.552 min	3.E-08	1.E+03
Ba-141 [1]	18.27 min	2.E-08	7.E+02
Ba-142 [1]	10.70 min	2.E-08	7.E+02
La-142 [1]	95.4 min	6.E-09	2.E+02
Pr-144m [2]	7.2 min	4.E-06	1.E+05
Nd-149 [1]	1.73 h	5.E-08	2.E+03
Gd-162 [2]	9.7 min	5.E-08	2.E+03
Td-162 [2]	7.76 min	2.E-08	7.E+02
Dy-157 [1]	8.06 h	6.E-08	2.E+03
Re-182m [1]	12.7 h	2.E-08	7.E+02
Os-190m [2]	9.9 min	1.E-08	4.E+02
Ir-190m [1]	3.2 h	5.E-07 [6]	2.E+04
Au-195m [2]	30.6 s	1.E-07	4.E+03)
Tl-200 [1]	26.1 h	1.E-08	4.E+02
Tl-207 [2]	4.77 min	1.E-06	4.E+04
Tl-208 [2]	3.053 min	5.E-09	2.E+02
Tl-209 [2]	2.20 min	9.E-09	3.E+02
Tl-210 [2]	1.30 min	7.E-09	3.E+02
Pb-204m [2]	66.9 min	9.E-09	3.E+02
Bi-211 [2]	2.13 min	4.E-07	1.E+04
Po-211 [2]	0.516 s	2.E-06	7.E+04
Rn-220	55.61 s	3.E-09	1.E+02
Rn-222	3.82 d	3.E-09	1.E+02
Th-233 [2]	22.3 min	5.E-07	2.E+04

TABLE A-3.—DERIVED CONCENTRATION GUIDES (DCGS) FOR MEMBERS OF THE PUBLIC FOR EXTERNAL EXPOSURE DURING IMMERSION IN AN INFINITE HEMISPHERICAL CLOUD OF UNIFORM CONCENTRATION RESULTING IN AN EDE OF 100 MREM/YR (1 MSV/YR)—Continued

[Ci and Bq]

Radionuclide	Half-life	Air immersion DCG	
		(μ Ci/mL)	(Bq/m³)
Pa-234 [1]	6.70 h	1.E-08	4.E+02
Pa-234m [2]	1.17 min	8.E-07 [3]	3.E+04
U-239 [1]	23.40 min	4.E-07 [6]	1.E+04
Np-240 [1]	65 min	2.E-08	7.E+02
Np-240m [2]	7.4 min	6.E-08	2.E+03
Am-246 [1]	25.0 min	2.E-08	7.E+02

[1] Committed effective dose equivalent from inhalation is calculated in ICRP Publication 30, but the DCG value for external exposure to a contaminated atmospheric cloud is more restrictive than the DCG value for inhalation.

[2] Committed effective dose equivalent from inhalation is not calculated in ICRP Publication 30, but DCG value for external exposure to contaminated cloud should be more restrictive than DCG value for inhalation due to relatively short half-life of radionuclide.

[3] DCG value is determined by limit on annual dose equivalent to skin, rather than limit on annual effective dose equivalent.

[4] DCG value applies to radionuclide in vapor form only; DCG value for inhalation is more restrictive for radionuclide in inorganic form.

[5] DCG value applies to radionuclide in inorganic or vapor form.

[6] DCG value for exposure to contaminated atmospheric cloud is the same as DCG value for inhalation.

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