reasonable in relation to the objectives of the project;

(iv) The adequacy of the applicant's procedures for initiating and maintaining coordination with relevant State, local and professional organizations and agencies, for the purpose of furthering achievement of the project objectives;

(v) The adequacy of the applicant's plan to involve project participants with disabilities and, as appropriate, family members in the development, implementation, and on-going review of project outcomes; and

(vi) The adequacy of the applicant's plan to determine the effectiveness and timeliness in completion of the managerial procedures and objectives of the project's plan of operation.

(2) The maximum possible score awarded under this criterion is indicated in parentheses by the type of project proposed, as follows:

(i) For pilot projects (30 points).

(ii) For the clearinghouse project under § 307.15 (35 points).

(iii) For research projects (15 points).

(iv) For development, improvement, demonstration, or other projects (25 points).

(v) For replication, outreach, or utilization projects (30 points).

(vi) For preservice or inservice training projects (30 points).

(vii) For parent involvement projects (30 points).

(d) *Key personnel.* (20 points) (1) The Secretary reviews each application to determine the qualifications of the key personnel the applicant plans to use on the project, including—

(i) The qualifications of the project director or principal investigator;

(ii) The qualifications of each of the other key personnel to be used in the project;

(iii) the time that each person referred to in paragraphs (d)(1) (i) and (ii) of this section will commit to the project; and

(iv) Strategies of the applicant to identify and recruit personnel with disabilities or from traditionally under-represented groups.

(2) In determining the qualifications of each person referred to in paragraphs (d)(1) (i) and (ii) the Secretary also considers—

(i) Experience and training in conducting, documenting, and applying the types of activities to be conducted; and

(ii) Knowledge of the results and findings of relevant projects and potential for application of this information in addressing the unique needs of the children with deaf-blindness to be included in the project.

(e) *Evaluation.* (15 points) (1) The Secretary reviews each application to determine the quality of the plan for evaluating the project, including—

(i) The adequacy of the applicant's plan to determine, to the extent relevant, the effectiveness of the project in achieving measurable change and positive outcomes for children with deaf-blindness who were served by the project and others for whom the project was designed to benefit;

(ii) The adequacy of the applicant's plan to determine the effectiveness and timeliness in completion of the managerial procedures and objectives of the project's plan of operation; and

(iii) The procedures for recording, reviewing, analyzing, and interpreting for relevant audiences, data generated through conducting project activities.

(Authority: 20 U.S.C. 1422)

49. A new § 307.37 is added to read as follows:

§ 307.37 What additional consideration will be given by the Secretary in carrying out this part?

In carrying out this part, the Secretary takes into consideration the availability and quality of existing services for children with deaf-blindness in the country, and, to the extent practicable, ensures that all parts of the country have an opportunity to receive assistance under this part.

(Authority: 20 U.S.C. 1422)

§ 307.41 [Amended]

50. In § 307.41 the introductory paragraph is amended by removing the words "deaf-blind child or youth" and adding, in their place, the words "child or youth with deaf-blindness".

51. A new § 307.42 is added to read as follows:

§ 307.42 What other conditions must be met by a grantee under this program?

(a) The Secretary, if appropriate, requires grantees to prepare reports describing their procedures, findings, and other relevant information in a form that will maximize the dissemination and use of those procedures, findings, and information.

(b) The Secretary requires delivery of those reports, as appropriate, to—

(1) The regional and Federal resource centers, the clearinghouses, and the technical assistance to parents programs assisted under parts C and D of the Act;

(2) The National Diffusion Network;

(3) The ERIC Clearinghouse on the Handicapped and Gifted;

(4) The Child and Adolescent Service Systems Program (CASSP) under the National Institute of Mental Health;

(5) Appropriate parent and professional organizations;

(6) Organizations representing individuals with disabilities; and

(7) Such other networks as the Secretary may determine to be appropriate.

(Authority: 20 U.S.C. 1410(g))

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Tuesday
May 21, 1991

Part V

Department of Education

34 CFR Part 347

Technology-Related Assistance for Individuals with Disabilities; Training and Public Awareness Projects of National Significance; Proposed ru e

DEPARTMENT OF EDUCATION

34 CFR Part 347

RIN 1820-AA93

Technology-Related Assistance for Individuals with Disabilities: Training and Public Awareness Projects of National Significance

AGENCY: Department of Education.

ACTION: Notice of proposed rulemaking.

SUMMARY: The Secretary proposes regulations to implement the Training and Public Awareness Projects of National Significance under the Technology-Related Assistance for Individuals with Disabilities Program. The regulations implement part C of title II of the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (Pub. L. 100-407). The regulations describe the purposes of the program, the types of activities that may be supported, how the Secretary establishes priorities under the program, application requirements, the selection criteria by which the Secretary evaluates applications, and the requirements that must be met by those applicants that receive awards under the program.

DATES: Comments must be received on or before June 20, 1991.

ADDRESSES: All comments concerning these proposed regulations should be addressed to Betty Jo Berland, National Institute on Disability and Rehabilitation Research, Department of Education, 400 Maryland Avenue, SW., Washington, DC 20202.

FOR FURTHER INFORMATION CONTACT: Carol Cohen; Telephone: (202) 732-5607; deaf or hearing-impaired persons who use telecommunication devices for the deaf (TDD) may call (202) 732-5316.

A copy of any comments that concern information collection requirements should also be sent to the Office of Management and Budget at the address listed in the Paperwork Reduction Act section of this preamble.

SUPPLEMENTARY INFORMATION: The Technology-Related Assistance for Individuals with Disabilities Act of 1988 (Pub. L. 100-407) was enacted on August 19, 1988. In the Act, the Congress noted that there have been major advances in technology during the past decade. The Congress found that the provision of assistive technology devices and services can enable some persons with disabilities to have greater control over their own lives, increase their participation in education, employment, family, and community activities, interact to a greater extent with individuals who do not have disabilities, and otherwise benefit from opportunities that are commonly available to individuals who do not have disabilities. On August 9, 1989, the Secretary published final regulations to implement title I of the Act, the State Grants Program for Technology-Related Assistance for Individuals with Disabilities. That program provides funds to States, on a competitive basis, to develop consumer-responsive comprehensive statewide programs of technology-related assistance for individuals of all ages who have disabilities. On August 13, 1990, the Secretary published final regulations to implement part D of title II of the Act—Demonstration and Innovation Projects.

These proposed regulations are to implement part C of title II of the Act. These proposed regulations describe the activities that may be supported under each of the three project types and state the priorities that may be applied to each of them. From time to time, the Secretary will publish a notice in the **Federal Register** requesting applications for awards under this program; the notice may specify particular priorities under one or more of the project types. The Secretary will refer complete applications to one or more panels of expert peer reviewers, which will evaluate the applications according to the selection criteria in §§ 347.31, 347.32, or 347.33, as appropriate. The Secretary will seek the involvement, as members of the peer review panels, of: Individuals with disabilities, members of the families of individuals with disabilities, and others who have expertise, by reason of training or experience, in such areas as the provision of assistive technology devices or services; public administration; development and implementation of public systems; evaluation of service delivery programs; education, training, and public information; provision of services to individuals with disabilities and their families; health care and benefits administration; personal use of assistive technology; administration of direct loan programs; rehabilitation research; engineering, especially rehabilitation engineering; product testing; and other areas related to the purposes of the program.

In the Act, the Congress specified that the Secretary should seek public input in the development of the priorities under this program, and should publish in **Federal Register** a description of how the priorities were derived. In order to develop these priorities, NIDRR held a public hearing on September 28, 1990 in Washington, DC. This meeting was announced in the **Federal Register** and NIDRR mailed copies of the meeting announcement along with invitations to testify to an extensive list of organizations and individuals who had expressed interest in technology assistance in the past. The mailing went to title I State technology projects, State vocational rehabilitation agencies, applicants and grantees in the title II part D program, Rehabilitation Engineering Centers, Rehabilitation Research and Training Centers, and consumer organizations. Thirty-three organizations presented oral testimony. NIDRR also accepted and considered written comments for one month after the hearing. In all, over one hundred comments and letters of recommendation were received. On the basis of an analysis of the testimony and written comments, NIDRR developed the proposed priorities contained in this document. As provided by § 75.105 of the Education Department General Administrative Regulations (EDGAR), the Secretary may elect to establish other priorities in the future by proposing additional priorities for public comment.

The selection criteria for applications for technology training and public awareness projects are detailed in §§ 347.31, 347.32, and 347.33 and include the extent to which the proposed project addresses an important need; provides a plan of activities that indicates a likelihood of achieving the goals and objectives of the project; includes an appropriate plan for managing the activities under the grant; substantively involves individuals with disabilities or their families or representatives; and has a plan for disseminating the project results and a plan for evaluating the project that will provide an assessment of the extent to which the project has met its goals. The proposed regulations also clarify the obligations of a grantee with respect to information sharing and reporting. Grantees are required by EDGAR to provide final reports to NIDRR. The Department may also require individual grantees to provide reports and documents to information clearinghouses as appropriate to the purpose of the grant.

Executive Order 12291

These proposed regulations have been reviewed in accordance with Executive Order 12291. They are not classified as major because they do not meet the criteria for major regulations established in the order.

Intergovernmental Review

This program is excluded from the intergovernmental review provisions of

section 204 of the Demonstration Cities and Metropolitan Development Act because these are demonstration projects of national significance and do not directly affect State and local governments.

Regulatory Flexibility Act Certification

The Secretary certifies that these proposed regulations would not have a significant economic impact on a substantial number of small entities.

Only a small number of discretionary awards would be made under this program. Although small entities could apply for these grants, the grants would not have a significant economic impact on the recipients nor any impact on most small entities.

Paperwork Reduction Act of 1980

Sections 347.31, 347.32, 347.33, 347.40, and 347.41 contain information collection requirements. As required by the Paperwork Reduction Act of 1980, the Department of Education will submit a copy of these sections to the Office of Management and Budget (OMB) for its review.

(44 U.S.C. 3504(h))

These regulations affect private nonprofit and for-profit entities and institutions of higher education, which are the types of entities eligible to receive awards under this program. The Department needs and uses the information to evaluate the applications and select the entities that will receive the awards.

Annual public reporting and recordkeeping burden for this collection of information is expected to average 16 hours per response for 40 respondents, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Organizations and individuals desiring to submit comments on the information collection requirements should direct them to the Office of Information and Regulatory Affairs, room 3002, New Executive Office Building, Washington, DC 20503; Attention: Daniel Chenok.

Invitation to Comment

Interested persons are invited to submit comments and recommendations regarding these proposed regulations.

All comments submitted in response to these proposed regulations will be available for public inspection, during and after the comment period, in room 3422, 330 C Street, SW., Washington, D.C., between the hours of 8:30 a.m. and 4 p.m., Monday through Friday of each week except Federal holidays.

To assist the Department in complying with the specific requirements of Executive Order 12291 and the Paperwork Reduction Act of 1980 and their overall requirements for reducing regulatory burden, the Secretary invites comment on whether there may be further opportunities to reduce any regulatory burden found in these proposed regulations.

Assessment of Educational Impact

The Secretary particularly requests comments on whether the proposed regulations in this document would require transmission of information that is being gathered by or is available from any other agency or authority of the United States.

List of Subjects in 34 CFR Part 347

Administrative practice and procedure, Education, Educational research, Grant programs—education, Handicapped, Reporting and recordkeeping requirements.

(Catalog of Federal Domestic Assistance Number 84.236, National Institute on Disability and Rehabilitation Research)

Dated: May 15, 1991.

Lamar Alexander,

Secretary of Education.

The Secretary proposes to amend title 34 of the Code of Federal Regulations by adding a new part 347 to read as follows:

PART 347—TRAINING AND PUBLIC AWARENESS PROJECTS OF NATIONAL SIGNIFICANCE IN TECHNOLOGY-RELATED ASSISTANCE FOR INDIVIDUALS WITH DISABILITIES

Subpart A—General

Sec.

Subpart B—What Kinds of Activities Does the Department Support Under This Program?

Subpart C—[Reserved]

Subpart D—How Does the Secretary Make an Award?

Subpart E—What Conditions Must Be Met After an Award?

Authority: 29 U.S.C. 2201–2271, unless otherwise noted.

Subpart A—General

§ 347.1 What is the training and public awareness projects program?

(a) The technology training program provides awards to nonprofit or for-profit entities to develop, demonstrate, disseminate, and evaluate curricula, materials, and methods used to train individuals with disabilities, their family members or representatives, employers, insurers, and persons providing services to or otherwise having contact with persons with disabilities, regarding the provision of technology-related assistance. This program also supports the conduct of training sessions related to technology-related assistance for these entities.

(b) The technology careers program provides support to institutions of higher education to prepare personnel for careers relating to the provision of technology-related assistance to individuals with disabilities.

(c) The public awareness program provides awards to for-profit and nonprofit entities, to carry out national projects that recognize and build awareness of the importance and efficacy of assistive technology devices and assistive technology services for individuals of all ages with disabilities functioning in various settings in daily life.

(Authority: 29 U.S.C. 2251 and 2252)

§ 347.2 What are the purposes of the training and public awareness projects program?

(a) The purposes of technology training projects are to develop and test curricula, materials, and techniques, and to conduct projects to train individuals

of all ages with disabilities functioning in various settings of daily life.

(b) The purpose of technology careers projects is to prepare individuals for careers relating to the provision of technology-related assistance to individuals with disabilities through undergraduate and graduate level education, continuing education, and in-service training.

(c) The purpose of public awareness projects is to build awareness of the importance and efficacy of assistive technology devices and services for individuals of all ages with disabilities functioning in various settings of daily life.

(Authority: 29 U.S.C. 2251–2252)

§ 347.3 Who is eligible for assistance under this program?

(a) Nonprofit and for-profit entities are eligible to receive awards under the technology training program. Public agencies are not eligible to receive awards under the technology training program.

(b) Institutions of higher education are eligible to receive awards under the technology careers program.

(c) Nonprofit and for-profit entities are eligible to receive awards under the public awareness projects program. Public agencies are not eligible to receive awards under the public awareness projects program.

(Authority: 29 U.S.C. 2251 and 2252)

§ 347.4 What regulations apply to this program?

The following regulations apply to the Training and Public Awareness Projects program:

(a) The Education Department General Administrative Regulations (EDGAR) in 34 CFR Part 74 (Administration of Grants to Institutions of Higher Education, Hospitals, and Nonprofit Organizations), Part 75 (Direct Grant Programs), Part 77 (Definitions that Apply to Department Regulations), Part 80 (Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments), Part 81 (General Education Provisions Act—Enforcement), Part 82 (New Restrictions on Lobbying), Part 85 (Governmentwide Debarment and Suspension (Nonprocurement) and Governmentwide Requirements for a Drug-Free Workplace (Grants)), and Part 86 (Drug-Free Schools and Campuses).

(b) The regulations in this part 347.

(Authority: 29 U.S.C. 2201–2253)

§ 347.5 What definitions apply to this program?

(a) Definitions in EDGAR. The following terms used in this part are defined in 34 CFR 77 [1]:

Applicant
Application
Award
Department
EDGAR
Fiscal year
Grant
Grant period
Nonprofit
Nonpublic
Private
Project
Project Period
Public

(b) Definitions in the Technology-Related Assistance for Individuals with Disabilities Act of 1988. The following terms used in the part are defined in section 3 of the Act.

Assistive technology device
Assistive technology service
Individual with disabilities
Institution of higher education
Secretary
Technology-related assistance
Underserved group

(c) Additional definition. As used in this part—"Act" means the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (Pub. L. 100–407).

(Authority: 29 U.S.C. 2201–2271)

Subpart B—What Kinds of Activities Does the Department Support Under This Program?

§ 347.10 What types of projects may be supported under this program?

Under this program, the Secretary awards funds to support the following types of projects:

(a) Technology training projects that may include—

(1) Development, demonstration, delivery, evaluation, and dissemination of training modules on the use of technology-related assistance for consumer organizations, individuals with disabilities or their families or representatives, and advocates;

(2) In-service training for individuals who provide services to or representation for individuals with disabilities, including in-service training for health care workers, teachers, rehabilitation engineers, and other rehabilitation workers;

(3) Training for policymakers and administrators in public and private agencies that have contact with or impact on individuals with disabilities; and

(4) Training regarding the provision of technology-related assistance for employers, manufacturers, and insurers, including training related to product use, financing, and marketing.

(b) Technology career development projects that may include undergraduate and graduate level instructional courses, curriculum development, traineeships, or fellowships and other educational stipends or allowances to prepare personnel for careers relating to the provision of technology-related assistance to individuals with disabilities, especially projects that will train individuals who will provide technical assistance, administer programs, or prepare personnel necessary to support the development and implementation of consumer-responsive, statewide programs of technology-related assistance for individuals with disabilities.

(c) Public awareness projects of a national scope that use: general or specialized media to disseminate information on the benefits and availability of technology-related assistance; techniques to prepare and disseminate analyses of the efficacy of technology-related assitance; national or regional conferences to promote knowledge and interest in technology-related assistance; and award and recognition programs to promote public credit for sustained outstanding effort in the development and use of technology-related assistance.

(Authority: 29 U.S.C. 2251–2253)

§ 347.11 What are the priorities under the technology training program?

(a) Each year the Secretary may establish priorities to support training for individuals with disabilities, their families or representatives, service providers, and other relevant parties, including projects in one or more of the following areas:

(1) Development and implementation of training programs for the purpose of informing consumers and their families about assistive technology services and devices, including training in self-advocacy, funding sources, and policy development.

(2) Development and dissemination of instructional materials for consumers and their families, including self-instruction and multimedia materials, on a range of available technologies and technology information resources, using a variety of accessible formats.

(3) Development and evaluation of training programs that include use of telecommunications, TDD, computer conferences, and other available technologies to instruct consumers and their families about assistive technology.

(4) Development, testing, and dissemination of models for consumers to evaluate different approaches to assistive technology training, including consumer training.

(5) Development, evaluation, and dissemination of models using consumers and their families to train other consumers and their families about the availability and utility of assistive technology.

(6) Development and implementation of approaches to involve manufacturers of assistive technology in improved training of consumers and their families in the use of assistive technology.

(7) Development and implementation of methods for training consumers in rural areas in the use of assistive technology.

(8) Conduct of inservice training for rehabilitation counselors in the provision of assistive technology.

(9) Development, evaluation, implementation, and dissemination of training for representatives of business, industry, and employers on the availability and value of assistive technology for persons with disabilities in employment and in work settings.

(10) Development and implementation of training programs for private insurers and other third party payment representatives on the availability and benefits of assistive technology.

(11) Development, evaluation, implementation, and dissemination of inservice training programs on assistive technology for persons with disabilities for physical therapists.

(12) Development, evaluation, implementation, and dissemination of inservice training programs on assistive technology for persons with disabilities for speech-language pathologists.

(13) Development, evaluation, implementation, and dissemination of inservice training programs on assistive technology for persons with disabilities for occupational therapists.

(14) Development, evaluation, implementation, and dissemination of inservice training programs on assistive technology and application of technology for persons with disabilities for rehabilitation engineers and other engineers who have contact with persons with disabilities in the provision of assistive technology.

(15) Development, evaluation, implementation, and dissemination of models for training low-incidence disability groups on the uses and benefits of assistive technology.

(16) Development, evaluation, implementation, and dissemination of training programs for underserved populations, including economically disadvantaged populations. in the uses of assistive technology.

(17) Development, evaluation, implementation, and dissemination of training modules for older Americans with disabilities who can benefit from assistive technology.

(18) Development, evaluation, implementation, and dissemination of training programs on the use and adaption of commercially available, mass-marketed technologies that have application for persons with disabilities.

(19) Development, evaluation, implementation, and dissemination of training programs about assistive technologies with special application for employment specifically for persons with disabilities who are preparing to enter the job market.

(b) The Secretary will announce the priorities, if any, in an application notice in the **Federal Register.**

(Authority: 29 U.S.C. 2201–2271)

§ 347.12 What are the priorities under the technology careers program?

(a) Each year the Secretary may establish priorities to support training for individuals with disabilities, their families or representatives, service providers, and other relevant parties, with special emphasis on training individuals who will administer programs, provide technical assistance to, or prepare personnel necessary to support the consumer-responsive, statewide programs of technology-related assistance for individuals with disabilities, including projects in one or more of the following areas:

(1) Development of curricula that will ensure competency in rehabilitation technology for engineers.

(2) Development of curricula for speech-language pathologists to ensure competency in the provision of assistive technology.

(3) Development of curricula for occupational therapists to ensure competency in the provision of assistive technology.

(4) Development of curricula for career training programs for physical therapists to ensure competency in the provision of assistive technology.

(5) Development of curricula to prepare personnel for assistive technology careers, including careers in program administration.

(6) Development of training curricula that focus on funding, policy, and advocacy of persons training to be involved in direct service delivery.

(7) Implementation of curricula involving classroom instruction and clinical experience in community-based and at-home settings for either physical therapists, occupational therapists, nurses, physicians in specialities relevant to disability, rehabilitation counselors, speech-language-hearing pathologists, rehabilitation educators, or rehabilitation engineers.

(8) Development and implementation of technology career training programs for students from underserved population groups, including minorities, who are preparing to become service delivery professionals.

(9) Conduct of training programs for individuals preparing to become administrators of programs that provide technology-related assistance.

(10) Implementation of training programs for individuals who will prepare personnel for work in programs that provide technology-related assistance.

(11) Implementation of scholarships, fellowships, and traineeships for undergraduate or graduate students preparing for careers in the management or delivery of technology-related assistance to individuals with disabilities.

(b) The Secretary will announce the priorities, if any, in an application notice in the **Federal Register.**

(Authority: 29 U.S.C. 2201–2271)

§ 347.13 What are the priorities under the public awareness projects program?

(a) The Secretary may establish annual priorities for public awareness projects, including projects in one or more of the following areas:

(1) Development and implementation with consumer involvement, of a multimedia public awareness campaign using national media such as radio, TV, newspapers, and other publications.

(2) Development and implementation of a model public awareness campaign using specialized media, including minority media, to reach previously underserved populations.

(3) Conduct of national or regional conferences that focus on public awareness of the benefits of assistive technology and that include manufacturers, industry representatives, and employers.

(4) Conduct of national or regional conferences for third party payers and private insurance representatives that focus on awareness of the benefits of assistive technology.

(5) Development and dissemination of useful marketing strategies to increase public awareness of assistive technology.

(6) Development of a series of videotapes on assistive technology designed to inform and change attitudes that could be used by medical

practitioners and other clinical service providers.

(7) Development and dissemination of a course for training service providers and consumers to improve and foster public awareness.

(8) Development and dissemination of a public awareness campaign for use by general service organizations, professional associations, and other representational and information groups to increase public awareness of techniques for the provision of assistive technology.

(b) The Secretary will announce the priorities, if any, in an application notice in the **Federal Register**.

(Authority: 29 U.S.C. 2201–2271)

Subpart C [Reserved]

Subpart D—How Does the Secretary Make an Award?

§ 347.30 How does the Secretary evaluate applications under this program?

(a) The Secretary evaluates each application—

(1) For technology training project according to the selection criteria in § 347.31;

(2) For technology career project according to the criteria in § 347.32;

(3) For a public awareness project according to the criteria in § 347.33.

(b) The Secretary awards each application a value of zero to five (0–5) for each of the criteria listed in §§ 347.31, 347.32, and 347.33 respectively. These values are based on how well the application addresses each criterion, as follows: Outstanding (5); Superior (4); Satisfactory (3); Marginal (2); Poor (1); or not addressed in the application (0). In this way, each criterion is judged according to a uniform scale.

(c) Because the Secretary considers certain criteria to be more important than others, the Secretary has weighted each criterion as indicated in §§ 347.31, 347.32, and 347.33 respectively. The value awarded to each criterion in an application is multiplied by the standard weight accorded to that criterion in § 347.31, § 347.32, or § 347.33 as appropriate.

(d) The final score for each application is determined by totaling the scores computed for each criterion.

(e) The maximum score for each application is 100 points.

(Authority: 29 U.S.C. 2251)

§ 347.31 What selection criteria are used to evaluate applications for technology training projects under this program?

The Secretary reviews each application for a model technology training project award to determine the degree to which—

(a) *Importance and significance of proposed activity (Weight: 3; Total Points: 15).* (1) The project responds adequately to all of the requirements of the announced priority, if any;

(2) The proposed activity addresses a significant need in the provision of technology-related training, and the development, dissemination, and evaluation of curricula, materials, and methods used to train individuals with disabilities, their families, and the professionals who work with persons with disabilities; and

(3) The proposed project is likely to result in new, improved, and useful techniques for training individuals about assistive technology services, devices, and information resources;

(b) *Plan of activities* (Weight: 4; Total Points: 20). (1) Indicates a likelihood that the proposed activities will accomplish the goals and objectives of the project;

(2) Is based on a sound conceptual and instructional model;

(3) Uses appropriate materials and populations;

(4) Provides appropriate review of literature and related activities and indicates a familiarity with state-of-the-art in assistive technology services, devices, and information; and

(5) Uses appropriate methodology for measurement and analysis of the effectiveness of the training program;

(c) *Inclusion of individuals with disabilities and their families or representatives* (Weight: 4; Total Points: 20). (1) In the development of the project, including the assessment of problems and needs;

(2) In the establishment of goals and objectives for the project;

(3) In the planning and implementation of the functions and activities to be carried out under the project grant;

(4) In the evaluation of activities under the grant and the assessment of the training program; and

(5) In the dissemination of training models and curricula;

(d) *Management plan* (Weight: 4; Total Points: 20). (1) Includes an adequate number of staff qualified by training and experience to implement the proposed activities;

(2) Appropriately manages and accounts for the fiscal resources of the project;

(3) Details internal procedures for the management of the resources under the grant, including specification of responsibilities and administrative authority, and provisions for internal monitoring of progress;

(4) Includes realistic timelines for the implementation of project activities so as to ensure accomplishment of proposed goals and objectives within the time period proposed in the application;

(5) Allots sufficient and appropriate resources from the grant or other sources for the accomplishment of the proposed project activities; and

(6) Details resources, experience, and capabilities of the institution or organization to accomplish the goals and objectives proposed in the application;

(e) *Dissemination plan* (Weight: 2; Total Points: 10). (1) Provides for the dissemination of findings and the documentation of the project for replication purposes;

(2) Provides indications that the model curricula, training programs, and informational materials, if successful, are likely to be replicable in other settings involving training in the use of technology-related assistance;

(3) Indicates with appropriate analysis and support the potential for program expansion, enhancement, and replication of any special strategies or materials developed; and

(4) Provides mechanisms to assure the likely adoption and use of the curricula;

(f) *Evaluation plan* (Weight: 3; Total Points: 15). (1) Specifies adequate indicators of accomplishment for each of the goals and objectives;

(2) Specifies appropriate measures to be used and the data elements needed for these measures;

(3) Specifies appropriate and feasible data sources and data collection methods;

(4) Specifies appropriate methods of data analysis that are likely to yield objective and meaningful evaluation results; and

(5) Allocates sufficient resources including personnel, funds, and administrative priority, to the evaluation.

(Authority: 29 U.S.C. 2201–2271)

§ 347.32 What selection criteria are used to evaluate applications for technology career development projects under this program?

The Secretary reviews each application for a technology career development project award to determine the degree to which—

(a) *Importance and significance of proposed activities* (Weight: 3; Total Points: 15). (1) The project responds adequately to all of the requirements of the announced priority, if any;

(2) The applicant proposes to develop or provide career training in an

assistive-technology-related discipline or in an area of study in which there is a shortage of qualified and trained personnel, or to provide training to a trainee population in which there is a need for more qualified personnel; and

(3) The proposed project is likely to result in new, improved and useful programs for preparing personnel for careers relating to the provision of technology-related assistance for persons with disabilities;

(b) *Plan of activities* (Weight: 4; Total Points: 20). (1) Indicates a likelihood that the proposed activities will accomplish the goals and objectives of the project;

(2) Is based on a sound conceptual and instructional model;

(3) Uses appropriate materials and populations; and

(4) Provides appropriate review of literature and related activities and indicates a familiarity with state-of-the-art in assistive technology, services, information, and related studies.

(c) *Inclusion of individuals with disabilities and their families or representatives* (Weight: 4; Total Points: 20). (1) In the development of the project, including the assessment of problems and needs;

(2) In the establishment of goals and objectives for the project;

(3) In the planning and implementation of the functions and activities to be carried out under the project grant;

(4) In the evaluation of activities under the grant and the assessment of the demonstration model; and

(5) In the dissemination of project findings and of replicable models;

(d) *Management plan* (Weight: 4; Total Points: 20). (1) Includes an adequate number of staff qualified by training and experience to implement the proposed activities;

(2) Appropriately manages and accounts for the fiscal resources of the project;

(3) Details internal procedures for the management of the resources under the grant, including specification of responsibilities and administrative authority, and provisions for internal monitoring of progress;

(4) Includes realistic timelines for the implementation of project activities so as to ensure accomplishment of proposed goals and objectives within the time period proposed in the application;

(5) Allots sufficient and appropriate resources from the grant or other sources for the accomplishment of the proposed project activities; and

(6) Details resources experience, and capabilities of the institution to accomplish the goals and objectives proposed in the application;

(e) *Dissemination plan* (Weight: 2; Total Points: 10). (1) Provides for the dissemination of findings and the documentation of the project for replication purposes;

(2) Provides indications that the model, if successful, is likely to be replicable in other settings involving training for careers in the provision of assistive technology services to persons with disabilities;

(3) Indicates with appropriate analysis and support the potential for program expansion, enhancement, and replication of any special strategies or materials developed; and

(4) Provides mechanisms to assure the likely adoption and use of the curricula;

(f) *Evaluation plan* (Weight: 3; Total Points: 15). (1) Specifies adequate indicators of accomplisment for each of the goals and objectives;

(2) Specifies appropriate measures to be used and the data elements needed for these measures;

(3) Specifies appropriate and feasible data sources and data collection methods;

(4) Specifies appropriate methods of data analysis that are likely to yield objective and meaningful evaluation results; and

(5) Allocates sufficient resources including personnel, funds, and administrative priority, to the evaluation.

(Authority: 29 U.S.C. 2201–2271)

§ 347.33 What selection criteria are used to evaluate applications for public awareness projects under this program?

The Secretary reviews each application for a public awareness project award to determine the degree to which—

(a) *Importance and significance of proposed activities* (Weight: 3; Total Points: 15). (1) The project responds adequately to all of the requirements of the announced priority; in any;

(2) The proposed activity addresses a significant problem not now being addressed or addresses problems in a new and different way;

(3) The applicant proposes to carry out projects that recognize and build awareness of the importance and efficacy of assistive technology devices and assistive technology services for individuals with disabilities; and

(4) The proposed project is likely to result in new, improved, and useful programs for informing individuals about assistive technology.

(b) *Plan of activities* (Weight: 5; Total Points: 25). (1) Indicates a likelihood that the proposed activities will accomplish the goals and objectives of the project;

(2) Uses appropriate media and materials and addresses appropriate target populations;

(3) Demonstrates a thorough knowledge of the statute and of the literature and related activities, and indicates a familiarity with state-of-the-art in consumer needs, assistive technology services, information, and related activities;

(4) Demonstrates familiarity with needs assessment research as it relates to public awareness about assistive technology services, devices, and information; and

(5) Indicates an awareness of and familiarity with various general and specialized media necessary to achieve the project's public awareness objectives;

(c) *Inclusion of individuals with disabilities and their families or representatives* (Weight: 4; Total Points: 20). (1) In the development of the project, including the assessment of problems and needs;

(2) In the establishment of goals and objectives for the project;

(3) In the planning and implementation of the functions and activities to be carried out under the project grant;

(4) In the evaluation of activities under the grant and the assessment of the demonstration model; and

(5) In the dissemination of project findings and of replicable models;

(d) *Management plan* (Weight: 4; Total Points: 20). (1) Includes an adequate number of staff qualified by training and experience to implement the proposed activities;

(2) Appropriately manages and accounts for the fiscal resources of the project;

(3) Details internal procedures for the management of the resources under the grant, including specification of responsibilities and administrative authority, and provisions for internal monitoring of progress;

(4) Includes realistic timelines for the implementation of project activities so as to ensure accomplishment of proposed goals and objectives within the time period proposed in the application;

(5) Allots sufficient and appropriate resources from the grant or other sources for the accomplishment of the proposed project activities; and

(6) Details resources experience, and capabilities of the institution or organization to accomplish the goals and objectives proposed in the application;

(e) *Dissemination plan* (Weight: 2; Total Points: 10). (1) Provides for the dissemination of findings and the documentation of the project for replication purposes;

(2) Provides indications that the model, if successful, is likely to be replicable or adaptable in other settings involving the provision of assistive technology services to persons with disabilities;

(3) Indicates, with appropriate analysis and support, the potential for program expansion, enhancement and replication of any special strategies or materials developed; and

(4) Provides mechanisms to assure the likely adoption and use of the model;

(f) *Evaluation plan* (Weight: 3, Total Points: 15). (1) Specifies adequate indicators of accomplishment for each of the goals and objectives;

(2) Specifies appropriate measures to be used and the data elements needed for these measures;

(3) Specifies appropriate and feasible data sources and data collection methods;

(4) Specifies appropriate methods of data analysis that are likely to yield objective and meaningful evaluation results; and

(5) Allocates sufficient resources including personnel, funds, and administrative priority, to the evaluation.

(Authority: 29 U.S.C. 2201–2271)

Subpart E—What Conditions Must Be Met after an Award?

§ 347.40 What are the requirements of a grantee for coordination and information sharing?

(a) The Secretary may require each grantee under this program to provide information, including data about program activities and results, to—

(1) Grantees under the State Grants for Technology-Related Assistance for Individuals with Disabilities Program;

(2) The entity providing technical assistance to the State Grants for Technology-Related Assistance for Individuals with Disabilities program as prescribed in section 106(b)(1) of the Act;

(3) Agencies designated by Governors to make applications under the State Grants for Technology-Related Assistance for Individuals with Disabilities program;

(4) Entities conducting evaluations of the State Grants for Technology-Related Assistance for Individuals with Disabilities program for the Secretary;

(5) The Secretary; and

(6) Any other entity designated by the Secretary.

(b) Grantees receiving assistance under this program that are located in States with State Grants for Technology-Related Assistance for Individuals with Disabilities shall provide evidence of their efforts to coordinate activities with those grantees.

(c) Grantees must share information on project activities and findings with any technical assistance and information network designated by the Secretary if such a network is established.

(Authority: 29 U.S.C. 2211–2271)

§ 347.41 What are the reporting requirements for a grantee?

(a) Each grantee shall submit a copy of its final report to the National Rehabilitation Information Center.

(b) Each grantee shall submit to the Department a copy of any curriculum or training program that is developed or implemented, as well as copies of any media materials, videotapes, audio-visual materials, scripts, or other training and public awareness materials developed under the grant.

(Authority: 29 U.S.C. 2211–2271)

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Part VI

Nuclear Regulatory Commission

10 CFR Part 20 et al.
Standards for Protection Against Radiation; Final Rule

NUCLEAR REGULATORY COMMISSION

10 CFR Parts 2, 19, 20, 30, 31, 32, 34, 35, 39, 40, 50, 61 and 70

RIN 3150-AA38

Standards for Protection Against Radiation

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is revising its standards for protection against ionizing radiation. This action is necessary to incorporate updated scientific information and to reflect changes in the basic philosophy of radiation protection. The revision conforms the Commission's regulations to the Presidential Radiation Protection Guidance to Federal Agencies for Occupational Exposure and to recommendations of national and international radiation protection organizations.

EFFECTIVE DATE: This regulation becomes effective on (30 days after publication in the **Federal Register**). However, licensees may defer implementation of this rule until January 1, 1993. The information collection requirements are not effective until NRC publishes the OMB Clearance in the **Federal Register** (see § 20.1009).

ADDRESSES: Copies of documents relating to the proposed rule published on January 9, 1986 (51 FR 1092), or this document may be examined and copied for a fee in the Commission's Public Document Room at 2120 L Street NW. (Lower-Level), Washington, DC 20555.

FOR FURTHER INFORMATION CONTACT: Harold T. Peterson, Jr., Division of Regulatory Applications, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Telephone (301) 492-3640.

SUPPLEMENTARY INFORMATION:

I. Introduction

A. Purpose of the Revision

The purpose of this amendment to 10 CFR part 20 is to modify the NRC's radiation protection standards to reflect developments in the principles and scientific knowledge underlying radiation protection that have occurred since part 20 was originally issued more than 30 years ago. These developments not only include updated scientific information on radionuclide uptake and metabolism, but also reflect changes in the basic philosophy of radiation protection. Incorporation of these changes will ensure that part 20 continues to provide adequate protection of public health and safety.

It is also the purpose of this final rule to implement the 1987 Presidential guidance on occupational radiation exposure (see section II.D). The Atomic Energy Commission (AEC) and the NRC have followed past Federal radiation protection guidance, and conformance with the guidance is viewed by the Commission as being necessary to ensure that NRC licensees are using levels of protection comparable to those used by Federal agencies.

The AEC and the NRC have generally followed the basic radiation protection recommendations of the International Commission on Radiological Protection (ICRP) and its U.S. counterpart, the National Council on Radiation Protection and Measurements (NCRP), in formulating basic radiation protection standards. In 1977, ICRP issued revised recommendations for a system of radiation dose limitation. This system, which was described in ICRP Publication 26,[1] introduced a number of significant modifications to existing concepts and recommendations of the ICRP and the NCRP that are now being incorporated in the NRC regulations. In particular, this amendment to part 20 puts into practice recommendations from ICRP Publication 26 and subsequent ICRP publications. The Federal radiation protection guidance signed by the President on January 20, 1987, is also based upon the ICRP 1977 recommendations in ICRP Publication 26.

In adopting the basic tenets of the ICRP system of dose limitation, the Nuclear Regulatory Commission recognizes that, when application of the dose limits is combined with the principle of keeping all radiation exposures "as low as is reasonably achievable," the degree of protection could be significantly greater than from relying upon the dose limits alone.

B. Fundamental Radiation Protection Principles

The radiation protection standards in this final rule are based upon the assumptions that—

(1) Within the range of exposure conditions usually encountered in radiation work, there is a linear relationship, without threshold, between dose and probability of stochastic health effects (such as latent cancer and genetic effects) occurring;

(2) The severity of each type of stochastic health effect is independent of dose; and

(3) Nonstochastic (nonrandom) radiation-induced health effects can be prevented by limiting exposures so that doses are below the thresholds for their induction.

The first assumption, the linear nonthreshold dose-effect relationship, implies that the potential health risk is proportional to the dose received and that there is an incremental health risk associated with even very small doses, even radiation doses much smaller than doses received from naturally occurring radiation sources. These health risks, such as cancer, are termed stochastic because they are statistical in nature; i.e., for a given level of dose, not every person exposed would exhibit the effect. The second assumption means that when a stochastic effect is induced, the severity of the effect is not related to the radiation dose received. The third assumption implies that there are effects, termed nonstochastic effects, for which there is an apparent threshold; i.e., a dose level below which the effect is unlikely to occur. An example of a nonstochastic effect is the formation of radiation-induced cataracts of the eyes.

The above assumptions are necessary because it is generally impossible to determine whether or not there are any increases in the incidence of disease at very low doses and low dose rates, particularly in the range of doses to members of the general public resulting from NRC-licensed activities. It is firmly established, both from animal studies and human epidemiological studies (such as those of the radium dial painters, radiologists, and the atomic bomb survivors) that there is an increased incidence of certain cancers associated with radiation exposure at high doses and high dose rates. However, whether these effects occur at very low doses and, if they occur, whether their occurrence is linearly proportional to dose are not firmly established. This creates considerable uncertainty in the magnitude of the risk at low doses and low dose rates. There is no clear human evidence of radiation-induced genetic damage to the children of irradiated parents. Such effects are inferred from studies of mice and nonmammalian species (e.g., fruit flies).

In the absence of convincing evidence that there is a dose threshold or that low levels of radiation are beneficial, the Commission believes that the assumptions regarding a linear nonthreshold dose-effect model for

[1] Recommendations of the International Commission on Radiological Protection, January 13, 1977, ICRP Publication No. 26 (1977). (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.)

cancers and genetic effects and the existence of thresholds only for certain nonstochastic effects remain appropriate for formulating radiation protection standards and planning radiation protection programs.

C. Background

Standards for radiation protection were originally issued by the former AEC in the late 1950s (22 FR 548, January 29, 1957) and republished in 1960. These standards have been modifed since that time by a series of amendments relating to specific issues; however, no complete revision of part 20 has been made since the original standards were issued.

The NRC issued an advance notice of proposed rulemaking (ANPRM) in the **Federal Register** of March 20, 1980 (45 FR 18023). This ANPRM requested comments on possible topics in part 20 that should be revised. The responses received to this announcement were considered in the formulation of the proposed rule.

During the development of this rule, early comments from licensees, labor unions, public interest groups, other Federal agencies, and scientific organizations were solicited, discussed, and considered in formulating the proposed rule. In addition, the NRC staff has benefited from its participation in several public meetings held by the Environmental Protection Agency (EPA) in connection with the guidance for occupational radiation exposure. These amendments to part 20 and the Federal guidance on occupational exposure were developed in parallel and are both based primarily on the ICRP recommendations. The comments made in these EPA-sponsored meetings and those received by EPA on the draft guidance published by EPA in the January 23, 1981 **Federal Register** (46 FR 7836) were reviewed by the NRC staff and considered in preparing the proposed part 20.

The NRC published the proposed revision of the 10 CFR part 20 rule in the **Federal Register** on January 9, 1986 (51 FR 1092). More than 800 sets of public comments were received on the proposed revision. The public comments on the proposed revision were categorized, analyzed, and taken into account in developing the final rule. The principal public comments and the NRC staff responses to them are discussed in section VI.

II. Developments Since the Proposed Revision Was Issued

A. ICRP 1985 Paris Meeting

In March 1985, the International Commission on Radiological Protection (ICRP) held a meeting in Paris, France, to review the work of the various ICRP task groups and committees. One of the outcomes of this meeting was an ICRP statement [2] that the ICRP intended the principal dose limit for members of the general public to be 1 millisievert (100 millirems) in a year, rather than 5 millisieverts (500 millirems). This clarification has been taken into account for the limits adopted for members of the public in the final rule and is discussed more fully in the discussion on proposed § 20.301.

A second recommendation of the ICRP made at that time concerned the appropriate quality factor for converting the absorbed dose from neutrons (in rads or grays) to a dose equivalent (in rems or sieverts). The ICRP statement recommended increasing the quality factor for high-energy neutrons by a factor of 2. The quality factor for fast neutrons, for example, would be increased from 10 to 20. This change has the effect of doubling the apparent biological effectiveness of high-energy neutrons. For reasons explained in the discussion of quality factors (see the discussion of proposed § 20.4), the NRC has not adopted this recommendation in this final rule.

B. ICRP 1987 Washington Meeting

The primary focus of the statement issued by the ICRP following the 1987 meeting in Washington [3] was ICRP Publication No. 48.[4] That publication discussed higher transfer factors for transport of certain transuranic elements across the intestinal walls. These higher fractional absorption factors have been incorporated in revisions to the annual limits on intake (ALIs) and derived air concentrations (DACs) in appendix B to §§ 20.1001–20.2401 of this final rule. The changes resulting from the use of these revised factors would not change either the ingestion or inhalation ALIs for plutonium in the oxide or nitrate forms, but would lower the ALIs for other compounds or mixtures by a factor of 10. The transfer factor for the gut transfer of neptunium was found to be an order of magnitude lower than the value used in ICRP–30 and, consequently, the ingestion ALI can be increased by almost an order of magnitude. The transfer factors for americium, curium, and californium were found to be a factor of 2 higher than the ICRP–30 value so the ingestion ALIs are reduced by a factor of 2. Parameters applicable to inhalation ALIs and DACs are less affected by the new intestinal absorption factor than the ingestion ALIs as the transfer from the gastrointestinal (GI) tract to the blood for these radionuclides is generally far less significant than transfer from the lung to the blood.

C. ICRP 1987 Como Meeting

Following its 1987 meeting in Como, Italy, the ICRP issued a statement [5] that reviewed the existing estimates of the biological risks of ionizing radiation and, in particular, the preliminary data from the reanalysis of the Hiroshima-Nagasaki atomic bomb followup studies. Reanalysis of these data indicated that the risks from gamma radiation are approximately a factor of 2 higher than previous estimates for the general population and are also higher, but by a smaller factor, for workers. The ICRP concluded in 1987 that this information alone was "not considered sufficient at that time to warrant a change in the dose limits for occupational exposure and, for the general population, the increase in risk indicated by the new data is not considered to require an immediate change in the recommended dose limits, following the reduction by the ICRP (in 1985) in the principal limit from 5 to 1 mSv in a year (from sources other than medical and natural background radiation)." The ICRP also noted that the potential higher risks indicated by the reanalysis of the atomic bomb data should not be a major consideration as the dose limits should not be of primary importance in controlling doses if the principle of keeping radiation exposures "as low as is reasonably achievable" is being practiced. This position has since been modified by the ICRP 1990 Statement (see section II.I below).

[2] International Commission on Radiological Protection, "Statement from the 1985 Paris Meeting of the [ICRP]," British Journal of Radiology, Vol. 58, page 910: 1985; also Health Physics, 48(6): 828–829 (June 1985).

[3] International Commission on Radiological Protection, "ICRP Statement from 1987 Washington Meeting," Health Physics 53(3): 335–342 (1987).

[4] International Commission on Radiological Protection, "The Metabolism of Plutonium and Related Elements," ICRP Publication No. 48 (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.) (1986).

[5] International Commission on Radiological Protection, "Statement from the 1987 Como Meeting of the [ICRP]." Health Physics, 54(1): 125–132 (1988).

D. Federal Radiation Protection Guidance on Occupational Exposure

On January 20, 1987, President Reagan approved revised guidance to Federal agencies for occupational radiation protection. This guidance, which was published in the **Federal Register** (52 FR 2822; January 27, 1987), generally adopts the philosophy and methodology of ICRP Publications 26 and 30. The amendments to part 20 in this final rule were developed in parallel with the development of the guidance. Because of this parallel development, the proposed part 20 rule conformed with the draft Federal guidance available at the time the proposed part 20 rule was written. However, because of changes made to both the draft guidance and the draft part 20 revision, there were a few differences between the guidance in its final published form and the proposed part 20 revision. As discussed in the respective sections below, changes to the proposed rule have been made in order to implement the final version of the Federal guidance.

E. NCRP Report No. 91

On June 1, 1987, the National Council on Radiation Protection and Measurements (NCRP) issued a report [6] containing updated NCRP recommendations for radiation protection limits. These recommendations replace recommendations published in 1971. The majority of these recommendations are in accord with the 1977 recommendations of the ICRP and, consequently, were already reflected in the proposed part 20 rule. There are, however, several NCRP recommendations that were not in the ICRP–26 recommendations. These NCRP recommendations are:

(1) A general "guideline" that the cumulative effective dose equivalent to a worker should not exceed 1 times the worker's age in years; i.e., 1×N instead of the former 5(N−18) formula;

(2) Use of committed effective dose equivalent for planning purposes and the use of annual (rather than committed) doses for post-(internal) exposure control;

(3) A monthly dose limit as well as a limit on total gestation dose to the embryo/fetus;

(4) Adoption of a 0.1-rem (1 mSv) effective doses equivalent limit for exposure of the general public with the condition that the "site operator" assess the total exposure to the most exposed individual if estimated or measured exposures exceed 25 percent of this limit (25 millirems or 0.25 mSv per year);

(5) The use of "reference levels" set up by the radiation user below the regulatory limits;

(6) A Negligible Individual Risk Level of 1 millirem (0.01 mSv) per year. This level is the ". . . average annual excess risk of fatal health effects attributable to irradication, below which further effort to reduce radiation exposure to the individual is unwarranted" (NCRP No. 91, p. 43).

These NCRP recommendations were issued after publication of the proposed part 20 rule and, consequently, there has not been an opportunity for public comment on them. For this reason, these NCRP recommendations are not being adopted in the amendments to part 20 presented in this final rule.

F. The 1988 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR–88)

The United Nations Scientific Committee on the Effects of Atomic Radiation has analyzed data on the sources and effects of atomic radiation and published a series of reports containing summaries of the sources of radiation, the doses received by workers and members of the general public from these sources, and an analysis of the potential health risks from exposure to ionizing radiation.

The latest report in this series is the 1988 report. The 1988 report [7] contains more recent information on the health risks of ionizing radiation determined from a reevaluation of the data on the survivors of the Hiroshima-Nagasaki atomic bombings. Based upon these data, the radiation risk at high doses and high dose rates is estimated to be 7.1×10^{-4} fatal health effects per rad (0.071 effects per gray). For estimating the risk from radiation doses below 100 rads, the UNSCEAR report recommended that a dose rate reduction factor be applied to account for the reduced effectiveness of lower doses and lower dose rates. This would lead to an estimated risk of fatality of between $(0.7 \text{ to } 3.5) \times 10^{-4}$ health effects per rad for low doses such as those encountered in routine occupational exposure and the even lower doses that might be received by members of the general public from NRC- (or Agreement State) licensed activities. The fatal cancer risk value associated with the 1977 ICRP recommendations,[1] is 1.25×10^{-4} (the proposed part 20 rule, 51 FR 1102, January 9, 1986) so that the risks as estimated by the 1988 UNSCEAR report for low doses are between 1.7 times lower to 2.8 times higher than the earlier ICRP estimate. Implications of an increased risk are discussed in section II.I.

G. The 1988 Report of the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR–IV) [8]

The 1988 BEIR–IV report supplements the 1980 BEIR–III report by providing a more detailed analysis of the risks from internal alpha-emitting radionuclides to complement the emphasis of the BEIR–III report on gamma and beta radiation. Revised risk estimates are given for intakes of radon, radium, polonium, thorium, uranium, and higher transuranic elements (e.g., plutonium).

The radionuclide given the greatest emphasis in the BEIR–IV report is radon (radon–222), the gaseous decay product of radium–226. The radon dose conversion factor in the BEIR–IV report for exposure conditions representative of those of the general public is consistent with the value used to derive the airborne effluent concentration limit for radon–222 in appendix B to §§ 20.1001–20.2401, table 2 of the amendments of 10 CFR part 20 contained in this final rule.

H. The 1990 Report of the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR–V) [9]

The BEIR–V report is another comprehensive reevaluation of the health risks of radiation exposure based upon the revised dose estimates for the survivors of the atomic bombings of Hiroshima and Nagasaki. The BEIR–V report gives risk estimates for leukemia and non-leukemia (solid cancers) that are about two to five times higher than the estimates in the 1980 BEIR–III report. The BEIR–V report gives the following factors as the principal reasons for this

[6] National Council on Radiation Protection and Measurements (NCRP), "Recommendations on Limits for Exposure to Ionizing Radiation," NCRP Report No. 91 (June 1, 1987). [Available for sale from the NCRP, 7910 Woodmont Avenue, suite 800, Bethesda, MD 20814–3095.]

[7] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), "Sources, Effects and Risks of Ionizing Radiation, 1988 Report to the General Assembly, Sales Section, United Nations, NY 10017 (1988).

[8] National Academy of Sciences-National Research Council, Committee on the Biological Effects of Ionizing Radiation, "Health Risks of Radon and Other Internally Deposited Alpha-Emitters, (BEIR–IV)," National Research Council, National Academy Press, Washington, DC 20418 (1988).

[9] National Academy of Sciences-National Research Council, Committee on the Biological Effects of Ionizing Radiation, "Health Effects of Exposure to Low Levels of Ionizing Radiation, (BEIR–V)," National Research Council, National Academy Press, Washington, DC 20418 (1990).

increase: (1) Use of different dose-response and risk projection models, (2) revised estimates of the doses to the individual survivors of the atomic bombings in Japan, and (3) improved epidemiological data from additional years of followup studies since the BEIR–III report was completed in 1980.

The BEIR–V Committee uses the linear dose response model and the relative risk projection model to extrapolate the fatal tumor risk to future periods. The relative risk projection model assumes the risk to be proportional to the natural cancer incidence, which generally increases with age. Because of this dependence on age, the relative risk model generally predicts higher future (lifetime) risks than the absolute risk model which employs a constant added risk per year with increasing age. Estimates are given of the risk as a function of the time since the exposure occurred and the age and sex of the exposed person. The BEIR–V report, like the UNSCEAR–88 report, indicates that a reduction factor should be applied to the risk estimates derived from high doses and dose rates in order to apply them to low dose and low dose-rate situations. Although neither the BEIR–V report nor the UNSCEAR–88 report recommends a specific value for this factor, both reports indicate that this factor should be greater than 2 (larger reduction factors would give a lower risk per unit dose). Assuming a factor of 2 reduction in the risk estimates derived from high doses and high dose rates, BEIR–V would give a lifetime risk of a radiation-induced cancer fatality of about 4×10^{-4} fatal cancers/rem (0.04 per sievert) for workers and 5×10^{-4} per rem (0.05 per sievert) for the general population, the higher value for the public being associated with the higher sensitivity and the longer period of elevated risk associated with the younger ages present in the general population. The values of 5×10^{-4} is three times as large as the recommended value in the 1980 BEIR–III report and four times as large as the estimate in the 1977 ICRP–26[1] report (see section II.F).

The BEIR–V report also summarized the data on the frequency of severe mental retardation found in the children of Hiroshima and Nagasaki atomic bomb survivors. These children were exposed *in utero* at gestational ages of 8–15 weeks and the risk of severe mental retardation during this period is about 4×10^{-3} per rem with a possible threshold for the effect in the range of 20 to 40 rem. The risk of severe retardation was less during other gestational ages; there was no evidence of increased risk in survivors exposed earlier than 8 weeks or later than 26 weeks after conception.

The estimates of genetic effects to the offspring of irradiated individuals remained similar to those in the 1972 BEIR–I and 1980 BEIR–III reports. As radiation-induced inherited abnormalities have not been observed directly in humans, estimates of genetic effects have been based primarily upon experimental studies with mice. These studies suggest that it would take a dose of about 100 rads to double the natural frequency of genetically transmitted diseases.

I. ICRP 1990 Recommendations

On June 22, 1990, the International Commission on Radiological Protection issued a press release indicating that it would issue revised recommendations for radiation protection based upon the newer studies of radiation risks (such as those described in sections F, G, and H above). The press release indicated that the ICRP would recommend a reduction in the occupational dose limit from an equivalent of 5 rems per year to an average of 2 rems per year with some allowance for year-to-year flexibility. The ICRP dose limit for long-term exposure of members of the general public would remain equivalent to the level adopted in this amendment to part 20, 0.1 rem per year.

The Nuclear Regulatory Commission does not believe that additional reductions in the dose limits are urgently required by the latest radiation risk estimates. Due to the practice of maintaining radiation exposures ALARA ("as low as is reasonably achievable"), the average radiation dose to occupationally exposed individuals is well below the limits in either the previous or amended part 20 and also below the limits recommended by the ICRP. For example, in 1987 about 97 percent of the workers in nuclear power plants, industrial radiography, reactor fuel fabrication, and radioisotope manufacturing, four of the industries having the highest potential for occupational radiation exposures, received annual doses of less than 2 rems, which is the occupational limit proposed by the ICRP.

As a result of the application of the ALARA philosophy to effluent release standards in appendix I to 10 CFR part 50 for nuclear power reactors and EPA's 40 CFR part 190 for the uranium fuel cycle, doses from radioactive effluents from fuel cycle facilities are already much less than the 0.1 rem per year standard in this final rule. The 0.1 rem per year remains as the level recommended by the ICRP for protection of the general public.

Until the final ICRP recommendations are published, and the need for further revisions in NRC standards established, the Commission believes it would be advisable to proceed with the promulgation of the proposed dose limits, rather than deferring the dose reductions that are already associated with the amendments to part 20 in this final rule. The Commission will carefully review the final recommendations of the International Commission on Radiological Protection, the comments of the scientific community and others on these recommendations, and the ICRP response to these comments. In addition, the Commission staff will review the recommendations of other expert bodies, such as the National Council on Radiation Protection and Measurements, and participate in the deliberations of the U.S. Committee on Interagency Radiation Research and Policy Coordination and any interagency task force convened by the Environmental Protection Agency to consider revised Federal radiation guidance. Any future reductions in the dose limits by the Commission would be the subject of a future rulemaking proceeding.

III. Issues Being Resolved Separately

As noted in the above discussion, there are several areas where the Commission believes a better scientific consensus is needed before adopting values different from those in the present part 20. There are also several areas where issues raised in the public comments (see section VI) are being resolved in other NRC rulemaking proceedings because of either their scope, complexity, or timing. The following issues are being or will be resolved in other NRC rulemaking proceedings:

(1) Establishment of "Below Regulatory Concern (BRC)" levels (related to *de minimis* levels and a negligible level of risk). On June 27, 1990, the Commission announced the issuance of a policy statement on Below Regulatory Concern, which was subsequently published in the **Federal Register** on July 3, 1990 (55 FR 27522). This policy statement establishes the framework for the Commission to formulate rules and licensing decisions to exempt certain practices involving small quantities of radioactive materials from some or all regulatory controls. The BRC policy statement sets forth criteria for protection of both individuals (individual dose criteria) and population groups (a collective dose criterion).

(2) Limits for decommissioning of nuclear facilities and for residual radioactive contamination. This is being actively pursued by the NRC staff by developing criteria for residual contamination of soils and structures, which are one aspect of the implementation of the Below Regulatory Concern policy and are necessary to fully implement the Commission's earlier rulemaking on General Requirements for Decommissioning Nuclear Facilities (53 FR 24018, June 27, 1988). The NRC staff is also participating in an EPA Interagency Task Force on Residual Radioactivity.

(3) Limits and calculational procedures for dealing with the "hot particle" issue (small particles found in nuclear reactors that, because of their high activity and small size, produce high localized doses to skin). The NRC notes that the National Council on Radiation Protection and Measurements (NCRP) has recently issued new recommendations regarding "hot particles" in NCRP Report No. 106, "Limit for Exposure to 'Hot Particles' On the Skin," December 31, 1989. A modified NRC enforcement policy statement with regard to the "hot particle issue" was published in the Federal Register of July 31, 1990 (55 FR 31113). The NCRP report, together with a forthcoming ICRP report on the biological effects of skin irradiation and other technical analyses, will be considered in a future rulemaking to set limits for skin irradiation.

(4) Modification of NRC incident notification requirements. A modification of the incident notification requirements was issued for public comment on May 14, 1990 (55 FR 19890). If this proposal is adopted as a final rule, it would modify both §§ 20.1–20.601 and the amendments contained in §§ 20.1001–20.2401.

(5) Publication of a separate rule for large irradiators. A new part 36 has been proposed for public comment (Federal Register of December 4, 1990, 55 FR 50008). The detailed requirements for irradiators presently in the amended part 20 (§ 20.1803) will eventually be deleted and replaced by the provisions incorporated in the new part 36.

There are also additional areas where the scientific basis is not yet resolved sufficiently to justify a change from current practice. These two areas require better scientific consensus on the appropriate position: (1) The need for and impact of a lifetime cumulative dose limit of 1 rem per year of age and (2) quality factors, especially for neutrons, low-energy beta-emitters, and high-energy gamma photons. These issues will be reconsidered as consensus positions are reached by the scientific community.

IV. Need for Additional Regulatory Guidance

The Commission recognizes that the incorporation of many new concepts into part 20 will require additional guidance and explanation on their application to practical problems in radiation protection. The Commission also notes the desirability of having such additional guidance available at the same time that the final rule is issued in effective form. However, it was impractical, both for reasons of scheduling and availability of resources, for these guides to be developed concurrently with part 20. Some of the regulatory guides being developed or revised to assist in the implementation of the amended part 20 are:

(1) Content of Radiation Protection Programs at Nuclear Power Plants;

(2) Interpretation of Bioassay Measurements (Draft Regulatory Guide 8.9, Revision 1),

(3) Criteria and Procedures for Summation of Internal and External Occupational Doses,

(4) Acceptable Criteria for Planned Special Exposures and for Satisfying Documentation Requirements;

(5) Methods and Parameters for Calculating the Dose to the Embryo/Fetus;

(6) Instructions for Recording and Reporting Occupational Radiation Exposures (includes NRC Forms 4 and 5).

The Commission has instructed the staff to have these and other draft guides published for public comment early in 1991 and published in final form by December 31, 1991.

V. Implementation and Existing License Conditions

Section 20.1008 of the amendments to part 20 in this final rule provides that NRC licensees must implement the rule on or before January 1, 1993. Until January 1, 1993, applicants seeking new licenses and holders of existing licenses have the option of complying with the new provisions of part 20 in §§ 20.1001–20.2401 or with the earlier provisions of part 20 in §§ 20.1–20.601. Early implementation may benefit applicants for new licenses or license renewals as they could avoid having to adopt and implement the earlier provisions of part 20 for only a short period of time prior to the required implementation date of the final rule. Licensees (or applicants) that wish to adopt the provisions of this final rule prior to the required implementation date should notify either the Director, Office of Nuclear Reactor Regulation (for power and research reactors) or the Director, Office of Nuclear Material Safety and Safeguards (for industrial, academic, and medical licensees, fuel cycle and waste disposal facilities).

The amendments to part 20 in this final rule have been incorporated into the existing 10 CFR part 20 while retaining the existing requirements. However, the new requirements have been renumbered to run from § 20.1001 to § 20.2401 in order to satisfy legal conditions associated with the necessity of having two sets of requirements on the same subject in effect at the same time. The existing part 20 retains its current section numbers (§§ 20.1–20.601). Licensees are required to comply with either §§ 20.1–20.601 inclusive or with the requirements in § 20.1001–20.2401 inclusive, but not both sets of requirements. Licensees cannot comply with selected requirements from both the new rule and the earlier version, but must comply with the complete set of requirements in either §§ 20.1–20.601 or in §§ 20.1001–20.2401.

The NRC will issue a regulatory guide that provides the section and paragraph identifiers in the amendments to part 20 (§§ 20.1001–20.2401) and the corresponding sections or paragraphs in the earlier part 20 (§§ 20.1–20.601). This document will be issued shortly after the publication of this rule and will enable licensees to locate sections of the amendments to part 20 that correspond to sections of the earlier part 20 cited in license conditions and technical specifications.

NRC Agreement States each have regulations compatible with the existing 10 CFR Part 20. Agreement States normally amend their regulations to preserve compatibility within three years after NRC issues final rules. In the Commission's view, it is desirable to minimize the period when different radiation standards and methods of determining doses are in effect across the nation. The States and the public have had extensive advance knowledge of the planned revision of part 20. Consequently, the Commission believes that the Agreement States must proceed as quickly as possible to conform to the amendments to part 20 presented in this final rule and should require that all Agreement State licensees comply on or before January 1, 1994. The States are encouraged to provide the flexibility for early adoption should licensees so choose. As just discussed, the Commission has provided what it believes is adequate time (until January 1, 1993) from publication of the final rule before all NRC licensees must comply. Agreement States may also wish to

provide additional time for their licensees to comply to facilitate transition and the Commission would have no objection so long as compliance is required by January 1, 1994.

VI. Summary of Public Comments and Changes from Proposed Rule

The purpose of this section is to respond to comments raised on the proposed rule and to explain and highlight the changes made to the proposed rule. This section presents, for each paragraph or section of the rule, the principal public comments on the proposed rule, an NRC staff response to the comments (where appropriate), and a summary of the principal changes that were made to the proposed rule. This section has been arranged so that it corresponds to the structure of the proposed rule. However, the following text is not intended to create any additional requirement not already in the regulatory text.

Subpart A—General Provisions

Proposed Section 20.1 Purpose [Section 20.1001 in This Final Rule]

Final rule: A new sentence was added to convey the intent of the former § 20.9 in the proposed rule (which has been removed) that the regulations in Part 20 should not hinder a licensee's actions to protect health and safety in the event of an emergency. It is the Commission's intent that the regulations be observed to the extent practicable during emergencies, but that conformance with the regulations should not hinder any actions that are necessary to protect public health and safety such as lifesaving or maintaining confinement of radioactive materials.

In this regard, the Commission notes that the Federal guidance on occupational radiation protection states that those dose standards only apply to normal operating conditions. The Commission believes that the dose limits for normal operation should remain the primary guidelines in emergencies. However, the Commission also recognizes that, in an emergency, operations that do not conform to the regulations may have to be carried out to achieve the high-priority tasks of worker, public, and facility protection. The purpose of the addition to this section is to assure licensees that their first priority should be to carry out those actions that are necessary to protect workers and the public from radiation exposure, to perform lifesaving activities, to prevent or limit the spread of radioactive contamination or the release of radioactive materials to the environment, and to preserve an adequate margin of safety. In evaluating any ensuing violations and their severity, the Commission will consider on a case-by-case basis any extenuating circumstances.

Proposed Section 20.2 Scope [Section 20.1002 in This Final Rule]

Final rule: The statement of scope remains essentially the same as in the proposed rule except that "background radiation" has replaced "natural background." This change was made to include residual global fallout and ambient radon levels within the definition of "background."

Proposed Section 20.3 Definitions [Section 20.1003 in This Final Rule]

General: Because of the large number of comments that dealt primarily with wording changes or that questioned the need for or the use of particular definition, the individual comments will not be discussed separately. However, these comments did result in substantial revisions to many of the definitions that appeared in the proposed rule. Those definitions that were added, modified, or deleted as a result of the public comments are listed below.

Comment: Differentiation among different kinds of dose equivalents. The potential for confusion among different dose equivalents was noted. Commenters noted that effective dose equivalents, committed effective dose equivalents, and doses to the lens of eye, skin, or extremities were all expressed in units of rems or sieverts and may be difficult to distinguish from one another.

Response: In the final rule the NRC staff has applied unique names for these previously undesignated quantities including: eye dose equivalent, shallow-dose equivalent (skin), shallow-dose equivalent (extremities), and total effective dose equivalent. The ICRP did not give these quantities specific names. The use of characteristic names is intended to reduce confusion in using these units. In this regard, it should be noted that the licensee is required to designate, in a clear and unambiguous manner, the quantities that are being recorded (see § 20.2101(b)).

Final rule: All the important definitions have been collected into one section, § 20.1003 Definitions. Unlike the proposed rule, which employed groups of related terms ("Area Terms," "Dose Terms," "Monitoring Terms," etc.), all of the definitions in the amended rule are listed in strict alphabetical order. This organization also avoids the presence of "local definitions" that appear only in a specific section of the regulation.

1. New Terms. The following definitions have been added to the final rule. These definitions have been added to clarify the meaning of the terms:

a. "Activity"
b. "Background radiation"
c. "Derived air concentration-hours" ("DAC-hours")
d. "Dosimetry processor"
e. "Entrance or access point"
f. "Generally applicable environmental standard"
g. "Individual monitoring device"
h. "Quality factor"
i. "Sanitary sewerage"
j. "Total effective dose equivalent (TEDE)."

2. Revised Definitions. The following definitions have been revised or modified from the definition used in the proposed rule:

a. "Absorbed dose"
b. "Annual limit *on* intake"
c. "Class"
d. "Committed dose equivalent"
e. "Committed effective dose equivalent"
f. "Derived air concentration"
g. "Dose equivalent"
h. "Effective dose equivalent"
i. "Embryo/fetus"
j. "Eye dose equivalent"
k. "Member of the public"
l. "Nonstochastic"
m. "Person"
n. "Planned special exposure"
o. "Quarter"
p. "Survey"
q. "Weighting factor"
r. "Working level"
s. "Year"

3. Definitions and terms deleted. Two definitions were deleted because the terms no longer appear in the rule: "Collective effective dose equivalent" and "Roentgen." "Natural background" has been replaced by "Background radiation."

Proposed Section 20.4 Units of Radiation Dose [Section 20.1004 in This Final Rule]

Comment: Choice of the system of units. Several commenters expressed a preference for retaining the older "special" units (the curie, rad, and rem) rather than allowing the use of the newer SI units. Reasons cited for retaining the older system included: present widespread use and licensee familiarity, potential for misunderstandings with the newer units, the need for worker retraining (particularly while learning the new ICRP system of dose limitation), and the costs associated with changing recordkeeping systems. A smaller

number of commenters favored changing over to the SI units: becquerels, grays, and sieverts.

Response: Although both the "special units" and the SI units appear in the text of part 20 (to increase the familiarity of licensees with the SI units), the Commission has decided that adoption of the SI units at this time is not necessary. The Commission recognizes that the new terms and methodological approaches in the amendments to part 20 are complex and that imposition of the SI system of units on top of this complexity would further increase the potential for confusion. Consequently, at the present time, the recordkeeping, reporting, and notification requirements require the use of the "special units," the rad, the rem, and the curie. However, as the national move to metrication continues, as anticipated in section 5164 of the Omnibus Trade and Competitiveness Act of 1988 (Pub. L. 100–418), at some later time there may be amendments to part 20 that would require the use of SI units only (becquerels, grays, and sieverts).

Final rule: The amendments to part 20 in this final rule include the International System of Units (SI units) for distance, area, and volume. The older "special units" are retained for licensee use in records or reports, i.e., activity (curie), absorbed dose (rad), and dose equivalent (rem).

Comment: Quality factors for neutrons. The quality factor is the conversion factor between the absorbed dose (rads) and the dose equivalent (rems). Several publications [10, 11, 11a] have recommended changes in neutron quality factors that are a factor of 2 higher than those in proposed part 20. These changes would raise the quality factor for fast neutrons from 10 to 20.

Response: Increases in the quality factor for neutrons are suggested by some animal experimental data on the relative biological effectiveness (RBE) of neutrons. However, there appears to be considerable uncertainty as to whether the data actually demonstrate an increase in the hazard of neutrons. Because the RBE is defined as a ratio of doses to produce equivalent biological effects, it is not clear whether the apparent increase in the neutron RBE is due to the increased effectiveness of neutrons or whether it actually results from the decreased effectiveness of the reference gamma radiation at low doses.

Final rule: The NRC has decided not to revise the neutron quality factor at this time but to defer any change until there is greater scientific consensus on the most appropriate value. A major consideration underlying this decision is that neutron exposures at most NRC-licensed facilities are currently small and the potential increase of a factor of 2 would not have a major health or regulatory impact.

The decision to defer any change is consistent with recommendations of the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) of the Office of Science and Technology Policy that there should not be a revision of the value of the neutron quality factor at this time without more study. This position is also reflected in papers from the United Kingdom National Radiological Protection Board (UKNRPB) [12] and a statement of the neutron quality factor from the British Committee on Radiation Units and Measurements.[13]

Comment: Table of neutron quality factors. Several commenters questioned the accuracy and timeliness of the table of neutron quality factors and fluence rates (to give dose equivalents of 1 rem) that appeared in the proposed rule. Some commenters suggested that there were more appropriate tables published by the NCRP or ICRP.

Response: The tables in the proposed and amended rules were taken from NCRP Report No. 38 [14] and are appropriate for the neutron dose equivalent at a soft tissue depth of 1 centimeter (which is the depth specified for the determination of the deep dose equivalent). There are newer tables from the ICRP, but these tables incorporate the factor of 2 increase in the neutron quality factor. (See the preceding discussion of the neutron quality factor.)

Subpart B—Radiation Protection Programs

Proposed Section 20.102 "As Low As Is Reasonably Achievable" (ALARA) [Section 20.1101 Radiation Protection Programs in This Final Rule]

Comment: The concept of ALARA is a philosophical principle of radiation protection and, as such, it should not be made into a regulatory requirement. A primary objection to changing the status of ALARA from the hortatory suggestion in § 20.1(c) of §§ 20.1–20.601 ("licensees should") to a mandatory requirement ("licensees shall") in proposed § 20.102 is that there are no guidelines (except for light-water-reactor (LWR) effluents) as to what constitutes ALARA. Because of the subjective nature of an "ALARA level," there are problems in the retrospective evaluation of licensee performance by NRC inspectors and, at least in one case, interpretations by the courts concerning whether the levels achieved were truly "as low as is reasonably achievable."

Response: There were a number of comments that expressed similar concerns regarding the proposed implementation of "ALARA." The emphasis on ALARA actions has been revised from detailed requirements to document all ALARA actions to a requirement to have a radiation protection program that includes measures to keep doses and intakes "as low as is reasonably achievable." This shift is to emphasize that the ALARA concept is intended to be an operating principle rather than an absolute minimization of exposures.

Comment: Any requirement for ALARA should include a lower bound. Many commenters felt that there should be a "floor" for ALARA.

Response: The Commission agrees that there would be advantages to establishing such a "floor," below which efforts to further reduce doses would not be necessary. An NRC policy statement on "Below Regulatory Concern" was announced on June 27, 1990, and published in the **Federal Register** on July 3, 1990 (55 FR 27522). The Below Regulatory Concern levels in that policy statement delineate criteria below which additional licensee actions to further reduce doses would not be required. Specific rulemaking actions will be carried out to define operational thresholds for particular classes of activities such as disposal of very low-level contaminated materials. The BRC policy statement provides a framework for evaluating these case-specific actions. (See also discussion on proposed § 20.304.)

[10] International Commission on Radiological Units and Measurements, "The Quality Factor in Radiation Protection," ICRU Report No. 40 (1986). (Available for sale from ICRU Publications, 7910 Woodmont Avenue, suite 800, Bethesda, MD 20814–3095.)

[11] International Commission on Radiological Protection, "Data for Use in Protection Against External Radiation," ICPR Publication No. 51 (January 1988). (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.)

[11a] See footnotes 2, 3, and 4.

[12] J.A. Dennis, "The Relative Biological Effectiveness of Neutron Radiation and Its Implications for Quality Factor and Dose Limitation," Nuclear Energy 20(2). 133–149 (1967).

[13] British Committee on Radiation Units and Measurements (BCRU), "Memorandum from the BCRU: Effective Quality Factor for Neutrons," Physics in Medicine and Biology 31 (7):797–799 (1986).

[14] National Council on Radiation Protection and Measurements, "Protection Against Neutron Radiation," NCRP Report No. 38 (January 1971). (Available for sale from the NCRP, 7910 Woodmont Avenue, suite 800, Bethesda, MD 20814–3095.)

Comment: Compliance with "ALARA-based" standards should constitute being ALARA. Several commenters supported the statement in the proposed part 20 (20.102(b)) that compliance with EPA's 40 CFR part 190 and with appendix I to 10 CFR part 50 should constitute *de facto* compliance with the requirement to keep LWR effluents ALARA. Environmental Protection Agency (EPA) comments did not support this view.

Response: Appendix I to 10 CFR part 50 defines ALARA levels of radioactive materials in LWR effluents. If the design objectives of appendix I are met, it constitutes a demonstration that the effluents are ALARA and no additional effort is required to reduce the effluent levels. Although the EPA interprets 40 CFR part 190 as an "ALARA-based" standard, it also believes that 40 CFR part 190 constitutes an upper bound, not a lower bound, to ALARA efforts.[15] Consequently, compliance with 40 CFR part 190 is not in itself sufficient to demonstrate that releases and doses are ALARA.

As appendix I to part 50 defines ALARA design objectives that constitute ALARA effluent levels, meeting these levels is sufficient to demonstrate ALARA effluent releases. In order for light-water reactors to demonstrate that doses from both effluents and direct radiation are ALARA, it is necessary to demonstrate that effluents meet the design objectives of appendix I to 10 CFR part 50, that direct radiation from onsite sources (gamma radiation from external radwaste tanks and turbines ("turbine shine")) is also ALARA, and the total dose to any member of the public is within the numerical standards in 40 CFR part 190. Meeting these conditions will constitute sufficient evidence that offsite doses from LWRs are ALARA and in conformance with both appendix I and 40 CFR part 190.

Comment: The NRC should establish "reference levels" in its rules. One commenter thought that the NRC should have "reference levels" for licensee action in part 20.

Response: The Commission recognizes that licensees generally establish their own lower "reference levels" in order to keep from reaching and exceeding the Commission's formal dose limits. Based upon the public comments on the reference level for exposure of members of the public, which was in the proposed § 20.303, this approach would not be favored by a majority of licensees. Several commenters viewed the reference level for the dose to members of the public as being applied exactly as if it were a limit. Consequently, if the NRC were to specify generic reference levels for licensee action, the impact might be similar to lowering the magnitude of the dose limits. The Commission believes that the use of the ALARA philosophy is a preferable means to keep exposures well below the limits established by the Commission.

Final rule. The final rule establishes a requirement for all licensees to have a radiation protection program that includes provisions for keeping radiation doses ALARA. It is expressly intended that the level of this program and efforts to document it are commensurate with the size of the licensed facility and the potential hazards from radiation exposure and the intake of radioactive materials.

The requirement for a radiation protection program is not new; it was discussed in the proposed rule (under ALARA) and is consistent with requirements in part 33 (§§ 33.13, 33.14, and 33.15), part 34 (§ 34.11), part 35 (§§ 35.20–35.31), and part 40 (§ 40.32) of the NRC regulations, with the information requested in chapter 12 of Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," and with the conditions in most licenses issued by the Commission. The extent of this program and requirements for written records and procedures for operating the program are intended to be commensurate with the scope and potential hazards associated with the licensee's activities. The Commission recognizes the need to provide guidance on the scopes of radiation protection programs and such guidance will be prepared in the form of regulatory guides.

The Commission continues to emphasize the importance of the ALARA concept to an adequate radiation protection program. In order to strengthen this concept, the Commission has adopted a requirement that all licensees include provisions for maintaining radiation doses and intakes of radioactive materials as low as is reasonably achievable as part of their radiation protection programs. Compliance with this requirement will be judged on whether the licensee has incorporated measures to track and, if necessary, to reduce exposures and not whether exposures and doses represent an absolute minimum or whether the licensee has used all possible methods to reduce exposures. This shift in emphasis should reduce potential problems of retrospective evaluation of licensee performance under admittedly subjective criteria. However, the licensee should be able to demonstrate that periodic reviews of performance have been made and that efforts have been made to achieve ALARA. As noted above, the level of effort expended on the radiation protection programs should reflect the magnitude of the potential exposures, both the magnitude of average and maximum individual doses and, in facilities with large numbers of employees, collective (population) doses. A nuclear power reactor licensee would be expected to have a considerably larger program than a licensee with only small sealed sources.

The Commission has not adopted a requirement that a numerical cost-benefit analysis (optimization analysis) be used to demonstrate ALARA. The quantitative approach is useful for those situations where both costs and benefits (dose reduction) can be quantitated, such as in shielding design or analysis of decontamination methods. The Commission encourages licensees to employ quantified analyses to define ALARA, but their use is not required. One reason for this is that many ALARA procedures simply reflect sound operating practice and do not lend themselves to a numerical analysis. Another reason is that cost-benefit analyses could have a cost associated with obtaining the necessary information and carrying out the analysis that may exceed the monetary value of the dose reduction. Thus, the quantitative optimization analysis would be expected to be used primarily in situations where both the costs of control and the resultant benefits were not only quantifiable, but also appreciable compared to the cost of performing the analysis.

Subpart C—Occupational Dose Limits

Proposed Section 20.201 Occupational Dose Limits for Adults [Section 20.1201 in This Final Rule]

Comment: Elimination of the 5(N–18) age-prorated cumulative dose limit and the adoption of the 5-rem annual effective dose limit. Most commenters favored this change noting that licensees have generally succeeded in keeping doses below 5 rems per year for the past

[15] Letter of January 7, 1986, from Sheldon Meyers, Director, Office of Radiation Programs, Office of Air and Radiation, U.S. Environmental Protection Agency, to Robert B. Minogue, Director, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission. (This letter is reproduced as enclosure B to the comments of the Environmental Protection Agency on the 10 CFR part 20 revision (Docket PR–19, 20, 30 et al., 50 FR 51992, Comment # 769).)

few years and, therefore, are already meeting the new limit.

Comment: Lifetime dose limits. A few commenters believe that there should be a limit on the cumulative total dose that can be received by any individual in a lifetime.

Response: The Commission considered the use of a lifetime dose limit but rejected it. The EPA had proposed such a limit (100 rems) in its proposed Federal Guidance on Occupational Radiation Exposure (46 FR 7836, January 23, 1981) but withdrew it.

If the magnitude of the annual dose is limited, there is a *de facto* limitation of the lifetime dose that can be received. The Commission believes that such a *de facto* lifetime limit is preferable to an actual cumulative lifetime dose limit because the cumulative limit could act to limit employability. This, in turn, raises questions concerning the right of an individual to pursue employment in a chosen profession. If an individual were to deplete the "dose bank" provided by a lifetime dose limit, it might be difficult to obtain future employment using ionizing radiation.

Comment: Quarterly dose limit. A number of commenters noted that the ICRP system of dose limitation does not have quarterly or other limits covering periods less than a year. The public comments also noted the possibility of giving rise to two violations for the same event (i.e., the possibility of exceeding both the quarterly and annual dose limits in one event), thereby incurring two penalties.

Response: The quarterly limit (only for deep-dose equivalent) had been retained in the proposed rule as a result of suggestions received from several groups during the development of the rule. The primary protection function of retaining a quarterly limit was to reduce the potential for receiving several high doses within a relatively short period of time. However, there is not much of a radiobiological significance between 10 rems (two 5-rem doses) and 6 rems (two 3-rem doses) received in a short time period. One consideration is the employability of a worker who has exceeded the dose limit. A worker who exceeded the 5-rem annual dose limit might have to work in a job not involving radiation for a year (or take part in a planned special exposure) instead of only a calendar quarter if a quarterly dose was used.

Final rule: In order to maintain compatibility with the ICRP and to eliminate the possibility of double violations, the quarterly limit has not been kept and only annual limits are stated.

Comment: Eye dose limit. Some commenters questioned the 15-rem (0.15-sievert) eye limit used in the proposed rule noting that ICRP Publication No. 26 contains a recommended value of 0.3 sieverts (30 rems).

Response: The ICRP recommended a reduction in the limit for the eye to 0.15 sieverts (15 rems) at their Brighton, England, meeting in 1980.[16] This was done because the ICRP concluded that, for a lifetime of occupational exposure at the former 0.3-sievert (30-rem) limit, some opacities in the lens of the eye might be produced that could develop to the point of causing deterioration of vision (even without further radiation exposure). In most situations, the limits for the deep-dose equivalent and the shallow-dose equivalent to the skin should ensure that the eye dose limit is also met. Consequently, the reduction from 30 rems to 15 rems is not expected to have a significant impact on either health protection or control cost.

Comment: Parameters defining the shallow-dose equivalent ("skin dose"). The proposed rule would have established a dose limit for the skin of 50 rems averaged over 10 square centimeters (10 cm^2). There were several comments concerning the scientific basis for this area. Some commenters suggested other surface areas, such as 15 cm^2, as being better suited to measurement conditions. Proponents of the larger areas generally favored these areas because of their compatibility with either contamination survey practices or with the physical size of survey instrument detector probes.

One set of comments prepared by the developer of the NRC's VARSKIN computer program for skin dose calculation (comment letter No. 262 in the NRC Public Document Room) contains a well-documented discussion of the selection of an appropriate area over which to average the skin dose. These comments conclude that 1 cm^2 is a more appropriate area than either 10 cm^2 or 100 cm^2.

Response: ICRP Publication 26 contains two recommendations for such areas: a 100-cm^2 area and a 1-cm^2 area, the larger area being associated with routine monitoring for skin contamination and the smaller area being associated with accident dose evaluation. After reviewing these comments and various recommendations regarding skin dose measurements, the Commission has decided to use the smaller area of 1 cm^2 for routine skin dose evaluations. The 1-cm^2 area is consistent with the prior recommendations in NCRP Report No. 39 [17] and ICRP Publication No. 9 [18] as well as the smaller area recommended in ICRP Publication No. 26.

Within the past several years, there have been instances where very small (5–250 μm) "hot" particles of fuel or activated corrosion products have been discovered in reactor facilities, on workers or their clothing, and, in a few isolated cases, in workers' vehicles or homes. These particles are generally too large to pose a significant risk from inhalation, but are capable of producing intense beta-radiation doses over very small areas of the skin. The principal hazard appears to be skin ulceration if the particles remain localized on the skin surface. The primary uncertainty associated with evaluating the hazard of these small particles is determining the skin area or tissue volume to which the dose is to be computed (or even whether "dose" is the most appropriate indicator of the hazard). The NRC requested the National Council on Radiation Protection and Measurements (NCRP) to look into the hot particle issue and make recommendations. The NCRP's recommendations have been published in NCRP Report No. 106 [19] and use a criterion based upon the number of radioactive disintegrations that have occurred (μCi-hours) rather than dose. The NRC staff is reviewing these recommendations and has issued an Information Notice on a modified enforcement policy for hot particles.

Final rule: The amendments to part 20 in this final rule specify an area of 1 cm^2 for skin dose evaluations.

Comment: Effective dose equivalent for external exposure. The most prevalent comment concerning the effective dose equivalent is the restriction in the proposed rule of the risk-weighted organ dose "effective dose" concept to internal doses without

[16] International Commission on Radiological Protection, "Statement and Recommendations of the 1980 Brighton Meeting," *Annuals of the ICRP 4*(3/4) Oxford, England: Pergamon Press (1980). (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.)

[17] National Council on Radiation Protection and Measurements, "Basic Radiation Protection Criteria," NCRP Report No. 39 (January 15, 1971), page 79, paragraph 207. (Available for sale from the NCRP, 7910 Woodmont Avenue, suite 800, Bethesda, MD 20814–3095.)

[18] International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection (adopted September 17, 1965)," ICRP Publication No. 9 (1966), page 6, paragraph 28. (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.)

[19] National Council on Radiation Protection and Measurements, "Limit for Exposure to 'Hot Particles' on the Skin," NCRP Report No. 106 (December 31, 1989). (Available for sale from the NCRP, 7910 Woodmont Avenue, suite 800, Bethesda MD 20814–3095.)

permitting a similar approach to be employed for external doses. There were several comments that noted the desirability of using organ weighting factors for external doses.

Response: The ICRP and NCRP recommendations and the 1987 Federal guidance on occupational radiation exposure in principle permit the use of external weighting factors. However, none of the principal standard-setting organizations has included specific recommendations for the use of weighting factors for external dose.

The application of weighting factors also entails calculation of organ doses instead of whole-body doses from external radiation. One component of this calculation is estimation of the attenuation of the radiation as a function of the depth of the organ in the body. There are practical problems in the determination of the type and energies of the radiation involved and of the orientation of the individual with respect to the source of the radiation that have to be considered in making such calculations. Therefore, application of weighting factors for external exposures will be evaluated on a case-by-case basis until more guidance and additional weighting factors (such as for the head and the extremities) are recommended.

Final rule: External doses to the head, trunk (including male gonads), arms above the elbow, or legs above the knee are to be treated as whole-body doses. For the purpose of weighting the external whole-body dose (for adding it to the internal dose), a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure may be approved on a case-by-case basis upon request to the NRC.

Comment: Allowance for exposure after limits are exceeded. Commenters noted that allowance of an additional 1 rem per quarter dose limit for a worker who had already exceeded the 5-rem annual limit might be counterproductive. Workers who remain under the annual limit, and whose dose was X rems, would be constrained to receive (5 − X) rems, whereas workers who received more than 5 rems in the first quarter could be allowed an additional 4 rems (1 rem in each of the four quarters). One commenter suggested that this could provide an incentive for individuals who are approaching the dose limit to deliberately exceed the limit and thereby protect their employability by taking advantage of the extra dose allowance available to those who have exceeded the limits. Another commenter believed that such a blanket authorization to exceed the limits was inappropriate and preferred prior NRC review of the use of these extra doses on a case-by-case basis.

Response: The purpose of the dose allowance was to protect the worker's employability after having received a dose above the dose limits. Although intentionally getting additional exposure might be in the worker's interest for employability reasons, such an action would not be in the worker's interest with respect to health protection. Licensees having workers with critical skills who are approaching the dose limits early in the year or workers who have received an accidental overexposure should consider use of the planned special exposure (§ 20.1206) to permit continued employment.

Final rule: The allowance of an additional 1 rem per quarter following an exposure in excess of the limits has been deleted.

Proposed Section 20.202 Compliance with Requirements for Summation of Internal and External Dose [Section 20.1202 in This Final Rule]

Comment: Implementation burden. Many commenters felt that the burden of adding external and internal doses was substantial, particularly as most licensees would be faced with either external exposure situations or internal dose situations, but not both.

Response: The NRC staff disagrees that there will be a substantial recordkeeping burden because this summation will be required only if both the internal dose and the external dose are each likely to exceed 10 percent of the dose limit. Thus, in most situations, as noted in the comments, only one component will be required to be measured and, consequently, summation of internal and external doses will not be required.

Final rule: The requirement remains that the committed effective dose equivalent and the deep-dose equivalent should be summed to give the total effective dose equivalent. However, this summation need only be performed if both components are required to be monitored (i.e., exceed 10% of an applicable dose limit). If the summation of doses is not required, then the limit applies to the component (internal or external) that is measured. The NRC is planning to issue additional guidance in the form of a regulatory guide. This guide will be on procedures to be used in estimating committed effective dose equivalents and deep-dose equivalents and guidance on when internal and external doses have to be summed.

Comment: Use of individual metabolic or dosimetric data. Several commenters thought that the proposed rule required the use of specific metabolic and dosimetric parameters for the exposed individual. One commenter also thought that the use of such parameters would "invalidate the stochastic approach of the regulation, which presumes that the effects of radiation exposure at these levels are statistical in nature."

Response: It was not intended that licensees would be required to collect and use specific metabolic or dosimetric information on exposed individuals for use in dose assessments. The intent was to permit the use of personal data for dose assessment when such data were available. The use of parameters that are more appropriate for a particular exposed individual than those assumed for the "Reference Man" should improve the accuracy of the dose estimate for that individual. This is unrelated to the concept of stochastic health effects.

The statistical nature of the potential stochastic effects of low doses of ionizing radiation does not require that the associated dose estimates be based on Reference Man doses. However, it is necessary to resort to population-averaged dose-to-risk conversion factors as there are no health risk coefficients available for specific individuals.

(Monitoring thresholds and thresholds for summation of internal and external dose—see discussion under proposed § 20.502)

Note: Section 20.1202(c) in this final rule states that: "The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure." This requirement is intended to apply primarily to situations where there are steep gradients in the radiation dose rate, depending upon location within the facility and spatial orientation of the worker's body. For example, good practice for a worker in a nuclear power plant who is reaching up into a radioactive steam generator would be to wear at least two personnel dosimeters: one to monitor the extremity dose (worn on the finger or wrist) and one to monitor the whole-body dose (worn on the upper arm). For routine monitoring in relatively homogeneous radiation fields, special consideration to identify the actual "highest" exposed area would not be required.

Proposed Section 20.203 Determination of External Dose from Airborne Radioactive Material [Section 20.1203 in This Final Rule]

Comment: This could be read to require that the air concentration be measured at two locations. This section appears to require that the air concentration be measured at the location of the individual and at the point of maximum concentration in the cloud. The regulation should emphasize

the reliance on personnel dosimeters or other monitoring devices.

Response and final rule: The proposed rule § 20.203 (section 20.1203 in this final rule) has been shortened considerably. The revised section emphasizes the use of survey instruments and personnel monitoring devices to evaluate the external dose. The remaining technical guidance from this section in the proposed rule will be incorporated into a regulatory guide.

Proposed Section 20.204 Determination of Internal Exposure [Section 20.1204 in This Final Rule]

Comment: Interim dose calculation factors and parameters. The portion of part 20 in §§ 20.1–20.601 was based on ICRP–2 [20] dosimetry and metabolic models. The amendments to part 20 in this final rule employ the ICRP–30 [21] dose parameters. There was concern regarding whether the more recent ICRP–30 parameters should be used, particularly when the value is to be compared with the concentration limits associated with §§ 20.1–20.601 of part 20.

Response: The NRC is planning to issue a regulatory guide that will address the use of bioassay measurements for determining compliance with part 20. Appropriate parameters for calculating organ doses from radionuclide intakes can be found in ICRP–30 and its supplements. Dose factors in Federal Guidance Report #11 [22] are also acceptable for use in calculating occupational exposures for compliance with either §§ 20.1–20.601 or with §§ 20.1001–20.2401, except that the individual organ dose values must be used for §§ 20.1–20.601. The effective dose factors can be used for evaluating compliance with §§ 20.1001–20.2401, but cannot be used in evaluating compliance with §§ 20.1–20.601.

The effective dose equivalent factors in Federal Guidance Report #11 do not employ a rounding method suggested in ICRP–30. For this reason, the dose factors in Report #11 may be slightly higher (10–20 percent) than the effective dose factors that correspond to the ALIs and DACs in both the amended part 20 and Report #11. These dose factors would be more restrictive (give slightly higher doses for the same intake) than dose factors computed using the ICRP–30 roundoff procedure, but they can be used for evaluating compliance with part 20.

Proposed Section 20.205 [Deleted] Further Provisions—Internal Exposure Involving Radionuclides With Very Long Effective Half-Lives

Comment: Exemption for long-lived radionuclides and the use of the committed dose equivalent concept. The use of the concept of a "committed dose equivalent" drew numerous comments. This approach entails assigning to the year of intake the future internal dose (the "committed dose equivalent" over 50 years) from radionuclides taken into the body during that year. The proposed rule (in § 20.205) allowed an exemption from the use of committed dose equivalents for several long-lived radionuclides.

Many of the commenters objected to having to assign the future 50-year dose to a single year. Others suggested that variable integration periods be allowed instead of one fixed 50-year value. One argument offered in support of either of these positions is that many adult workers would not normally be expected to live long enough to accrue the full 50-year committed dose equivalent. Commenters pointed out that while pre-exposure controls (such as the annual limits on intake and the derived air concentrations) should be based upon the committed dose equivalent concept for planning and control, the use of controls based upon limiting the annual effective dose equivalent rate (rather than using the committed dose equivalent) might be preferable for post-exposure management following actual radionuclide intakes.

It was also noted that there were several additional nuclides that had similar half-lives and retention characteristics but were not included in the proposed exception. Among these were cobalt, strontium, and americium. The approach in the proposed rule was characterized as appearing to place almost complete emphasis on the control of the work environment rather than on the assessment and control of the individual worker.

Response: The concept of dose commitment is not new; this concept has been used as the basis for controlling internal doses since the late 1950s when ICRP Publication No. 2 [22a] and the present 10 CFR part 20 were published. However, the term "committed dose equivalent" applied to future doses from internal emitters initially appeared in 1977 in ICRP Publication No. 26. [22b]

The concentration limits for air and water in the appendix B to §§ 20.1–20.601 were based upon concentrations which, if continually inhaled (for air) or ingested (for water) over a 50-year period, would produce a dose rate in the "critical organ" in the 50th year that was numerically equal to the annual organ dose limit. For certain radionuclides that slowly approached a constant body burden, primarily those radionuclides that have both long radiological half-lives and long biological clearance half-times, the limiting organ dose rate is not reached by the 50th year. For shorter-lived radionuclides and those that are rapidly removed from the body, equilibrium may be attained more rapidly and the limiting annual organ dose rate could persist over many years.

The limiting dose rate in the 50th year from a constant intake of a radionuclide each year over a 50-year period is numerically equal to the total dose integrated over the 50-year period from a single year's intake of the same magnitude. Therefore, controlling the integrated future ("committed") dose for each year's radionuclide intake also controls the annual dose rate in the 50th year to be within the dose limit.

It was noted that use of limits to annual doses in some cases would not ensure that doses in future years would be within limits. The example of the ingrowth of americium-241 from plutonium-241 was cited in which, even if the initial annual dose from plutonium-241 were within the limit, the ingrowth of the radiologically more significant americium-241 would lead to doses higher than the limits in subsequent years.

There are only a few radionuclides that would not attain an equilibrium level (and a constant annual organ dose rate) within time periods of less than 50 years. The use of the committed dose equivalent, rather than controlling internal dose on the basis of annual dose, substantially overestimates annual doses only for those radionuclides that do not reach an equilibrium level in the body early in the working lifetime. These radionuclides are primarily the long-lived radionuclides for which the exemptions of § 20.205 in the proposed rule were intended. Radionuclides (such as cobalt-

[20] International Commission on Radiological Protection, "Report of Committee II on Permissible Dose for Internal Radiation," ICRP Publication No. 2 (1959). (Available for sale from Pergamon, Press, Inc., Elmsford, NY 10523.)

[21] International Commission on Radiological Protection, "Limits for Intakes of Radionuclides by Workers," ICRP Publication No. 30. (Available for sale from Pergamon, Press, Inc., Elmsford, NY 10523.)

[22] Environmental Protection Agency, Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration, and Dose Conversion Factors for Inhalation, Submersion and Ingestion." USEPA Report EPA–520/1–88–020 (September 1988). (Available from the USEPA, Office of Radiation Programs, 401 M Street, SW., Washington, DC 20460.)

[22a] See footnote 20.

[22b] See footnote 1.

60, strontium-90, and americium-241) that were easily measured at airborne concentrations or body burdens below the DAC and ALI values were not included in the list of exempted radionuclides because an exemption was not believed to be necessary for them.

The annual limits on intake and derived air concentrations are used mainly for pre-exposure control rather than post-exposure dose assessment so that fine-tuning these values to specific ages or adjusting them for factors such as the length of the period over which the committed dose is evaluated or to differences in individual organ sizes (as were suggested) is not warranted for occupational dose assessment. The use of age-dependent committed dose factors as suggested by some commenters would add needless complexity to the assessment of internal doses and cannot be justified on the basis of the availability of information on either age-dependent metabolic parameters or age-dependent radiobiological risk information.

The use of an annual dose limitation system, even with a reduction in the allowable dose limit from 5 rems to 3 rems such as in the proposed § 20.205, does not provide a limitation on the lifetime radiation dose or risk equivalent to that provided by the committed dose limitation system of this final rule for all classes of workers. Although long-term workers would be protected to the same degree under either the annual or committed dose systems, short-term or temporary workers could get somewhat higher lifetime doses under a dose limitation system based on limiting only individual annual dose. Furthermore, it is neither reasonable nor practical to expect future employers to take special measures to control radiation dose to workers who transfer because a previous employer, working under annual organ dose limits, permitted intakes that would result in future dose rates that are appreciable fractions of the allowable dose limits. Such a practice would not be fair to workers whose future employability may be limited because of the additional restrictions a new employer would have to put on their exposure, or to future employers of these workers who may have to assess internal doses from residual body burdens of internal radionuclides in order to show compliance. The annual dose system also requires a complex bookkeeping effort because the annual dose limit for each worker depends upon the worker's pre-existing body burden of radioactive materials.

Final rule: For the reasons discussed above, the Commission has decided not to adopt proposed § 20.205 and the exemptions for certain long-lived radionuclides for the final rule. The use of the committed dose equivalent will be applied uniformly to all radionuclides, regardless of half-life. The Commission recognizes that the removal of this exemption, combined with the lowering of the airborne concentration limits for several radionuclides (notably thorium and uranium), could impact on the current and future facilities that use these materials. Licensees that are affected by these changes may request an extension of the implementation time in order to make the necessary modifications to comply with the revised limits as they relate to long-lived radionuclides identified in the proposed § 20.205. In addition, licensees should note the flexibility provided in §§ 20.1001–20.2401 for more accurate dose assessments to be made that might show that additional controls were not required in order to meet the dose limits. Specifically, § 20.1204 allows the use of actual particle-size distributions and physicochemical characteristics of airborne particulates to define a site-specific derived air concentration to be used in lieu of the generic values in appendix B to §§ 20.1001–20.2401. Such adjustments result in the use of more precise dose estimates because of a better characterization of the actual exposure conditions. Although these adjustments might permit higher airborne radionuclide concentration limits to be used, the same degree of health protection would exist because the radiation dose (and risk) would remain the same. This section also allows for whole-body counting or bioassay measurements to determine the behavior of radioactive materials in the individual and the use of these data to estimate intakes and calculate internal doses. A 7-month delay between a bioassay or retention measurement and recording of the associated dose is also permitted in order to make confirmatory measurements.

The Commission recognizes that alternative methods may be identified in the future that might achieve the same degree of lifetime risk limitation for both short-term and long-term workers as the dose system recommended by the ICRP and the Radiation Protection Guidance to Federal Agencies for Occupational Exposure, and adopted in amendments to 10 CFR part 20 in this final rule. The Commission further believes that, to be acceptable, such alternatives should not result in an adverse impact on worker employability or result in undue recordkeeping or excessive monitoring requirements for the future employers of transferring workers.

Proposed Section 20.206 Planned Special Exposures [Section 20.1206 in This Final Rule]

Comment: The use of planned special exposures could result in lifetime cumulative doses greater than those doses formerly permitted under the 5(N − 18) formula. One commenter noted that the new regulatory scheme, including planned special exposures, allowed a higher total lifetime dose than was permitted using the 5(N − 18) formula. The calculation presumes a working lifetime of 47 years (starting at age 18 and ending at age 65). Under the amendments to part 20 in this final rule, the lifetime limiting dose would be 260 rems ((5 rems per year) × (47 years) + 5(5 rems) (planned special exposures) = 235 + 25 = 260 rems). Under the 5(N − 18) formula, at age 65 (N = 65), the cumulative dose would be 5(47) = 235 rems. The comment further noted that the NCRP recommended (in NCRP Report No. 91) a cumulative dose limit of 1 rem × age; the Department of Energy has proposed a 100-rem lifetime dose limit, and the ICRP at its 1984 Stockholm meeting inferred a goal of 1 rem per year. Other commenters noted that, because of the potential lifetime dose including the planned special exposure, the claim on 51 FR 1121 (Table 5), of the proposed rule that "Individuals receiving highest exposure will be reduced" is unjustified and incorrect.

Response: The analysis of maximum doses discussed above is overly simplified because it assumes that there are individuals who will be exposed at the allowable dose limit every year of their working lifetime. Under the old 5(N − 18) formula, the unused portion of the dose limit (the difference between the actual dose received and 5 rems) became part of a "dose bank" that could be drawn on in later years (at a rate up to 3 rems per quarter or 12 rems per year). This "dose bank," which is inherent in the age-prorated formula of 5(N − 18), does not exist with the straight annual dose limit. If the worker's exposure is under the 5-rem annual dose limit, there is no way to recapture the difference for use in future years. Consequently, the average annual dose (for the more highly exposed workers) associated with amendments to part 20 in this final rule is expected to be less than under the former rule.

As noted above (see Response under proposed § 20.201—Occupational Dose Limits), the Commission considered the

use of a lifetime dose limit but rejected it.

Comment: Planned special exposures should not be limited to external exposures but should also be permitted for internal exposures. Several commenters noted that it was inconsistent to treat internal and external doses as equivalent by summing them and then restricting planned special exposures to only external doses. Commenters also pointed out that the total effective dose equivalent (TEDE) could be minimized in some cases if some external doses were reduced at the expense of incurring some internal doses.

Response: The Commission agrees that restricting the use of planned special exposures to only external doses would be inconsistent with the ALARA principle and the presumed equivalence of internal and external doses inherent in the amendments to part 20 in this final rule. Consequently, the requirements have been modified so that internal doses may be included in planned special exposures in order that the total dose (TEDE) can be controlled in keeping with ALARA.

Comment: The annual dose allowed in a planned special exposure does not agree with the recommendations of the ICRP. A few commenters thought that the allowable annual dose from planned special exposures should be 10 rems as stated in the ICRP recommendations. Other commenters agreed with the NRC's modification to reduce the annual dose for planned special exposures to 5 rems.

Response: The NRC has intentionally reduced the dose allowed in any year from a planned special exposure from the 10-rem value proposed by the ICRP to 5 rems. The lifetime total limit from planned special exposures of 25 rems remains the same as the ICRP recommendation. The Commission believes that it would be better to distribute the dose over the lifetime more evenly than to permit a large portion of the cumulative dose to be received within a small period of time. In this sense it should be recalled that the planned special exposure is in addition to the normal dose limits. The initial ICRP proposal would have permitted a 15-rem dose in 1 year, 10 rems from planned special exposures and 5 rems from routine operation. Under the Part 20 condition, it would be theoretically possible to get a 10-rem dose in 1 year, 5 rems from a planned special exposure and 5 rems from routine operation. This is roughly equivalent to the 12 rems (3 rems/quarter) that could be received under the present Part 20 limitations using the 5(N − 18) formula.

Comment: Subtraction of emergency doses. Some commenters suggested that doses received under emergency conditions, up to a lifetime total of 25 rems, not be subtracted from the lifetime allowance for planned special exposures. It was also suggested that the employability of the individual might be jeopardized if the dose "bank" were depleted.

Response: The NRC has not officially sanctioned the 25-rem "forgivable" emergency dose that has been recommended by some organizations for a once-in-a-lifetime dose that would not be counted against an individual's lifetime dose. Consequently, all doses received as result of occupational exposure must be recorded in an individual worker's record.

The Commission believes that planned special exposures will be used infrequently so that the lack of a dose bank for some individuals would not be a major drawback to their employability.

Comment: The time period for notifying exposed individuals of their dose is too short. A number of commenters thought that the 15-day period for notifying exposed individuals of their exposure from a planned special exposure was too short. Some commenters noted that most NRC reporting requirements provide a 30-day, not a 15-day, period. Other commenters suggested that the 15-day period could give the impression (to the worker) that an inordinate risk was involved when that was not the case.

Response: The 15-day period for notification was intended to be unique and to further emphasize that "planned special exposures" were indeed "special." However, the Commission has extended the time period for notification of the individual from 15 days to 30 days to allow licensees additional time to estimate internal exposures that are now permitted in §§ 20.1001–20.2401 of the amended part 20 rule to be part of a planned special exposure. The requirement to notify the NRC (see § 20.2204) that a planned special exposure has taken place is also 30 days.

Comment: Doses received during a planned special exposure that do not exceed the dose limits for normal operation should not have to be recorded as planned special exposures or be subtracted from the lifetime planned special exposure limit. A few commenters expressed concern that exposures during planned special exposures that did not result in doses to an individual in excess of the occupational annual dose limits would nevertheless have to be reported separately and subtracted from the individual's lifetime allotment for planned special exposures.

Response: The intent of the planned special exposure was that it would be used infrequently in circumstances where the elimination of the 5(N − 18) lifetime cumulative limit might create a severe handicap to the licensee's operations. Being able to switch doses between planned special exposures and routine dose limits would tend to encourage the use of planned special exposures as the licensee would have nothing to lose by using the planned special exposure. This is contrary to the Commission's intent that the planned special exposures be restricted to "special" situations. Once a licensee decides to conduct a planned special exposure, all of the unique limitations, reporting, and recordkeeping requirements are to apply, even if the doses actually received fall within the dose limits for routine operations.

Final rule: The provisions of planned special exposures have been extended to include internal exposures, and the reporting time to the individuals involved and the NRC have been changed to 30 days to allow sufficient time for analysis of internal dose.

Proposed Section 20.207 Occupational Dose Limits for Minors [Section 20.1207 in This Final Rule]

Comment: Exposure of Minors. One commenter stated that minors should not be exposed to radiation because they do not meet the criteria for occupational radiation exposure. The commenter argued that minors are not trained regarding radiation protection, do not derive a benefit from employment, and would require the preparation of an NRC Form 4 if they were workers.

Response: Allowing minors to be occupationally exposed to radiation is permitted in § 20.104. All individuals, including minors, who enter a restricted area are required (10 CFR 19.12) to be instructed as to the risks involved. Minors who are employed receive salaries and other associated benefits of employment so that there does not appear to be a major difference in this respect from other workers. Furthermore, licensees are required under §§ 20.1–20.601 and under §§ 20.1001–20.2401 to maintain the same exposure records for minors as for adults.

An alternative to this procedure would be to exclude minors completely

from radiation-related work. This does not appear to be desirable as the monetary, experience, and educational benefits that may accrue to the minor appear to outweigh the small incremental risk involved (Particularly considering the reduced dose limits applied to minors). Consequently, no change has been made from the proposed rule.

Proposed Section 20.208 Dose to an Embryo/Fetus [Section 20.1208 in This Final Rule]

Comment: Biologic basis for lower dose limits for pregnant women. There were comments that cited older studies and recommendations for dose limits for the embryo/fetus that are considerably higher than 0.5 rem. These comments questioned the biological basis for the 0.5 rem dose limit for the embryo/fetus in the proposed rule.

Response: The biological effects of ionizing radiation upon the embryo/fetus are summarized in Regulatory Guide 8.13.[23] The limit of 0.5 rem during the entire gestation period is based upon a recommendation by the NCRP in 1977.[24] The International Commission on Radiological Protection (ICRP–26) [24a] recommended 0.3 times the annual dose limit or 15 mSv (1.5 rems) over the full gestation period and 5 mSv (0.5 rem) in the first 2 months of pregnancy. More detailed information can be found in publications of the NCRP,[24] ICRP,[25] UNSCEAR,[26] and the OECD/NEA.[27]

Final rule: The limit for the embryo/fetus of a declared pregnant woman is 0.5 rem over the entire gestation period. There is also an admonition that the licensee avoid substantial variation above the average monthly exposure rate that would comply with the 0.5-rem limit. These conditions are consistent with the Federal guidance on occupational radiation exposure and with the recommendations of the NCRP in NCRP Report No. 91.

Comment: Licensee's Responsibilities to Protect the Embryo/Fetus of an Undeclared Pregnant Woman. Several commenters raised the question of whether the licensee had any responsibility for protecting the embryo/fetus of an obviously pregnant female employee who had not formally declared her pregnancy to the employer.

Response: It is the fundamental responsibility of the pregnant worker to decide when or whether she will formally declare her condition to her employer. This position is derived from court rulings concerning a pregnant woman's rights regarding termination of the pregnancy. Having a woman formally declaring her pregnancy to her employer derives from legal, not health protection, considerations. If she chooses not to declare her pregnancy, the licensee will not be required under the Commission's regulations to limit her dose to the 0.5-rem limit.

Undeclared pregnant women are protected under the NRC regulations for all workers. The normal occupational dose limits would still be in effect and would have to be complied with, and the dose would also have to be kept "as low as is reasonably achievable." In addition, as part of her initial employment, the woman should have received instructions in radiation protection (10 CFR 19.12), and she should have been provided with a copy of the current version of Regulatory Guide 8.13.

It might be prudent for a licensee to remind a pregnant, but undeclared, worker of the special limit for protection of the embryo/fetus of a declared pregnant woman and to provide another copy of Regulatory Guide 8.13 to her. However, if the licensee has previously provided this information to the employee, it is not a Commission requirement that it be done again. If the requirements referred to in the previous paragraph have been fulfilled, the licensee will not be cited for a violation of the Commission's regulations if the estimated dose to the embryo/fetus of an undeclared pregnant woman exceeds the 0.5-rem limit, even if the worker's pregnant state seems obvious.

Section 161c. of the Atomic Energy Act gives NRC the authority to require such information to be provided by the worker. However, such a requirement could be considered to be discriminatory and an invasion of personal privacy. It would also be unenforceable because only the woman and her physician know when she knew of the pregnancy and patient-doctor communications are privileged. Infringement on personal privacy is also a drawback that applies to requiring the female worker to supply information concerning her "fertility" or "infertility."

Comment: Estimation of Dose to the Embryo/Fetus. The assignment to the embryo/fetus of a dose equal to the dose to the declared pregnant woman was questioned. For example, would it be reasonable to assign to the embryo/fetus a dose based upon the dose received by the woman's shoulder or head?

Commenters also indicated that licensees should be permitted to employ factors other than a factor of 2 and take into account shielding of the embryo/fetus by maternal organs and the placenta in evaluating the external dose component of the embryo/fetus.

Response: The concept used in the proposed rule of relating the dose to the embryo/fetus to the dose received by the mother has been modified. The final rule permits direct calculation of the dose to the embryo/fetus. This was done so that the use of more accurate dose assessments would not be precluded by the rule. The internal dose to the embryo/fetus may or may not be directly proportional to the dose received by the mother.

A forthcoming regulatory guide will provide guidance on methods for calculating the dose to the embryo/fetus. For interim assessments of the dose to the embryo/fetus, it may be assumed that the dose to the embryo/fetus from external radiation and from radionuclides in the body that are relatively uniformly distributed, such as cesium-137 and compounds of tritium and carbon-14 that are not organically bound, is the same as the dose to the mother since under these circumstances the same energy would be deposited per gram of tissue in both the mother and the fetus. For external gamma irradiation, the assumption that the dose to the fetus is the same as to the mother should be conservative (yield calculated doses that are somewhat higher than the actual doses determined by more precise evaluations).

Permitting calculations of the embryo/fetal dose using reduction factors for attenuation within the body of the mother would entail knowledge of the energy spectra of the incident radiation. As noted previously (Response for proposed § 20.201), photon spectral measurements, although technically feasible, are not currently required by the Commission and are considered to be beyond the scope of routine radiation

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[23] U.S. Nuclear Regulatory Commission, "Instructions Concerning Prenatal Radiation Exposure," Regulatory Guide 8.13, Rev. 2, December 1987.

[24] National Council on Radiation Protection and Measurements, "Review of Radiation Dose Limit for Embryo and Fetus in Occupationally Exposed Women," NCRP Report No. 53 (1977). (Available for sale from the NCRP, 7910 Woodmont Avenue, suite 800, Bethesda, MD 20814–3095.)

[24a] See footnote 1.

[25] International Commission on Radiological Protection, "Developmental Effects of Irradiation on the Brain of the Embryo and Fetus," Annals of the ICRP 16 4) (1986). (Available for sale from Pergamon, Press, Inc., Elmsford, NY 10523.)

[26] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), "Genetic and Somatic Effects of Ionizing Radiation". Sales Section, United Nations, NY (1986' particularly Chapter III, Biological Effects of Pre-natal Irradiation."

[27] Organization for Economic Cooperation and Development/Nuclear Energy Agency, "The Biological Basis for the Control of Prenatal Irradiation," OECD/NEA, Paris, France (1988).

protection survey measurements. The small amount of reduction in the calculated dose afforded by such attenuation corrections would be secondary in importance compared to uncertainties due to body orientation, partial-body exposure from collimated beams of radiation, and the radiobiological sensitivity of the embryo/fetus.

In situations where the use of a single dose measurement would be inappropriate for both the woman and the embryo/fetus, a solution would be to monitor the two doses separately.

Comment: Additional Dose Increment Allowed to Pregnant Women Beyond the Dose Limits. The rationale was requested by a few commenters for permitting an extra 0.05 rem (0.5 millisievert) beyond the 0.5-rem (5 millisieverts) dose limit to an embryo/fetus.

Response: The small additional dose is intended to apply in situations where the embryo/fetus has accumulated a substantial fraction of the dose limit or has already exceeded the limit before the woman formally declares herself to be a "declared pregnant woman." If the incremental 0.05-rem dose were not available, a woman having already received a dose in excess of the 0.5-rem limit might not be able to be further employed in a radiation-related job. The licensee could be in "instant noncompliance" as the embryo/fetus dose limit could have been exceeded before the licensee was aware that it was applicable (i.e., before the woman declared her pregnancy). Thus, the small incremental 0.05-rem dose provides a means of ensuring continued employment for the woman and also removes the threat of inadvertent noncompliance on the part of the licensee. The additional risk posed by this incremental dose to the embryo/fetus is small compared to the potential risk from the overall 0.5-rem dose limit.

Final rule: The final rule corrects an anomaly in the proposed rule regarding the application of the additional 0.05-rem incremental dose. In the proposed rule, the additional 0.05-rem dose was available if the embryo/fetal dose limit had been exceeded prior to the woman's declaration of pregnancy (even if the dose were 0.501 rem). However, the additional 0.05-rem dose increment would not have been available if the embryo/fetal dose were less than the 0.5-rem limit (even if the dose were as much as 0.499 rem). There is no significant difference in risk between 0.551 (0.501 + 0.05) rem and 0.549 (0.499 + 0.05) rem. This provision would have resulted in unnecessary penalties to both the licensee and the declared pregnant woman. In the final rule, the 0.05-rem dose increment is available as an additional dose if the embryo/fetal dose at the time of declaration is greater than 0.45 rem (0.45 = 0.5 − 0.05).

Subpart D—Radiation Dose Limits for Individual Members of the Public

Proposed Section 20.301 Dose Limits for Individual Members of the Public [Section 20.1301 in This Final Rule]

Comment: NRC should defer changes to limits for the general public until the EPA issues revised Federal guidance. The EPA suggested that NRC not modify its radiation limits for protection of the general public until EPA prepares revised Federal guidance on dose limits applicable to the general public (the recently issued Federal guidance applied only to occupational radiation protection).

Response: Although it would be desirable to use Federal guidance as a basis for the revision of the limits for the public, the Commission believes that Part 20 needs to be based on a consistent set of principles and concepts rather than having its standards for workers using one dose limitation system and its standards for the general public using an entirely different (and outmoded) system. The latest Federal guidance does not address radiation exposure of the general public and, although the NRC staff is represented on an EPA Task Group which is developing draft Federal guidance on doses to members of the general public, the Commission has chosen not to defer these limits until this Task Group has completed drafting the guidance and EPA makes recommendations to the President for its issuance. The Commission's intent to address these limits was noted explicitly in the statement of considerations that accompanied the proposed rule (51 FR 1118, section XXVIII).

Comment: Facilities that are subject to other lower standards should not have to demonstrate compliance with the 0.1-rem limit ["reference level"]. Several commenters expressed concern that additional efforts would be required to demonstrate compliance with the proposed 0.1-rem "reference level." For licensees that were already subject to the 0.025-rem (25-millirem) limits of EPA's 40 CFR part 190, this appeared to be an unnecessary burden.

Response: The concept that 0.1 rem represents a "Reference Level" has been eliminated. The 0.1-rem value in the final rule represents the primary dose limit for protection of the public. This change from the proposed rule reflects the clarifications by the ICRP (see section II.A.) regarding the usage of the 0.1-rem and 0.5-rem recommended dose levels. This change does not represent a major change from the proposed rule. Many commenters had indicated a belief that, because of the reporting and control requirements associated with the 0.1-rem reference level, it already represented a *de facto* limit.

Demonstration of compliance with the limits in 40 CFR part 190 or with the design objectives of appendix I to 10 CFR part 50 will be deemed to demonstrate compliance with the 0.1-rem dose limit for most licensed facilities. Power reactor licensees that comply with appendix I may also have to demonstrate that they are within the 0.025-rem limit in 40 CFR part 190. Demonstration of compliance with the limits of 40 CFR part 190 will be considered to demonstrate compliance with the 0.1-rem limit. For uranium mills it will be necessary to show that the dose from radon and its daughters, when added to the dose calculated for 40 CFR part 190 compliance, does not exceed 0.1 rem.

The dose rate limit of 2 millirems in any 1 hour from § 20.105(b)(1) of the present part 20 was omitted in the proposed rule but has been reinstated in the final rule. The reason for this is that this limit provides a more readily measurable quantity than the 100 millirem per year value and can be more easily verified by short-term measurements.

Comment: Inclusion of doses from other licensed or unlicensed radiation sources. Many commenters expressed an opinion that the dose should not be all-inclusive and should not include fallout from nuclear weapons tests, transportation of radioactive material, or other sources of radiation not under the control of the licensee.

Response: The new lower dose limit for members of the general public (which was described as a "reference level" in the proposed rule) applies only to doses from radiation and radioactive materials under the licensee's control. The EPA's generally applicable environmental radiation limit for nuclear power operations (40 CFR part 190) does apply to the total dose from all sources within the uranium fuel cycle. However, in its practical implementation, the sources would have to be located within a few miles of each other for the combined dose contributions to be significantly different from the dose from either facility alone.

The definition of "natural background" has been replaced by "background radiation," which means

radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices. This clarifies sources of radiation and radionuclides that can be excluded from evaluations of the dose from licensed activities.

Comment: Differentiation of limits for long-term operation and for shorter-term transient operation. A number of commenters noted that ICRP–26 described the 0.1 rem (1 mSv) per year value as intended to be an average goal for long-term operation but that 0.5 rem (5 mSv) was intended as the primary annual dose limit for members of the public. Some commenters suggested that a lifetime dose limit be established for members of the public.

Response: As noted above in section II.A., the ICRP has modified its interpretation in the ICRP statement issued following their 1985 Paris meeting,[27a] so that the primary standard is 1 mSv (0.1 rem) per year. This clarification of ICRP philosophy is reflected in part 20 by the change of the 0.1 rem per year value from a "reference level" in the proposed rule to a primary limit in the final rule.

Final rule: It should be emphasized that the 0.1 rem per year limit in Part 20 is not intended to be applied as a long-term average goal. It is an annual limit. As a matter of practicality, long-term (or lifetime) dose limits for members of the public cannot be implemented unless each year's dose is kept within the long-term goal. Doses to individuals in the general public are not usually monitored directly (locations rather than individuals in the offsite environment are monitored). As individuals may change residency and there is no reporting or tracking system, lifetime doses to specific individuals in the general population are very difficult to determine.

The 0.5 rem per year limit is available only upon specific application to and approval by the Commission (see § 20.1301(c)). A 0.5-rem value has been retained in order to apply to transient situations and to alleviate the immediate need to redesign or reshield existing facilities that were designed to meet the former 0.5-rem limit. The 0.5-rem limit is intended to be applied primarily to temporary situations where operation of a facility, or the person's exposure to radiation and radioactive emissions, is not expected to result in doses above 0.1 rem over long periods of time. For design of new installations, the 0.1-rem limit should be used. However, existing facilities may apply for NRC approval to use the 0.5-rem limit while more complete evaluation of the need for any additional modifications is performed. Such facilities may include, for example, hospitals with existing teletherapy machines that were designed, constructed, and installed to comply with a 0.5 rem annual dose limit.

The Commission is aware that some categories of licensees, such as uranium mills and *in situ* uranium mining facilities, may experience difficulties in determining compliance with the values in appendix B to §§ 20.1001–20.2401, Table 2, for certain radionuclides, such as radon-222. Provision has been made for licensees to use air and water concentration limits for protection of members of the general public that are different from those in appendix B to §§ 20.1001–20.2401, table 2, if the licensee can demonstrate that the physicochemical properties of the effluent justify such modification and the revised value is approved by the NRC. For example, uranium mill licensees could, under this provision, adjust the table 2 value for radon (with daughters) to take into account the actual degree of equilibrium present in the environment. This provision permits (upon NRC approval) the use of concentration limits for members of the general public that better represent actual exposure conditions. This is similar to the allowance for use of modified derived air concentrations (with Commission approval) in § 20.1204(c)(2). In both situations, licensees would be permitted to propose radionuclide concentration limits for their facility that reflect actual properties of the effluents rather than using the generic concentration-to-dose assumptions associated with values in appendix B to §§ 20.1001–20.2401. These adjustments tailor the concentration limits to specific conditions, provide the same limitation of dose, and do not permit any greater risk even though the adjusted concentration limits (for members of the general public or for workers) may be higher than the appendix B to §§ 20.1001–20.2401 generic values.

Use of this provision, applied to the percentage of radionuclide equilibrium existing in radioactive decay chains, could provide a factor of 2 or 3 upward change in the appropriate air concentration limit. In addition, the licensee can demonstrate compliance by calculating the dose to the nearest resident rather than meeting the air concentration limit at the site boundary in accordance with 10 CFR 20.1302(b)(1). This should provide an additional factor of 2 or 3 allowance. Lastly, if the 0.1-rem effective dose limit still cannot be met, the licensee can apply to NRC under § 20.1301(c) for permission to use a temporary 0.5 rem per year limit rather than the 0.1 rem per year limit. Section 20.1301(c) of final rule requires that, in order to receive permission for use of this higher dose limit, the licensee has to specify (1) the need for and expected duration of the higher value, (2) their program to assess and control doses, and (3) procedures to control doses to be ALARA. These options used singularly or in combination coupled with process or operational modifications of these facilities is expected to provide sufficient flexibility to enable most uranium recovery facilities to comply with the provisions of the amendment to 10 CFR part 20 in this final rule.

Proposed Section 20.303 [Reserved]

The former 0.1-rem "Reference Level" and the EPA Standard for Nuclear Power Operations that were in this section in the proposed rule are included as primary limits for members of the public in § 20.1301 of the final rule.

Proposed Section 20.304 De Minimis Level and Collective Dose Evaluations [Deleted]

Comment: Adoption of a threshold for calculating collective (population) doses. The proposed § 20.304 would have allowed licensees to disregard doses to individuals that were less than 1 millirem per year when evaluating collective (population or "person-rem") doses. A major criticism of this section was the narrowness of its scope. The section pertained only to a change in the calculational methodology for estimating collective doses and would not have permitted unrestricted release of any materials or equipment.

Most comments from people and organizations within the nuclear power and radiation applications industry favored this measure as an initial step toward developing more general "below regulatory concern" (BRC) levels. Several commenters thought that NRC acknowledgment of the concept of a BRC level was more important than the specific proposal to truncate collective dose calculations. Many commenters thought that a generic BRC level would limit unnecessary expenditure of resources that would otherwise have to be spent to control inconsequential risks.

There were also a number of comments that were not in favor of either the proposed collective dose

[27a] See footnote 2.

cutoff or the more general application of the concept of below regulatory concern. A few commenters expressed opinions that it did not appear feasible to arrive at a universal *de minimis* level because the level that would appear to be truly insignificant to most people would be too low to result in any appreciable saving to the industry. There also were comments that noted that the proposed collective dose cutoff could cause large numbers of potential adverse health effects to be overlooked if they resulted from small radiation doses delivered to very large numbers of people. Many commenters, both pro and con regarding the adoption of a BRC level, thought that a threshold value for collective dose should also be developed. A few commenters noted that the focus of the more generic BRC concept tended to be for single licensees and that it might be necessary to consider the impacts from multiple licensees.

Many of the commenters who supported a generic BRC concept did not agree with the numerical value (0.001 rem per year) proposed for the cutoff, believing it to be too low. An explanation for this opinion was that if 0.001 rem represented an insignificant level of risk, then all larger doses might be perceived as representing "significant" levels of risk. A value of 0.010 rem was noted by several commenters as being a more suitable value and still represented an inconsequential risk.

Response: The Commission agrees that "Below Regulatory Concern" (BRC) levels would be useful and has issued a policy statement on the application of the concept of BRC with regard to waste disposal ("Radioactive Waste Below Regulatory Concern," 51 FR 30839, August 29, 1986) and a general policy statement on BRC (55 FR 27522, July 3, 1990). The general policy statement establishes the framework for the Commission to formulate rules and licensing decisions to exempt certain practices involving small quantities of radioactive materials from some or all regulatory controls. The BRC policy statement sets forth criteria for protection of both individuals (individual dose criteria) and population groups (a collective dose criterion).

In order to ensure that any computational changes reflect the effort to develop the BRC policy, the Commission removed the threshold for truncating collective doses (Proposed § 20.304) from part 20 and has included such a threshold in the generic BRC policy statement. This deletion is also consistent with comments that noted that this section described a method for calculating a quantity (collective dose) that was not required to be calculated by part 20 and comments that such details of calculations would be better in a regulatory guide rather than in a regulation.

Subpart E—[Reserved]

Subpart F—Surveys and Monitoring

Proposed Section 20.501 Surveys [Section 20.1501 in This Final Rule]

Comment: Accreditation of Personnel Monitoring Processors. There were a number of comments concerning the desirability of requiring accreditation of personnel dosimetry processors.

It was also noted that the National Voluntary Laboratory Accreditation Program (NVLAP) does not provide accreditation for doses delivered to the lens of the eye, a depth equivalent to approximately 0.3 centimeter (an areal density of 300 milligrams per square centimeter). The only tissue depth equivalents that are accredited at this time are 1.0 centimeter (the deep-dose equivalent) and 0.007 centimeter (the shallow or "skin" dose equivalent).

Response: The issuance of a dosimetry accreditation requirement or "NVLAP Rule" overlapped the part 20 rulemaking. Because this issue was the subject of a recent separate NRC rulemaking, issues concerning the desirability of such a program were considered and addressed in the rulemaking on accreditation. No revision from the dosimeter processor accreditation rule (52 FR 4601; February 13, 1987) has been made, and the amendments to part 20 in this final rule incorporates the final form of the accreditation rule.

As noted in the discussion of the "eye dose equivalent" in section XI, "Standards for Occupational Exposure of Individuals," of the proposed part 20 rule, the Commission believes that compliance with the eye dose limit will be generally ensured by compliance with the deep-dose limit. Consequently, the lack of accreditation for this depth should not have a major impact on the degree of protection of the eye.

Comment: The accreditation requirement requires the use of a commercial dosimetry service.

Response: This is an incorrect interpretation of the dosimetry accreditation rule (52 FR 4601; February 13, 1987). That rule, which is incorporated into the amendments to part 20 in this final rule, states that the dosimetry processor must be accredited. It is possible for licensees that provide their own dosimetry services to be accredited.

Comment: Lack of specificity in monitoring requirements. Commenters noted that the monitoring requirements, both in the present part 20 and in the proposed rule, were general and imprecise.

Response: Many portions of part 20 are not very specific and detailed because part 20 contains the NRC's general radiation protection requirements and applies to all classes of licensees, including large power reactors, universities, and medical institutions as well as small radionuclide and sealed source users. Because of this breadth of application, the requirements in part 20 cannot be very detailed for any one type of facility. However, the requirements in part 20 are designed to provide the framework for all licensees and to establish provisions that the NRC considers to be fundamental to basic radiation protection.

Proposed Section 20.502 Conditions Requiring Individual Monitoring of External and Internal Occupational Dose [Section 20.1502 in This Final Rule]

Comment: Monitoring Thresholds. A number of commenters questioned the rationale for the lack of agreement of the thresholds in the proposed rule for monitoring external doses (10 percent of the annual limits) and for requiring monitoring of internal doses (30 percent of the annual limit). It was frequently mentioned that starting to require monitoring at 30 percent of the dose limit could result in overlooking doses of 1.5 rems (30 percent of 5 rems). The 1.5-rem value would have been above the limits for minors and for the embryo/fetus (0.5 rem) and was characterized as being a rather substantial fraction of the deep-dose equivalent limit. In this connection, it was also noted that the possibility existed, when large external doses were expected, of exceeding a total effective dose equivalent limit of 5 rems because the licensee was not aware of the internal dose contribution.

Some commenters thought that the monitoring thresholds would be understood more easily if they were expressed as doses instead of percentages.

Response: The unequal thresholds for requiring monitoring of internal doses (30 percent of the dose limit) and external doses (10 percent of the dose limit) were originally set because of the difficulties in performing low-level bioassay analyses of alpha-emitting radionuclides at fuel fabrication and other facilities where actinides may be prevalent. (Bioassays for the radionuclides most commonly found at

nuclear power reactors were viewed as generally being able to meet the 10 percent threshold set for external doses.) In situations such as bioassay for alpha-emitting radionuclides, it may be difficult to detect 10 percent of the ALI or 10 percent of the dose limit by bioassay measurements on excreta.

The monitoring threshold is a predetermined level of anticipated dose for carrying out bioassay procedures and does not represent a required level of detection sensitivity. If, by a reasonable analysis of the working environment, it appears that a worker is likely to inhale radioactive materials at concentrations that could produce an annual committed effective dose equivalent of 0.5 rem (10 percent of the 5-rem limit) or more, then that worker's intake should be monitored using measurements of exposure (e.g., estimates of DAC-hours based upon measured air concentrations) or intake (such as by whole-body counting or other bioassay technique) or by measurements of both exposure and intake. Whether the actual doses received were in excess of 10 percent of the limits could only be determined from these subsequent measurements. The TEDE has to be evaluated if *both* the internal and external dose components have to be monitored.

The monitoring thresholds are specified as percentages of the dose limits rather than as doses because the thresholds apply to several different dose limits: the total effective dose equivalent, the eye dose equivalent, and the shallow-dose equivalent.

Final rule: The threshold for monitoring internal doses have been dropped from 30 percent of the dose limit to 10 percent of the limit. This provides consistency in the internal and external monitoring requirements. The Commission acknowledges that, in some cases, particularly bioassay measurements of transuranic elements, it may not be feasible to actually confirm such levels by bioassay. However, the monitoring threshold is not a requirement on the capability of the measurement. Average airborne radionuclide concentrations and the expected time of exposure can be used to estimate radionuclide intakes and the need for bioassay or other monitoring methods.

The Commission intends to issue a regulatory guide on the procedures to be used in estimating committed effective dose equivalents and deep-dose equivalents and guidance on when they have to be summed.

Comment: Evaluation of radionuclide intakes for respirator wearers. Several commenters mentioned that internal does monitoring, such as bioassays, should not be required solely because respiratory protection devices were used. The rationale given by the commenters was that the requirement provides a negative incentive for using respirators and is, therefore, counter to ALARA operating practices.

Response: The requirement (in § 20.502(b)(3) of the proposed rule) for bioassays for anyone using respiratory protection has been dropped. The Commission agrees that such a requirement might be a disincentive for using respirators as part of an ALARA effort. There is, however, a requirement (in § 20.1703) for bioassays to be conducted, as appropriate, as part of a respiratory protection program. Whether bioassays are necessary for a particular individual will depend upon whether that individual could have exceeded 10 percent of the annual limit on intake (ALI) or was exposed to airborne radionuclide concentrations in excess of the monitoring threshold. An evaluation of internal dose would be required if there were a potential for exceeding 10 percent of an annual limit on intake (0.1 ALI), whether or not a respirator is worn.

Note: Because the requirement for performing bioassays for a particular individual has been separated from the wearing of a respirator, the concentrations to be used for evaluating monitoring thresholds are those of the ambient atmosphere before credit is taken for respiratory protective factors. One of the purposes of such bioassays is to confirm the effectiveness of the respiratory protection being provided. If bioassay were made dependent upon the corrected air concentration (after dividing by the protection factor), it would be equivalent to assuming that the intended protection factor was correct without further verification.)

Subpart G—Control of Exposure from External Sources in Restricted Areas

Proposed Sections 20.601, 20.602, and 20.603 Control of Access to High and Very High Radiation Areas [Sections 20.1601, 20.1602, and 20.1603 in This Final Rule]

Comment: Inapplicability of requirements to nuclear power reactors. Many commenters indicated that the proposed requirements for control of entry into very high radiation areas could not be applied to nuclear power reactors because of the number and size of potential "very high radiation areas" and the physical inability to restrict access to these areas. Similarly, interlocks that can result in the withdrawal or cessation of the radiation source may be unworkable in nuclear power reactors. Several commenters proposed incorporating requirements for power reactors that are similar to reactor license conditions in reactor technical specifications.

Response: The Commission recognizes that the detailed requirements applicable to large irradiators that are currently in § 20.203(c)(6) should be in a specific regulation dealing with these facilities rather than in part 20. For this reason, these detailed requirements will be placed in a future part 36 of title 10 which has been issued for public comment (**Federal Register** of December 4, 1990; 55 FR 50008) and applies specifically to irradiators. When that rule is made effective, the Commission will transfer these requirements from part 20 to part 36. In the meantime, the NRC staff will issue a regulatory guide that provides more specific detailed guidance for nuclear power reactors on high and very high radiation areas.

Comment: Choice of Dose Rate Defining a "Very High Radiation Area." Several commenters believed that the 500 rads per hour dose rate that defines a "very high radiation area" was too high, noting the proximity of this value to the median lethal dose (LD_{50}) for acute radiation exposures. Alternative values, such as 1 rem per hour at 30 centimeters, were proposed.

Response: The seriousness of this dose rate was a factor in its adoption. The 500 rads per hour value appears in 10 CFR 20.203(c)(6) as a criterion for additional access controls for irradiators (similar in scope to the requirements of § 20.1603 in the final rule). However, § 20.203 does not use a unique designation such as the "very high radiation area" designation used in the proposed and final part 20 rules. The difference between the 1 rem per hour definition of a "very-high" radiation area used in reactor technical specifications and the 500 rads per hour definition used in amendments to part 20 in the final rule is discussed in a regulatory guide.

Comment: Meaning of "direct surveillance." Several commenters thought that the term "direct surveillance" used in the proposed § 20.601 could be interpreted to require stationing an observer at the entrance to the "high" or "very high" radiation areas.

Response: The final rule permits "* * * continuous direct or electronic surveillance over a high radiation area that is capable of preventing unauthorized entry * * *". This removes the burden of having to station a person in or near a "radiation area," but requires interlocks or electronic locks so that the remotely located

observer may prevent entry into the area when necessary.

Final rule: The section on very high radiation areas has been divided into two sections. Section § 20.1602 provides a general requirement for restricting access to such areas. This general requirement applies to all very high radiation areas, regardless of the type of licensed operation, including those at nuclear power reactors. A second, more detailed, set of requirements applies only to large gamma irradiators. This section, § 20.1603, restates requirements for irradiators that are in § 20.203(c)(6).

Subpart H—Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas

Proposed Sections 20.701 and 20.702 Use of Process or Other Engineering Controls and Use of Other Controls [Sections 20.1701 and 20.1702 in This Final Rule]

Comment: "Use of other controls." Commenters suggested that, if workers could be exposed to concentrations of radioactive materials greater than 1 derived air concentration, ALARA should be applied to the total of internal and external doses (to the total effective dose equivalent). It was noted that this condition was included in the Federal Guidance on Occupational Radiation Exposure.

Response: Modifications have been made in the final rule to permit ALARA considerations to apply to the total effective dose equivalent rather than just the internal dose portion.

Comment: Some commenters indicated that the use of respirators should be permitted even if their use would not be able to reduce airborne concentrations below 1 DAC. They noted that this would be consistent with the ALARA philosophy.

Response: Proposed § 20.702 has been rewritten to clarify the intent that the concentration of 1 DAC is not a cutoff on the voluntary use of respirators but is intended to be the point where some corrective action (including, but not limited to, the use of respirators) by the licensee would be required when the use of ventilation and process controls cannot further reduce the airborne concentrations of radioactive materials.

Proposed Section 20.703 Use of Individual Respiratory Protection Equipment [Section 20.1703 in This Final Rule]

Comment: The proposed rule permits low estimates but not high estimates of intake to be corrected. Commenters noted that the proposed rule [§ 20.703(a)(1)] was not balanced as correction of intake estimates based upon dividing DAC-hours by the respirator protection factor was only permitted if the initial estimate was later shown (by bioassay results) to have been low.

Response: The rule has been modified so that corrected estimates of actual intake can be used in records in place of earlier estimated intakes, regardless of whether the change would result in an increase or in a decrease in the intake estimate.

Comment: NRC should provide a recommended minimum acceptable standard for determining an individual's physical fitness for respirator use. Part 20 requires that a physician determine that an individual worker is physically able to wear a respirator. NRC should, therefore, provide guidance to the physician on minimum standards for wearing respirators.

Response: The NRC policy is that the decision as to medical fitness has been, and continues to be, left to the physician; i.e., the medical doctor should decide what constitutes minimum health standards for respirator wearers. Furthermore, the requirements may vary, depending on the respirator used and physical situations, such as the type of work to be performed, which are outside the scope of part 20. Licensees desiring more guidance should obtain ANSI Standard Z88.6(1984), "For Respiratory Protection—Respirator Use—Physical Qualifications For Personnel," which was developed as an industry consensus standard that provides definitive guidance to "identify the responsibilities of the physician, the employee, and management in determining the employee's ability to use a respirator."

Comment: NRC should permit a health professional to certify physical capability to use a respirator rather than requiring a physician to perform each required certification. The proposed rule requires that a physician annually certify a worker's physical suitability for using a respirator. This should be broadened to permit any qualified health professional, acting under a physician's orders, to perform the actual certification rather than requiring a doctor to do this.

Response: As noted in the previous response, the decision on the physical ability of an individual to wear a respirator is a subjective judgment that, in the Commission's opinion, requires the decisionmaker to have a medical degree. The Commission notes that this annual certification could easily be included in an annual physical checkup.

Comment: The selection of respirator protection factors based upon "average concentrations" and not "peak airborne concentrations" is an improvement. The proposed rule permitted protection factors to be applied to the time-averaged air concentration rather than the peak air concentration in part 20 (§§ 20.1–20.601).

Response: Despite some favorable comments on this change, the Commission has determined that the use of the average airborne concentration may not provide an adequate margin for health protection and, in the final rule, has reverted to the use of the anticipated peak concentration.

Final rule: The proposed rule has been modified to require a respiratory protection program when respiratory protection devices are being used to limit intakes, whether or not credit is taken for respiratory protection factors. Allowance has been made for use of respirators that do not provide protection factors that would keep exposures below the derived air concentrations if (and only if) such use would keep the total effective dose equivalent ALARA. Such a determination should only be reached after careful consideration of the trade-off between calculated reductions in total dose based on ALARA evaluations and increased internal doses resulting from alternative procedures that do not minimize internal exposures.

Proposed Section 20.704 Further Restrictions on the Use of Respiratory Protection Equipment [Section 20.1704 in This Final Rule]

Comment: Proposed § 20.704 should be deleted. This section, which states that the Commission may impose additional conditions on respirator use, is not necessary because proposed § 20.1302 permits the NRC to place additional requirements on a licensee.

Response: Although the commenters are correct that proposed § 20.1302 in this final rule gives the Commission general authority to impose additional requirements on licensees, the Commission believes that the restatement of this policy in a section pertaining specifically to respiratory protection is desirable. As noted by the comments, this section does not create any additional requirement on the licensee not otherwise contained in the regulations.

Final rule: The requirements contained in the proposed rule are retained.

Subpart I—Storage and Control of Licensed Material

Proposed Sections 20.801 and 20.802 Security of Stored Material and Control of Material Not in Storage [Sections 20.1801 and 20.1802 in This Final Rule]

Comment: Definition of "secure." Several commenters requested a definition of the term "secure," which they felt was vague and did not provide an indication of the required licensee action.

Response: The phrase has been rearranged and now reads "secure from unauthorized removal or access," which is similar to the wording in the part 20. This should provide sufficient clarification of what was intended by "secure."

Comment: Unnecessary restrictions on research. One commenter thought that the requirement to secure small quantities of radioactive materials when they are not in use would interfere with university research.

Response: The Commission believes that locking radiotracer laboratories when they are not being used is a small nuisance compared to the consequences of unauthorized access to or theft of the radioactive materials, which could result in contamination of unrestricted areas or exposure of individuals, as well as having to report a loss of licensed material to the NRC.

Subpart J—Precautionary Procedures

Proposed Section 20.901 Caution Signs [Section 20.1901 in This Final Rule]

Comment: Black should be permitted as an acceptable color for the radiation warning symbol. Several commenters requested that the color black should also be allowed to be used on signs and for stenciling on packages. The fading of magenta inks in sunlight and the use of black for marking international shipments were cited as supporting this position.

Response: The Commission believes that, although the "magenta-on-yellow" color scheme has provided a unique warning of possible radiation hazards, "black-on-yellow" would also be acceptable. The fading of the magenta color as cited above may reduce the visibility of the sign with time. Because of the cost impacts if existing warning signs had to be replaced, the Commission is permitting the use of black in addition to continued approval of magenta and purple, rather than requiring replacement.

Final rule: This section has been modified to add black as an acceptable color for the radiation warning symbol.

Proposed Section 20.902 Posting Requirements [Section 20.1902 in This Final Rule]

Comment: The terms "Caution" and "Danger" are not used consistently. Commenters noted that "Caution" or "Danger" could be used on signs for "Radiation Areas," "High Radiation Areas," and "Very High Radiation Areas" despite the considerable variation in the hazards that might exist in these different areas.

Response and final rule: The Commission agrees that the terms "Caution" and "Danger" should be used in a more consistent manner. The final rule permits only the term "Caution" to be used in "Radiation Areas." "Caution" or "Danger" may be used in "High Radiation Areas," since it covers a considerable range from 0.1 rem per hour to over 500 rads per hour. Only "Grave Danger" may be used in "Very High Radiation Areas." This should provide more emphasis on the use of "Danger," the importance of which might have been diminished by its prior applicability to the lower hazard "Radiation Area." "Caution" is inappropriate for use in "very high radiation areas" because of the potential hazard.

Comment: There should be a requirement to post all "restricted areas" whether or not it is a radiation or an airborne radioactivity area.

Response: The objective of posting is to warn personnel of a potential hazard. A "restricted area," *per se,* does not warrant such a warning. There is nothing to prevent a licensee from posting a notice designating a "restricted area," but such action is not required.

Comment: The definition of "airborne radioactivity area" would require tracking of employee "stay times" (time spent in the area). The second option to the definition of "airborne radioactivity area" would require performing surveys of airborne activity and tracking the time spent by workers in the area. The present rule would have only necessitated the survey.

Response: There are two alternative definitions of an "airborne radioactivity area"; only the second one would require consideration of stay times. This second option does not require posting in areas that have low occupancy times and airborne radioactivity concentrations between 0.3 and 1.0 times the applicable DACs.

Comment: Areas containing only noble gases should not require posting as "airborne radioactivity areas." The hazard associated with such areas is primarily from external radiation.

Response: The DACs in appendix B that apply to noble gases (and define an "airborne radioactivity area") are based upon submersion doses; therefore, the relationship remains valid. It should be noted that, because some short-lived noble gases have particulate daughters (such as ^{88}Rb and ^{138}Cs), the warning denoted by posting as an "airborne radioactivity area" may still be required.

Comment: There is no evident need to post all rooms containing 10 times the proposed appendix C levels. The requirement to post a caution sign in rooms that store ten times the appendix C concentrations is unwarranted. There was some concern noted that such posting could deter firefighters or other emergency workers from entering an otherwise safe area, and increased damages could result.

Response: Complete dispersion of 10 times the activity listed in appendix C to §§ 20.1001–20.2401 could produce air concentrations for some radionuclides in excess of the occupational DACs. For example, if 10 times the appendix C quantities were dispersed in a 1,000 cubic foot (10 ft. x 10 ft. x 10 ft.) room, the resulting concentrations would be 35 times the DAC for organic carbon-14, 58 times the DAC for cesium-137, about 18 times the DACs for iodine-131 and tritium (water vapor), and approximately 6 times the DAC for technetium-99m. These appear to be sufficiently large to justify a posting requirement, particularly to caution firefighters in case of a fire.

Comment: The posting requirement should not be applied to sealed sources, such as gauges. Posting the entrances to areas having radioisotopic gauges could require multiple postings in large buildings.

Response: Posting is only required at entrances to the room containing the source and only when the dose rate at 30 centimeters would exceed 0.005 rem (0.05 mSv) in any hour (§ 20.1903(c)) unless areas outside the room warrant posting as "radiation areas" and are already posted.

Proposed Section 20.903 Exceptions to Posting Requirements [Section 20.1903 in This Final Rule]

Comment: The proposed rule omits the past exemption for posting rooms containing only packages prepared for transportation.

Response: The Commission believes that there should be posting of these areas because there is no restriction on the length of time that packages may remain in a room. If the packages contain only small quantities of radioactive materials, then posting of

the room would still be exempted under the remaining exemptions. The term "prepared for transportation" does include packages that are intended to be carried in a "sole use" vehicle. Such packages are permitted to have higher allowable dose rates than those specified in DOT (or NRC) limits for general shipment.

Final rule: The exception for posting areas containing packages prepared for transportation has not been reinstated.

Comment: The requirement for a person in attendance would be unworkable in a hospital. The requirement (in lieu of posting the room containing a radiotherapy patient) for a person in attendance in order to prevent entry was interpreted as requiring a 24-hour escort for each radiotherapy patient.

Response: The intent was to generally require posting of therapy patients' rooms. (As noted in one of the comments, the dose rate from patients even with diagnostic nuclear medicine treatments might exceed dose rates of 0.002 rem per hour.) The intent of "in attendance" would be satisfied by a duty nurse at a nursing station, providing that the station was in sight of the entrance to the patient's room.

Proposed Section 20.904 Labeling Containers [Section 20.1904 in This Final Rule]

Comment: There is no way to meet the requirement to label containers in some nuclear power plants or in hot cells. It is difficult to mark the detailed information on a container in some areas of a plant or in hot cells.

Response: Section 20.1905 contains exceptions to the labeling requirements that take care of the problem noted by the commenter.

(Note: For the purpose of this section, "Mixed Fission Products" and "Fission and Activation Products" may be regarded as radionuclides, provided that the total activity is also specified. Designations as to the process stream or location sampled or type of sample (e.g., "primary coolant") may also be helpful as an additional designation of the potential hazard.)

Proposed Section 20.905 Exemptions to Labeling Requirements [Section 20.1905 in This Final Rule]

Comment: The proposed rule omits existing exemptions for packages containing only exempt quantities and those containing less than 10 mCi or less of tritium, iodine-125, carbon-14, and sulfur-35.

Response: While these sources pose little external hazard from gamma radiation, the quantities could be a potential internal hazard if the package were ruptured and the contents were released. Consequently, some warning remains appropriate.

Comment: The proposed rule omitted the existing exemption from labeling for packages labeled for shipment in accordance with DOT requirements.

Response and final rule: The exemption for DOT-labeled packages has been restored because the Commission agrees that the DOT labeling is sufficient to denote the presence of radioactive materials and provide an indication of any potential hazard. Quantities and concentrations not requiring DOT labels would not warrant an NRC labeling requirement. (See § 20.1905(d).)

Proposed Section 20.906 Procedures for Handling Packages [Section 20.1906 in this Final Rule]

Comment: The requirement to monitor all packages is unnecessary. The requirement to monitor all incoming packages containing radioactive materials is unnecessary and in large installations creates a substantial monitoring burden.

Response: This requirement has been reevaluated and modified in order to reduce the burden.

Final rule: Section 20.1906 in the final rule requires incoming packages to be monitored when: (1) They are labeled as containing radioactive materials according to DOT regulations, or (2) when a package is damaged or leaking. The first provision would reinstate the exemption from monitoring for shipments of small quantities of radioactive materials that would not require DOT labeling.

Comment: The requirement to survey external surfaces of packages is unnecessary. Several commenters with extensive experience in monitoring packages noted that external contamination was rarely if ever present and that wipe tests are time-consuming both to make the smears and to count them.

Response: Experience in the shipment of thousands of packages each year has been very good. However, potential problems with leaking packages during transit warrant continued monitoring upon receipt to ensure that leaking packages are found and reported. Appropriate action can then be taken to determine the extent of contamination in transport vehicles and storage areas in order to limit the consequences and avoid recurrence. However, an exemption from the contamination survey requirement has been provided for special form (sealed) sources that are being moved to and from work sites in licensee owned or operated vehicles. This partially restores an exemption for all special form sources from the package survey requirements in § 20.205(b)(1)(ii).

The Commission believes that restoring this exemption will not result in any additional hazard. An external radiation survey of the package is still required. The primary purpose of this external survey of sealed sources is to ensure that the source is still properly secured and shielded after transporting it.

Final rule: The requirement to monitor external surfaces of packages has been retained and applies to the two classes of packages for which surveys are required (labeled "radioactive" and damaged or leaking). A partial exemption to sealed sources transported for field use has been reinstated because of the difficulty in making field measurements of surface contamination and because the transporting vehicle is not in general commerce.

Comment: The requirement to monitor packages within 3 hours is unwarranted. This requirement would be difficult to meet for several types of licensees, some of which do not have a full-time health physics staff person.

Response: Licensees receiving labeled packages of radioactive materials to which this requirement applies are expected to have available persons who are qualified to perform such monitoring. However, the person monitoring the package need not be a board-certified health physicist.

Final rule: The 3-hour period in § 20.205(b)(1) has been retained except if the package is received after normal working hours (§ 20.1906(c)).

Subpart K—Waste Disposal

Proposed Section 20.1001 General Requirements [Section 20.2001 in this Final Rule]

Comment: Decay in storage as a disposal option. Many commenters noted favorably the addition of "decay in storage" as an allowed waste disposal option. Several commenters, however, did not believe that the option, as expressed in the proposed rule, was particularly helpful.

Response: Technically, the "decay in storage" option has always been available to a licensee since the license permitted possession of the radioactive materials and these materials naturally underwent radioactive decay. The option was formally included in the proposed and final rules because the list of disposal options is exclusive and there have been questions as to whether this is currently allowed under §§ 20.1-

20.601. It should be noted that this option does not allow material that has "decayed in storage" to be released to unrestricted area unless it meets the requirements of one of the other allowed forms of waste disposal in part 20, or the requirements of § 32.92, "Decay-in-Storage," of 10 CFR part 35, or the specific requirements given in any NRC or Agreement State license conditions.

The NRC staff considered adding a separate "Disposal by Decay in Storage" option with specific criteria for unrestricted release of material after decay. These criteria are commonly included in source and byproduct material licenses. However, the provisions included in 10 CFR 35.92 and certain specific license conditions pertain to relatively short-lived radionuclides and are neither appropriate nor applicable to other classes of licenses, such as those issued under part 50. Also, when evaluated for a specific licensed activity, it is possible to consider existing pathways of exposure and to establish specific criteria for decay.

General criteria in a rule would need to be sufficiently conservative to take into account all reasonably conceivable pathways, thereby reducing the applicable level from what would be permitted in a case-by-case evaluation.

Final rule: The final rule has been modified to explicitly list "decay-in-storage" as an authorized form of disposal. Section 20.2001 has been modified to incorporate the requirements that were in § 20.1002(b) of the proposed rule. These provisions require NRC licenses for persons who receive wastes containing licensed radioactive materials for treatment, for treatment or disposal by incineration, decay-in-storage, or disposal in facilities licensed under part 60 or part 61.

Proposed Section 20.1003 Disposal by Release into Sanitary Sewerage [Section 20.2003 in this Final rule]

Comment: Removal of allowance for disposal of "dispersible wastes." A number of commenters felt that the restriction of wastes released to sanitary sewers to soluble wastes would have an adverse impact on certain licensees that had disposed of "dispersible" but insoluble radioactive materials under § 20.303(a). In particular, the practice was mentioned of grinding up animal carcasses with subsequent sewer disposal of the ground residue. This practice is permitted by § 20.303(a) but would not have been permitted under the proposed rule.

Response: In the final rule, the Commission has modified the conditions in the proposed rule for disposal of radioactive wastes into sanitary sewer systems so that "dispersible biological materials" may continue to be disposed of by release to sanitary sewers. This means of disposal is advantageous compared with other alternatives for disposal of this type of biological material.

The prohibition on disposal of insoluble materials via the sanitary sewer was intended to prevent disposal via sanitary sewers of material in which the radioactive material is primarily in an insoluble for, such as flakes of metallic foil containing americium-241. Such materials may accumulate in the sewer system, in the sewer treatment plants, and in the sewer sludge.

Final rule: The final rule permits disposal into sanitary sewers of: (1) Radionuclides in soluble form or (2) radionuclides in readily dispersible biological material, provided that the limits in appendix B to §§ 20.1001–20.2401, table 3, on the average monthly concentrations and the limits in § 20.2003(a)(4) on the total activity released annually are met. The disposal of nonbiological insoluble materials is no longer permitted because of potential reconcentration of these materials in the sanitary sewer system, sewage treatment plants, and sewage sludge. This prohibition for insoluble materials is the reasons why there are no values listed for insoluble materials in table 3 of appendix B to §§ 20.1001–20.2401.

Comment: The rationale for the reduction in the limits for sewer disposal is not explained. The concentration limits for radionuclides released to sanitary sewer systems in the proposed rule have been reduced by a factor of 10 from the former rule. The reduction did not appear to take into account the dilution afforded from multiple users of the sewer system. Commenters indicated that they thought that this reduction would increase the amount of material that would have to be disposed of via a low-level radioactive waste burial site and could result in increased radiation doses to workers having to package this material.

Response: This assumption noted by many commenters that radionuclides discharged into sanitary sewer systems are not ingested is not necessarily true because water in large lake or river systems may be recycled. The dilution afforded by having multiple users of a sewer systems can be offset in part because there can also be several users that discharge radioactive wastes into the same sewer system. The amendments to part 20 in this final rule permit a higher concentration limit for discharges into sanitary sewers than for other liquid effluent releases of radioactive materials, but have lower concentration limits than were allowed for sewage. In view of past contamination incidents (involving cobalt-60 and americium-241) and the reduction in the dose limit for members of the public, the Commission believes that continuation of the higher limits is no longer desirable.

The NRC has underway a study of the dose pathways associated with disposal of radioactive materials via sanitary sewers. This study will help clarify the potential for human exposure.

Comment: The exemption on disposal of human excreta should be removed. Hospitals should have to comply with the same regulations as other licensees.

Response: Disposal into a sanitary sewer system (which was designed specifically to handle this type of waste) is the preferred method of disposal because of the other health considerations in handling human excreta in addition to radiation protection. This exemption is currently in 20.303(d) of part 20.

Proposed Section 20.1004 Treatment or Disposal by Incineration [Section 20.2004 in this Final Rule]

Comment: Relaxation of specific NRC authorization for incineration. A number of comments questioned the need for the existing requirement that incineration of radioactive materials requires specific prior NRC approval (except for small quantities of tritium and carbon-14, which are specifically exempted). These commenters noted that the source of the released material (from an incinerator stack or from a fume hood vent) should not be the basis of requiring specific prior NRC approval of incineration while permitting general effluent releases.

Response: Relaxation of the prior approval requirement for incineration was considered in connection with the amendments to part 20 of this final rule. The requirement for prior NRC approval of incineration remains in the amendments to part 20 in this final rule because the acceptability of incineration as a disposal option, except for exempted quantities of radioactive materials, must be determined on a site-specific basis considering: (1) Incinerator design, (2) the variable isotopic composition and activity of the material to be burned, and (3) potential human exposure to effluents, which may require special calculational methods because of complex meterorologic conditions and other factors.

Final rule: Disposal by incineration still requires specific approval by the Commission (or Agreement State)

whether done only for wastes from the licensed facility or whether done for wastes received from other licensees.

Proposed Section 20.1005 Disposal of Specific Wastes [Section 20.2005 in this Final Rule]

Comment: There should be a definition of ALARA for solid wastes. Many commenters suggested the need for ALARA or exempt quantities of radioactive material in solid wastes so that very low-level solid wastes could be disposed of without regard to their radioactivity.

Response: The Commission agrees that such levels would be useful and has developed a policy statement regarding levels of dose and risk that can be used to determine that specific practices involve radiation hazards that are Below Regulatory Concern (BRC). This policy statement was published in the **Federal Register** on July 3, 1990 (55 FR 27522). The BRC policy statement provides a comprehensive policy that will establish a disciplined and consistent framework for all future Commission exemption decisions. This includes potential application to rulemaking or licensing actions for disposal of slightly contaminated solid radioactive wastes. The Commission is developing a program for implementing the BRC policy separate from this part 20 rulemaking.

Proposed Section 20.1006 Transfer for Disposal and Manifests [Section 20.2006 in this Final Rule]

Comment: This section should not be in part 20.

Response and final rule: This section is in part 20 because it relates to the radiation protection aspects of low-level waste shipments.

Proposed Section 20.1007 Compliance with Environmental and Health Protection Regulations [Section 20.2007 in this Final Rule]

Final rule: This section has a counterpart in the present part 20 and in the proposed rule (§ 20.1005) stating that meeting part 20 requirements does not remove the responsibility of licensees, when disposing of licensed radioactive materials, from meeting the requirements of other applicable Federal, State, and local regulations applicable to toxic or hazardous wastes.

The advisory statement in the final rule has been expanded to cover all methods of waste disposal. This section of the rule is advisory and is not intended to imply that NRC will take enforcement action for violations of other environmental protection regulations issued under statutes other than the Atomic Energy Act.

Subpart L—Records

Standardization of Record Retention Requirements

Final rule: Records directly pertaining to effluents released to the general environment, waste disposal, and doses received by individuals are to be kept until the "Commission terminates each pertinent license requiring the record." Other record retention requirements in this subpart generally have been modified to be "3 years after the record is made." This change is in conformance with the final rule published in the **Federal Register** on May 27, 1988 (53 FR 19240) on record retention requirements for other parts of the NRC regulations. This change provides for consistent record retention requirements throughout the NRC regulations in 10 CFR chapter I.

Proposed Section 20.1101 General Requirements [Section 20.2101 in this Final Rule]

Comment: The units used in records should be limited to those commonly in use: the rad, the rem, and the curie. Some commenters thought that the use of SI units (gray, sievert, and becquerel) should not be allowed.

Response and final rule: The Commission agrees that the use of "special units," the rad, the rem, and the curie, is preferable at this time. This will avoid any difficulties arising from trying to implement both a new regulation and new units. This will reduce potential problems in records and reports that could result from some licensees using the "SI units" and some using the older "special units." The final rule requires the use of the "special units" instead of the "SI units." (See the discussion of this topic under proposed § 20.4 Units.)

Proposed Section 20.1102 Records of Radiation Protection Programs [Revised Section 20.2102 in this Final Rule]

Comment: Added implementation burden associated with requirements for formal radiation programs. A number of commenters thought that the requirement to have a formal ALARA program would result in substantial increased costs due to additional recordkeeping, procedural requirements, and quality assurance requirements.

Response: As discussed under proposed § 20.101, these provisions have been modified to require ALARA as one part of a licensee's radiation protection program. The adoption of requirements for licensees to have a formal radiation protection program was not intended to cause large implementation costs. Much of the cost associated with the recordkeeping requirements in the proposed rule was a result of the ALARA documentation requiremer ts. These recordkeeping requirements have been reduced in the final rule by deleting specific reference to documenting ALARA actions. Specific types of records will be developed by each licensee as part of its radiation protection prgram. Therefore, this section contains general recordkeeping requirements associated with the radiation protection program.

Comment: The recordkeeping burden for small licensees requires a commitment of resources that is not commensurate with the risk. (In section XXXVI of the proposed rule (51 FR 1121–1122), NRC specifically requested comments on the magnitude of the impact of the proposed rule on small licensees and requested suggestions on how these impacts could be reduced.) Quite a few commenters expressed their belief that the proposed rule will require more extensive monitoring and recordkeeping efforts than are required by §§ 20.1–20.601. Several commenters suggested that the NRC explore possible exemptions or exclusions for academic licensees and other users of small quantities of licensed material. Other commenters expresed the view that the protection of public health for both the worker and the general public should be the same regardless of the size or economic resources of the licensee.

Response: Because of the changes to reduce the recordkeeping burden discussed in response to the preceding comment and because the basic requirement in § 20.1101 calls for effort "* * * commensurate with the scope and extent of licensed activities * * *," the Commission has not made further exemptions or exclusions from the recordkeeping requirements in this section for certain types of licensees.

Proposed Section 20.1104 Determination of Prior Occupational Dose [Section 20.2104 in this Final Rule]

Comment: Medical and academic licensees would have difficulty in complying with the requirement to determine prior exposures. The transitory nature of personnel in these facilities would make meeting these requirements very costly. Doses to employees are small fractions of the limits so that such costs would be difficult to justify.

Response: The requirement to determine dose received in the current year implements the annual dose limits. The requirement to attempt to obtain

records of lifetime cumulative doses follows one of the provisions of the guidance to Federal agencies on occupational radiation protection. Efforts to obtain prior exposure histories are only required for workers who are required to be monitored under § 20.1502. Determination of prior doses received during planned special exposures or doses in excess of the annual limits are required only for workers who will be used in planned special exposures.

Comment: The recording of "fictitious" radiation doses should be avoided. The present and proposed rules state that, when information is not available regarding the dose received for a specific period, the licensee should assume that the dose received was at the dose limit. Several commenters thought that this was inappropriate. Some commenters mentioned that this practice might be nonconservative as it would tend to overestimate the dose used in any epidemiological studies of radiation effects, thereby resulting in an underestimate of the risk associated with a unit radiation dose.

Response and final rule: The final rule has been modified so that it does not require any assumed dose value to be recorded in case of incomplete prior dose histories. Only the lack of data must be recorded for periods where there is no information. However, for the current year, where there are missing data, an assumption is to be made for establishing administrative controls: the portion of the dose limit remaining for the current year is reduced by 1.25 rems for each calendar quarter for which information is missing. (The values for other limits, such as the shallow dose equivalent or eye dose equivalent should be reduced by one-quarter of their annual limit for each unreported quarter.) The licensee must note the absence of this information on the employee's record but should not enter the assumed dose value as part of the employee's permanent dose record. For example, an employee who had prior radiation working experience joins Company X on July 1st but does not have the prior radiation records. This employee's dose should be limited to 2.5 rems (5 rems-2(1.25)=2.5 rems) until such time as the records are obtained.

Comment: There should be a quarterly dose limit to cover workers whose records have not been received from a former employer. A 0.5-rem dose might be appropriate for this purpose.

Response: If data were missing for all four quarters (employment commenced late in the fourth calendar quarter), then the employee could not be exposed to radiation above the level for a member of the general public. However, this limit is 0.1 rem per year not 0.5 rem.

Proposed Section 20.1105 Records of Planned Special Exposures [Section 20.2105 in this Final Rule]

See discussion under proposed section 20.1204.

Proposed Section 20.1106 Records of Individual Monitoring Results [Section 20.2106 in this Final Rule]

Comment: NRC should not require reporting or recording of cumulative doses. A number of commenters noted that the ICRP system of dose limitation is based (as one of the principles) on controlling annual doses. Consequently, they questioned the need for recording cumulative doses.

Response: Although the commenters are correct that there is no longer a cumulative dose restriction in part 20 (such as the former 5(N–18) formula), the Federal Guidance on Occupational Exposure (see section II.D) contains a recommendation that cumulative dose records be maintained and provided to the worker.

Comment: The proposed rule does not require recording annual doses as listed in the 1987 Federal occupational guidance.

Response: "Annual dose" is specified in the guidance and is the same as the annual deep-dose equivalent for external doses. However, "annual dose" is not required to be recorded by the amendments to part 20 in this final form for internal doses. This is consistent with an exception noted in footnote 5 to the Federal guidance (Federal Register of January 27, 1977; 52 FR 2832):

> When these conditions on intake of radioactive materials have been satisfied [i.e., meeting the committed dose limits], it is not necessary to assess contributions from such intakes to annual doses in future years, and, as an operational procedure, such doses may be assigned to the year of intake for the purpose of assessing compliance.

Proposed Paragraph 20.1106(b)—See Discussion under Proposed § 20.1204

Comment: The recordkeeping requirement in the proposed § 20.1106(d)(2) would require that all records begin at the beginning of a calendar year. This would create an unnecessary hardship on dosimeter processors since they could not stagger the dosimeter changeover schedules to provide a more uniform workload distribution.

Response and final rule: The term "year" in § 20.1003 replaces the term "calendar year" in proposed § 20.3 and permits the licensee to define the year to begin anytime in January. A licensee may change the starting date, provided that the change is made at the beginning of the year and provided that no day is omitted and no day is included twice in consecutive years.

Comment: The requirement in proposed § 20.1106(e) for each licensee to keep a copy of the dosimeter processor's accreditation certificate creates an undue burden on commercial processors. Commercial dosimeter processors would have to print and distribute thousands of their certificates so that each user had a copy.

Response: The proposed rule contained a requirement for the licensee to maintain a copy of the dosimetry processing accreditation certificate issued to the processor providing dosimetry services to the licensee. This requirement, which was in the proposed dosimetry accreditation rule, was considered unnecessary and was dropped as a requirement in the final version of that rule. Consequently, it has been deleted from this final rule. Licensees who provide their own dosimeter processing services do have to maintain a copy of their NVLAP accreditation certificate for inspection.

Comment: The NRC should consider a "traveling dose history" that can move with the worker. This was suggested, particularly for transient workers and for workers employed concurrently by two employers. The master record will reside with the current employer and would have to be transmitted by the worker to a new employer.

Response: Because the NRC can only regulate its licensees and has no authority over individual workers, the recordkeeping and transmittal requirements for dose histories are placed on the licensee and not on the worker. The concept of a "passport" incorporating security and dosimetry data has been used successfully in Japan and elsewhere. The requirements for determination of prior exposures that are in § 20.2104 provide a similar record to a "moving history," but this would have to be updated by each new employer.

Concurrent employment with two (or more) employers requires special attention so that the combined doses from both employers would not exceed the dose limits. When two employers are aware of such concurrent employment, the simplest expedient to achieve this goal is for them to agree that the dose limit they will use for this employee in the individual programs is less than one-half of the NRC dose limits (the fraction of the dose limit allocated to each employer might also be determined on the basis of the relative

amount of time worked at each location).

The problem of dual employment is more of a problem when the employee has not confided in the employer. The licensee is required to ascertain the employment and dose record for the current year for new employees (§ 20.2104). If the employee deliberately falsifies this information, the licensee would not know of concurrent employment and the licensee would not be penalized for combined doses from both employers that exceeded the dose limits. If a current employee takes on additional outside radiation work without informing the employer, the employer should not be penalized. It should be noted that, under the new reporting requirements in § 20.2206, individual dose records will be required to be submitted to the NRC for all workers for those categories of licensees formerly subject to § 20.407, including nuclear power reactor licensees.

Final rule: Section 20.2106 has been modified in order to separate the requirement for keeping a record from the format of the record. A clarification has been added that the dose information on an embryo/fetus be kept with the mother's dose record.

Proposed Section 20.1107 Records of Doses to Individual Members of the Public [Section 20.2107 of this Final Rule]

Comment: Reporting requirements for exceeding "reference levels." The proposed rule contained requirements for reporting exposures in excess of the "reference levels" for doses to members of the general public. Many commenters thought that this was excessive because this was not an actual regulatory limit.

Response: The 100 millirems per year "reference level" for doses to members of the general public in the proposed rule has been incorporated as the dose limit in the final rule for members of the general public so that the associated recording and reporting requirements now pertain to a regulatory limit.

Final rule: Section 20.2107 has been broadened in scope from "effluents" in the proposed § 20.1107 to pertain to records of all estimates of doses received by individual members of the public. Doses to member of the public are calculated from measurements of direct radiation, and radionuclides in effluents, and the environment rather than as measurements pertaining to a particular individual. This difference in method of dose assessment from the more direct measurements used for occupational exposure does not imply any lessening of requirements for keeping adequate records of effluents released to unrestricted areas.

Proposed Section 20.1108 Records of Waste Disposal [section 20.2108 of this Final Rule]

Final rule: Section 20.2108 is unchanged from § 20.1108 of the proposed rule.

Proposed Section 20.1109 Records of Testing Entry Control Devices for Very High Radiation Areas [Section 20.2109 of this Final Rule]

Final rule: Section 20.2109 contains an addition to the proposed rule for keeping records of tests of entry control devices for very high radiation areas. This addition is based upon a requirement in § 20.203(c)(6).

Proposed Section 20.1110 Form of Records [Section 20.2110 in this Final Rule]

Comment: NRC should allow computerized recordkeeping systems to handle records. A few licensees suggested that NRC allow "electronic" recordkeeping systems and provide guidance for their use.

Response: The Commission agrees that there is great value in the use of "electronic media." There are a growing number of licensees that are using computer information networks for retaining and transmitting radiation dose histories and other worker-related information among different facilities.

Final rule: The amendments to part 20 in this final rule expand the definition of "record" to include "electronic media." The use of electronic media requires authentication and the prevention of alteration or loss of the records. As with requirements for paper records, the electronic media must be capable of producing a legible copy of the record.

Subpart M—Reports

Proposed Section 20.1201 Reports of Theft or Loss of Licensed Material [Section 20.2201 in this Final Rule]

Comment: The term "substantial exposure" in proposed § 20.1201(a) should be defined. The requirement to report the loss of radiation sources capable of producing "substantial exposure" needs to be more precise.

Response: The term "substantial exposure" in the proposed rule has been replaced in the final rule by a specific designation of the activity of lost source that requires immediate reporting to the Commission. This quantity is 1,000 times the activity levels in appendix C to §§ 20.1001–20.2401. For sealed sources of cobalt-60, cesium-137, or iridium-192, this activity would produce a dose of about 25 rems at 1 foot over a 30-day period (25 rems is the dose that requires immediate Commission notification). Although somewhat similar doses may be projected from inhalation of dispersible material, the exact exposure conditions would have to be known in order to make a valid activity-to-dose relationship.

Final rule: The final rule now contains specific activity criteria for immediate reporting rather than the vague term, "substantial exposure."

Comment: The quantity for reporting the loss of a source is too low (too high). The reportable quantity of 10 times the appendix C activity values appeared to some commenters to be overly restrictive; others thought that all lost or missing radiation sources should be reported.

Response: The specified 30-day reporting level is a compromise between having higher reporting levels and having a requirement that all lost or missing sources be reported. Further, the report permits review of the circumstances involved including any lack of security of materials or weakness in the licensee's control program that may be unrelated to the sources being stolen or lost, but may be pertinent in avoiding recurrent theft or loss.

Final rule: The activity levels in appendix C to §§ 20.1001–20.2401 for some long-lived radionuclides have been increased from those specified in appendix C to the proposed rule. This increase means that the loss of milligram quantities of natural uranium will not have to be reported as was the case in the proposed rule.

Comment: A 30-day telephone report should not be required concomitant with a written report. Proposed §§ 20.1201(a)(1)(ii) and 20.1201(b) both call for a 30-day report; the first requires a telephone report and the latter section requires a written report.

Response and final rule: The rule has been revised to clarify that the written reports required by § 20.2201(b) are to be submitted within 30 days of the telephone notification required by § 20.2201(a), rather than both being within 30 days of learning of the theft or loss.

Comment: The rule should provide for a "grace period" before having to report a lost source to NRC. Commenters noted that, in many instances, a source "lost" in transit eventually turns up. Some specified period, such as 7 days, should be permitted before a "lost" source would have to be reported to the NRC.

Response: The final rule contains two notification requirements: the one for

immediate notification only pertains to those sources that exceed 1,000 times the activity levels in appendix C to §§ 20.1001–20.2401. The second notification requirement pertains to sources that exceed 10 times the activity levels in appendix C and that are still missing after 30 days. This provides a grace period of 30 days for reporting the loss of most sources.

Proposed Section 20.1202 Notification of Incidents [Section 20.2202 in this Final Rule]

Comment: The requirements for immediate notification of NRC are too low. Some commenters thought that the doses associated with the requirements for immediate reporting to NRC (five times the respective annual limits) would not produce any discernible harmful effects to the individual to warrant immediate reporting.

Response: Doses of the order of 25 rems (5 times the 5-rem annual dose limit) can produce discernible biological effects in the body in the form of chromosome aberrations and changes in the white blood cell populations. Although the majority of these effects are temporary, they could be discerned. However, irrespective of the potential for discernible effects, doses at these levels represent a major breakdown in the licensee's control over the radioactive material, and the Commission believes that it is important that NRC be promptly notified so that it can take actions, if necessary, to limit further consequences.

Final rule: The final rule retains the previous reporting requirement.

Comment: Immediate reporting should be required if there is any potential for dose reduction. The Environmental Protection Agency (EPA) suggested that incidents always be reported if there is the potential for significantly reducing public doses through protective actions. It is believed by the EPA that this would occur at doses significantly less than those of the proposed reporting criteria.

Response: The incident reporting levels and response times have been selected to limit attention to the more potentially serious events without the entire NRC emergency response network being activated unduly for events involving only small quantities of radioactive materials. For most cases, it is expected that the licensee would have initiated any necessary remedial measures.

Comment: Immediate and 24-hour notification requirements should be suspended in the case of a declared emergency at a nuclear power plant. Commenters felt that any emergency at a nuclear power plant will involve onsite NRC staff and that stopping emergency activities to make the part 20 incident reports could be a burden on the licensee.

Response and final rule: These reports are particularly easy to make for nuclear power reactors (the reactor operator merely has to pick up the dedicated NRC telephone line to get the NRC Operations Center). There are certain functions of the NRC (such as activating the NRC Incident Response Plan) that require that NRC be notified; therefore, this notification requirement has been retained.

Proposed Section 20.1203 Reports of Exposures, Radiation Levels, and Concentrations [Section 20.2203 in this Final Rule]

Comment: There is no requirement for reporting doses that exceed the limit for protection of the embryo/fetus in proposed § 20.208.

Response and final rule: A requirement has been added to the final rule in § 20.2203(a)(2)(iii).

Comment: The identifiers required in proposed § 20.1203(b)(2) for the embryo/fetus should be those of the mother. As the fetus has no date of birth and no Social Security account number, those of the mother should be used.

Response and final rule: A footnote to this effect has been added to § 20.2203.

Comment: Reports of exceeding the 0.1-rem reference level should not be required. A number of commenters noted that the 0.1-rem reference level was not a limit and, therefore, exceeding it should not necessitate a report to the NRC.

Response: As a result of changes in the ICRP interpretation of the 0.1-rem level and the former 0.5-rem dose limit, the 0.1-rem level is now the recommended limit. Consequently, 0.1 rem is the primary limit applicable to members of the general public and reports are justified when it is exceeded.

Comment: Smaller licensees, such as nuclear medicine facilities, should be exempted from the reporting requirements of proposed § 20.1203. Licensees are required to report concentrations in unrestricted areas that exceed 10 times any applicable limit in the license. Because some nuclear medicine units use the room air volume for dilution, calculated concentrations exceeding 10 times the appendix B limits might frequently occur. This would require either more frequent reporting to NRC or use of more sophisticated atmospheric dispersion models.

Response: The reporting requirements are very similar to those in the part 20 §§ 20.1–20.601. Part 35 of the Commission's regulations, which deals with medical applications, covers the medical use of noble gases and in § 35.205(a) limits airborne concentrations to the 10 CFR part 20 appendix B to §§ 20.1–20.601 concentrations. Experience has not indicated large numbers of reports of such limits being exceeded.

Proposed Section 20.1204 Reports of Planned Special Exposures [Section 20.2204 in this Final Rule]

Comment: The license should not have to file a separate report to NRC for Planned Special Exposures. Several commenters objected to having to file these separate reports each time a Planned Special Exposure is carried out. This was viewed as representing a reporting requirement for operating within the NRC regulations. It was suggested that this information be included in the employee's records without reporting to NRC.

Response: Because of the newness of the concept, the NRC wishes to monitor carefully the use of the Planned Special Exposures. Further, while the Planned Special Exposures are provided in the final rule, its use does represent a situation in which the licensee is operating outside of the normal dose limits, and of which the Commission should be aware.

Comment: Period for reporting planned special exposures. Several commenters noted that the 15-day period for reporting planned special exposures is shorter than the 30-day period usually allowed for similar reports.

Response: The reporting period of a planned special exposure has been increased from 15 days to 30 days to be more consistent with other reporting requirements.

Proposed Section 20.1206 Reports of Individual Monitoring [Section 20.2206 in this Final Rule]

Comment: Could the requirement for the reporting of individual exposures be construed as an invasion of privacy? Some commenters believed that requiring the reporting of individual doses rather than a statistical summary might constitute an invasion of personal privacy.

Response: The Commission does not believe that submission of individual dose data constitutes an invasion of privacy. Such data have been reported to the NRC routinely in the termination reports for some time. Such information will be protected in accordance with the Privacy Act and will be restricted, as it has been in the past, to use by NRC officials, NRC contractors, or qualified

scientific investigators. Instructions on protecting this information appear in § 20.2106(d).

Comment: If the radiation exposure data are collected into a central repository, would the NRC be the proper place for it? One commenter felt that the radiation exposure data might be better maintained by an agency whose charter encompasses the analysis of the data for estimates of risk.

Response: Arguments might be made for other agencies having the lead role in the storage and analysis of those data; however, it is the NRC that has the statutory authority to require that these data be collected. Although the part 20 recordkeeping requirements are intended primarily to fulfill NRC's information needs for regulation, the NRC has continuing contacts with agencies that have expertise in conducting epidemiological studies (such as the National Cancer Institute of the National Institutes of Health and the Office of Health and Safety of the Department of Energy) to ensure that the part 20 reporting and recordkeeping requirements do not lose information that would be vital to carrying out studies of this type.

Comment: The total collective (person-rem) dose should be reported. It was felt by one commenter that NRC should require the total collective dose to be reported so that the numbers used in NUREG–0473 (NRC's annual summary of occupational radiation doses) will be the same as those calculated by the licensee.

Response: The reason for a possible discrepancy between a licensee's estimate of the collective dose to workers and the estimate published by the NRC has been that the licensee may sum the actual individual doses and the NRC estimate is based upon the statistical summary rather than the actual individual dose reports. Such differences should be reduced in the future because NRC will also be using dose information for individuals. The final rule requires licensees who previously submitted the dose summaries to report the individual dose data to NRC. Both collective dose calculations should then be using the same data base.

Comment: The termination report required in proposed § 20.1207 should (or should not) be replaced with an annual report for all personnel monitored. Some commenters felt that an annual report just to the NRC should replace the present requirement for a termination report. Other commenters felt that annual reports to the NRC of doses to individuals constituted a considerably larger burden than did a statistical summary. Some commenters, who disagree with filing an annual report to the NRC, were in favor of giving such an annual dose summary to the worker. Other commenters suggested that all licensees be required to submit an annual report to NRC on each monitored individual.

Response: The reporting of individual monitoring data will help track doses to individuals who are exposed at several facilities during any given year and whose total dose would be underreported by statistical reports prepared at each work site. Such information is shown at the present time only by analysis of the termination reports.

Licensees who were previously required to file both annual statistical summaries and termination reports with the NRC will, instead, submit annual dose reports to NRC for all workers for whom monitoring is required under § 20.1502. A copy of the annual report to NRC could also be given to the individual worker in order to satisfy the revised reporting requirement in § 19.13 of 10 CFR part 19. Although this may entail some additional burden to licensees, the use of "electronic media" for recordkeeping might in fact reduce overall costs. It is intended that large employers (such as nuclear power reactor licensees) would submit an electronic copy of their dose reports in a prescribed format to the NRC in lieu of paper copies of individual records.

Subpart N—Exemptions and Additional Requirements

Proposed Section 20.1301 Applications for Exemptions [Section 20.2301 in this Final Rule]

Comment: NRC should make the issuance of exemptions a matter of public record. Several commenters felt that the issuance of any exemptions under this section should require public notice and comment. The EPA stated that exemptions could adversely affect its ability to control radionuclides under the Safe Drinking Water Act.

Response: The NRC has issued few exemptions under this longstanding provision and has not exempted anyone from the dose limits for a worker or for a member of the public. Any exemption that could have a significant impact on the environment would be evaluated in accordance with the Commission's requirements in 10 CFR part 51 under the National Enviornmental Policy Act. Regarding EPA's comment on controlling radionuclides under the Safe Drinking Water Act, the Commission will ensure that potential impacts on water resources and drinking water supply systems are considered in evaluations of proposed exemptions, such as alternative liquid effluent concentration limits. Where appropriate, NRC will coordinate with EPA to ensure that drinking water supplies are appropriately protected by any proposed exemptions.

Proposed Appendix A (Appendix A to §§ 20.1001–20.2401—Protection Factors for Respirators in this Final Rule)

Comment: The protection factor for air-purifying respirators with particulate elements is too low. The listed protection factor for air-purifying respirators with particulate filters is 50, whereas both ANSI Z88.2 and the OSHA regulations in 29 CFR part 134 use 100.

Response: The NRC never endorsed ANSI Z88.2–1980, whereas the OSHA regulations generally follow ANSI standards. The current NRC-allowed protection factors (PFs) are based upon research conducted by the Los Alamos National Laboratory (LANL). These recommendations included a PF of 50 for full face respirators, based on experimental data on actual testing of personnel using respirators under carefully controlled conditions. In actual use, there is essentially no difference between a PF of 50 versus a PF of 100, so that there should be little or no real impact on field use of respirators or on operations at nuclear facilities that would result from using the higher protection factor.

Comment: Several respiratory equipment specifications in appendix A should be applicable only for areas that are "immediately dangerous to life and health." Footnotes "h" and "i" contain specifications for air flow rates and flow calibration and a requirement for standby rescuers to be available when using supplied-air suits. These were felt to be unneeded considering that, if the air flow failed, the person could withstand a small exposure to the airborne radionuclides while exiting the area after removing the protective hood.

Response: The supposition that conditions "immediately dangerous to life and health" do not exist is not always correct. Failure of an airline in supplied-air suits may be considered as "immediately dangerous to life and health" because there is an acute danger of suffocation if the air supply is interrupted and the hood cannot be removed by the wearer. Rapid recovery of and assistance to the individual in the supplied-air suit necessitates the presence of a pre-equipped rescuer.

Proposed Appendix B (Appendix B to §§ 20.1001–20.2401—Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage in the Final Rule)

General comments: Most of the comments from radiation protection professionals favored the adoption of the ICRP–26/ICRP–30 annual limits on intake and the derived air concentrations. Comments from private citizens were against adoption of the ICRP values because the majority of the values would increase (as stated in Section XXIX of the proposed rule, 51 FR 1120).

Response: From an occupational protection standpoint, the changes that result from adoption of the ICRP risk-based approach lead to higher limiting intake values than in appendix B to §§ 20.1–20.601. These increases result from the increase in the allowable ceiling for organ doses. The values that served as the basis for calculating the concentration limits used in appendix B to §§ 20.1–20.601 were organ dose limits of 5, 15, and 30 rems. The new concentration limits in appendix B to §§ 20.1001–20.2401 are based upon the effective (weighted) organ dose or upon the nonstochastic limit that forms an organ dose ceiling when the stochastic risk is not limiting. These changes increase the limiting annual organ doses (when only one organ is irradiated) for those doses that are limited by the stochastic (effective dose) limit from 5 rems to 20 rems for the gonads, from 15 rems to 32 rems per year for the breast, and from 15 rems to 42 rems for the lung. Limiting doses to other organs increase from the former 15- and 30-rem values to the 50-rem nonstochastic limit.

The former ICRP–2 "critical organ" concept based the limiting intake upon controlling the dose rate to the organ receiving the highest dose rate (the "critical organ"). The doses to organs other than the critical organ did not have to be evaluated, even if these doese were close to the estimated dose to the critical organ. The ICRP–26/30 system evaluates the doses to the major organs and the six remaining organs that receive the next highest doses. These doses are then multiplied by the appropriate weighting factors (w_T) and are summed to give a risk-weighted "effective dose." The concentration limits that are based upon this ICRP approach reflect the doses to all principal organs that are irradiated, not just the one organ that receives the highest dose as was done in §§ 20.1–20.601.

Many of the comments from private citizens do not appear to reflect the proposed rule because many of the comments objected to raising the limits for radionuclide concentrations applicable to the general public. As noted in the discussion of appendix B in the notice of proposed rulemaking (section XXIX, 51 FR 1119–1120), the concentration limits for members of the public were based upon a "reference level" dose (now the dose limit for members of the general public) of 0.1 rem per year and incorporated an additional factor of 2 reduction (proposed appendix B; 51 FR 1145) for age-dependency and combined air and water intakes. Thus, the concentration limits for the public reflect a reduction in their basis from a whole-body annual dose of 0.5 rem in part 20 (§§ 20.1–20.601) to 0.05 rem in the proposed and final rules. The concentration limits for individual radionuclides may be higher or lower for members of the general public in unrestricted areas in appendix B to §§ 20.1001–20.2401 than in the former tables because of changes that occurred in the intervening 25 years in the metabolic and other parameters used to calculate internal doses. These changes are reflected in ICRP Publication 30 and its supplements and amendments. However, these changes are a result of changes in the scientific techniques and parameters used in calculating doses and do not reflect an increase in the allowable dose limits, which, in reality, have been decreased in the amendment to part 20 in this final rule.

Comment: NRC should consider deleting table 2 from appendix B. The concentration limits in appendix B do not provide adequate protection of children and infants because they do not take into account age dependency in a proper manner. Compliance with the dose limits, rather than with these concentration limits, should be required.

Response: The use of the effective dose equivalent concept reduces the importance of age-dependent intake-to-dose factors. Age dependency is of primary importance in calculating organ doses. Those organs for which age dependency is important, such as the thyroid gland, are of lesser importance because of lower w_T values (for the thyroid, for example, $w_T = 0.03$) used to calculate the effective dose. A factor of 2 is included in the calculation of concentration limits for release to air and water, which, in part, accounts for age dependency. In addition, the Commission believes that there is a lack of detailed age-dependent metabolic data for all but the most common radionuclides that will inhibit such attempts to increase the precision of the dose estimates.

Many smaller licensees routinely use concentrations and the appendix B tables in order to demonstrate compliance. The use of concentration limits for determining compliance is a well-established practice that is economical for many of the smaller licensees. Despite the growing availability of simplified dose assessment models, the Commission is continuing to accept the use of concentrations to demonstrate compliance with the dose limits.

Comment: The appendix B tables fail to account for the chemical toxicity of natural and low-enriched uranium. This fails to take into account the possible kidney (renal) damage associated with the chemical toxicity.

Response: There is a separate limit for uranium intake that is based upon the chemical toxicity. This limit was expressed as footnote 3 to appendix B, page 1199 of the January 9, 1986 notice of proposed rulemaking and also as § 20.204(i) on page 1131. In the final rule, it appears as footnote 3 in appendix B to §§ 20.1001–20.2401, but the limit also has been moved up in the text to the section on dose limits and now appears as § 20.1201(e).

Comment: The limits for occupational and nonoccupational exposure to radon-222 and its particulate daughters do not appear to be consistent with the airborne concentration limits for other radionuclides in terms of risk.

Response: The occupational concentration limits for radon-222 are based on the existing Federal guidance, which is 4 WLM (4 Working-Level Months) per year. The annual limit on intake (ALI) is stated as 100 μCi or 4 working-level months. The derived air concentration (DAC) in Part 20 for occupational exposure to radon-222 of 3×10^{-8} is equivalent to 0.33 working levels (this equivalence is also given in the appendix B table). The concentration limit for members of the general public is a factor of 300 lower and, like the other airborne concentration limits, represents an effective dose of 0.05 rem per year.

Comment: Concentration limits for tritium omit chemical forms other than for tritiated water vapor.

Response: As there is expected to be no occupational intake via oral ingestion, and most of the commonly used organic tritiated compounds are not volatile, inhalation and transpiration through the skin are the principal pathways of exposure. Different intake limits would apply to hydrogen gas (H_1

or T_2) and tritiated water vapor (HTO). The HT or T_2 gas is rapidly converted to HTO by isotopic exchange and oxidation (both in air and in the body) so that specifying a submersion dose limit for HT would understate the actual radiological impact. Comparison with other derived limits for other chemical forms shows that the use of the concentration limits for HTO provides an adequate level of protection for most of the other chemical forms.

Comment: No concentration limits are listed for natural thorium. There are limits for natural uranium, but corresponding concentration limits for natural thorium are not given. The isotopic composition of thorium can vary somewhat with different ores and with different times after chemical separation.

Response: A licensee should use the thorium-232 value or, if a more precise value is desired, use the procedure for mixtures in appendix B to §§ 20.1001–20.2401 applied to the actual isotopic concentrations present.

Comment: The derived air concentrations for the general public are not always 0.1 times the occupational values.

Response: The limits for the general public are calculated solely from the stochastic risks. This differs from ICRP, which would use a "capping" organ dose limit of 5 rems (0.1 x the nonstochastic limit of 50 rems) in deriving the organ dose limit for organs that are limited by the nonstochastic risk. If there is a threshold for nonstochastic effects for the worker at 50 rems, it would also apply to a member of the public. Rather than applying a factor of 10 reduction to a nonstochastic value, the limiting stochastic (effective) dose was used to calculate the concentration limits for the general public. Values are not based on the nonstochastic risk for members of the public, even if they were the basis for the calculation of the DACs and ALIs for the worker. This difference in method of calculation accounts for the lack of a consistent ratio between worker DACs and effluent limits for the public.

Proposed Appendix C (Appendix C to §§ 20.1001–20.2401—Quantities of Licensed Material Requiring Labeling in the Final Rule)

Comment: The reduction from 100 μCi to 0.001 μCi for thorium values will require posting of areas where thoriated-nickel machine parts are used.

Response: On the basis of specific activity considerations, the 100 μCi limit has been retained for long-lived radionuclides (half-lives longer than 10^8 years) such as thorium-232, which would require several grams of material to produce the stated activity level. Because this is based on half-life, two isotopes may be treated differently, e.g., uranium-235, which does not meet the half-life criterion, has a value in Appendix C to §§ 20.1001–20.2401 of 0.001 μCi, and uranium-238, which exceeds the 10^8-year criterion, has a value of 100 μCi.

Proposed Appendix D (Appendix D to §§ 20.1001–20.2401—United States Nuclear Regulatory Commission Regional Offices in the Final Rule)

No comments were received on this section.

Proposed Appendix E (Appendix E to §§ 20.1001–20.2401 [Reserved in this Final Rule])

Final rule: The calculational guidelines and equations that appeared in proposed appendix E are being incorporated into a regulatory guide on summation of internal and external doses. This will make it easier to revise and clarify the calculational methods without having to resort to formal rulemaking. (Note: NRC routinely issues regulatory guides for public comment before making them final.)

Proposed Appendix F (Appendix F to §§ 20.1001–20.2401—Requirements for Low-Level Waste Transfer for Disposal at Land Disposal Facilities and Manifests in this Final Rule)

(Note: Appendix F is derived directly from requirements inserted by the Part 61 rulemaking proceeding on low-level radioactive waste disposal sites. These requirements were in § 20.311. Because these requirements are relatively recent, they were not modified in the amendments to Part 20 in this final rule. The Commission is considering revisions to the manifest requirements in a rulemaking separate from this Part 20 rulemaking.)

VII. Conforming Amendments

Accompanying these amendments to part 20 in this final rule are amendments to other parts of chapter I that update citations to 10 CFR part 20 that are found in these other regulations. These conforming amendments are to be implemented in accordance with the schedule for implementing the amendments to part 20 in this final rule as reflected in § 20.1008.

Two amendments are particularly important as they go beyond updating cross-reference citations. One amendment to appendix C to 10 CFR part 2 updates and modifies the examples of the severity levels associated with violations of 10 CFR part 20. In accordance with the implementation schedule above, licensees will remain subject to the version of part 2, appendix C, supplement IV of the NRC enforcement policy in redesignated supplement IV for §§ 20.1–20.601. The conforming amendments to supplement IV for §§ 20.1001–20.2401 of appendix C to 10 CFR part 2 would only apply after January 1, 1993, or when a licensee implements the part 20 before that date.

The Commission does not believe that solicitation of public comment on the conforming changes to appendix C (of 10 CFR part 2) is required before they are issued in final form.

The second major change to other parts is the requirement to provide all workers with information on their radiation doses. This modification was made to conform to the 1987 Federal guidance on occupational radiation exposure. Formerly, part 19 required licensees to furnish such a report at least annually upon the request of the worker. The change deletes the words "upon request." Public comment is not being solicited on this change as the comments were requested in the proposed rule (section XXVII, 51 FR 1118) on the option of requiring reports to individual workers. (These comments are discussed with regard to proposed § 20.1106). Part 19 has been amended to require licensees to advise each worker at least annually of the worker's dose recorded when requested (if the licensee is still implementing §§ 20.1–20.601) or annually, whether requested or not, when the licensee adopts §§ 20.1001–20.2401.

VIII. Finding of No Significant Environmental Impact: Availability

The Commission has determined under the National Environmental Policy Act of 1969, as amended and the Commission's regulations in subpart A of 10 CFR part 51 that this rule is not a major Federal action significantly affecting the quality of the human environment and therefore an environmental impact statement is not required. The amendments to part 20 in this final rule change the level for protection of the general public from an implicit limit of 0.5 rem per year to an explicit limit of 0.1 rem per year. There are also numerous changes in airborne and water radionuclide concentration limits. These changes result from changes in the models and parameters used to estimate the radiation dose associated with intake of a radionuclide. Some of the concentration limits for the general public are higher or lower than previous concentration limits; and some

are of the same magnitude as the previous limits.

Despite the changes in the dose and concentration limits, the Commission believes that issuance of the final rule will not have a major impact on the environment. The primary basis for this conclusion is that NRC (and Agreement State) licensees have implemented radiation protection measures that keep radiation exposures and radioactive effluents as low as reasonably achievable (ALARA) in accordance with provisions of 10 CFR 20.1(c) and comparable State provisions. These measures, whether established by rule, license, or good management practice, have been particularly successful in minimizing effluents to the general environment and exposures to members of the public and radiation workers. The final rule will make such ALARA programs mandatory as a part of licensee radiation protection programs.

In addition to 10 CFR part 20 and existing ALARA programs, there are other regulations that govern allowable doses to members of the public and that remain unchanged by the amendments to part 20. These other regulations include appendix I to 10 CFR part 50, 10 CFR parts 60 and 61, and the EPA's generally-applicable environmental standards in 40 CFR part 190. These standards set limits or design objectives (appendix I) for releases of radioactive material to the general environment that are generally more restrictive than the dose limits in part 20. Consequently, since these more restrictive standards remained essentially unchanged by the part 20 amendments, the level of public protection and the associated environmental impact are not changed appreciably from those associated with existing practice under the §§ 20.1–20.601 of part 20 and the aforenamed regulations.

The environmental assessment and finding of no significant impact on which this determination is based are available for inspection at the NRC Public Document Room, 2120 L Street NW. (Lower-Level), Washington, DC 20555. Single copies of the environmental assessment and finding of no significant impact are available from Harold T. Peterson, Jr., Nuclear Regulatory Commission, NL/S–139, Washington, DC 20555, telephone: (301) 492–3640.

IX. Paperwork Reduction Act Statement

The final rule amends information collection requirements that are subject to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501, et seq.). The requirements contained in §§ 20.101–20.601 were approved by the Office of Management and Budget approval numbers 3150–0014. Forms 4 and 5 in current use were approved under OMB approval numbers 3150–0005 and 3150–0006.

Additional information collection requirements in §§ 20.1001–20.2401 will be submitted by NRC to the Office of Budget and Management for review and approval of the paperwork requirements before they can become effective. Notice of OMB approval will be published by the NRC in the Federal Register.

X. Revised Regulatory Analysis

The Commission has issued a final regulatory analysis for this regulation. This revised analysis was based on the draft regulatory analysis as modified to account for the changes from the proposed rule resulting from public comments on both the proposed rule and the staff's modified rule in SECY–88–315 and supplemental papers. Copies of both the draft and final regulatory analysis are available for inspection and copying for a fee in the NRC Public Document Room (See **ADDRESSES.**)

XI. Final Regulatory Flexibility Analysis

In accordance with the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission has prepared a regulatory flexibility analysis that indicated the new amendments will apply to all NRC licensees. The NRC has approximately 7,500 licensees, approximately one-quarter of which are classified as small entities.

(Note: Agreement States, which implement comparable regulations under Section 274 of the Atomic Energy Act of 1954, as amended, have about 16,000 licensees of which a comparable number are assumed to be small entities.)

The types of small entities that would be affected by this rule include physicians, small hospitals, small laboratories, industrial applications in small industries, radiographers, and well loggers.

Copies of the draft and final regulatory analysis are available for inspection and copying, for a fee, in the NRC Public Document Room (See **ADDRESSES.**)

XII. Backfit Analysis

A final backfit analysis has been prepared for this rule and may be examined and copied for a fee in the Commission's Public Document Room (see **ADDRESSES**). For the reasons stated in this backfit analysis, the Commission has concluded that the amendments to part 20 in this final rule, as applied to nuclear power reactors, provide a substantial increase in overall protection of public health and safety both for workers and for members of the general public. The Commission's conclusion rests on both quantitative and qualitative grounds. The Commission believes that the reductions in allowable dose limits that are embodied in these part 20 amendments contribute to substantial increases in the protection of public health and safety. Although current practice, including the philosophy of keeping radiation exposures as low as is reasonably achievable (ALARA), generally has kept radiation exposures well below the existing limits, the reductions in the allowable dose limits ensure that such doses will also remain low in the future.

There are several qualitative factors that support the Commission's conclusion that the part 20 amendments provide a substantial increase in protection. One of the main qualitative factors is that it is necessary to revise the 30-year-old part 20 to ensure that the NRC regulations reflect the current state of radiation protection science. Any future revisions in dose limits recommended by ICRP or NCRP would undoubtedly be based upon the 1977 ICRP and 1987 NCRP recommendations and, therefore, would be more easily incorporated into the framework of the amended part 20 (§§ 20.1001–20.2401) than in the framework of §§ 20.1–20.601 of part 20. Other qualitative factors include: maintaining consistency with international radiation protection programs, keeping the radiation protection requirements consistent with current risk assessment methodologies, and having the NRC's standards conform to Federal radiation protection guidance.

The Commission is adopting the final rule based in part on the conclusions of this analysis that the rule provides for a substantial increase in the over-all protection of the public health and safety and that the direct and indirect costs of its implementation are justified in terms of the quantitative and qualitative benefits associated with the rule. The Commission notes, however, that, even had the analysis not concluded that the amendments to part 20 in this final rule provide a substantial increase in the overall public health and safety, it could have gone forward with the rule because the changes made to part 20 also amount to a redefinition of the level of adequate protection and the backfit rule's substantial increase in protection and cost justification standards do not apply to a redefinition of adequate protection.

Additional Views of Commissioner Curtiss with Respect to Backfit

I have examined the proposed Part 20 amendments from the standpoint of whether and, if so, how the backfit rule should apply to this particular rulemaking. The nature and effects of the proposed changes to part 20 lead me to the conclusion that the proposed amendments, in essence, would redefine what is necessary for adequate protection of the public health and safety in the radiation protection area. Thus, while I believe that we should apply the backfit rule to this part 20 rulemaking effort, I also believe that this rulemaking constitutes a redefinition of adequate protection as described in 10 CFR 50.109(a)(4)(iii) and that the usual backfit analysis and cost-benefit balancing are therefore not required in this instance.

On the question of whether such an approach would require this rule to be renoticed for further public comment, I have concluded that there was ample indication in the notice of proposed rulemaking that the Commission is rethinking its radiation protection standards across-the-board in this part 20 rulemaking. Moreover, this initiative was explained in a manner that could logically be construed to encompass the approach to backfitting described above. Of particular importance, the notice of proposed rulemaking itself seems to indicate that the Commission is contemplating an action that would redefine what is necessary for adequate protection in the radiation protection area. For example, the notice states that:

> [T]he Nuclear Regulatory Commission (NRC) is proposing a major revision of its regulations in 10 CFR Part 20 which provide the requirements for the protection of individuals who are exposed * * * to ionizing radiation from routine activities * * * which are licensed by the NRC * * * * The intent of the revision is to improve NRC radiation protection standards by reflecting developments in the principles that underlie radiation protection and advances in related sciences that have occurred since the promulgation of 10 CFR Part 20 nearly thirty years ago * * * * The expected result of promulgating and implementing the proposed revised rule is an improved rule that provides better assurance of protection; establishes a clear health protection basis for limits and other regulatory actions taken to protect public health; applies to all licensees in a consistent manner; and reflects current information on health risk, dosimetry, and radiation protection practices and experiences.
>
> 51 FR 1092 (January 9, 1986).

With regard to existing Part 20 standards, the Commission noted that:

> [i]n promulgating these standards, the AEC emphasized "that the standards are subject to change with the development of new knowledge, with significant increase in the average exposure of the whole population to radiation and with further experience in the administration of the Commission's regulatory program." Consistent with this emphasis, the proposed revision reflects new knowledge, increased uses of radiation and generation of radiation sources, and experience gained during the past twenty years* * * * [Earlier] revisions [to the existing part 20] have not kept the regulations in accord with more recent recommendations of scientific organizations * * * to improve overall protection and establish a clear health risk rationale * * * * [T]he central thrust of the revision [is] to ensure that radiation protection is adequate and defendable when judged by good protection practices and contemporary standards.
>
> 51 FR 1093, 1094 (citations omitted).

In discussing the benefits of the proposed rulemaking, the Commission indicated that:

> [t]he proposed revision to Part 20 includes numerous changes required to bring the radiation protections standards into accord with current defendable [sic] scientific knowledge, and to reflect contemporary scientific and philosophical approaches to protection against radiation * * * * The Commission anticipates that promulgating and implementing the proposed rule will result in a regulation that provides better assurance of protection, establishes a clear health protection basis for limits, applies to all licensees, including small entities, in a consistent manner, and reflects current information on health risk, dosimetry, and radiation protection practices and experiences.
>
> 51 FR 1120, 1122.

Consistent with all of these statements on the nature of the proposed changes to part 20, a supplemental notice of proposed rulemaking that requested comments on a proposed backfit analysis indicated that:

> [T]his is the first complete revision of these regulations in over 25 years. This revision will bring the Commission's radiation protection standards into accord with current recommendations of the International Commission on Radiological Protection (ICRP).
>
> The proposed revision to 10 CFR part 20 [is] intended to:
>
> a. Update the quarter-century-old 10 CFR Part 20 to incorporate advances in science and new concepts of radiation protection methodology and philosophy;
>
> b. Implement pending Federal radiation guidance on occupational radiation protection;
>
> c. Implement the principal current dose-limiting recommendations of the ICRP;
>
> d. Incorporate the ICRP "effective dose equivalent" concept;
>
> e. Update the limits on airborne radionuclide intakes, effluent releases and doses from inhaled or ingested radionuclides using up-to-date metabolic models and dose factors; and
>
> f. Require that licensees have programs for keeping radiation exposures "as low as is reasonably achievable" (ALARA).
>
> 51 FR 30870, 30871 (August 29, 1986).

Overall, these various characteristics of the purpose, intent, and nature of the proposed changes to part 20 lead to the conclusion that the Commission is, in fact, rethinking its radiation protection standards. For these reasons, I believe that the notice adequately describes the nature and substance of the proposed rule changes and that renoticing to further reflect a Commission judgment that the proposed changes constitute a redefinition of adequate protection is not necessary.

List of Subjects

10 CFR Part 20

Byproduct material, licensed material, nuclear materials, nuclear power plants and reactors, occupational safety and health, packaging and containers, penalty, radiation protection, reporting and recordkeeping requirements, special nuclear material, source material, waste treatment and disposal.

10 CFR Parts 2, 19, 30, 31, 32, 34, 35, 39, 40, 50, 61, and 70

Radiation protection.

Under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and 5 U.S.C. 552 and 553, the following amendments to 10 CFR parts 2, 19, 20, 30, 31, 32, 34, 35, 39, 40, 50, 61 and 70 are published as a document subject to codification.

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

1. The authority citation for part 20 is revised to read as follows:

Authority: Secs. 53, 63, 65, 81, 103, 104, 161, 182, 186, 68 Stat. 930, 933, 935, 936, 937, 948, 953, 955, as amended (42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201, 2232, 2236), secs. 201, as amended, 202, 206, 88 Stat. 1242, as amended, 1244, 1246 (U.S.C. 5841, 5842, 5846).

Section 20.408 also issued under secs. 135, 141, Pub. L. 97–425, 96 Stat. 2232, 2241 (42 U.S.C. 10155, 10161).

For the purposes of sec. 233, 68 Stat. 958, as amended (42 U.S.C. 2273); §§ 20.101, 20.102, 20.103 (a), (b), and (f), 20.104 (a) and (b), 20.105(b), 20.106(a), 20.201, 20.202(a), 20.205, 20.207, 20.301, 20.303, 20.304, 20.305, 20.1102, 20.1201–20.1204, 20.1206, 20.1207, 20.1208, 20.1301, 20.1302, 20.1501, 20.1502, 20.1601 (a) and (d), 20.1602, 20.1603, 20.1701, 20.1704, 20.1801, 20.1802, 20.1901(a), 20.1902, 20.1904, 20.1906, 20.2001, 20.2002, 20.2003, 20.2004, 20.2005 (b) and (c), 20.2006, 20.2101–20.2110, 20.2201–20.2206, and 20.2301 are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C.

2201(b)); § 20.2106(d) is issued under the Privacy Act of 1974, Pub. L. 93–579, 5 U.S.C. 552a; and §§ 20.102, 20.103(e), 20.401–20.407, 20.408(b), 20.409, 20.1102(a) (2) and (4), 20.1204(c), 20.1206 (g) and (h), 20.1904(c)(4), 20.1905 (c) and (d), 20.2005(c), 20.2006(b)–(d), 20.2101–20.2103, 20.2104(b)–(d), 20.2105–20.2108, and 20.2201–20.2207 are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

2. Appendix A is redesignated as appendix A to §§ 20.1–20.601 and the heading for appendix A is revised to read as follows:

Appendix A to §§20.1–20.601—Protection Factors for Respirators

3. Appendix B is redesignated as appendix B to §§ 20.1–20.601 and the heading for appendix B is revised to read as follows:

Appendix B §§ 20.1–20.601—Concentrations in Air and Water Above Natural Background

4. Appendix C is redesignated as appendix C to §§ 20.1–20.601 and the heading for appendix C is revised to read as follows:

Appendix C to §§ 20.1–20.601

5. Appendix D is redesignated as appendix D to §§ 20.1–20.601 and the heading for appendix D is revised to read as follows:

Appendix D to §§ 20.1–20.601—United States Nuclear Regulatory Commission Regional Offices

6. Part 20 is amended by adding a center heading and Subparts A through O to read as follows:

Regulations Mandatory as of January 1, 1993 With Earlier Compliance Encouraged

Subpart A—General Provisions

Sec.

Regulations Mandatory as of January 1, 1993 With Earlier Compliance Encouraged

Subpart A—General Provisions

§ 20.1001 Purpose.

(a) The regulations in this part establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the Nuclear Regulatory Commission. These regulations are issued under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended.

(b) It is the purpose of the regulations in this part to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part. However, nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety.

§ 20.1002 Scope.

The regulations in this part apply to persons licensed by the Commission to receive, possess, use, transfer, or dispose of byproduct, source, or special nuclear material or to operate a production or utilization facility under parts 30 through 35, 39, 40, 50, 60, 61, 70, or 72 of this chapter. The limits in this part do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of

medical diagnosis or therapy, or to voluntary participation in medical research programs.

§ 20.1003 Definitions.

As used in this part:

Absorbed dose means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

Act means the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), as amended.

Activity is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

Adult means an individual 18 or more years of age.

Airborne radioactive material means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

Airborne radioactivity area means a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations—

(1) In excess of the derived air concentrations (DACs) specified in appendix B, to §§ 20.1001–20.2401, or

(2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

ALARA (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of appendix B to §§ 20.1001–20.2401).

Background radiation means radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission.

Bioassay (radiobioassay) means the determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

Byproduct material means—

(1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material; and

(2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition.

Class (or *lung class* or *inhalation class*) means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

Collective dose is the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Commission means the Nuclear Regulatory Commission or its duly authorized representatives.

Committed dose equivalent ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed effective dose equivalent ($H_{E,50}$) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \Sigma w_T H_{T,50}$).

Controlled area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Declared pregnant woman means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Deep-dose equivalent (H_d), which applies to external whole-body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

Department means the Department of Energy established by the Department of Energy Organization Act (Pub. L. 95–91, 91 Stat. 565, 42 U.S.C. 7101 et seq.) to the extent that the Department, or its duly authorized representatives, exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers, and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104 (b), (c), and (d) of the Energy Reorganization Act of 1974 (Pub. L. 93–438, 88 Stat. 1233 at 1237, 42 U.S.C. 5814) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Pub. L. 95–91, 91 Stat 565 at 577–578, 42 U.S.C. 7151).

Derived air concentration (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of appendix B to §§ 20.1001–20.2401.

Derived air concentration-hour (DAC-hour) is the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rems (0.05 Sv).

Dose or *radiation dose* is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dose equivalent (H_T) means the product of the absorbed dose in tissue,

quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Dosimetry processor means an individual or an organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the equipment.($H_{E,50} = \Sigma w_T H_{T,50}$)

Effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma w_T H_T$).

Embryo/fetus means the developing human organism from conception until the time of birth.

Entrance or access point means any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

Exposure means being exposed to ionizing radiation or to radioactive material.

External dose means that portion of the dose equivalent received from radiation sources outside the body.

Extremity means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Eye dose equivalent applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Generally applicable environmental radiation standards means standards issued by the Environmental Protection Agency (EPA) under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

Government agency means any executive department, commission, independent establishment, corporation wholly or partly owned by the United States of America, which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government.

Gray [See § 20.1004].

High radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Individual means any human being.

Individual monitoring means—

(1) The assessment of dose equivalent by the use of devices designed to be worn by an individual;

(2) The assessment of committed effective dose equivalent by bioassay (see *Bioassay*) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or

(3) The assessment of dose equivalent by the use of survey data.

Individual Monitoring Devices (individual monitoring equipment) means devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.

Internal dose means that portion of the dose equivalent received from radioactive material taken into the body.

License means a license issued under the regulations in parts 30 through 35, 39, 40, 50, 60, 61, 70, or 72 of this chapter.

Licensed material means source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Commission.

Licensee means the holder of a license.

Limits (dose limits) means the permissible upper bounds of radiation doses.

Lost or missing licensed material means licensed material whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

Member of the public means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

Minor means an individual less than 18 years of age.

Monitoring (radiation monitoring, radiation protection monitoring) means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

Nonstochastic effect means health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

NRC means the Nuclear Regulatory Commission or its duly authorized representatives.

Occupational dose means the dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Person means—

(1) Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Department of Energy (except that the Department shall be considered a person within the meaning of the regulations in 10 CFR chapter I to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission under section 202 of the Energy Reorganization Act of 1974 (88 Stat. 1244), the Uranium Mill Tailings Radiation Control Act of 1978 (92 Stat. 3021), the Nuclear Waste Policy Act of 1982 (96 Stat. 2201), and section 3(b)(2) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (99 Stat. 1842)), any State or any political subdivision of or any political entity within a State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and

(2) Any legal successor, representative, agent, or agency of the foregoing.

Planned special exposure means an infrequent exposure to radiation, separate from and in addition to the annual dose limits.

Public dose means the dose received by a member of the public from exposure to radiation and to radioactive material released by a licensee, or to another source of radiation either within a licensee's controlled area or in unrestricted areas. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

Quality Factor (Q) means the modifying factor (listed in tables

1004(b).1 and 1004(b).2 of § 20.1004) that is used to derive dose equivalent from absorbed dose.

Quarter means a period of time equal to one-fourth of the year observed by the licensee (approximately 13 consective weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

Rad (See § 20.1004).

Radiation (ionizing radiation) means alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this part, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Reference man means a hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Rem (See § 20.1004).

Respiratory protective device means an apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Sanitary sewerage means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

Shallow-dose equivalent (H_s), which applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 square centimeter.

Sievert (See § 20.1004).

Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

Source material means—

(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or

(2) Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

Special nuclear material means—

(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or

(2) Any material artificially enriched by any of the foregoing but does not include source material.

Stochastic effects means health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Survey means an evalulation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted area means an area, access to which is neither limited nor controlled by the licensee.

Uranium fuel cycle means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel to the extent that these activities directly support the production of electrical power for public use. Uranium fuel cycle does not include mining operations, operations at waste disposal sites, transportation of radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and byproduct materials from the cycle.

Very high radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

[Note: At very high doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts)].

Week means 7 consecutive days starting on Sunday.

Weighting factor w_T, for an organ or tissue (T) is the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are:

ORGAN DOSE WEIGHTING FACTORS

Organ or tissue	w_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	[1] 0.30
Whole Body	[2] 1.00

[1] 0.30 results from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

[2] For the purpose of weighting the external whole body dose (for adding it to the internal dose), a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

Whole body means, for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

Working level (WL) is any combination of short-lived radon daughters (for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212) in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy.

Working level month (WLM) means an exposure to 1 working level for 170 hours (2,000 working hours per year/12 months per year = approximately 170 hours per month).

Year means the period of time beginning in January used to determine compliance with the provisions of this part. The licensee may change the starting date of the year used to determine compliance by the licensee provided that the change is made at the beginning of the year and that no day is

omitted or duplicated in consecutive years.

§ 20.1004 Units of radiation dose.

(a) Definitions. As used in this part, the units of radiation dose are:

Gray (Gy) is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 Joule/kilogram (100 rads).

Rad is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 gray).

Rem is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem=0.01 sievert).

Sievert is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv=100 rems).

(b) As used in this part, the quality factors for converting absorbed dose to dose equivalent are shown in table 1004(b).1.

TABLE 1004(b).1.—QUALITY FACTORS AND ABSORBED DOSE EQUIVALENCIES

Type of radiation	Quality factor (Q)	Absorbed dose equal to a unit dose equivalent [a]
X-, gamma, or beta radiation	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

[a] Absorbed dose in rad equal to 1 rem or the absorbed dose in gray equal to 1 sievert.

(c) If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in rems per hour or sieverts per hour, as provided in paragraph (b) of this section, 1 rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of the regulations in this part, be assumed to result from a total fluence of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee may use the fluence rate per unit dose equivalent or the appropriate Q value from table 1004(b).2 to convert a measured tissue dose in rads to dose equivalent in rems.

TABLE 1004(b).2.—MEAN QUALITY FACTORS, Q, AND FLUENCE PER UNIT DOSE EQUIVALENT FOR MONOENERGETIC NEUTRONS

	Neutron energy (MeV)	Quality factor [a] (Q)	Fluence per unit dose equivalent [b] (neutrons cm^{-2} rem^{-1})
(thermal)	2.5×10^{-8}	2	980×10^{6}
	1×10^{-7}	2	980×10^{6}
	1×10^{-6}	2	810×10^{6}
	1×10^{-5}	2	810×10^{6}
	1×10^{-4}	2	840×10^{6}
	1×10^{-3}	2	980×10^{6}
	1×10^{-2}	2.5	1010×10^{6}
	1×10^{-1}	7.5	170×10^{6}
	5×10^{-1}	11	39×10^{6}
	1	11	27×10^{6}
	2.5	9	29×10^{6}
	5	8	23×10^{6}
	7	7	24×10^{6}
	10	6.5	24×10^{6}
	14	7.5	17×10^{6}
	20	8	16×10^{6}
	40	7	14×10^{6}
	60	5.5	16×10^{6}
	1×10^{2}	4	20×10^{6}
	2×10^{2}	3.5	19×10^{6}
	3×10^{2}	3.5	16×10^{6}
	4×10^{2}	3.5	14×10^{6}

[a] Value of quality factor (Q) at the point where the dose equivalent is maximum in a 30-cm diameter cylinder tissue-equivalent phantom.

[b] Monoenergetic neutrons incident normally on a 30-cm diameter cylinder tissue-equivalent phantom.

§ 20.1005 Units of radioactivity.

For the purposes of this part, activity is expressed in the special unit of curies (Ci) or in the SI unit of becquerels (Bq), or their multiples, or disintegrations (transformations) per unit of time.

(a) One becquerel=1 disintegration per second (s^{-1}). (b) One curie=3.7×10^{10} disintegrations per second=3.7×10^{10} becquerels=2.22×10^{12} disintegrations per minute.

§ 20.1006 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by an officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

§ 20.1007 Communications.

Unless otherwise specified, communications or reports concerning the regulations in this part should be addressed to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, DC 20555. A communication, report, or application may be delivered in person to the Office of the Executive Director for Operations, 11555 Rockville Pike, Rockville, MD 20852.

§ 20.1008 Implementation.

(a) Licensees shall implement the provisions of §§ 20.1001–20.2401 on or before January 1, 1993. If a licensee chooses to implement the provisions of §§ 20.1001–20.2401 prior to January 1, 1993, the licensee shall implement all provisions of these sections not otherwise exempted by paragraph (d) of this section, and shall provide written notification to either the Director of the Office of Nuclear Materials Safety and Safeguards or the Director of the Office of Nuclear Reactor Regulation, as appropriate, that the licensee is adopting early implementation of §§ 20.1001–20.2401 and associated appendices. Until January 1, 1993, or until the licensee notifies the Commission of early implementation, compliance will be required with §§ 20.1–20.601 of this part.

(b) After the time the licensee implements §§ 20.1001–20.2401, the applicable section of §§ 20.1001–20.2401 shall be used in lieu of any section in §§ 20.1–20.601 of this part that is cited in license conditions or technical specifications, except as specified in paragraphs (c), (d) and (e) of this section. If the requirements of this part are more restrictive than the existing license condition, then the licensee shall comply with this part unless exempted by paragraph (d) of this section.

(c) Any existing license condition or technical specification that is more restrictive than a requirement in §§ 20.1001–20.2401 remains in force until there is a technical specification change, license amendment, or license renewal.

(d) If a license condition or technical specification exempted a licensee from a provision of Part 20 in §§ 20.1–20.601, it exempts a licensee from the corresponding provision of §§ 20.1001–20.2401.

(e) If a license condition cites provisions in §§ 20.1–20.601 and there are no corresponding provisions in §§ 20.1001–20.2401, then the license condition remains in force until there is a technical specification change, license amendment, or license renewal that modifies or removes this condition.

§ 20.1009 Reporting, recording, and application requirements: OMB approval.

(a) The Nuclear Regulatory Commission will submit the information collection requirements contained in this part to the Office of Management and Budget for approval as required by the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). The information collection requirements in this part will not become effective until OMB clearance is obtained and published in the **Federal Register.**

(b) The information collection requirements contained in this part appear in §§ 20.1101, 20.1202, 20.1204, 20.1206, 20.1301, 20.1501, 20.1601, 20.1603, 20.1703, 20.1901, 20.1902, 20.1904, 20.1906, 20.2002, 20.2004, 20.2006, 20.2102, 20.2103, 20.2104, 20.2105, 20.2106, 20.2107, 20.2108, 20.2109, 20.2110, 20.2201, 20.2202, 20.2203, 20.2204, 20.2206, Appendix F to §§ 20.1001–20.2401, and NRC Form 4 and NRC Form 5.

Subpart B—Radiation Protection Programs

§ 20.1101 Radiation protection programs.

(a) Each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of this part. (See § 20.2102 for recordkeeping requirements relating to these programs.)

(b) The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

(c) The licensee shall periodically (at least annually) review the radiation protection program content and implementation.

Subpart C—Occupational Dose Limits

§ 20.1201 Occupational dose limits for adults.

(a) The licensee shall control the occupational dose to individual adults, except for planned special exposures under § 20.1206, to the following dose limits.

(1) An annual limit, which is the more limiting of—

(i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or

(ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv).

(2) The annual limits to the lens of the eye, to the skin, and to the extremities, which are:

(i) An eye dose equivalent of 15 rems (0.15 Sv), and

(ii) A shallow-dose equivalent of 50 rems (0.50 Sv) to the skin or to any extremity.

(b) Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year (see § 20.1206(e)(1)) and during the individual's lifetime (see § 20.1206(e)(2)).

(c) The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure. The deep-dose equivalent, eye dose equivalent and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

(d) Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in table 1 of appendix B to §§ 20.1001–20.2401 and may be used to determine the individual's dose (see § 20.2106) and to demonstrate compliance with the occupational dose limits.

(e) In addition to the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 of appendix B to §§ 20.1001–20.2401).

(f) The licensee shall reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person (see § 20.2104(e)).

§ 20.1202 Compliance with requirements for summation of external and internal doses.

(a) If the licensee is required to monitor under both §§ 20.1502(a) and (b), the licensee shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee is required to monitor only under § 20.1502(a) or only under § 20.1502(b), then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses by meeting one of the conditions specified in paragraph (b) of this section and the conditions in paragraphs (c) and (d) of this section.

(Note: The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.)

(b) *Intake by inhalation.* If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep-dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

(1) The sum of the fractions of the inhalation ALI for each radionuclide, or

(2) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or

(3) The sum of the calculated committed effective dose equivalents to all significantly irradiated[1] organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit.

(c) *Intake by oral ingestion.* If the occupationally exposed individual also receives an intake of radionuclides by oral ingestion greater than 10 percent of the applicable oral ALI, the licensee shall account for this intake and include it in demonstrating compliance with the limits.

(d) *Intake through wounds or absorption through skin.* The licensee shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption.

Note: The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be further evaluated.

§ 20.1203 Determination of external dose from airborne radioactive material.

Licensees shall, when determining the dose from airborne radioactive material, include the contribution to the deep-dose equivalent, eye dose equivalent, and shallow-dose equivalent from external exposure to the radioactive cloud (see appendix B to §§ 20.1001–20.2401, footnotes 1 and 2).

Note: Airborne radioactivity measurements and DAC values should not be used as the primary means to assess the deep-dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep-dose equivalent to an individual should be based upon measurements using instruments or individual monitoring devices.

§ 20.1204 Determination of internal exposure.

(a) For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee shall, when required under § 20.1502, take suitable and timely measurements of—

(1) Concentrations of radioactive materials in air in work areas; or

(2) Quantities of radionuclides in the body; or

[1] An organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, w_T, and the committed dose equivalent, H_{50}, per unit intake is greater than 10 percent of the maximum weighted value of H_{50} (i.e., $w_T H_{50,T}$) per unit intake for any organ or tissue.

(3) Quantities of radionuclides excreted from the body; or

(4) Combinations of these measurements.

(b) Unless respiratory protective equipment is used, as provided in § 20.1703, or the assessment of intake is based on bioassays, the licensee shall assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

(c) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior or the material in an individual is known, the licensee may—

(1) Use that information to calculate the committed effective dose equivalent, and, if used, the licensee shall document that information in the individual's record; and

(2) Upon prior approval of the Commission, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material (e.g., aerosol size distribution or density); and

(3) Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide (see appendix B to §§ 20.1001–20.2401) to the committed effective dose equivalent.

(d) If the licensee chooses to assess intakes of Class Y material using the measurements given in § 20.1204(a)(2) or (3), the licensee may delay the recording and reporting of the assessments for periods up to 7 months, unless otherwise required by §§ 20.2202 or 20.2203, in order to permit the licensee to make additional measurements basic to the assessments.

(e) If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours must be either—

(1) The sum of the ratios of the concentration to the appropriate DAC value (e.g., D, W, Y) from appendix B to §§ 20.1001–20.2401 for each radionuclide in the mixture; or

(2) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

(f) If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture must be the most restrictive DAC of any radionuclide in the mixture.

(g) When a mixture of radionuclides in air exists, licensees may disregard certain radionuclides in the mixture if—

(1) The licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in § 20.1201 and in complying with the monitoring requirements in § 20.1502(b), and

(2) The concentration of any radionuclide disregarded is less than 10 percent of its DAC, and

(3) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

(h)(1) In order to calculate the committed effective dose equivalent, the licensee may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 5 rems (0.05 Sv) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

(2) When the ALI (and the associated DAC) is determined by the nonstochastic organ dose limit of 50 rems (0.5 Sv), the intake of radionuclides that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) (the stochastic ALI) is listed in parentheses in table 1 of appendix B to §§ 20.1001–20.2401. In this case, the licensee may, as a simplifying assumption, use the stochastic ALIs to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALIs, the licensee must also demonstrate that the limit in § 20.1201(a)(1)(ii) is met.

§ 20.1205 [Reserved]

§ 20.1206 Planned special exposures.

A licensee may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in § 20.1201 provided that each of the following conditions is satisfied—

(a) The licensee authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the higher exposure are unavailable or impractical.

(b) The licensee (and employer if the employer is not the licensee) specifically authorizes the planned special exposure, in writing, before the exposure occurs.

(c) Before a planned special exposure, the licensee ensures that the individuals involved are—

(1) Informed of the purpose of the planned operation;

(2) Informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and

(3) Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

(d) Prior to permitting an individual to participate in a planned special exposure, the licensee ascertains prior doses as required by § 20.2104(b) during the lifetime of the individual for each individual involved.

(e) Subject to § 20.1201(b), the licensee does not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses in excess of the limits to exceed—

(1) The numerical values of any of the dose limits in § 20.1201(a) in any year; and

(2) Five times the annual dose limits in § 20.1201(a) during the individual's lifetime.

(f) The licensee maintains records of the conduct of a planned special exposure in accordance with § 20.2105 and submits a written report in accordance with § 20.2204.

(g) The licensee records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposures is not to be considered in controlling future occupational dose of the individual under § 20.1201(a) but is to be included in evaluations required by § 20.1206 (d) and (e).

§ 20.1207 Occupational dose limits for minors.

The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adult workers in § 20.1201.

§ 20.1208 Dose to an embryo/fetus.

(a) The licensee shall ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv). (For recordkeeping requirements, see § 20.2106.)

(b) The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section.

(c) The dose to an embryo/fetus shall be taken as the sum of—

(1) The deep-dose equivalent to the declared pregnant woman; and

(2) The dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv),

or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with paragraph (a) of this section if the additional dose to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

Subpart D—Radiation Dose Limits for Individual Members of the Public

§ 20.1301 Dose limits for individual members of the public.

(a) Each licensee shall conduct operations so that—

(1) The total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from the licensee's disposal of radioactive material into sanitary sewerage in accordance with § 20.2003, and

(2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any one hour.

(b) If the licensee permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

(c) A licensee or license applicant may apply for prior NRC authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv). The licensee or license applicant shall include the following information in this application:

(1) Demonstration of the need for and the expected duration of operations in excess of the limit in paragraph (a) of this section;

(2) The licensee's program to assess and control dose within the 0.5 rem (5 mSv) annual limit; and

(3) The procedures to be followed to maintain the dose as low as is reasonably achievable.

(d) In addition to the requirements of this part, a licensee subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190 shall comply with those standards.

(e) The Commission may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents in order to restrict the collective dose.

§ 20.1302 Compliance with dose limits for individual members of the public.

(a) The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in § 20.1301.

(b) A licensee shall show compliance with the annual dose limit in § 20.1301 by—

(1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit; or

(2) Demonstrating that—

(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in table 2 of appendix B to §§ 20.1001–20.2401; and

(ii) If an individual were continually present in an unrestricted area, the dose from external sources would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

(c) Upon approval from the Commission, the licensee may adjust the effluent concentration values in appendix B to §§ 20.1001–20.2401, table 2, for members of the public, to take into account the actual physical and chemical characteristics of the effluents (e.g., aerosal size distribution, solubility, density, radioactive decay equilibrium, chemical form).

Subpart E—[Reserved]

Subpart F—Surveys and Monitoring

§ 20.1501 General.

(a) Each licensee shall make or cause to be made, surveys that—

(1) May be necessary for the licensee to comply with the regulations in this part; and

(2) Are reasonable under the circumstances to evaluate—

(i) The extent of radiation levels; and

(ii) Concentrations or quantities of radioactive material; and

(iii) The potential radiological hazards that could be present.

(b) The licensee shall ensure that instruments and equipment used for quantitative radiation measurements (e.g., dose rate and effluent monitoring) are calibrated periodically for the radiation measured.

(c) All personnel dosimeters (except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities) that require processing to determine the radiation dose and that are used by licensees to comply with § 20.1201, with other applicable provisions of this chapter, or with conditions specified in a license must be processed and evaluated by a dosimetry processor—

(1) Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

(2) Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

§ 20.1502 Conditions requiring individual monitoring of external and internal occupational dose.

Each licensee shall monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this part. As a minimum—

(a) Each licensee shall monitor occupational exposure to radiation and shall supply and require the use of individual monitoring devices by—

(1) Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in § 20.1201(a),

(2) Minors and declared pregnant women likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of any of the applicable limits in § 20.1207 or § 20.1208, and

(3) Individuals entering a high or very high radiation area.

(b) Each licensee shall monitor (see § 20.1204) the occupational intake of radioactive material by and assess the committed effective dose equivalent to—

(1) Adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable ALI(s) in table 1, Columns 1 and 2, of appendix B to §§ 20.1001–20.2401; and

(2) Minors and declared pregnant women likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.05 rem (0.5 mSv).

Subpart G—Control of Exposure From External Sources in Restricted Areas

§ 20.1601 Control of access to high radiation areas.

(a) The licensee shall ensure that each entrance or access point to a high radiation area has one or more of the following features—

(1) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a

deep-dose equivalent of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates;

(2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

(3) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

(b) In place of the controls required by paragraph (a) of this section for a high radiation area, the licensee may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

(c) A licensee may apply to the Commission for approval of alternative methods for controlling access to high radiation areas.

(d) The licensee shall establish the controls required by paragraphs (a) and (c) of this section in a way that does not prevent individuals from leaving a high radiation area.

(e) Control is not required for each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the Department of Transportation provided that—

(1) The packages do not remain in the area longer than 3 days; and

(2) The dose rate at 1 meter from the external surface of any package does not exceed 0.01 rem (0.1 mSv) per hour.

(f) Control of entrance or access to rooms or other areas in hospitals is not required solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who will take the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the limits established in this part and to operate within the ALARA provisions of the licensee's radiation protection program.

§ 20.1602 Control of access to very high radiation areas.

In addition to the requirements in § 20.1601, the licensee shall institute additional measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 500 rads (5 grays) or more in 1 hour at 1 meter from a radiation source or any surface through which the radiation penetrates.

§ 20.1603 Control of access to very high radiation areas—irradiators.

(a) Each area in which there may exist radiation levels in excess of 500 rads (5 grays) in 1 hour at 1 meter from a sealed radioactive source [2] that is used to irradiate materials must meet the following requirements.

(1) Each entrance or access point must be equipped with entry control devices which—

(i) Function automatically to prevent any individual from inadvertently entering the area when very high radiation levels exist;

(ii) Permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the sealed source, to be reduced below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour; and

(iii) Prevent operation of the source if the source would produce radiation levels in the area that could result in a deep-dose equivalent to an individual in excess of 0.1 rem (1 mSv) in 1 hour.

(2) Additional control devices must be provided so that, upon failure of the entry control devices to function as required by paragraph (a)(1) of this section—

(i) The radiation level within the area, from the sealed source, is reduced below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make an individual attempting to enter the area aware of the hazard and at least one other authorized individual, who is physically present, familiar with the activity, and prepared to render or summon assistance, aware of the failure of the entry control devices.

(3) The licensee shall provide control devices so that, upon failure or removal of physical radiation barriers other than the source's shielded storage container—

(i) The radiation level from the source is reduced below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.

(4) When the shield for the stored source is a liquid, the licensee shall provide means to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding.

(5) Physical radiation barriers that comprise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of paragraphs (a) (3) and (4) of this section.

(6) Each area must be equipped with devices that will automatically generate conspicuous visible and audible alarm signals to alert personnel in the area before the source can be put into operation and in sufficient time for any individual in the area to operate a clearly identified control device, which must be installed in the area and which can prevent the source from being put into operation.

(7) Each area must be controlled by use of such administrative procedures and such devices as are necessary to ensure that the area is cleared of personnel prior to each use of the source.

(8) Each area must be checked by a radiation measurement to ensure that, prior to the first individual's entry into the area after any use of the source, the radiation level from the source in the area is below that at which it would be possible for an individual to receive a deep-dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour.

(9) The entry control devices required in paragraph (a)(1) of this section must have been tested for proper functioning (see § 20.2109 for recordkeeping requirements).

(i) Testing must be conducted prior to initial operation with the source of radiation on any day (unless operations were continued uninterrupted from the previous day); and

(ii) Testing must be conducted prior to resumption of operation of the source of radiation after any unintended interruption; and

(iii) The licensee shall submit and adhere to a schedule for periodic tests of the entry control and warning systems.

[2] This section applies to radiation from byproduct, source, or special nuclear materials that are used in sealed sources in non-self-shielded irradiators. This section does not apply to radioactive sources that are used in teletherapy, in radiography, or in completely self-shielded irradiators in which the source is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual. This section also does not apply to sources from which the radiation is incidental to some other use or to nuclear reactor-generated radiation.

(10) The licensee may not conduct operations, other than those necessary to place the source in safe condition or to effect repairs on controls, unless control devices are functioning properly.

(11) Entry and exit portals that are used in transporting materials to and from the irradiation area, and that are not intended for use by individuals, must be controlled by such devices and administrative procedures as are necessary to physically protect and warn against inadvertent entry by any individual through these portals. Exit portals for processed materials must be equipped to detect and signal the presence of any loose radiation sources that are carried toward such an exit and to automatically prevent loose radiation sources from being carried out of the area.

(b) Persons holding licenses or applicants for licenses for radiation sources that are within the purview of paragraph (a) of this section and that will be used in a variety of positions or in locations, such as open fields or forests, that make it impracticable to comply with certain requirements of paragraph (a) of this section, such as those for the automatic control of radiation levels, may apply to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, for approval of the use of alternative safety measures. Any alternative safety measures must provide a degree of personnel protection at least eqivalent to those specified in paragraph (a) of this section. At least one of the alternative measures must include an entry-preventing interlock control based on a measurement of the radiation that ensures the absence of high radiation levels before an individual can gain access to the area where such radiation sources are used.

(c) The entry control devices required by paragraphs (a) and (b) of this section must be established in such a way that no individual will be prevented from leaving the area.

Subpart H—Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas

§ 20.1701 Use of process or other engineering controls.

The licensee shall use, to the extent practicable, process or other engineering controls (e.g., containment or ventilation) to control the concentrations of radioactive material in air.

§ 20.1702 Use of other controls.

When it is not practicable to apply process or other engineering controls to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the licensee shall, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

(a) Control of access;

(b) Limitation of exposure times;

(c) Use of respiratory protection equipment; or

(d) Other controls.

§ 20.1703 Use of individual respiratory protection equipment.

(a) If the licensee uses respiratory protection equipment to limit intakes pursuant to § 20.1702—

(1) The licensee shall use only respiratory protection equipment that is tested and certified or had certification extended by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA).

(2) If the licensee wishes to use equipment that has not been tested or certified by NIOSH/MSHA, has not had certification extended by NIOSH/MSHA, or for which there is no schedule for testing or certification, the licensee shall submit an application for authorized use of that equipment, including a demonstration by testing, or a demonstration on the basis of reliable test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.

(3) The licensee shall implement and maintain a respiratory protection program that includes—

(i) Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate exposures;

(ii) Surveys and bioassays, as appropriate, to evaluate actual intakes;

(iii) Testing of respirators for operability immediately prior to each use;

(iv) Written procedures regarding selection, fitting, issuance, maintenance, and testing of respirators, including testing for operability immediately prior to each use; supervision and training of personnel; monitoring, including air sampling and bioassays; and recordkeeping; and

(v) Determination by a physician prior to initial fitting of respirators, and at least every 12 months thereafter, that the individual user is physically able to use the respiratory protection equipment.

(4) The licensee shall issue a written policy statement on respirator usage covering—

(i) The use of process or other engineering controls, instead of respirators;

(ii) The routine, nonroutine, and emergency use of respirators; and

(iii) The periods of respirator use and relief from respirator use.

(5) The licensee shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief.

(6) The licensee shall use equipment within limitations for type and mode of use and shall provide proper visual, communication, and other special capabilities (such as adequate skin protection) when needed.

(b) In estimating exposure of individuals to airborne radioactive materials, the licensee may make allowance for respiratory protection equipment used to limit intakes pursuant to § 20.1702, provided that the following conditions, in addition to those in § 20.1703(a), are satisfied:

(1) The licensee selects respiratory protection equipment that provides a protection factor (see appendix A to §§ 20.1001–20.2401) greater than the multiple by which peak concentrations of airborne radioactive materials in the working area ae expected to exceed the values specified in appendix B to §§ 20.1001–20.2401, table 1, column 3. If the selection of a respiratory protection device with a protection factor greater than the peak concentration is inconsistent with the goal specified in § 20.1702 of keeping the total effective dose equivalent ALARA, the licensee may select respiratory protection equipment with a lower protection factor only if such a selection would result in keeping the total effective dose equivalent ALARA. The concentration of radioactive material in the air that is inhaled when respirators are worn may be initially estimated by dividing the average concentration in air, during each period of uninterrupted use, by the protection factor. If the exposure is later found to be greater than estimated, the corrected value must be used; if the exposure is later found to be less than estimated, the corrected value may be used.

(2) The licensee shall obtain authorization from the Commission

before assigning respiratory protection factors in excess of those specified in appendix A to §§ 20.1001–20.2401. The Commission may authorize a licensee to use higher protection factors on receipt of an application that—

(i) Describes the situation for which a need exists for higher protection factors, and

(ii) Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

(c) The licensee shall use as emergency devices only respiratory protection equipment that has been specifically certified or had certification extended for emergency use by NOISH/MSHA.

(d) The licensee shall notify, in writing, the Director of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401 at least 30 days before the date that respiratory protection equipment is first used under the provisions of either § 20.1703 (a) or (b).

§ 20.1704 Further restrictions on the use of respiratory protection equipment.

The Commission may impose restrictions in addition to those in §§ 20.1702, 20.1703, and appendix A to §§ 20.1001–20.2401 to—

(a) Ensure that the respiratory protection program of the licensee is adequate to limit exposures of individuals to airborne radioactive materials; and

(b) Limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

Subpart I—Storage and Control of Licensed Material

§ 20.1801 Security of stored material.

The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

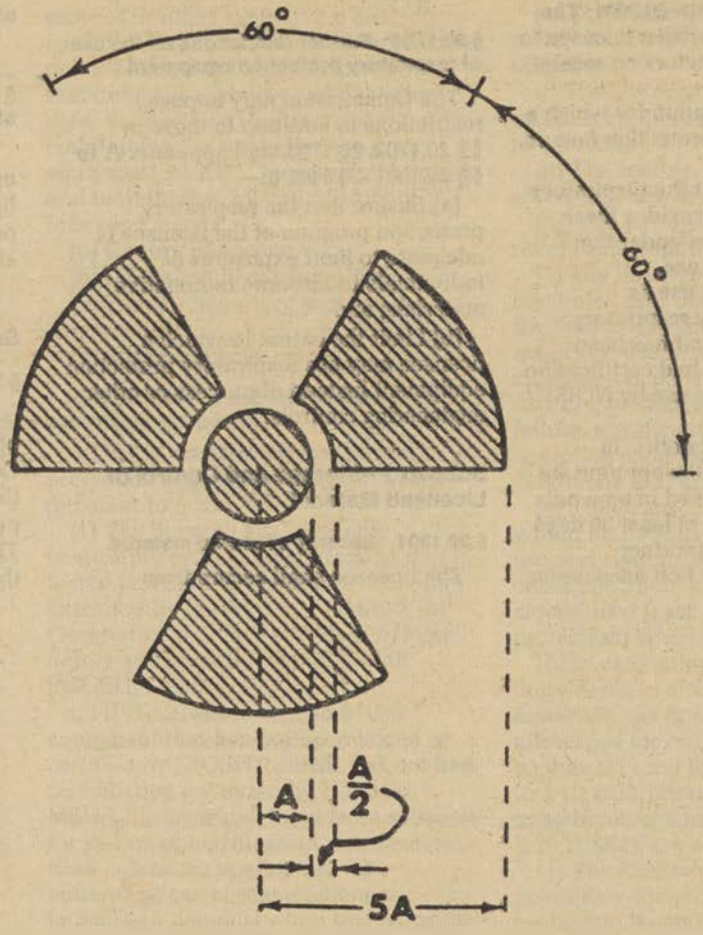
§ 20.1802 Control of material not in storage.

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Subpart J—Precautionary Procedures

§ 20.1901 Caution signs.

(a) *Standard radiation symbol.* Unless otherwise authorized by the Commission, the symbol prescribed by this part shall use the colors magenta, or purple, or black on yellow background. The symbol prescribed by this part is the three-bladed design:



RADIATION SYMBOL

(1) Cross-hatched area is to be magenta, or purple, or black, and

(2) The background is to be yellow.

(b) *Exception to color requirements for standard radiation symbol.* Notwithstanding the requirements of paragraph (a) of this section, licensees are authorized to label sources, source holders, or device components containing sources of licensed materials that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

(c) *Additional information on signs and labels.* In addition to the contents of signs and labels prescribed in this part, the licensee may provide, on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures.

§ 20.1902 Posting requirements.

(a) *Posting of radiation areas.* The licensee shall post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

(b) *Posting of high radiation areas.* The licensee shall post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

(c) *Posting of very high radiation areas.* The licensee shall post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA."

(d) *Posting of airborne radioactivity areas.* The licensee shall post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

(e) *Posting of areas or rooms in which licensed material is used or stored.* The licensee shall post each area or room in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in appendix C to §§ 20.1001–20.2401 with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

§ 20.1903 Exceptions to posting requirements.

(a) A licensee is not required to post caution signs in areas or rooms containing radioactive materials for

periods of less than 8 hours, if each of the following conditions is met:

(1) The materials are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to radiation or radioactive materials in excess of the limits established in this part; and

(2) The area or room is subject to the licensee's control.

(b) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs pursuant to § 20.1902 provided that—

(1) The patient is being treated with sealed sources or has been treated with unsealed radioactive material in quantities less than 30 millicuries (110 MBq, or the measured dose rate at 1 meter from the patient is less than 0.005 rem (0.05 mSv) per hour; and

(2) There are personnel in attendance who will take the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the limits established in this part and to operate within the ALARA provisions of the licensee's radiation protection program.

(c) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level at 30 centimeters from the surface of the source container or housing does not exceed 0.005 rem (0.05 mSv) per hour.

§ 20.1904 Labeling containers.

(a) The licensee shall ensure that each container of licensed material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must also provide sufficient information (such as the radionuclide(s) present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment) to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

(b) Each licensee shall, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

§ 20.1905 Exemptions to labeling requirements.

A licensee is not required to label—

(a) Containers holding licensed material in quantities less than the quantities listed in appendix C to §§ 20.1001–20.2401; or

(b) Containers holding licensed material in concentrations less than those specified in table 3 of appendix B to §§ 20.1001–20.2401; or

(c) Containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by this part; or

(d) Containers when they are in transport and packaged and labeled in accordance with the regulations of the Department of Transportation,[3] or

(e) Containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record (examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells). The record must be retained as long as the containers are in use for the purpose indicated on the record; or

(f) Installed manufacturing or process equipment, such as reactor components, piping, and tanks.

§ 20.1906 Procedures for receiving and opening packages.

(a) Each licensee who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in § 71.4 and appendix A to part 71 of this chapter, shall make arrangements to receive—

(1) The package when the carrier offers it for delivery; or

(2) Notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

(b) Each licensee shall monitor the external surfaces of a package known to contain radioactive material for radioactive contamination and radiation levels if the package—

(1) Is labeled as containing radioactive material; or

(2) Has evidence of potential contamination, such as packages that are crushed, wet, or damaged.

(c) The licensee shall perform the monitoring required by paragraph (b) of this section as soon as practicable after receipt of the package, but not later than 3 hours after the package is received at the licensee's facility if it is received during the licensee's normal working hours, or not later than 3 hours from the beginning of the next working day if it is received after working hours.

(d) The licensee shall immediately notify the final delivery carrier and, by telephone and telegram, mailgram, or facsimile, the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401 when—

(1) Removable radioactive surface contamination exceeds the limits of § 71.87(i) of this chapter; or

(2) External radiation levels exceed the limits of § 71.47 of this chapter.

(e) Each licensee shall—

(1) Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and

(2) Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

(f) Licensees transferring special form sources in licensee-owned or licensee-operated vehicles to and from a work site are exempt from the contamination monitoring requirements of paragraph (b) of this section, but are not exempt from the survey requirement in paragraph (b) of this section for measuring radiation levels that is required to ensure that the source is still properly lodged in its shield.

Subpart K—Waste Disposal

§ 20.2001 General requirements.

(a) A licensee shall dispose of licensed material only—

(1) By transfer to an authorized recipient as provided in § 20.2006 or in the regulations in parts 30, 40, 60, 61, 70, or 72 of this chapter; or

(2) By decay in storage; or

(3) By release in effluents within the limits in § 20.1301; or

(4) As authorized under §§ 20.2002, 20.2003, 20.2004, or § 20.2005.

(b) A person must be specifically licensed to receive waste containing licensed material from other persons for:

(1) Treatment prior to disposal; or

(2) Treatment or disposal by incineration; or

(3) Decay in storage; or

(4) Disposal at a land disposal facility licensed under part 61 of this chapter; or

(5) Disposal at a geologic repository under part 60 of this chapter.

§ 20.2002 Method for obtaining approval of proposed disposal procedures.

A licensee or applicant for a license may apply to the Commission for approval of proposed procedures, not

[3] Labeling of packages containing radioactive materials is required by the Department of Transportation (DOT) if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by DOT regulations 49 CFR 173.403 (m) and (w) and 173.421–424.

otherwise authorized in the regulations in this chapter, to dispose of licensed material generated in the licensee's activities. Each application shall include:

(a) A description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal; and

(b) An analysis and evaluation of pertinent information on the nature of the environment; and

(c) The nature and location of other potentially affected licensed and unlicensed facilities; and

(d) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in this part.

§ 20.2003 Disposal by release into sanitary sewerage.

(a) A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

(1) The material is readily soluble (or is readily dispersible biological material) in water; and

(2) The quantity of licensed or other radioactive material that the licensee releases into the sewer in 1 month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in table 3 of appendix B to §§ 20.1001–20.2401; and

(3) If more than one radionuclide is released, the following conditions must also be satisfied:

(i) The licensee shall determine the fraction of the limit in table 3 of appendix B to §§ 20.1001–20.2401 represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in table 3 of appendix B to §§ 20.1001–20.2401; and

(ii) The sum of the fractions for each radionuclide required by paragraph (a)(3)(i) of this section does not exceed unity; and

(4) The total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 5 curies (185 GBq) of hydrogen-3, 1 curie (37 GBq) of carbon-14, and 1 curie (37 GBq) of all other radioactive materials combined.

(b) Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in paragraph (a) of this section.

§ 20.2004 Treatment or disposal by incineration.

A licensee may treat or dispose of licensed material by incineration only in the amounts and forms specified in § 20.2005 or as specifically approved by the Commission pursuant to § 20.2002.

§ 20.2005 Disposal of specific wastes.

(a) A licensee may dispose of the following licensed material as if it were not radioactive:

(1) 0.05 microcurie (1.85 kBq), or less, of hydrogen-3 or carbon-14 per gram of medium used for liquid scintillation counting; and

(2) 0.05 microcurie (1.85 kBq), or less, of hydrogen-3 or carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.

(b) A licensee may not dispose of tissue under paragraph (a)(2) of this section in a manner that would permit its use either as food for humans or as animal feed.

(c) The licensee shall maintain records in accordance with § 20.2108.

§ 20.2006 Transfer for disposal and manifests.

(a) The requirements of this section and appendix F to §§ 20.1001–20.2401 are designed to control transfers of low-level radioactive waste intended for disposal at a land disposal facility (as defined in part 61 of this chapter), establish a manifest tracking system, and supplement existing requirements concerning transfers and recordkeeping for those wastes.

(b) Each shipment of radioactive waste intended for disposal at a licensed land disposal facility must be accompanied by a shipment manifest as specified in section I of appendix F to §§ 20.1001–20.2401.

(c) Each shipment manifest must include a certification by the waste generator as specified in section II of appendix F to §§ 20.1001–20.2401.

(d) Each person involved in the transfer for disposal and disposal of waste, including the waste generator, waste collector, waste processor, and disposal facility operator, shall comply with the requirements specified in section III of appendix F to §§ 20.1001–20.2401.

§ 20.2007 Compliance with environmental and health protection regulations.

Nothing in this subpart relieves the licensee from complying with other applicable Federal, State, and local regulations governing any other toxic or hazardous properties of materials that may be disposed of under this subpart.

Subpart L—Records

§ 20.2101 General provisions.

(a) Each licensee shall use the units: curie, rad, rem, including multiples and subdivisions, and shall clearly indicate the units of all quantities on records required by this part.

(b) The licensee shall make a clear distinction among the quantities entered on the records required by this part (e.g., total effective dose equivalent, shallow-dose equivalent, eye dose equivalent, deep-dose equivalent, committed effective dose equivalent).

§ 20.2102 Records of radiation protection programs.

(a) Each licensee shall maintain records of the radiation protection program, including:

(1) The provisions of the program; and

(2) Audits and other reviews of program content and implementation.

(b) The licensee shall retain the records required by paragraph (a)(1) of this section until the Commission terminates each pertinent license requiring the record. The licensee shall retain the records required by paragraph (a)(2) of this section for 3 years after the record is made.

§ 20.2103 Records of surveys.

(a) Each licensee shall maintain records showing the results of surveys and calibrations required by §§ 20.1501 and 20.1906(b). The licensee shall retain these records for 3 years after the record is made.

(b) The licensee shall retain each of the following records until the Commission terminates each pertinent license requiring the record:

(1) Records of the results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents; and

(2) Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose; and

(3) Records showing the results of air sampling, surveys, and bioassays required pursuant to § 20.1703(a)(3) (i) and (ii); and

(4) Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.

§ 20.2104 Determination of prior occupational dose.

(a) For each individual who may enter the licensee's restricted or controlled area and is likely to receive, in a year,

an occupational dose requiring monitoring pursuant to § 20.1502, the licensee shall—

(1) Determine the occupational radiation dose received during the current year; and

(2) Attempt to obtain the records of lifetime cumulative occupational radiation dose.

(b) Prior to permitting an individual to participate in a planned special exposure, the licensee shall determine—

(1) The internal and external doses from all previous planned special exposures; and

(2) All doses in excess of the limits (including doses received during accidents and emergencies) received during the lifetime of the individual.

(c) In complying with the requirements of paragraph (a) of this section, a licensee may—

(1) Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual may have received during the current year;

(2) Accept, as the record of lifetime cumulative radiation dose, an up-to-date NRC Form 4, or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by the licensee); and

(3) Obtain reports of the individual's dose equivalent(s) from the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by the licensee) by telephone, telegram, electronic media, or letter. The licensee shall request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

(d) The licensee shall record the exposure history, as required by paragraph (a) of this section, on NRC Form 4, or other clear and legible record, of all the information required on that form.[4] The form or record must show each period in which the individual received occupational exposure to radiation or radioactive material and must be signed by the individual who received the exposure. For each period for which the licensee obtains reports, the licensee shall use the dose shown in the report in preparing NRC Form 4. For any period in which the licensee does not obtain a report, the licensee shall place a notation on NRC Form 4 indicating the periods of time for which data are not available.

(e) If the licensee is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee shall assume—

(1) In establishing administrative controls under § 20.1201(f) for the current year, that the allowable dose limit for the individual is reduced by 1.25 rems (12.5 mSv) for each quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

(2) That the individual is not available for planned special exposures.

(f) The licensee shall retain the records on NRC Form 4 or equivalent until the Commission terminates each pertinent license requiring this record. The licensee shall retain records used in preparing NRC Form 4 for 3 years after the record is made.

§ 20.2105 Records of planned special exposures.

(a) For each use of the provisions of § 20.1206 for planned special exposures, the licensee shall maintain records that describe—

(1) The exceptional circumstances requiring the use of a planned special exposure; and

(2) The name of the management official who authorized the planned special exposure and a copy of the signed authorization; and

(3) What actions were necessary; and

(4) Why the actions were necessary; and

(5) How doses were maintained ALARA; and

(6) What individual and collective doses were expected to result, and the doses actually received in the planned special exposure.

(b) The licensee shall retain the records until the Commission terminates each pertinent license requiring these records.

§ 20.2106 Records of individual monitoring results.

(a) *Recordkeeping requirement.* Each licensee shall maintain records of doses received by all individuals for whom monitoring was required pursuant to § 20.1502, and records of doses received during planned special exposures, accidents, and emergency conditions. These records [5] must include, when applicable—

(1) The deep-dose equivalent to the whole body, eye dose equivalent, shallow-dose equivalent to the skin, and shallow-dose equivalent to the extremities; and

(2) The estimated intake or body burden of radionuclides (see § 20.1202); and

(3) The committed effective dose equivalent assigned to the intake or body burden of radionuclides; and

(4) The specific information used to calculate the committed effective dose equivalent pursuant to § 20.1204(c); and

(5) The total effective dose equivalent when required by § 20.1202; and

(6) The total of the deep-dose equivalent and the committed dose to the organ receiving the highest total dose.

(b) *Recordkeeping frequency.* The licensee shall make entries of the records specified in paragraph (a) of this section at least annually.

(c) *Recordkeeping format.* The licensee shall maintain the records specified in paragraph (a) of this section on NRC Form 5, in accordance with the instructions for NRC Form 5, or in clear and legible records containing all the information required by NRC Form 5.

(d) *Privacy protection.* The records required under this section should be protected from public disclosure because of their personal privacy nature. These records are protected by most State privacy laws and, when transferred to the NRC, are protected by the Privacy Act of 1974, Public Law 93–579, 5 U.S.C. 552a, and the Commission's regulations in 10 CFR part 9.

(e) the licensee shall maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy shall also be kept on file, but may be maintained separately from the dose records.

(f) The licensee shall retain each required form or record until the Commission terminates each pertinent license requiring the record.

§ 20.2107 Records of dose to individual members of the public.

(a) Each licensee shall maintain records sufficient to demonstrate compliance with the dose limit for

[4] Licensees are not required to reevaluate the separate external dose equivalents and internal committed dose equivalents or intakes of radionuclides assessed under §§ 20.1–20.601. Further, occupational exposure histories obtained and recorded on NRC Form 4 before January 1, 1991, would not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

[5] Assessments of dose equivalent and records made using units in effect before the licensee's adoption of this part need not be changed.

individual members of the public (see § 20.1301).

(b) The licensee shall retain the records required by paragraph (a) of this section until the Commission terminates each pertinent license requiring the record

§ 20.2108 Records of waste disposal.

(a) Each licensee shall maintain records of the disposal of licensed materials made under §§ 20.2002, 20.2003, 20.2004, 20.2005, 10 CFR part 61 and disposal by burial in soil, including burials authorized before January 28, 1981.[6]

(b) The licensee shall retain the records required by paragraph (a) of this section until the Commission terminates each pertinent license requiring the record.

§ 20.2109 Records of testing entry control devices for very high radiation areas.

(a) Each licensee shall maintain records of tests made under § 20.1603(a)(9) on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.

(b) The licensee shall retain the records required by paragraph (a) of this section for 3 years after the record is made.

§ 20.2110 Form of records.

Each record required by this part must be legible throughout the specified retention period. The record may be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records, such as letters, drawings, and specifications, must include all pertinent information, such as stamps, initials, and signatures. The licensee shall maintain adequate safeguards against tampering with and loss of records.

Subpart M—Reports

§ 20.2201 Reports of theft or loss of licensed material.

(a) Telephone reports. (1) Each licensee shall report by telephone as follows:

(i) Immediately after its occurrence becomes known to the licensee, any lost, stolen, or missing licensed material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in appendix C to §§ 20.1001–20.2401 under such circumstances that it appears to the licensee that an exposure could result to persons in unrestricted areas; or

(ii) Within 30 days after the occurrence of any lost, stolen, or missing licensed material becomes known to the licensee, all licensed material in a quantity greater than 10 times the quantity specified in appendix C to §§ 20.1001–20.2401 that is still missing at this time.

(2) Reports must be made as follows:

(i) Licensees having an installed Emergency Notification System shall make the reports to the NRC Operations Center in accordance with § 50.72 of this chapter, and

(ii) All other licensees shall make reports to the NRC Operations Center.

(b) *Written reports.* (1) Each licensee required to make a report under paragraph (a) of this section shall, within 30 days after making the telephone report, make a written report setting forth the following information:

(i) A description of the licensed material involved, including kind, quantity, and chemical and physical form; and

(ii) A description of the circumstances under which the loss or theft occurred; and

(iii) A statement of disposition, or probable disposition, of the licensed material involved; and

(iv) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and

(v) Actions that have been taken, or will be taken, to recover the material; and

(vi) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

(2) Reports must be made as follows:

(i) For holders of an operating license for a nuclear power plant, the events included in paragraph (b) of this section must be reported in accordance with the procedures described in § 50.73(b), (c), (d), (e), and (g) of this chapter and must include the information required in paragraph (b)(1) of this section, and

(ii) All other licensees shall make reports to the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401.

(c) A duplicate report is not required under paragraph (b) of this section if the licensee is also required to submit a report pursuant to §§ 30.55(c), 40.64(c), 50.72, 50.73, 70.52, 73.27(b), 73.67(e)(3)(vi), 73.67(g)(3)(iii), 73.71, or § 150.19(c) of this chapter.

(d) Subsequent to filing the written report, the licensee shall also report any additional substantive information on the loss or theft within 30 days after the licensee learns of such information.

(e) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who may have received exposure to radiation are stated in a separate and detachable part of the report.

§ 20.2202 Notification of incidents.

(a) Immediate notification. Notwithstanding any other requirements for notification, each licensee shall immediately report any event involving byproduct, source, or special nuclear material possessed by the licensee that may have caused or threatens to cause any of the following conditions—

(1) An individual to receive—

(i) A total effective dose equivalent of 25 rems (0.25 Sv) or more; or

(ii) An eye dose equivalent of 75 rems (0.75 Sv) or more; or

(iii) A shallow-dose equivalent to the skin or extremities of 250 rads (2.5 Gy) or more; or

(2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures); or

(3) A loss of 1 working week or more of the operation of any facilities affected; or

(4) Damage to property in excess of $200,000.

(b) Twenty-four hour notification. Each licensee shall, within 24 hours of discovery of the event, report any event involving loss of control of licensed material possessed by the licensee that may have caused, or threatens to cause, any of the following conditions:

(1) An individual to receive, in a period of 24 hours—

(i) A total effective dose equivalent exceeding 5 rems (0.05 Sv); or

(ii) An eye dose equivalent exceeding 15 rems (0.15 Sv); or

(iii) A shallow-dose equivalent to the skin or extremities exceeding 50 rems (0.5 Sv); or

[6] A previous § 20.304 permitted burial of small quantities of licensed materials in soil before January 28, 1981, without specific Commission authorization.

(2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures); or

(3) A loss of 1 day or more of the operation of any facilities affected; or

(4) Damage to property in excess of $2,000.

(c) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who have received exposure to radiation or radioactive material are stated in a separate and detachable part of the report.

(d) Reports made by licensees in response to the requirements of this section must be made as follows:

(1) Licensees having an installed Emergency Notification System shall make the reports required by paragraphs (a) and (b) of this section to the NRC Operations Center in accordance with 10 CFR 50.72; and

(2) All other licensees shall make the reports required by paragraphs (a) and (b) of this section by telephone to the NRC Operations Center and by telegram, mailgram, or facsimile to the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401.

(e) The provisions of this section do not include doses that result from planned special exposures, that are within the limits for planned special exposures, and that are reported under § 20.2204.

§ 20.2203 Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the limits.

(a) Reportable events. In addition to the notification required by § 20.2202, each licensee shall submit a written report within 30 days after learning of any of the following occurrences:

(1) Any incident for which notification is required by § 20.2202; or

(2) Doses in excess of any of the following:

(i) The occupational dose limits for adults in § 20.1201; or

(ii) The occupational dose limits for a minor in § 20.1207; or

(iii) The limits for an embryo/fetus of a declared pregnant woman in § 20.1208; or

(iv) The limits for an individual member of the public in § 20.1301; or

(v) Any applicable limit in the license; or

(3) Levels of radiation or concentrations of radioactive material in—

(i) A restricted area in excess of any applicable limit in the license; or

(ii) An unrestricted area in excess of 10 times any applicable limit set forth in this part or in the license (whether or not involving exposure of any individual in excess of the limits in § 20.1301); or

(4) For licensees subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR part 190, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

(b) Contents of reports. (1) Each report required by paragraph (a) of this section must describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

(i) Estimates of each individual's dose; and

(ii) The levels of radiation and concentrations of radioactive material involved; and

(iii) The cause of the elevated exposures, dose rates, or concentrations; and

(iv) Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, generally applicable environmental standards, and associated license conditions.

(2) Each report filed pursuant to paragraph (a) of this section must include for each individual [7] exposed: the name, Social Security account number, and date of birth. The report must be prepared so that this information is stated in a separate and detachable part of the report.

(c) For holders of an operating license for a nuclear power plant, the occurrences included in paragraph (a) of this section must be reported in accordance with the procedures described in § 50.73(b), (c), (d), (e), and (g) of this chapter and must also include the information required by paragraph (b) of this section. Occurrences reported in accordance with § 50.73 of this chapter need not be reported by a duplicate report under paragraph (a) of this section.

(d) All licensees, other than those holding an operating license for a nuclear power plant, who make reports under paragraph (a) of this section shall submit the report in writing to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, DC 20555, with a copy to the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401.

[7] With respect to the limit for the embryo-fetus (§ 20.1208), the identifiers should be those of the declared pregnant woman.

§ 20.2204 Reports of planned special exposures.

The licensee shall submit a written report to the Administrator of the appropriate NRC Regional Office listed in appendix D to §§ 20.1001–20.2401 within 30 days following any planned special exposure conducted in accordance with § 20.1206, informing the Commission that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by § 20.2105.

§ 20.2205 [Reserved]

§ 20.2206 Reports of individual monitoring.

(a) This section applies to each person licensed by the Commission to—

(1) Operate a nuclear reactor designed to produce electrical or heat energy pursuant to § 50.21(b) or § 50.22 of this chapter or a testing facility as defined in § 50.2 of this chapter; or

(2) Possess or use byproduct material for purposes of radiography pursuant to Parts 30 and 34 of this chapter; or

(3) Possess or use at any one time, for purposes of fuel processing, fabricating, or reprocessing, special nuclear material in a quantity exceeding 5,000 grams of contained uranium-235, uranium-233, or plutonium, or any combination thereof pursuant to part 70 of this chapter; or

(4) Possess high-level radioactive waste at a geologic repository operations area pursuant to part 60 of this chapter; or

(5) Possess spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to part 72 of this chapter; or

(6) Receive radioactive waste from other persons for disposal under part 61 of this chapter; or

(7) Possess or use at any time, for processing or manufacturing for distribution pursuant to parts 30, 32, 33 or 35 of this chapter, byproduct material in quantities exceeding any one of the following quantities:

Radionuclide	Quantity of radionuclide [1] in curies
Cesium-137	1
Cobalt-60	1
Gold-198	100
Iodine-131	1
Iridium-192	10
Krypton-85	1,000
Promethium-147	10
Technetium-99m	1,000

[1] The Commission may require as a license condition, or by rule, regulation, or order pursuant to § 20.2302, reports from licensees who are licensed to use radionuclides not on this list, in quantities sufficient to cause comparable radiation levels.

(b) Each licensee in a category listed in paragraph (a) of this section shall submit an annual report of the results of individual monitoring carried out by the licensee for each individual for whom monitoring was required by § 20.1502 during that year. The licensee may include additional data for individuals for whom monitoring was provided but not required. The licensee shall use Form NRC 5 or electronic media containing all the information required by Form NRC 5.

(c) The licensee shall file the report required by § 20.2206(b), covering the preceding year, on or before April 30 of each year. The licensee shall submit the report to the Director, Office of Nuclear Regulatory Research, Nuclear Regulatory Commission, Washington, DC 20555.

Subpart N—Exemptions and Additional Requirements

§ 20.2301 Applications for exemptions.

The Commission may, upon application by a licensee or upon its own initiative, grant an exemption from the requirements of the regulations in this part if it determines the exemption is authorized by law and would not result in undue hazard to life or property.

§ 20.2302 Additional requirements.

The Commission may, by rule, regulation, or order, impose requirements on a licensee, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

Subpart O—Enforcement

§ 20.2401 Violations.

(a) The Commission may obtain an injunction or other court order to prevent a violation of the provisions of—

(1) The Atomic Energy Act of 1954, as amended;

(2) Title II of the Energy Reorganization Act of 1974, as amended; or

(3) A regulation or order issued pursuant to those Acts.

(b) The Commission may obtain a court order for the payment of a civil penalty imposed under section 234 of the Atomic Energy Act:

(1) For violations of—

(i) Sections 53, 57, 62, 63, 81, 82, 101, 103, 104, 107 or 109 of the Atomic Energy Act of 1954, as amended;

(ii) Section 206 of the Energy Reorganization Act;

(iii) Any rule, regulation, or order issued pursuant to the sections specified in paragraph (b)(1)(i) of this section;

(iv) Any term, condition, or limitation of any license issued under the sections specified in paragraph (b)(1)(i) of this section.

(2) For any violation for which a license may be revoked under Section 186 of the Atomic Energy Act of 1954, as amended.

(c) Any person who willfully violates a provision of the Atomic Energy Act or regulation or order issued under the requirements of that Act may be quilty of a crime and, upon conviction, be punished by fine or imprisonment or both, as provided by law.

7. Part 20 is amended by adding Appendix A to §§ 20.1001—20.2401 to read as follows:

APPENDIX A TO §§ 20.1001—20.2401—PROTECTION FACTORS FOR RESPIRATORS [a]

Description [b]	Modes [c]	Protection Factors [d] Particulates only	Protection Factors [d] Particulates, gases, & vapors [e]	Tested & Certified Equipment: National Institute for Occupational Safety and Health/Mine Safety and Health Administration tests for permissibility
I. Air-Purifying Respirators: [f]				
Facepiece, half-mask [g]	NP	10		30 CFR Part 11, Subpart K.
Facepiece, full	NP	50		
Facepiece, half-mask full, or hood	PP	1000		
II. Atmosphere-Supplying Respirators:				
1. Air-line respirator:				
Facepiece, half-mask	CF		1000	30 CFR Part 11, Subpart J.
Facepiece, half-mask	D		5	
Facepiece, full	CF		2000	
Facepiece, full	D		5	
Facepiece, full	PD		2000	
Hood	CF		(h)	
Suit	CF		(i)	(i)
2. Self-contained breathing apparatus (SCBA):				
Facepiece, full	D		50	30 CFR Part 11, Subpart H.
Facepiece, full	PD		[k] 10,000	
Facepiece, full	RD		50	
Facepiece, full	RP		[l] 5,000	
III. Combination Respirators:				
Any combination of air-purifying and atmosphere-supplying respirators		Protection factor for type and mode of operation as listed above.		30 CFR Part 11, § 11.63(b).

Footnotes

a. For use in the selection of respiratory protective devices to be used only where the contaminants have been identified and the concentrations (or possible concentrations) are known.

b. Only for shaven faces and where nothing interferes with the seal of tight-fitting facepieces against the skin. (Hoods and suits are excepted.)

c. The mode symbols are defined as follows:

CF = continuous flow
D = demand
NP = negative pressure (i.e., negative phase during inhalation)
PD = pressure demand (i.e., always positive pressure)

PP=positive pressure
RD=demand, recirculating (closed circuit)
RP=pressure demand, recirculating (closed circuit)

d.1. The protection factor is a measure of the degree of protection afforded by a respirator, defined as the ratio of the concentration of airborne radioactive material outside the respiratory protective equipment to that inside the equipment (usually inside the facepiece) under conditions of use. It is applied to the ambient airborne concentration to estimate the concentrations inhaled by the wearer according to the following formula:

$$\text{Concentration inhaled} = \frac{\text{Ambient airborne concentration}}{\text{Protection factor}}$$

2. The protection factors apply:

(a) Only for individuals trained in using respirators and wearing properly fitted respirators that are used and maintained under supervision in a well-planned respiratory protective program.

(b) For air-purifying respirators only when high efficiency particulate filters (above 99.97% removal efficiency by thermally generated 0.3 μm dioctyl phthalate (DOP) test or equivalent) are used in atmospheres not deficient in oxygen and not containing radioactive gas or vapor respiratory hazards.

(c) No adjustment is to be made for the use of sorbents against radioactive material in the form of gases or vapors.

(d) For atmosphere-supplying respirators only when supplied with adequate respirable air. Respirable air shall be provided of the quality and quantity required in accordance with NIOSH/MSHA certification (described in 30 CFR part 11). Oxygen and air shall not be used in the same apparatus.

e. Excluding radioactive contaminants that present an absorption or submersion hazard. For tritium oxide, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of less than 2 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. If the protection factor for a device is 5 the effective protection factor for tritium is about 1.4; for devices with protection factors of 10 the effective factor for tritium oxide is about 1.7, and for devices with protection factors of 100 or more the effective factor for tritium oxide is about 1.9. Air-purifying respirators are not suitable for protection against tritium oxide. See also footnote i concerning supplied-air suits.

f. Canisters and cartridges shall not be used beyond service-life limitations.

g. Under-chin type only. This type of respirator is not satisfactory for use where it might be possible (e.g., if an accident or emergency were to occur) for the ambient airborne concentrations to reach instantaneous values greater than 10 times the pertinent values in table 1, column 3 of appendix B to §§ 20.1001—20.2401 of this part. This type of respirator is not suitable for protection against plutonium or other high-toxicity materials. The mask is to be tested for fit prior to use, each time it is donned.

h.1. Equipment shall be operated in a manner that ensures that proper air flow-rates are maintained. A protection factor of no more than 1000 may be utilized for tested-and-certified supplied-air hoods when a minimum air flow of 6 cubic feet (0.17 cubic meters) per minute is maintained and calibrated air–line pressure gauges or flow measuring devices are used. A protection factor of up to 2000 may be used for tested and certified hoods only when the air flow is maintained at the manufacturer's recommended maximum rate for the equipment, this rate is greater than 6 cubic feet (0.17 cubic meters) per minute, and calibrated air–line pressure gauges or flow measuring devices are used.

2. The design of the supplied-air hood or helmet (with a minimum flow of 6 cfm (0.17 m^3 per minute) of air) may determine its overall efficiency and the protection it provides. For example, some hoods aspirate contaminated air into the breathing zone when the wearer works with hands-overhead. This aspiration may be overcome if a short cape-like extension to the hood is worn under a coat or overalls. Other limitations specified by the approval agency shall be considered before using a hood in certain types of atmospheres (see footnote i).

i. Appropriate protection factors shall be determined, taking into account the design of the suit and its permeability to the contaminant under conditions of use. There shall be a standby rescue person equipped with a respirator or other apparatus appropriate for the potential hazards and communications equipment whenever supplied-air suits are used.

j. No approval schedules are currently available for this equipment. Equipment is to be evaluated by testing or on the basis of reliable test information.

k. This type of respirator may provide greater protection and be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure, such as skin absorption, must be taken into account in such circumstances.

l. Quantitative fit testing shall be performed on each individual and no more than 0.02% leakage is allowed with this type of apparatus. Perceptible outward leakage of gas from this or any positive pressure self-contained breathing apparatus is unacceptable because service life will be reduced substantially. Special training in the use of this type of apparatus shall be provided to the wearer.

Note 1: Protection factors for respirators as may be approved by the U.S. Bureau of Mines/National Institute for Occupational Safety and Health (NIOSH), according to applicable approvals for respirators for type and mode of use to protect against airborne radionuclides, may be used to the extent that they do not exceed the protection factors listed in this table. The protection factors listed in this table may not be appropriate to circumstances where chemical or other respiratory hazards exist in addition to radioactive hazards. The selection and use of respirators for such circumstances should take into account applicable approvals of the U.S. Bureau of Mines/NIOSH.

Note 2: Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix B to §§ 20.1001–20.2401 of this part are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

8. Part 20 is amended by adding Appendix B to §§ 20.1001–20.2401 to read as follows:

Appendix B to §§ 20.1001–20.2401—Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage

Introduction

For each radionuclide Table 1 indicates the chemical form which is to be used for selecting the appropriate ALI or DAC value. The ALIs and DACs for inhalation are given for an aerosol with an activity median aerodynamic diameter (AMAD) of 1 μm and for three classes (D,W,Y) of radioactive material, which refer to their retention (approximately days, weeks or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times of less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. Table 2 provides concentration limits for airborne and liquid effluents released to the general environment. Table 3 provides concentration limits for discharges to sanitary sewer systems.

Notation

The values in Tables 1, 2, and 3 are presented in the computer "E" notation. In this notation a value of 6E−02 represents a value of 6×10^{-2} or 0.06, 6E+2 represents 6×10^{2} or 600, and 6E+0 represents 6×10^{0} or 6.

Table 1 "Occupational"

Note that the columns in Table 1, of this appendix captioned "Oral Ingestion ALI,"

"Inhalation ALI," and "DAC," are applicable to occupational exposure to radioactive material.

The ALIs in this appendix are the annual intakes of a given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 5 rems (stochastic ALI) or (2) a committed dose equivalent of 50 rems to an organ or tissue (non-stochastic ALI). The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of 5 rems. The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w_T. This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of w_T are listed under the definition of weighting factor in § 20.1003. The non-stochastic ALIs were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

A value of $w_T=0.06$ is applicable to each of the five organs or tissues in the "remainder" category receiving the highest dose equivalents, and the dose equivalents of all other remaining tissues may be disregarded. The following parts of the GI tract—stomach, small intestine, upper large intestine, and lower large intestine—are to be treated as four separate organs.

Note that the dose equivalents for extremities (hands and forearms, feet and lower legs), skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

When an ALI is defined by the stochastic dose limit, this value alone, is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses. (Abbreviated organ or tissue designations are used: LLI wall = lower large intestine wall; St. wall = stomach wall; Blad wall = bladder wall; and Bone surf = bone surface.)

The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure that non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low value. If, in a particular situation involving a radionuclide for which the non-stochastic ALI is limiting, use of that non-stochastic ALI is considered unduly conservative, the licensee may use the stochastic ALI to determine the committed effective dose equivalent. However, the licensee shall also ensure that the 50-rem dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose to that organ (not the effective dose). For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the nonstochastic ALIs (ALI_{ns}) that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity (i.e., Σ (intake (in μCi) of each radionuclide/ALI_{ins}) <1.0). If there is an external deep dose equivalent contribution of H_d then this sum must be less than $1-(H_d/50)$ instead of being <1.0.

Note that the dose equivalents for extremities (hand and forearms, feet and lower legs), skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

The derived air concentration (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by: DAC=ALI(in μCi)/(2000 hours per working year$\times$60 minutes/hour$\times 2\times10^4$ ml per minute)=[ALI/2.4×10^7] μCi/ml, where 2×10^4 ml is the volume of air breathed per minute at work by "Reference Man" under working conditions of "light work."

The DAC values relate to one of two modes of exposure: either external submersion or the internal committed dose equivalents resulting from inhalation of radioactive materials. Derived air concentrations based upon submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each radionuclide separately.

The ALI and DAC values relate to exposure to the single radionuclide named, but also include contributions from the in-growth of any daughter radionuclide produced in the body by the decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

The value of ALI and DAC do not apply directly when the individual both ingests and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both, or when the individual is exposed to both internal and external radiation (see § 20.1202). When an individual is exposed to radioactive materials which fall under several of the translocation classifications (i.e., Class D, Class W, or Class Y) of the same radionuclide, the exposure may be evaluated as if it were a mixture of different radionuclides.

It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical form of the compound and does not take into account the radiological half-life of different radioisotopes. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table 2

The columns in Table 2 of this appendix captioned "Effluents," "Air," and "Water," are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of § 20.1302. The concentration values given in Columns 1 and 2 of Table 2 are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.05 rem (50 millirem or 0.5 millisieverts).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to occur at the dose levels established for individual members of the public. For radionuclides, where the non-stochastic limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in Table 2. For this reason, the DAC and airborne effluent limits are not always proportional as was the case in appendix B to §§ 20.1–20.601.

The air concentration values listed in Table 2, Column 1, were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by 2.4×10^9, relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 5-rem annual occupational dose limit to the 0.1-rem limit for members of the public, a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values (derived for adults) so that they are applicable to other age groups.

For those radionuclides for which submersion (external dose) is limiting, the occupational DAC in Table 1, Column 3, was divided by 219. The factor of 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year). Note that an additional factor of 2 for age considerations is not warranted in the submersion case.

The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^7. The factor of 7.3×10^7 (ml) includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^5 (ml) which is the annual water intake of "Reference Man."

Note 2 of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings (including occupational inhalation ALIs and DACs, air and water effluent concentrations and sewerage) require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of the one of the listed radionuclides cannot be definitely excluded as being present either from knowledge of the radionuclide composition of the source or from actual measurements.

Table 3 "Sewer Disposal"

The monthly average concentrations for release to sanitary sewers are applicable to the provisions in § 20.2003. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^9(ml). The factor of 7.3×10^9(ml) is composed of a factor of 7.3×10^5(ml), the annual water intake by "Reference Man," and a factor of 10, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a reference man during a year, would result in a

committed effective dose equivalent of 0.5 rem.

LIST OF ELEMENTS

Name	Atomic Symbol	Atomic No.
Actinium	Ac	89
Aluminum	Al	13
Americium	Am	95
Antimony	Sb	51
Argon	Ar	18
Arsenic	As	33
Astatine	At	85
Barium	Ba	56
Berkelium	Bk	97
Beryllium	Be	4
Bismuth	Bi	83
Bromine	Br	35
Cadmium	Cd	48
Calcium	Ca	20
Californium	Cf	98
Carbon	C	6
Cerium	Ce	58
Cesium	Cs	55
Chlorine	Cl	17
Chromium	Cr	24
Cobalt	Co	27
Copper	Cu	29
Curium	Cm	96
Dysprosium	Dy	66
Einsteinium	Es	99
Erbium	Er	68
Europium	Eu	63
Fermium	Fm	100
Fluorine	F	9
Francium	Fr	87
Gadolinium	Gd	64

LIST OF ELEMENTS—Continued

Name	Atomic Symbol	Atomic No.
Gallium	Ga	31
Germanium	Ge	32
Gold	Au	79
Hafnium	Hf	72
Holmium	Ho	67
Hydrogen	H	1
Indium	In	49
Iodine	I	53
Iridium	Ir	77
Iron	Fe	26
Krypton	Kr	36
Lanthanum	La	57
Lead	Pb	82
Lutetium	Lu	71
Magnesium	Mg	12
Manganese	Mn	25
Mendelevium	Md	101
Mercury	Hg	80
Molybdenum	Mo	42
Neodymium	Nd	60
Neptunium	Np	93
Nickel	Ni	28
Niobium	Nb	41
Osmium	Os	76
Palladium	Pd	46
Phosphorus	P	15
Platinum	Pt	78
Plutonium	Pu	94
Polonium	Po	84
Potassium	K	19
Praseodymium	Pr	59
Promethium	Pm	61
Protactinium	Pa	91
Radium	Ra	88

LIST OF ELEMENTS—Continued

Name	Atomic Symbol	Atomic No.
Radon	Rn	86
Rhenium	Re	75
Rhodium	Rh	45
Rubidium	Rb	37
Ruthenium	Ru	44
Samarium	Sm	62
Scandium	Sc	21
Selenium	Se	34
Silicon	Si	14
Silver	Ag	47
Sodium	Na	11
Strontium	Sr	38
Sulfur	S	16
Tantalum	Ta	73
Technetium	Tc	43
Tellurium	Te	52
Terbium	Tb	65
Thallium	Tl	81
Thorium	Th	90
Thalium	Tm	69
Tin	Sn	50
Titanium	Ti	22
Tungsten	W	74
Uranium	U	92
Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40

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Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3 Inhalation	Col. 1	Col. 2	
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
1	Hydrogen-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
		Gas (HT or T_2)Submersion[1]: Use above values as HT and T_2 oxidize in air and in the body to HTO						
4	Beryllium-7	W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
		Y, oxides, halides and nitrates	-	2E+4	8E-6	3E-8	-	-
4	Beryllium-10	W, see ^{7}Be	1E+3 LLI wall (1E+3)	2E+2	6E-8	2E-10	-	-
		Y, see ^{7}Be	-	1E+1	6E-9	2E-11	2E-5	2E-4
6	Carbon-11[2]	Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
		Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
9	Fluorine-18[2]	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4 St wall (5E+4)	7E+4	3E-5	1E-7	-	-
				-	-	-	7E-4	7E-3
		W, fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re	-	9E+4	4E-5	1E-7	-	-
		Y, lanthanum fluoride	-	8E+4	3E-5	1E-7	-	-
11	Sodium-22	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	1E+3	5E-7	2E-9	-	-
13	Aluminum-26	D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	9E+1	4E-8	1E-10	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
14	Silicon-31	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and nitrates	-	3E+4	1E-5	5E-8	-	-
		Y, aluminosilicate glass	-	3E+4	1E-5	4E-8	-	-
14	Silicon-32	D, see ^{31}Si	2E+3	2E+2	1E-7	3E-10	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		W, see ^{31}Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{31}Si	-	5E+0	2E-9	7E-12	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+}, S^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+}, and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
		W, see ^{32}P	-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4	2E+4	7E-6	2E-8	-	-
			LLI wall (8E+3)	-	-	-	1E-4	1E-3
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3	-	2E+3	9E-7	3E-9	-
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	-	2E+2	1E-7	3E-10	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
17	Chlorine-38[2]	D, see ^{36}Cl	2E+4	4E+4	2E-5	6E-8	-	-
			St. wall (3E+4)	-	-	-	3E-4	3E-3
		W, see ^{36}Cl	-	5E+4	2E-5	6E-8	-	-
17	Chlorine-39[2]	D, see ^{36}Cl	2E+4	5E+4	2E-5	7E-8	-	-
			St. wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{36}Cl	-	6E+4	2E-5	8E-8	-	-
18	Argon-37	Submersion[1]	-	-	1E+0	6E-3	-	-
18	Argon-39	Submersion[1]	-	-	2E-4	8E-7	-	-
18	Argon-41	Submersion[1]	-	-	3E-6	1E-8	-	-
19	Potassium-40	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
19	Potassium-42	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
19	Potassium-43	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	Potassium-44[2]	D, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
			St. wall (4E+4)	-	-	-	5E-4	5E-3
19	Potassium-45[2]	D, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St. wall (5E+4)	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3	4E+3	2E-6	-	-	-
			Bone surf (4E+3)	Bone surf (4E+3)	-	5E-9	6E-5	6E-4
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
21	Scandium-43	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Scandium-44m	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49[2]	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E+1	1E-8	4E-11	-	-
		Y, $SrTiO_3$	-	6E+0	2E-9	8E-12	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
22	Titanium-45	D, see ^{44}Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{44}Ti	-	4E+4	1E-5	5E-8	-	-
		Y, see ^{44}Ti	-	3E+4	1E-5	4E-8	-	-
23	Vanadium-47[2]	D, all compounds except those given for W	3E+4 St. wall (3E+4)	8E+4 -	3E-5 -	1E-7 -	- 4E-4	- 4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see ^{47}V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
		W, see ^{47}V	-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ^{47}V	7E+4 LLI wall (9E+4)	3E+4 Bone surf (3E+4)	1E-5 -	- 5E-8	- 1E-3	- 1E-2
		W, see ^{47}V	-	2E+4	8E-6	2E-8	-	-
24	Chromium-48	D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
		Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49[2]	D, see ^{48}Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{48}Cr	-	1E+5	4E-5	1E-7	-	-
		Y, see ^{48}Cr	-	9E+4	4E-5	1E-7	-	-
24	Chromium-51	D, see ^{48}Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
		W, see ^{48}Cr	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{48}Cr	-	2E+4	8E-6	3E-8	-	-
25	Manganese-51[2]	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
25	Manganese-52m[2]	D, see ^{51}Mn	3E+4 St. wall (4E+4)	9E+4 -	4E-5 -	1E-7 -	- 5E-4	- 5E-3
		W, see ^{51}Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see ^{51}Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
		W, see ^{51}Mn	-	9E+2	4E-7	1E-9	-	-
25	Manganese-53	D, see ^{51}Mn	5E+4	1E+4 Bone surf (2E+4)	5E-6 -	- 3E-8	7E-4 -	7E-3 -
		W, see ^{51}Mn	-	1E+4	5E-6	2E-8	-	-
25	Manganese-54	D, see ^{51}Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
		W, see ^{51}Mn	-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see ^{51}Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{51}Mn	-	2E+4	9E-6	3E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3 Inhalation	Col. 1	Col. 2	
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
26	Iron-52	D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		W, oxides, hydroxides, and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ^{52}Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
		W, see ^{52}Fe	-	4E+3	2E-6	6E-9	-	-
26	Iron-59	D, see ^{52}Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		W, see ^{52}Fe	-	5E+2	2E-7	7E-10	-	-
26	Iron-60	D, see ^{52}Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
		W, see ^{52}Fe	-	2E+1	8E-9	3E-11	-	-
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
27	Cobalt-56	W, see ^{55}Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ^{55}Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ^{55}Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ^{55}Co	4E+3	7E+2	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ^{55}Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ^{55}Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ^{55}Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ^{55}Co	1E+3	7E+2	3E-7	1E-9	-	-
27	Cobalt-60m[2]	W, see ^{55}Co	1E+6 St. wall (1E+6)	4E+6	2E-3	6E-6	-	-
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	2E-2 -	2E-1 -
27	Cobalt-60	W, see ^{55}Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ^{55}Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-61[2]	W, see ^{55}Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{55}Co	2E+4	6E+4	2E-5	8E-8	-	-
27	Cobalt-62m[2]	W, see ^{55}Co	4E+4 St. wall (5E+4)	2E+5	7E-5	2E-7	-	-
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	7E-4 -	7E-3 -
28	Nickel-56	D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		W, oxides, hydroxides, and carbides	-	1E+3	5E-7	2E-9	-	-
		Vapor	-	1E+3	5E-7	2E-9	-	-
28	Nickel-57	D, see ^{56}Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	6E+3	3E-6	9E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
28	Nickel-59	D, see ^{56}Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
		W, see ^{56}Ni	-	7E+3	3E-6	1E-8	-	-
		Vapor	-	2E+3	8E-7	3E-9	-	-
28	Nickel-63	D, see ^{56}Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	8E+2	3E-7	1E-9	-	-
28	Nickel-65	D, see ^{56}Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{56}Ni	-	3E+4	1E-5	4E-8	-	-
		Vapor	-	2E+4	7E-6	2E-8	-	-
28	Nickel-66	D, see ^{56}Ni	4E+2	2E+3	7E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
		W, see ^{56}Ni	-	6E+2	3E-7	9E-10	-	-
		Vapor	-	3E+3	1E-6	4E-9	-	-
29	Copper-60[2]	D, all compounds except those given for W and Y	3E+4	9E+4	4E-5	1E-7	-	-
			St. wall (3E+4)	-	-	-	4E-4	4E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	4E-5	1E-7	-	-
29	Copper-61	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	4E+4	2E-5	6E-8	-	-
		Y, see ^{60}Cu	-	4E+4	1E-5	5E-8	-	-
29	Copper-64	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{60}Cu	-	2E+4	9E-6	3E-8	-	-
29	Copper-67	D, see ^{60}Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
		W, see ^{60}Cu	-	5E+3	2E-6	7E-9	-	-
		Y, see ^{60}Cu	-	5E+3	2E-6	6E-9	-	-
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63[2]	Y, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
			St. wall (3E+4)	-	-	-	3E-4	3E-3
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
30	Zinc-69[2]	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
31	Gallium-65[2]	D, all compounds except those given for W	5E+4	2E+5	7E-5	2E-7	-	-
			St. wall (6E+4)	-	-	-	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
31	Gallium-66	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-67	D, see ^{65}Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
		W, see ^{65}Ga	-	1E+4	4E-6	1E-8	-	-
31	Gallium-68[2]	D, see ^{65}Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{65}Ga	-	5E+4	2E-5	7E-8	-	-
31	Gallium-70[2]	D, see ^{65}Ga	5E+4 St. wall (7E+4)	2E+5	7E-5	2E-7	-	-
			-	-	-	-	1E-3	1E-2
		W, see ^{65}Ga	-	2E+5	8E-5	3E-7	-	-
31	Gallium-72	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-73	D, see ^{65}Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{65}Ga	-	2E+4	6E-6	2E-8	-	-
32	Germanium-66	D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
		W, oxides, sulfides, and halides	-	2E+4	8E-6	3E-8	-	-
32	Germanium-67[2]	D, see ^{66}Ge	3E+4 St. wall (4E+4)	9E+4	4E-5	1E-7	-	-
			-	-	-	-	6E-4	6E-3
		W, see ^{66}Ge	-	1E+5	4E-5	1E-7	-	-
32	Germanium-68	D, see ^{66}Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
		W, see ^{66}Ge	-	1E+2	4E-8	1E-10	-	-
32	Germanium-69	D, see ^{66}Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
		W, see ^{66}Ge	-	8E+3	3E-6	1E-8	-	-
32	Germanium-71	D, see ^{66}Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
		W, see ^{66}Ge	-	4E+4	2E-5	6E-8	-	-
32	Germanium-75[2]	D, see ^{66}Ge	4E+4 St. wall (7E+4)	8E+4	3E-5	1E-7	-	-
			-	-	-	-	9E-4	9E-3
		W, see ^{66}Ge	-	8E+4	4E-5	1E-7	-	-
32	Germanium-77	D, see ^{66}Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
		W, see ^{66}Ge	-	6E+3	2E-6	8E-9	-	-
32	Germanium-78[2]	D, see ^{66}Ge	2E+4 St. wall (2E+4)	2E+4	9E-6	3E-8	-	-
			-	-	-	-	3E-4	3E-3
		W, see ^{66}Ge	-	2E+4	9E-6	3E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
33	Arsenic-69[2]	W, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St. wall (4E+4)	-	-	-	6E-4	6E-3
33	Arsenic-70[2]	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	Arsenic-71	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds	4E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	6E-5	6E-4
33	Arsenic-78[2]	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Selenium-70[2]	D, all compounds except those given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and elemental Se	1E+4-	4E+4	2E-5	6E-8	-	-
34	Selenium-73m[2]	D, see ^{70}Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	6E-5	2E-7	-	-
34	Selenium-73	D, see ^{70}Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
		W, see ^{70}Se	-	2E+4	7E-6	2E-8	-	-
34	Selenium-75	D, see ^{70}Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
		W, see ^{70}Se	-	6E+2	3E-7	8E-10	-	-
34	Selenium-79	D, see ^{70}Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
		W, see ^{70}Se	-	6E+2	2E-7	8E-10	-	-
34	Selenium-81m[2]	D, see ^{70}Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{70}Se	2E+4	7E+4	3E-5	1E-7	-	-
34	Selenium-81[2]	D, see ^{70}Se	6E+4	2E+5	9E-5	3E-7	-	-
			St. wall (8E+4)	-	-	-	1E-3	1E-2
		W, see ^{70}Se	-	2E+5	1E-4	3E-7	-	-
34	Selenium-83[2]	D, see ^{70}Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	5E-5	2E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	Inhalation DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
35	Bromine-74m[2]	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	-	-
			St. wall (2E+4)	-	-	-	3E-4	3E-3
		W, bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74[2]	D, see ^{74m}Br	2E+4	7E+4	3E-5	1E-7	-	-
			St. wall (8E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	8E+4	4E-5	1E-7	-	-
35	Bromine-75[2]	D, see ^{74m}Br	3E+4	5E+4	2E-5	7E-8	-	-
			St. wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	5E+4	2E-5	7E-8	-	-
35	Bromine-76	D, see ^{74m}Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
		W, see ^{74m}Br	-	4E+3	2E-6	6E-9	-	-
35	Bromine-77	D, see ^{74m}Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
		W, see ^{74m}Br	-	2E+4	8E-6	3E-8	-	-
35	Bromine-80m	D, see ^{74m}Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
		W, see ^{74m}Br	-	1E+4	6E-6	2E-8	-	-
35	Bromine-80[2]	D, see ^{74m}Br	5E+4	2E+5	8E-5	3E-7	-	-
			St. wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{74m}Br	-	2E+5	9E-5	3E-7	-	-
35	Bromine-82	D, see ^{74m}Br	3E+3	4E+3	2E-6	5E-9	4E-5	4E-4
		W, see ^{74m}Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m}Br	5E+4	6E+4	3E-5	9E-8	-	-
			St. wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
35	Bromine-84[2]	D, see ^{74m}Br	2E+4	6E+4	2E-5	8E-8	-	-
			St. wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
36	Krypton-74[2]	Submersion[1]	-	-	3E-6	1E-8	-	-
36	Krypton-76	Submersion[1]	-	-	9E-6	4E-8	-	-
36	Krypton-77[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
36	Krypton-79	Submersion[1]	-	-	2E-5	7E-8	-	-
36	Krypton-81	Submersion[1]	-	-	7E-4	3E-6	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
36	Krypton-83m[2]	Submersion[1]			1E-2	5E-5	-	
36	Krypton-85m	Submersion[1]	-	-	2E-5	1E-7	-	-
36	Krypton-85	Submersion[1]	-	-	1E-4	7E-7	-	-
36	Krypton-87[2]	Submersion[1]	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion[1]	-	-	2E-6	9E-9	-	-
37	Rubidium-79[2]	D, all compounds	4E+4	1E+5	5E-5	2E-7	-	-
			St. wall (6E+4)	-	-	-	8E-4	8E-3
37	Rubidium-81m[2]	D, all compounds	2E+5	3E+5	1E-4	5E-7	-	-
			St. wall (3E+5)	-	-	-	4E-3	4E-2
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88[2]	D, all compounds	2E+4	6E+4	3E-5	9E-8	-	-
			St. wall (3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89[2]	D, all compounds	4E+4	1E+5	6E-5	2E-7	-	-
			St. wall (6E+4)	-	-	-	9E-4	9E-3
38	Strontium-80[2]	D, all soluble compounds except $SrTiO_3$	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and $SrTiO_3$	-	1E+4	5E-6	2E-8	-	-
38	Strontium-81[2]	D, see ^{80}Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{80}Sr	2E+4	8E+4	3E-5	1E-7	-	-
38	Strontium-82	D, see ^{80}Sr	3E+2	4E+2	2E-7	6E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		Y, see ^{80}Sr	2E+2	9E+1	4E-8	1E-10	-	-
38	Strontium-83	D, see ^{80}Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{80}Sr	2E+3	4E+3	1E-6	5E-9	-	-
38	Strontium-85m[2]	D, see ^{80}Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
		Y, see ^{80}Sr	-	8E+5	4E-4	1E-6	-	-
38	Strontium-85	D, see ^{80}Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see ^{80}Sr	-	2E+3	6E-7	2E-9	-	-
38	Strontium-87m	D, see ^{80}Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{80}Sr	4E+4	2E+5	6E-5	2E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
38	Strontium-89	D, see ^{80}Sr	6E+2	8E+2	4E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see ^{80}Sr	5E+2	1E+2	6E-8	2E-10	-	-
38	Strontium-90	D, see ^{80}Sr	3E+1	2E+1	8E-9	-	-	-
			Bone surf (4E+1)	Bone surf (2E+1)	-	3E-11	5E-7	5E-6
		Y, see ^{80}Sr	-	4E+0	2E-9	6E-12	-	-
38	Strontium-91	D, see ^{80}Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
		Y, see ^{80}Sr	-	4E+3	1E-6	5E-9	-	-
38	Strontium-92	D, see ^{80}Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{80}Sr	-	7E+3	3E-6	9E-9	-	-
39	Yttrium-86m[2]	W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
39	Yttrium-86	W, see ^{86m}Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-87	W, see ^{86m}Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-88	W, see ^{86m}Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
		Y, see ^{86m}Y	-	2E+2	1E-7	3E-10	-	-
39	Yttrium-90m	W, see ^{86m}Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
		Y, see ^{86m}Y	-	1E+4	5E-6	2E-8	-	-
39	Yttrium-90	W, see ^{86m}Y	4E+2	7E+2	3E-7	9E-10	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{86m}Y	-	6E+2	3E-7	9E-10	-	-
39	Yttrium-91m[2]	W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
		Y, see ^{86m}Y	-	2E+5	7E-5	2E-7	-	-
39	Yttrium-91	W, see ^{86m}Y	5E+2	2E+2	7E-8	2E-10	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see ^{86m}Y	-	1E+2	5E-8	2E-10	-	-
39	Yttrium-92	W, see ^{86m}Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{86m}Y	-	8E+3	3E-6	1E-8	-	-
39	Yttrium-93	W, see ^{86m}Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	2E+3	1E-6	3E-9	-	-
39	Yttrium-94[2]	W, see ^{86m}Y	2E+4	8E+4	3E-5	1E-7	-	-
			St. wall (3E+4)	-	-	-	4E-4	4E-3
		Y, see ^{86m}Y	-	8E+4	3E-5	1E-7	-	-
39	Yttrium-95[2]	W, see ^{86m}Y	4E+4	2E+5	6E-5	2E-7	-	-
			St. wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{86m}Y	-	1E+5	6E-5	2E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
40	Zirconium-86	D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
		Y, carbide	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-88	D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
		W, see ^{86}Zr	-	5E+2	2E-7	7E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-89	D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-93	D, see ^{86}Zr	1E+3 Bone surf (3E+3)	6E+0 Bone surf (2E+1)	3E-9 -	- 2E-11	- 4E-5	- 4E-4
		W, see ^{86}Zr	-	2E+1 Bone surf (6E+1)	1E-8 -	- 9E-11	- -	- -
		Y, see ^{86}Zr	-	6E+1 Bone surf (7E+1)	2E-8 -	- 9E-11	- -	- -
40	Zirconium-95	D, see ^{86}Zr	1E+3	1E+2 Bone surf (3E+2)	5E-8 -	- 4E-10	2E-5 -	2E-4 -
		W, see ^{86}Zr	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-97	D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ^{86}Zr	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{86}Zr	-	1E+3	5E-7	2E-9	-	-
41	Niobium-88[2]	W, all compounds except those given for Y	5E+4 St. wall (7E+4)	2E+5 -	9E-5 -	3E-7 -	- 1E-3	- 1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89m[2] (66 min)	W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
		Y, see ^{88}Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-89 (122 min)	W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{88}Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-90	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-93m	W, see ^{88}Nb	9E+3 LLI wall (1E+4)	2E+3 -	8E-7 -	3E-9 -	- 2E-4	- 2E-3
		Y, see ^{88}Nb	-	2E+2	7E-8	2E-10	-	-
41	Niobium-94	W, see ^{88}Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+1	6E-9	2E-11	-	-
41	Niobium-95m	W, see ^{88}Nb	2E+3 LLI wall (2E+3)	3E+3 -	1E-6 -	4E-9 -	- 3E-5	- 3E-4
		Y, see ^{88}Nb	-	2E+3	9E-7	3E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
41	Niobium-95	W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		Y, see ^{88}Nb	-	1E+3	5E-7	2E-9	-	-
41	Niobium-96	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-97[2]	W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{88}Nb	-	7E+4	3E-5	1E-7	-	-
41	Niobium-98[2]	W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
		Y, see ^{88}Nb	-	5E+4	2E-5	7E-8	-	-
42	Molybdenum-90	D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, oxides, hydroxides, and MoS_2	2E+3	5E+3	2E-6	6E-9	-	-
42	Molybdenum-93m	D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
		Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	-	-
42	Molybdenum-93	D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	-	-
42	Molybdenum-99	D, see ^{90}Mo	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	-	-
42	Molybdenum-101[2]	D, see ^{90}Mo	4E+4	1E+5	6E-5	2E-7	-	-
			St. wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{90}Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m[2]	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m}Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		W, see ^{93m}Tc	-	1E+5	4E-5	1E-7	-	-
43	Technetium-94m[2]	D, see ^{93m}Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{93m}Tc	-	6E+4	2E-5	8E-8	-	-
43	Technetium-94	D, see ^{93m}Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	1E-5	3E-8	-	-
43	Technetium-95m	D, see ^{93m}Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		W, see ^{93m}Tc	-	2E+3	8E-7	3E-9	-	-
43	Technetium-95	D, see ^{93m}Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	8E-6	3E-8	-	-
43	Technetium-96m[2]	D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-96	D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{93m}Tc	-	2E+3	9E-7	3E-9	-	-
43	Technetium-97m	D, see ^{93m}Tc	5E+3	7E+3	3E-6	-	6E-5	6E-4
			-	St. wall (7E+3)	-	1E-8	-	-
		W, see ^{93m}Tc	-	1E+3	5E-7	2E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
43	Technetium-97	D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		W, see ^{93m}Tc	-	6E+3	2E-6	8E-9	-	-
43	Technetium-98	D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{93m}Tc	-	3E+2	1E-7	4E-10	-	-
43	Technetium-99m	D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-99	D, see ^{93m}Tc	4E+3	5E+3	2E-6	-	6E-5	6E-4
			-	St. wall (6E+3)	-	8E-9	-	-
		W, see ^{93m}Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101[2]	D, see ^{93m}Tc	9E+4	3E+5	1E-4	5E-7	-	-
			St. wall (1E+5)	-	-	-	2E-3	2E-2
		W, see ^{93m}Tc	-	4E+5	2E-4	5E-7	-	-
43	Technetium-104[2]	D, see ^{93m}Tc	2E+4	7E+4	3E-5	1E-7	-	-
			St. wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{93m}Tc	-	9E+4	4E-5	1E-7	-	-
44	Ruthenium-94[2]	D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, halides	-	6E+4	3E-5	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	2E-5	8E-8	-	-
44	Ruthenium-97	D, see ^{94}Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-103	D, see ^{94}Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ^{94}Ru	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{94}Ru	-	6E+2	3E-7	9E-10	-	-
44	Ruthenium-105	D, see ^{94}Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{94}Ru	-	1E+4	6E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-106	D, see ^{94}Ru	2E+2	9E+1	4E-8	1E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		W, see ^{94}Ru	-	5E+1	2E-8	8E-11	-	-
		Y, see ^{94}Ru	-	1E+1	5E-9	2E-11	-	-
45	Rhodium-99[1]	D, all compounds except those given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		W, halides	-	8E+4	3E-5	1E-7	-	-
		Y, oxides and hydroxides	-	7E+4	3E-5	9E-8	-	-
45	Rhodium-99	D, see ^{99m}Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{99m}Rh	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{99m}Rh	-	2E+3	8E-7	3E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
45	Rhodium-100	D, see ^{99m}Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{99m}Rh	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{99m}Rh	-	4E+3	2E-6	5E-9	-	-
45	Rhodium-101m	D, see ^{99m}Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{99m}Rh	-	8E+3	4E-6	1E-8	-	-
		Y, see ^{99m}Rh	-	8E+3	3E-6	1E-8	-	-
45	Rhodium-101	D, see ^{99m}Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{99m}Rh	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{99m}Rh	-	2E+2	6E-8	2E-10	-	-
45	Rhodium-102m	D, see ^{99m}Rh	1E+3 LLI wall (1E+3)	5E+2	2E-7	7E-10	-	-
				-	-	-	2E-5	2E-4
		W, see ^{99m}Rh	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{99m}Rh	-	1E+2	5E-8	2E-10	-	-
45	Rhodium-102	D, see ^{99m}Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
		W, see ^{99m}Rh	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{99m}Rh	-	6E+1	2E-8	8E-11	-	-
45	Rhodium-103m[2]	D, see ^{99m}Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
		W, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
		Y, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
45	Rhodium-105	D, see ^{99m}Rh	4E+3 LLI wall (4E+3)	1E+4	5E-6	2E-8	-	-
				-	-	-	5E-5	5E-4
		W, see ^{99m}Rh	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{99m}Rh	-	6E+3	2E-6	8E-9	-	-
45	Rhodium-106m	D, see ^{99m}Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{99m}Rh	-	4E+4	2E-5	5E-8	-	-
		Y, see ^{99m}Rh	-	4E+4	1E-5	5E-8	-	-
45	Rhodium-107[2]	D, see ^{99m}Rh	7E+4 St. wall (9E+4)	2E+5	1E-4	3E-7	-	-
				-	-	-	1E-3	1E-2
		W, see ^{99m}Rh	-	3E+5	1E-4	4E-7	-	-
		Y, see ^{99m}Rh	-	3E+5	1E-4	3E-7	-	-
46	Palladium-100	D, all compounds except those given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
		W, nitrates	-	1E+3	5E-7	2E-9	-	-
		Y, oxides and hydroxides	-	1E+3	6E-7	2E-9	-	-
46	Palladium-101	D, see ^{100}Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{100}Pd	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{100}Pd	-	3E+4	1E-5	4E-8	-	-
46	Palladium-103	D, see ^{100}Pd	6E+3 LLI wall (7E+3)	6E+3	3E-6	9E-9	-	-
				-	-	-	1E-4	1E-3
		W, see ^{100}Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{100}Pd	-	4E+3	1E-6	5E-9	-	-
46	Palladium-107	D, see ^{100}Pd	3E+4 LLI wall (4E+4)	2E+4 Kidneys (2E+4)	9E-6	-	-	-
				-	-	3E-8	5E-4	5E-3
		W, see ^{100}Pd	-	7E+3	3E-6	1E-8	-	-
		Y, see ^{100}Pd	-	4E+2	2E-7	6E-10	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
46	Palladium-109	D, see ^{100}Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{100}Pd	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{100}Pd	-	5E+3	2E-6	6E-9	-	-
47	Silver-102[2]	D, all compounds except those given for W and Y	5E+4	2E+5	8E-5	2E-7	-	-
			St. wall (6E+4)	-	-	-	9E-4	9E-3
		W, nitrates and sulfides	-	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	-	2E+5	8E-5	3E-7	-	-
47	Silver-103[2]	D, see ^{102}Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104m[2]	D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104[2]	D, see ^{102}Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
47	Silver-105	D, see ^{102}Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
		W, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	D, see ^{102}Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-106[2]	D, see ^{102}Ag	6E+4	2E+5	8E-5	3E-7	-	-
			St. wall (6E+4)	-	-	-	9E-4	9E-3
		W, see ^{102}Ag	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{102}Ag	-	2E+5	8E-5	3E-7	-	-
47	Silver-108m	D, see ^{102}Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
		W, see ^{102}Ag	-	3E+2	1E-7	4E-10	-	-
		Y, see ^{102}Ag	-	2E+1	1E-8	3E-11	-	-
47	Silver-110m	D, see ^{102}Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
		W, see ^{102}Ag	-	2E+2	8E-8	3E-10	-	-
		Y, see ^{102}Ag	-	9E+1	4E-8	1E-10	-	-
47	Silver-111	D, see ^{102}Ag	9E+2	2E+3	6E-7	-	-	-
			LLI wall (1E+3)	Liver (2E+3)	-	2E-9	2E-5	2E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-112	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{102}Ag	-	1E+4	4E-6	1E-8	-	-
		Y, see ^{102}Ag	-	9E+3	4E-6	1E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
47	Silver-115[2]	D, see ^{102}Ag	3E+4 St. wall (3E+4)	9E+4	4E-5	1E-7	-	-
		W, see ^{102}Ag	-	-	-	-	4E-4	4E-3
		Y, see ^{102}Ag	-	9E+4	4E-5	1E-7	-	-
			-	8E+4	3E-5	1E-7	-	-
48	Cadmium-104[2]	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
48	Cadmium-107	D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{104}Cd	-	6E+4	2E-5	8E-8	-	-
		Y, see ^{104}Cd	-	5E+4	2E-5	7E-8	-	-
48	Cadmium-109	D, see ^{104}Cd	3E+2 Kidneys (4E+2)	4E+1 Kidneys (5E+1)	1E-8	-	-	-
		W, see ^{104}Cd	-	1E+2 Kidneys (1E+2)	5E-8	7E-11	6E-6	6E-5
		Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
			-			2E-10	-	-
48	Cadmium-113m	D, see ^{104}Cd	2E+1 Kidneys (4E+1)	2E+0 Kidneys (4E+0)	1E-9	-	-	-
		W, see ^{104}Cd	-	8E+0 Kidneys (1E+1)	4E-9	5E-12	5E-7	5E-6
		Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-
			-			2E-11	-	-
48	Cadmium-113	D, see ^{104}Cd	2E+1 Kidneys (3E+1)	2E+0 Kidneys (3E+0)	9E-10	-	-	-
		W, see ^{104}Cd	-	8E+0 Kidneys (1E+1)	3E-9	5E-12	4E-7	4E-6
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
			-			2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1 Kidneys (8E+1)	2E-8	-	4E-6	4E-5
		W, see ^{104}Cd	-	1E+2	5E-8	1E-10	-	-
		Y, see ^{104}Cd	-	1E+2	6E-8	2E-10	-	-
			-			2E-10	-	-
48	Cadmium-115	D, see ^{104}Cd	9E+2 LLI wall (1E+3)	1E+3	6E-7	2E-9	-	-
		W, see ^{104}Cd	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
			-	-	-	-	1E-5	1E-4
48	Cadmium-117m	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
48	Cadmium-117	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	9E-8	-	-
49	Indium-110[2] (69.1 min)	D, see ^{109}In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	6E+4	2E-5	8E-8	-	-
49	Indium-110 (4.9 h)	D, see ^{109}In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		W, see ^{109}In	-	2E+4	8E-6	3E-8	-	-
49	Indium-111	D, see ^{109}In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
		W, see ^{109}In	-	6E+3	3E-6	9E-9	-	-
49	Indium-112[2]	D, see ^{109}In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
		W, see ^{109}In	-	7E+5	3E-4	1E-6	-	-
49	Indium-113m[2]	D, see ^{109}In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		W, see ^{109}In	-	2E+5	8E-5	3E-7	-	-
49	Indium-114m	D, see ^{109}In	3E+2 LLI wall (4E+2)	6E+1	3E-8	9E-11	-	-
		W, see ^{109}In	-	1E+2	4E-8	1E-10	5E-6 -	5E-5 -
4	Indium-115m	D, see ^{109}In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	5E+4	2E-5	7E-8	-	-
49	Indium-115	D, see ^{109}In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
		W, see ^{109}In	-	5E+0	2E-9	8E-12	-	-
49	Indium-116m[2]	D, see ^{109}In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{109}In	-	1E+5	5E-5	2E-7	-	-
49	Indium-117m[2]	D, see ^{109}In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{109}In	-	4E+4	2E-5	6E-8	-	-
49	Indium-117[2]	D, see ^{109}In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
		W, see ^{109}In	-	2E+5	9E-5	3E-7	-	-
49	Indium-119m[2]	D, see ^{109}In	4E+4 St. wall (5E+4)	1E+5	5E-5	2E-7	-	-
		W, see ^{109}In	-	1E+5	6E-5	2E-7	7E-4 -	7E-3 -
50	Tin-110	D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	-	1E+4	5E-6	2E-8	-	-
50	Tin-111[2]	D, see ^{110}Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
		W, see ^{110}Sn	-	3E+5	1E-4	4E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
50	Tin-113	D, see ^{110}Sn	2E+3	1E+3	5E-7	2E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ^{110}Sn	2E+3	1E+3	5E-7	-	-	-
			LLI wall (2E+3)	Bone surf (2E+3)	-	3E-9	3E-5	3E-4
		W, see ^{110}Sn	-	1E+3	6E-7	2E-9	-	-
50	Tin-119m	D, see ^{110}Sn	3E+3	2E+3	1E-6	3E-9	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ^{110}Sn	-	1E+3	4E-7	1E-9	-	-
50	Tin-121m	D, see ^{110}Sn	3E+3	9E+2	4E-7	1E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-121	D, see ^{110}Sn	6E+3	2E+4	6E-6	2E-8	-	-
			LLI wall (6E+3)	-	-	-	8E-5	8E-4
		W, see ^{110}Sn	-	1E+4	5E-6	2E-8	-	-
50	Tin-123m[2]	D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
		W, see ^{110}Sn	-	1E+5	6E-5	2E-7	-	-
50	Tin-123	D, see ^{110}Sn	5E+2	6E+2	3E-7	9E-10	-	-
			LLI wall (6E+2)	-	-	-	9E-6	9E-5
		W, see ^{110}Sn	-	2E+2	7E-8	2E-10	-	-
50	Tin-125	D, see ^{110}Sn	4E+2	9E+2	4E-7	1E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
		W, see ^{110}Sn	-	4E+2	1E-7	5E-10	-	-
50	Tin-126	D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
		W, see ^{110}Sn	-	7E+1	3E-8	9E-11	-	-
50	Tin-127	D, see ^{110}Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		W, see ^{110}Sn	-	2E+4	8E-6	3E-8	-	-
50	Tin-128[2]	D, see ^{110}Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{110}Sn	-	4E+4	1E-5	5E-8	-	-
51	Antimony-115[2]	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-	-
51	Antimony-116m[2]	D, see ^{115}Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{115}Sb	-	1E+5	6E-5	2E-7	-	-
51	Antimony-116[2]	D, see ^{115}Sb	7E+4	3E+5	1E-4	4E-7	-	-
			St. wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	3E+5	1E-4	5E-7	-	-
51	Antimony-117	D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
		W, see ^{115}Sb	-	3E+5	1E-4	4E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
51	Antimony-118m	D, see ^{115}Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	-	-
51	Antimony-119	D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	-	-
51	Antimony-120[2] (16 min)	D, see ^{115}Sb	1E+5 St. wall (2E+5)	4E+5 -	2E-4 -	6E-7 -	- 2E-3	- 2E-2
		W, see ^{115}Sb	-	5E+5	2E-4	7E-7	-	-
51	Antimony-120 (5.76 d)	D, see ^{115}Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		W, see ^{115}Sb	9E+2	1E+3	5E-7	2E-9	-	-
51	Antimony-122	D, see ^{115}Sb	8E+2 LLI wall (8E+2)	2E+3 -	1E-6 -	3E-9 -	- 1E-5	- 1E-4
		W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	-	-
51	Antimony-124m[2]	D, see ^{115}Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
		W, see ^{115}Sb	2E+5	6E+5	2E-4	8E-7	-	-
51	Antimony-124	D, see ^{115}Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	2E+2	1E-7	3E-10	-	-
51	Antimony-125	D, see ^{115}Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
		W, see ^{115}Sb	-	5E+2	2E-7	7E-10	-	-
51	Antimony-126m[2]	D, see ^{115}Sb	5E+4 St. wall (7E+4)	2E+5 -	8E-5 -	3E-7 -	- 9E-4	- 9E-3
		W, see ^{115}Sb	-	2E+5	8E-5	3E-7	-	-
51	Antimony-126	D, see ^{115}Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	5E+2	2E-7	7E-10	-	-
51	Antimony-127	D, see ^{115}Sb	8E+2 LLI wall (8E+2)	2E+3 -	9E-7 -	3E-9 -	- 1E-5	- 1E-4
		W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	-	-
51	Antimony-128[2] (10.4 min)	D, see ^{115}Sb	8E+4 St. wall (1E+5)	4E+5 -	2E-4 -	5E-7 -	- 1E-3	- 1E-2
		W, see ^{115}Sb	-	4E+5	2E-4	6E-7	-	-
51	Antimony-128 (9.01 h)	D, see ^{115}Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, see ^{115}Sb	-	3E+3	1E-6	5E-9	-	-
51	Antimony-129	D, see ^{115}Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, see ^{115}Sb	-	9E+3	4E-6	1E-8	-	-
51	Antimony-130[2]	D, see ^{115}Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{115}Sb	-	8E+4	3E-5	1E-7	-	-
51	Antimony-131[2]	D, see ^{115}Sb	1E+4 Thyroid (2E+4)	2E+4 Thyroid (4E+4)	1E-5 -	- 6E-8	- 2E-4	- 2E-3
		W, see ^{115}Sb	- -	2E+4 Thyroid (4E+4)	1E-5 -	6E-8	- -	- -

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
52	Tellurium-116	D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ^{116}Te	5E+2 Bone surf (7E+2)	2E+2 Bone surf (4E+2)	8E-8 -	- 5E-10	- 1E-5	- 1E-4
		W, see ^{116}Te	-	4E+2	2E-7	6E-10	-	-
52	Tellurium-121	D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{116}Te	-	3E+3	1E-6	4E-9	-	-
52	Tellurium-123m	D, see ^{116}Te	6E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	9E-8 -	- 8E-10	- 1E-5	- 1E-4
		W, see ^{116}Te	-	5E+2	2E-7	8E-10	-	-
52	Tellurium-123	D, see ^{116}Te	5E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	8E-8 -	- 7E-10	- 2E-5	- 2E-4
		W, see ^{116}Te	-	4E+2 Bone surf	2E-7	-	-	-
			-	(1E+3)	-	2E-9	-	-
52	Tellurium-125m	D, see ^{116}Te	1E+3 Bone surf (1E+3)	4E+2 Bone surf (1E+3)	2E-7 -	- 1E-9	- 2E-5	- 2E-4
		W, see ^{116}Te	-	7E+2	3E-7	1E-9	-	-
52	Tellurium-127m	D, see ^{116}Te	6E+2	3E+2 Bone surf	1E-7	-	9E-6	9E-5
			-	(4E+2)	-	6E-10	-	-
		W, see ^{116}Te	-	3E+2	1E-7	4E-10	-	-
52	Tellurium-127	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{116}Te	-	2E+4	7E-6	2E-8	-	-
52	Tellurium-129m	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
		W, see ^{116}Te	-	2E+2	1E-7	3E-10	-	-
52	Tellurium-129[2]	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{116}Te	-	7E+4	3E-5	1E-7	-	-
52	Tellurium-131m	D, see ^{116}Te	3E+2 Thyroid (6E+2)	4E+2 Thyroid (1E+3)	2E-7 -	- 2E-9	- 8E-6	- 8E-5
		W, see ^{116}Te	-	4E+2 Thyroid	2E-7	-	-	-
			-	(9E+2)	-	1E-9	-	-
52	Tellurium-131[2]	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- 8E-5	- 8E-4
		W, see ^{116}Te	-	5E+3 Thyroid	2E-6	-	-	-
			-	(1E+4)	-	2E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
52	Tellurium-132	D, see ^{116}Te	2E+2 Thyroid (7E+2)	2E+2 Thyroid (8E+2)	9E-8	-	-	-
		W, see ^{116}Te	-	2E+2 Thyroid (6E+2)	9E-8	1E-9	9E-6	9E-5
			-		-	9E-10	-	-
52	Tellurium-133m[2]	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6	-	-	-
		W, see ^{116}Te	-	5E+3 Thyroid (1E+4)	2E-6	2E-8	9E-5	9E-4
			-		-	2E-8	-	-
52	Tellurium-133[2]	D, see ^{116}Te	1E+4 Thyroid (3E+4)	2E+4 Thyroid (6E+4)	9E-6	-	-	-
		W, see ^{116}Te	-	2E+4 Thyroid (6E+4)	9E-6	8E-8	4E-4	4E-3
			-		-	8E-8	-	-
52	Tellurium-134[2]	D, see ^{116}Te	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5	-	-	-
		W, see ^{116}Te	-	2E+4 Thyroid (5E+4)	1E-5	7E-8	3E-4	3E-3
			-		-	7E-8	-	-
53	Iodine-120m[2]	D, all compounds	1E+4 Thyroid (1E+4)	2E+4	9E-6	3E-8	-	-
53	Iodine-120[2]	D, all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6	-	2E-4	2E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6	2E-8	1E-4	1E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6	-	-	-
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8	2E-8	1E-4	1E-3
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8	-	-	-
53	Iodine-126	D, all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8	3E-10	2E-6	2E-5
53	Iodine-128[2]	D, all compounds	4E+4 St. wall (6E+4)	1E+5	5E-5	2E-7	-	-
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9	4E-11	2E-7	2E-6

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7 -	- 3E-9	- 2E-5	- 2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8 -	- 2E-10	- 1E-6	- 1E-5
53	Iodine-132m[2]	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6 -	- 3E-8	- 1E-4	- 1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7 -	- 1E-9	- 7E-6	- 7E-5
53	Iodine-134[2]	D, all compounds	2E+4 Thyroid (3E+4)	5E+4 -	2E-5 -	6E-8 -	- 4E-4	- 4E-3
53	Iodine-135	D, all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7 -	- 6E-9	- 3E-5	- 3E-4
54	Xenon-120[2]	Submersion[1]	-	-	1E-5	4E-8	-	-
54	Xenon-121[2]	Submersion[1]	-	-	2E-6	1E-8	-	-
54	Xenon-122	Submersion[1]	-	-	7E-5	3E-7	-	-
54	Xenon-123	Submersion[1]	-	-	6E-6	3E-8	-	-
54	Xenon-125	Submersion[1]	-	-	2E-5	7E-8	-	-
54	Xenon-127	Submersion[1]	-	-	1E-5	6E-8	-	-
54	Xenon-129m	Submersion[1]	-	-	2E-4	9E-7	-	-
54	Xenon-131m	Submersion[1]	-	-	4E-4	2E-6	-	-
54	Xenon-133m	Submersion[1]	-	-	1E-4	6E-7	-	-
54	Xenon-133	Submersion[1]	-	-	1E-4	5E-7	-	-
54	Xenon-135m[2]	Submersion[1]	-	-	9E-6	4E-8	-	-
54	Xenon-135	Submersion[1]	-	-	1E-5	7E-8	-	-
54	Xenon-138[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
55	Cesium-125[2]	D, all compounds	5E+4 St. wall (9E+4)	1E+5 -	6E-5 -	2E-7 -	- 1E-3	- 1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130[2]	D, all compounds	6E+4	2E+5	8E-5	3E-7	-	-
			St. wall (1E+5)	-	-	-	1E-3	1E-2
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
55	Cesium-132	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds	1E+5	1E+5	6E-5	2E-7	-	-
			St. wall (1E+5)	-	-	-	2E-3	2E-2
55	Cesium-134	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
55	Cesium-135m[2]	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
55	Cesium-137	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
55	Cesium-138[2]	D, all compounds	2E+4	6E+4	2E-5	8E-8	-	-
			St. wall (3E+4)	-	-	-	4E-4	4E-3
56	Barium-126[2]	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
56	Barium-128	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
56	Barium-131m[2]	D, all compounds	4E+5	1E+6	6E-4	2E-6	-	-
			St. wall (5E+5)	-	-	-	7E-3	7E-2
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds	2E+3	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
56	Barium-133	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
56	Barium-139[2]	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds	5E+2	1E+3	6E-7	2E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
56	Barium-141[2]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
56	Barium-142[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	Lanthanum-131[2]	D, all compounds except those given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
57	Lanthanum-132	D, see ^{131}La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-135	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
57	Lanthanum-137	D, see ^{131}La	1E+4	6E+1 Liver	3E-8	-	2E-4	2E-3
			-	(7E+1)	-	1E-10	-	-
		W, see ^{131}La	-	3E+2 Liver	1E-7	-	-	-
			-	(3E+2)	-	4E-10	-	-
57	Lanthanum-138	D, see ^{131}La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
		W, see ^{131}La	-	1E+1	6E-9	2E-11	-	-
57	Lanthanum-140	D, see ^{131}La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{131}La	-	1E+3	5E-7	2E-9	-	-
57	Lanthanum-141	D, see ^{131}La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-142[2]	D, see ^{131}La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{131}La	-	3E+4	1E-5	5E-8	-	-
57	Lanthanum-143[2]	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	-	-
			St. wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
58	Cerium-134	W, all compounds except those given for Y	5E+2	7E+2	3E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	-	-
58	Cerium-135	W, see ^{134}Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		Y, see ^{134}Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137m	W, see ^{134}Ce	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	4E+3	2E-6	5E-9	-	-
58	Cerium-137	W, see ^{134}Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		Y, see ^{134}Ce	-	1E+5	5E-5	2E-7	-	-
58	Cerium-139	W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
		Y, see ^{134}Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-141	W, see ^{134}Ce	2E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	6E+2	2E-7	8E-10	-	-
58	Cerium-143	W, see ^{134}Ce	1E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{134}Ce	-	2E+3	7E-7	2E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
58	Cerium-144	W, see ^{134}Ce	2E+2	3E+1	1E-8	4E-11	-	-
			LLI wall (3E+2)	-	-	-	3E-6	3E-5
		Y, see ^{134}Ce	-	1E+1	6E-9	2E-11	-	-
59	Praseodymium-136[2]	W, all compounds except those given for Y	5E+4	2E+5	1E-4	3E-7	-	-
			St. wall (7E+4)	-	-	-	1E-3	1E-2
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	-	-
59	Praseodymium-137[2]	W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-138m	W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
		Y, see ^{136}Pr	-	4E+4	2E-5	6E-8	-	-
59	Praseodymium-139	W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-142m[2]	W, see ^{136}Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-142	W, see ^{136}Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		Y, see ^{136}Pr	-	2E+3	8E-7	3E-9	-	-
59	Praseodymium-143	W, see ^{136}Pr	9E+2	8E+2	3E-7	1E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Pr	-	7E+2	3E-7	9E-10	-	-
59	Praseodymium-144[2]	W, see ^{136}Pr	3E+4	1E+5	5E-5	2E-7	-	-
			St. wall (4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-145	W, see ^{136}Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{136}Pr	-	8E+3	3E-6	1E-8	-	-
59	Praseodymium-147[2]	W, see ^{136}Pr	5E+4	2E+5	8E-5	3E-7	-	-
			St. wall (8E+4)	-	-	-	1E-3	1E-2
		Y, see ^{136}Pr	-	2E+5	8E-5	3E-7	-	-
60	Neodymium-136[2]	W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
60	Neodymium-138	W, see ^{136}Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		Y, see ^{136}Nd	-	5E+3	2E-6	7E-9	-	-
60	Neodymium-139m	W, see ^{136}Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		Y, see ^{136}Nd	-	1E+4	6E-6	2E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values: Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations: Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations: Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers: Monthly Average Concentration (μCi/ml)
60	Neodymium-139[2]	W, see ^{136}Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
		Y, see ^{136}Nd	-	3E+5	1E-4	4E-7	-	-
60	Neodymium-141	W, see ^{136}Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
		Y, see ^{136}Nd	-	6E+5	3E-4	9E-7	-	-
60	Neodymium-147	W, see ^{136}Nd	1E+3	9E+2	4E-7	1E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Nd	-	8E+2	4E-7	1E-9	-	-
60	Neodymium-149[2]	W, see ^{136}Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
		Y, see ^{136}Nd	-	2E+4	1E-5	3E-8	-	-
60	Neodymium-151[2]	W, see ^{136}Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		Y, see ^{136}Nd	-	2E+5	8E-5	3E-7	-	-
61	Promethium-141[2]	W, all compounds except those given for Y	5E+4	2E+5	8E-5	3E-7	-	-
			St. wall (6E+4)	-	-	-	8E-4	8E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-5	2E-7	-	-
61	Promethium-143	W, see ^{141}Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	7E+2	3E-7	1E-9	-	-
61	Promethium-144	W, see ^{141}Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		Y, see ^{141}Pm	-	1E+2	5E-8	2E-10	-	-
61	Promethium-145	W, see ^{141}Pm	1E+4	2E+2	7E-8	-	1E-4	1E-3
			-	Bone surf (2E+2)	-	3E-10	-	-
		Y, see ^{141}Pm	-	2E+2	8E-8	3E-10	-	-
61	Promethium-146	W, see ^{141}Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
		Y, see ^{141}Pm	-	4E+1	2E-8	6E-11	-	-
61	Promethium-147	W, see ^{141}Pm	4E+3	1E+2	5E-8	-	-	-
			LLI wall (5E+3)	Bone surf (2E+2)	-	3E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	1E+2	6E-8	2E-10	-	-
61	Promethium-148m	W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		Y, see ^{141}Pm	-	3E+2	1E-7	5E-10	-	-
61	Promethium-148	W, see ^{141}Pm	4E+2	5E+2	2E-7	8E-10	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{141}Pm	-	5E+2	2E-7	7E-10	-	-
61	Promethium-149	W, see ^{141}Pm	1E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{141}Pm	-	2E+3	8E-7	2E-9	-	-
61	Promethium-150	W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{141}Pm	-	2E+4	7E-6	2E-8	-	-
61	Promethium-151	W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{141}Pm	-	3E+3	1E-6	4E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
62	Samarium-141m[2]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Samarium-141[2]	W, all compounds	5E+4	2E+5	8E-5	2E-7	-	-
			St. wall (6E+4)	-		-	8E-4	8E-3
62	Samarium-142[2]	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1	4E-2	1E-11	-	-	-
			Bone surf (3E+1)	Bone surf (6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1	4E-2	2E-11	-	-	-
			Bone surf (3E+1)	Bone surf (7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4	1E+2	4E-8	-	-	-
			LLI wall (1E+4)	Bone surf (2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155[2]	W, all compounds	6E+4	2E+5	9E-5	3E-7	-	-
			St. wall (8E+4)	-	-	-	1E-3	1E-2
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Europium-145	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Europium-150 (12.62 h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-152m	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	4E+3	9E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (1E+2)	-	2E-10	-	-
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation		Col. 1	Col. 2	
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
63	Europium-157	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
63	Europium-158[2]	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
64	Gadolinium-145[2]	D, all compounds except those given for W	5E+4	2E+5	6E-5	2E-7	-	-
			St. wall (5E+4)	-	-	-	6E-4	6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ^{145}Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ^{145}Gd	-	3E+2	1E-7	4E-10	-	-
64	Gadolinium-147	D, see ^{145}Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{145}Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ^{145}Gd	1E+1	8E-3	3E-12	-	-	-
			Bone surf (2E+1)	Bone surf (2E-2)	-	2E-14	3E-7	3E-6
		W, see ^{145}Gd	-	3E-2	1E-11	-	-	-
			-	Bone surf (6E-2)	-	8E-14	-	-
64	Gadolinium-149	D, see ^{145}Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ^{145}Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ^{145}Gd	6E+3	4E+2	2E-7	-	9E-5	9E-4
			-	Bone surf (6E+2)	-	9E-10	-	-
		W, see ^{145}Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ^{145}Gd	2E+1	1E-2	4E-12	-	-	-
			Bone surf (3E+1)	Bone surf (2E-2)	-	3E-14	4E-7	4E-6
		W, see ^{145}Gd	-	4E-2	2E-11	-	-	-
			-	Bone surf (8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ^{145}Gd	5E+3	1E+2	6E-8	-	6E-5	6E-4
			-	Bone surf (2E+2)	-	3E-10	-	-
		W, see ^{145}Gd	-	6E+2	2E-7	8E-10	-	-
64	Gadolinium-159	D, see ^{145}Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{145}Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147[2]	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
65	Terbium-153	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Terbium-155	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Terbium-156m (5.0 h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
65	Terbium-156m (24.4 h)	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds	5E+4 LLI wall (5E+4)	3E+2 Bone surf (6E+2)	1E-7 -	- 8E-10	- 7E-4	- 7E-3
65	Terbium-158	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds	2E+3 LLI wall (2E+3)	2E+3 -	7E-7 -	2E-9 -	- 3E-5	- 3E-4
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2 LLI wall (8E+2)	7E+2 -	3E-7 -	1E-9 -	- 1E-5	- 1E-4
67	Holmium-155[2]	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157[2]	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159[2]	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Holmium-162m[2]	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Holmium-162[2]	W, all compounds	5E+5 St. wall (8E+5)	2E+6 -	1E-3 -	3E-6 -	- 1E-2	- 1E-1
67	Holmium-164m[2]	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Holmium-164[2]	W, all compounds	2E+5 St. wall (2E+5)	6E+5 -	3E-4 -	9E-7 -	- 3E-3	- 3E-2
67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds	9E+2 LLI wall (9E+2)	2E+3 -	7E-7 -	2E-9 -	- 1E-5	- 1E-4
67	Holmium-167	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
68	Erbium-169	W, all compounds	3E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
68	Erbium-171	W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
68	Erbium-172	W, all compounds	1E+3	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
69	Thulium-162[2]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St. wall (7E+4)	-	-	-	1E-3	1E-2
69	Thulium-166	W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
69	Thulium-167	W, all compounds	2E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
69	Thulium-170	W, all compounds	8E+2	2E+2	9E-8	3E-10	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
69	Thulium-171	W, all compounds	1E+4	3E+2	1E-7	-	-	-
			LLI wall (1E+4)	Bone surf (6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
69	Thulium-173	W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
69	Thulium-175[2]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St. wall (9E+4)	-	-	-	1E-3	1E-2
70	Ytterbium-162[2]	W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
		Y, oxides, hydroxides, and fluorides	-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ^{162}Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167[2]	W, see ^{162}Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
		Y, see ^{162}Yb	-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ^{162}Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ^{162}Yb	3E+3	4E+3	1E-6	5E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{162}Yb	-	3E+3	1E-6	5E-9	-	-
70	Ytterbium-177[2]	W, see ^{162}Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	5E+4	2E-5	6E-8	-	-
70	Ytterbium-178[2]	W, see ^{162}Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	4E+4	2E-5	5E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
71	Lutetium-169	W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		Y, oxides, hydroxides, and fluorides	-	4E+3	2E-6	6E-9	-	-
71	Lutetium-170	W, see ^{169}Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-171	W, see ^{169}Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-172	W, see ^{169}Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ^{169}Lu	-	1E+3	5E-7	2E-9	-	-
71	Lutetium-173	W, see ^{169}Lu	5E+3	3E+2 Bone surf	1E-7	-	7E-5	7E-4
			-	(5E+2)	-	6E-10	-	-
		Y, see ^{169}Lu	-	3E+2	1E-7	4E-10	-	-
71	Lutetium-174m	W, see ^{169}Lu	2E+3 LLI wall	2E+2 Bone surf	1E-7	-	-	-
			(3E+3)	(3E+2)	-	5E-10	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+2	9E-8	3E-10	-	-
71	Lutetium-174	W, see ^{169}Lu	5E+3	1E+2 Bone surf	5E-8	-	7E-5	7E-4
			-	(2E+2)	-	3E-10	-	-
		Y, see ^{169}Lu	-	2E+2	6E-8	2E-10	-	-
71	Lutetium-176m	W, see ^{169}Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		Y, see ^{169}Lu	-	2E+4	9E-6	3E-8	-	-
71	Lutetium-176	W, see ^{169}Lu	7E+2	5E+0 Bone surf	2E-9	-	1E-5	1E-4
			-	(1E+1)	-	2E-11	-	-
		Y, see ^{169}Lu	-	8E+0	3E-9	1E-11	-	-
71	Lutetium-177m	W, see ^{169}Lu	7E+2	1E+2 Bone surf	5E-8	-	1E-5	1E-4
			-	(1E+2)	-	2E-10	-	-
		Y, see ^{169}Lu	-	8E+1	3E-8	1E-10	-	-
71	Lutetium-177	W, see ^{169}Lu	2E+3 LLI wall	2E+3	9E-7	3E-9	-	-
			(3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+3	9E-7	3E-9	-	-
71	Lutetium-178m[2]	W, see ^{169}Lu	5E+4 St. wall	2E+5	8E-5	3E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
		Y, see ^{169}Lu	-	2E+5	7E-5	2E-7	-	-
71	Lutetium-178[2]	W, see ^{169}Lu	4E+4 St. wall	1E+5	5E-5	2E-7	-	-
			(4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{169}Lu	-	1E+5	5E-5	2E-7	-	-
71	Lutetium-179	W, see ^{169}Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{169}Lu	-	2E+4	6E-6	3E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
72	Hafnium-170	D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
		W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-
72	Hafnium-172	D, see ^{170}Hf	1E+3	9E+0	4E-9	-	2E-5	2E-4
			-	Bone surf (2E+1)	-	3E-11	-	-
		W, see ^{170}Hf	-	4E+1	2E-8	-	-	-
			-	Bone surf (6E+1)	-	8E-11	-	-
72	Hafnium-173	D, see ^{170}Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{170}Hf	-	1E+4	5E-6	2E-8	-	-
72	Hafnium-175	D, see ^{170}Hf	3E+3	9E+2	4E-7	-	4E-5	4E-4
			-	Bone surf (1E+3)	-	1E-9	-	-
		W, see ^{170}Hf	-	1E+3	5E-7	2E-9	-	-
72	Hafnium-177m[2]	D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{170}Hf	-	9E+4	4E-5	1E-7	-	-
72	Hafnium-178m	D, see ^{170}Hf	3E+2	1E+0	5E-10	-	3E-6	3E-5
			-	Bone surf (2E+0)	-	3E-12	-	-
		W, see ^{170}Hf	-	5E+0	2E-9	-	-	-
			-	Bone surf (9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2	1E-7	-	1E-5	1E-4
			-	Bone surf (6E+2)	-	8E-10	-	-
		W, see ^{170}Hf	-	6E+2	3E-7	8E-10	-	-
72	Hafnium-180m	D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{170}Hf	-	3E+4	1E-5	4E-8	-	-
72	Hafnium-181	D, see ^{170}Hf	1E+3	2E+2	7E-8	-	2E-5	2E-4
			-	Bone surf (4E+2)	-	6E-10	-	-
		W, see ^{170}Hf	-	4E+2	2E-7	6E-10	-	-
72	Hafnium-182m[2]	D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
		W, see ^{170}Hf	-	1E+5	6E-5	2E-7	-	-
72	Hafnium-182	D, see ^{170}Hf	2E+2	8E-1	3E-10	-	-	-
			Bone surf (4E+2)	Bone surf (2E+0)	-	2E-12	5E-6	5E-5
		W, see ^{170}Hf	-	3E+0	1E-9	-	-	-
			-	Bone surf (7E+0)	-	1E-11	-	-
72	Hafnium-183[2]	D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{170}Hf	-	6E+4	2E-5	8E-8	-	-
72	Hafnium-184	D, see ^{170}Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{170}Hf	-	6E+3	3E-6	9E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
73	Tantalum-172[2]	W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-
73	Tantalum-173	W, see ^{172}Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174[2]	W, see ^{172}Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	9E+4	4E-5	1E-7	-	-
73	Tantalum-175	W, see ^{172}Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
		Y, see ^{172}Ta	-	1E+4	6E-6	2E-8	-	-
73	Tantalum-176	W, see ^{172}Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		Y, see ^{172}Ta	-	1E+4	5E-6	2E-8	-	-
73	Tantalum-177	W, see ^{172}Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-178	W, see ^{172}Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
		Y, see ^{172}Ta	-	7E+4	3E-5	1E-7	-	-
73	Tantalum-179	W, see ^{172}Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
		Y, see ^{172}Ta	-	9E+2	4E-7	1E-9	-	-
73	Tantalum-180m	W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{172}Ta	-	6E+4	2E-5	8E-8	-	-
73	Tantalum-180	W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
		Y, see ^{172}Ta	-	2E+1	1E-8	3E-11	-	-
73	Tantalum-182m[2]	W, see ^{172}Ta	2E+5 St. wall (2E+5)	5E+5	2E-4	8E-7	-	-
		Y, see ^{172}Ta	-	4E+5	2E-4	6E-7	3E-3 -	3E-2 -
73	Tantalum-182	W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		Y, see ^{172}Ta	-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see ^{172}Ta	9E+2 LLI wall (1E+3)	1E+3	5E-7	2E-9	-	-
		Y, see ^{172}Ta	-	1E+3	4E-7	1E-9	2E-5 -	2E-4 -
73	Tantalum-184	W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
		Y, see ^{172}Ta	-	5E+3	2E-6	7E-9	-	-
73	Tantalum-185[2]	W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	6E+4	3E-5	9E-8	-	-
73	Tantalum-186[2]	W, see ^{172}Ta	5E+4 St. wall (7E+4)	2E+5	1E-4	3E-7	-	
		Y, see ^{172}Ta	-	2E+5	9E-5	3E-7	1E-3 -	1E-2 -
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
74	Tungsten-179[2]	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
74	Tungsten-185	D, all compounds	2E+3	7E+3	3E-6	9E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
75	Rhenium-177[2]	D, all compounds except those given for W	9E+4	3E+5	1E-4	4E-7	-	-
			St. wall (1E+5)	-	-	-	2E-3	2E-2
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-
75	Rhenium-178[2]	D, see ^{177}Re	7E+4	3E+5	1E-4	4E-7	-	-
			St. wall (1E+5)	-	-	-	1E-3	1E-2
		W, see ^{177}Re	-	3E+5	1E-4	4E-7	-	-
75	Rhenium-181	D, see ^{177}Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
		W, see ^{177}Re	-	9E+3	4E-6	1E-8	-	-
75	Rhenium-182 (12.7 h)	D, see ^{177}Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
		W, see ^{177}Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182 (64.0 h)	D, see ^{177}Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+3	9E-7	3E-9	-	-
75	Rhenium-184m	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	4E+2	2E-7	6E-10	-	-
75	Rhenium-184	D, see ^{177}Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{177}Re	-	1E+3	6E-7	2E-9	-	-
75	Rhenium-186m	D, see ^{177}Re	1E+3	2E+3	7E-7	-	-	-
			St. wall (2E+3)	St. wall (2E+3)	-	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+2	6E-8	2E-10	-	-
75	Rhenium-186	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	2E+3	7E-7	2E-9	-	-
75	Rhenium-187	D, see ^{177}Re	6E+5	8E+5	4E-4	-	8E-3	8E-2
			-	St. wall (9E+5)	-	1E-6	-	-
		W, see ^{177}Re	-	1E+5	4E-5	1E-7	-	-
75	Rhenium-188m[2]	D, see ^{177}Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{177}Re	-	1E+5	6E-5	2E-7	-	-
75	Rhenium-188	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		W, see ^{177}Re	-	3E+3	1E-6	4E-9	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values: Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations: Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations: Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers: Monthly Average Concentration (μCi/ml)
75	Rhenium-189	D, see ^{177}Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
		W, see ^{177}Re	-	4E+3	2E-6	6E-9	-	-
76	Osmium-180[2]	D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
		W, halides and nitrates	-	5E+5	2E-4	7E-7	-	-
		Y, oxides and hydroxides	-	5E+5	2E-4	6E-7	-	-
76	Osmium-181[2]	D, see ^{180}Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{180}Os	-	5E+4	2E-5	6E-8	-	-
		Y, see ^{180}Os	-	4E+4	2E-5	6E-8	-	-
76	Osmium-182	D, see ^{180}Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
		W, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
76	Osmium-185	D, see ^{180}Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
76	Osmium-189m	D, see ^{180}Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, see ^{180}Os	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{180}Os	-	2E+5	7E-5	2E-7	-	-
76	Osmium-191m	D, see ^{180}Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{180}Os	-	2E+4	8E-6	3E-8	-	-
		Y, see ^{180}Os	-	2E+4	7E-6	2E-8	-	-
76	Osmium-191	D, see ^{180}Os	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (3E+3)	-	-	-	3E-5	3E-4
		W, see ^{180}Os	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{180}Os	-	1E+3	6E-7	2E-9	-	-
76	Osmium-193	D, see ^{180}Os	2E+3	5E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
		W, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
76	Osmium-194	D, see ^{180}Os	4E+2	4E+1	2E-8	6E-11	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		W, see ^{180}Os	-	6E+1	2E-8	8E-11	-	-
		Y, see ^{180}Os	-	8E+0	3E-9	1E-11	-	-
77	Iridium-182[2]	D, all compounds except those given for W and Y	4E+4	1E+5	6E-5	2E-7	-	-
			St. wall (4E+4)	-	-	-	6E-4	6E-3
		W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
77	Iridium-184	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
77	Iridium-185	D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{182}Ir	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{182}Ir	-	1E+4	4E-6	1E-8	-	-
77	Iridium-186	D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{182}Ir	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{182}Ir	-	6E+3	2E-6	8E-9	-	-
77	Iridium-187	D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-188	D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
		Y, see ^{182}Ir	-	3E+3	1E-6	5E-9	-	-
77	Iridium-189	D, see ^{182}Ir	5E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	7E-5	7E-4
		W, see ^{182}Ir	-	4E+3	2E-6	5E-9	-	-
		Y, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
77	Iridium-190m[2]	D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
		W, see ^{182}Ir	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{182}Ir	-	2E+5	8E-5	3E-7	-	-
77	Iridium-190	D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
		W, see ^{182}Ir	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{182}Ir	-	9E+2	4E-7	1E-9	-	-
77	Iridium-192m	D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
		W, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
		Y, see ^{182}Ir	-	2E+1	6E-9	2E-11	-	-
77	Iridium-192	D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		W, see ^{182}Ir	-	4E+2	2E-7	6E-10	-	-
		Y, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
77	Iridium-194m	D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
		W, see ^{182}Ir	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{182}Ir	-	1E+2	4E-8	1E-10	-	-
77	Iridium-194	D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{182}Ir	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{182}Ir	-	2E+3	8E-7	3E-9	-	-
77	Iridium-195m	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	2E+4	9E-6	3E-8	-	-
77	Iridium-195	D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{182}Ir	-	5E+4	2E-5	7E-8	-	-
		Y, see ^{182}Ir	-	4E+4	2E-5	6E-8	-	-
78	Platinum-186	D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
78	Platinum-193m	D, all compounds	3E+3	6E+3	3E-6	8E-9	-	-
			LLI wall (3E+4)	-	-	-		
78	Platinum-193	D, all compounds	4E+4	2E+4	1E-5	3E-8	4E-5	4E-4
			LLI wall (5E+4)	-	-	-	-	-
78	Platinum-195m	D, all compounds	2E+3	4E+3	2E-6	6E-9	6E-4	6E-3
			LLI wall (2E+3)	-	-	-	-	-
78	Platinum-197m[2]	D, all compounds	2E+4	4E+4	2E-5	6E-8	3E-5	3E-4
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	2E-4	2E-3
78	Platinum-199[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	4E-5	4E-4
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	7E-4	7E-3
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	2E-5	2E-4
		W, halides and nitrates	-	2E+4	9E-6	3E-8	1E-4	1E-3
		Y, oxides and hydroxides	-	2E+4	8E-6	3E-8	-	-
79	Gold-194	D, see ^{193}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193}Au	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{193}Au	-	5E+3	2E-6	7E-9	-	-
79	Gold-195	D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{193}Au	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{193}Au	-	4E+2	2E-7	6E-10	-	-
79	Gold-198m	D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
79	Gold-198	D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	2E+3	8E-7	3E-9	-	-
		Y, see ^{193}Au	-	2E+3	7E-7	2E-9	-	-
79	Gold-199	D, see ^{193}Au	3E+3	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-		
		W, see ^{193}Au	-	4E+3	2E-6	6E-9	4E-5	4E-4
		Y, see ^{193}Au	-	4E+3	2E-6	5E-9	-	-
79	Gold-200m	D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{193}Au	-	2E+3	1E-6	3E-9	-	-
79	Gold-200[2]	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{193}Au	-	8E+4	3E-5	1E-7	-	-
		Y, see ^{193}Au	-	7E+4	3E-5	1E-7	-	-
79	Gold-201[2]	D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	-	-
			St. wall (9E+4)	-	-	-		
		W, see ^{193}Au	-	2E+5	1E-4	3E-7	1E-3	1E-2
		Y, see ^{193}Au	-	2E+5	9E-5	3E-7	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
80	Mercury-193m	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		D, see ^{193m}Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	4E+4	2E-5	6E-8	-	-
80	Mercury-194	Vapor	-	3E+1	1E-8	4E-11	-	-
		Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
		D, see ^{193m}Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see ^{193m}Hg	-	1E+2	5E-8	2E-10	-	-
80	Mercury-195m	Vapor	-	4E+3	2E-6	6E-9	-	-
		Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
		D, see ^{193m}Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	4E+3	2E-6	5E-9	-	-
80	Mercury-195	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		D, see ^{193m}Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	3E+4	1E-5	5E-8	-	-
80	Mercury-197m	Vapor	-	5E+3	2E-6	7E-9	-	-
		Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		D, see ^{193m}Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193m}Hg	-	5E+3	2E-6	7E-9	-	-
80	Mercury-197	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
		D, see ^{193m}Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{193m}Hg	-	9E+3	4E-6	1E-8	-	-
80	Mercury-199m[2]	Vapor	-	8E+4	3E-5	1E-7	-	-
		Organic D	6E+4	2E+5	7E-5	2E-7	-	-
			St. wall (1E+5)	-	-	-	1E-3	1E-2
		D, see ^{193m}Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
		W, see ^{193m}Hg	-	2E+5	7E-5	2E-7	-	-
80	Mercury-203	Vapor	-	8E+2	4E-7	1E-9	-	-
		Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
		D, see ^{193m}Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	1E+3	5E-7	2E-9	-	-
81	Thallium-194m[2]	D, all compounds	5E+4	2E+5	6E-5	2E-7	-	-
			St. wall (7E+4)	-	-	-	1E-3	1E-2

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
81	Thallium-194[2]	D, all compounds	3E+5 St. wall (3E+5)	6E+5 -	2E-4 -	8E-7 -	- 4E-3	- 4E-2
81	Thallium-195[2]	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198m[2]	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
81	Thallium-198	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Lead-195m[2]	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199[2]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E-1 Bone surf (1E+0)	2E-1 Bone surf (4E-1)	1E-10 -	- 6E-13	- 1E-8	- 1E-7
82	Lead-211[2]	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	8E+1 Bone surf (1E+2)	3E+1 -	1E-8 -	5E-11 -	- 2E-6	- 2E-5
82	Lead-214[2]	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bismuth-200[2]	D, nitrates W, all other compounds	3E+4 -	8E+4 1E+5	4E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
83	Bismuth-201[2]	D, see ^{200}Bi W, see ^{200}Bi	1E+4 -	2E+4 4E+4	1E-5 2E-5	4E-8 5E-8	2E-4 -	2E-3 -
83	Bismuth-202[2]	D, see ^{200}Bi W, see ^{200}Bi	1E+4 -	4E+4 8E+4	2E-5 3E-5	6E-8 1E-7	2E-4 -	2E-3 -

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
83	Bismuth-203	D, see ^{200}Bi	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{200}Bi	-	6E+3	3E-6	9E-9	-	-
83	Bismuth-205	D, see ^{200}Bi	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{200}Bi	-	1E+3	5E-7	2E-9	-	-
83	Bismuth-206	D, see ^{200}Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{200}Bi	-	9E+2	4E-7	1E-9	-	-
83	Bismuth-207	D, see ^{200}Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-210m	D, see ^{200}Bi	4E+1 Kidneys (6E+1)	5E+0 Kidneys (6E+0)	2E-9	-	-	-
		W, see ^{200}Bi	-	7E-1	3E-10	9E-12 9E-13	8E-7 -	8E-6 -
83	Bismuth-210	D, see ^{200}Bi	8E+2	2E+2 Kidneys (4E+2)	1E-7	-	1E-5	1E-4
		W, see ^{200}Bi	- -	3E+1	1E-8	5E-10 4E-11	- -	- -
83	Bismuth-212[2]	D, see ^{200}Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
		W, see ^{200}Bi	-	3E+2	1E-7	4E-10	-	-
83	Bismuth-213[2]	D, see ^{200}Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-214[2]	D, see ^{200}Bi	2E+4 St. wall (2E+4)	8E+2	3E-7	1E-9	-	-
		W, see ^{200}Bi	-	9E-2	4E-7	- 1E-9	3E-4 -	3E-3 -
84	Polonium-203[2]	D, all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, oxides, hydroxides, and nitrates	-	9E+4	4E-5	1E-7	-	-
84	Polonium-205[2]	D, see ^{203}Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
		W, see ^{203}Po	-	7E+4	3E-5	1E-7	-	-
84	Polonium-207	D, see ^{203}Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{203}Po	-	3E+4	1E-5	4E-8	-	-
84	Polonium-210	D, see ^{203}Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
		W, see ^{203}Po	-	6E-1	3E-10	9E-13	-	-
85	Astatine-207[2]	D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
		W	-	2E+3	9E-7	3E-9	-	-
85	Astatine-211	D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
		W	-	5E+1	2E-8	8E-11	-	-
86	Radon-220	With daughters removed	-	2E+4	7E-6	2E-8	-	-
		With daughters present	-	2E+1 (or 12 working level months)	9E-9 (or 1.0 working level)	3E-11	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2 (or 4 working level months)	3E-8 (or 0.33 working level)	1E-10	-	-
87	Francium-222[2]	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
87	Francium-223[2]	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	5E+0 Bone surf (9E+0)	7E-1	3E-10	9E-13	-	-
				-	-	-	1E-7	1E-6
88	Radium-224	W, all compounds	8E+0 Bone surf (2E+1)	2E+0	7E-10	2E-12	-	-
				-	-	-	2E-7	2E-6
88	Radium-225	W, all compounds	8E+0 Bone surf (2E+1)	7E-1	3E-10	9E-13	-	-
				-	-	-	2E-7	2E-6
88	Radium-226	W, all compounds	2E+0 Bone surf (5E+0)	6E-1	3E-10	9E-13	-	-
				-	-	-	6E-8	6E-7
88	Radium-227[2]	W, all compounds	2E+4 Bone surf (2E+4)	1E+4 Bone surf (2E+4)	6E-6	-	-	-
					-	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E+0 Bone surf (4E+0)	1E+0	5E-10	2E-12	-	-
				-	-	-	6E-8	6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3 LLI wall (2E+3)	3E+1 Bone surf (4E+1)	1E-8	-	-	-
					-	5E-11	3E-5	3E-4
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D, see ^{224}Ac	5E+1 LLI wall (5E+1)	3E-1 Bone surf (5E-1)	1E-10	-	-	-
					-	7E-13	7E-7	7E-6
		W, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-226	D, see ^{224}Ac	1E+2 LLI wall (1E+2)	3E+0 Bone surf (4E+0)	1E-9	-	-	-
					-	5E-12	2E-6	2E-5
		W, see ^{224}Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ^{224}Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ^{224}Ac	2E-1 Bone surf (4E-1)	4E-4 Bone surf (8E-4)	2E-13	-	-	-
					-	1E-15	5E-9	5E-8
		W, see ^{224}Ac	-	2E-3 Bone surf (3E-3)	7E-13	-	-	-
					-	4E-15	-	-
		Y, see ^{224}Ac	-	4E-3	2E-12	6E-15	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
89	Actinium-228	D, see ^{224}Ac	2E+3	9E+0 Bone surf	4E-9	-	3E-5	3E-4
			-	(2E+1)	-	2E-11	-	-
		W, see ^{224}Ac	-	4E+1	2E-8	-	-	-
			-	Bone surf (6E+1)	-	8E-11	-	-
		Y, see ^{224}Ac	-	4E+1	2E-8	6E-11	-	-
90	Thorium-226[2]	W, all compounds except those given for Y	5E+3 St. wall (5E+3)	2E+2	6E-8	2E-10	-	-
				-	-	-	7E-5	7E-4
		Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	-	-
90	Thorium-227	W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
		Y, see ^{226}Th	-	3E-1	1E-10	5E-13	-	-
90	Thorium-228	W, see ^{226}Th	6E+0 Bone surf (1E+1)	1E-2 Bone surf (2E-2)	4E-12 -	- 3E-14	- 2E-7	- 2E-6
		Y, see ^{226}Th	-	2E-2	7E-12	2E-14	-	-
90	Thorium-229	W, see ^{226}Th	6E-1 Bone surf (1E+0)	9E-4 Bone surf (2E-3)	4E-13 -	- 3E-15	- 2E-8	- 2E-7
		Y, see ^{226}Th	-	2E-3	1E-12	-	-	-
			-	Bone surf (3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ^{226}Th	4E+0 Bone surf (9E+0)	6E-3 Bone surf (2E-2)	3E-12 -	- 2E-14	- 1E-7	- 1E-6
		Y, see ^{226}Th	-	2E-2	6E-12	-	-	-
			-	Bone surf (2E-2)	-	3E-14	-	-
90	Thorium-231	W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
		Y, see ^{226}Th	-	6E+3	3E-6	9E-9	-	-
90	Thorium-232	W, see ^{226}Th	7E-1 Bone surf (2E+0)	1E-3 Bone surf (3E-3)	5E-13 -	- 4E-15	- 3E-8	- 3E-7
		Y, see ^{226}Th	-	3E-3	1E-12	-	-	-
			-	Bone surf (4E-3)	-	6E-15	-	-
90	Thorium-234	W, see ^{226}Th	3E+2 LLI wall (4E+2)	2E+2	8E-8	3E-10	-	-
				-	-	-	5E-6	5E-5
		Y, see ^{226}Th	-	2E+2	6E-8	2E-10	-	-
91	Protactinium-227[2]	W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
		Y, oxides and hydroxides	-	1E+2	4E-8	1E-10	-	-
91	Protactinium-228	W, see ^{227}Pa	1E+3	1E+1 Bone surf (2E+1)	5E-9 -	- 3E-11	2E-5 -	2E-4 -
		Y, see ^{226}Pa	-	1E+1	5E-9	2E-11	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
91	Protactinium-230	W, see ^{227}Pa	6E+2	5E+0	2E-9	7E-12	-	-
			Bone surf (9E+2)	-	-	-	1E-5	1E-4
		Y, see ^{227}Pa	-	4E+0	1E-9	5E-12	-	-
91	Protactinium-231	W, see ^{227}Pa	2E-1	2E-3	6E-13	-	-	-
			Bone surf (5E-1)	Bone surf (4E-3)	-	6E-15	6E-9	6E-8
		Y, see ^{226}Pa	-	4E-3	2E-12	-	-	-
			-	Bone surf (6E-3)	-	8E-15	-	-
91	Protactinium-232	W, see ^{227}Pa	1E+3	2E+1	9E-9	-	2E-5	2E-4
			-	Bone surf (6E+1)	-	8E-11	-	-
		Y, see ^{227}Pa	-	6E+1	2E-8	-	-	-
			-	Bone surf (7E+1)	-	1E-10	-	-
91	Protactinium-233	W, see ^{227}Pa	1E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
		Y, see ^{227}Pa	-	6E+2	2E-7	8E-10	-	-
91	Protactinium-234	W, see ^{227}Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{227}Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF_6, UO_2F_2, $UO_2(NO_3)_2$	4E+0	4E-1	2E-10	-	-	-
			Bone surf (6E+0)	Bone surf (6E-1)	-	8E-13	8E-8	8E-7
		W, UO_3, UF_4, UCl_4	-	4E-1	1E-10	5E-13	-	-
		Y, UO_2, U_3O_8	-	3E-1	1E-10	4E-13	-	-
92	Uranium-231	D, see ^{230}U	5E+3	8E+3	3E-6	1E-8	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ^{230}U	-	6E+3	2E-6	8E-9	-	-
		Y, see ^{230}U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see ^{230}U	2E+0	2E-1	9E-11	-	-	-
			Bone surf (4E+0)	Bone surf (4E-1)	-	6E-13	6E-8	6E-7
		W, see ^{230}U	-	4E-1	2E-10	5E-13	-	-
		Y, see ^{230}U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-233	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-234[3]	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
92	Uranium-235[3]	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10 -	- 3E-12	- 3E-7	- 3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-236	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10 -	- 3E-12	- 3E-7	- 3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-237	D, see ^{230}U	2E+3 LLI wall (2E+3)	3E+3 -	1E-6 -	4E-9 -	- 3E-5	- 3E-4
		W, see ^{230}U	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{230}U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238[3]	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10 -	- 3E-12	- 3E-7	- 3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-239[2]	D, see ^{230}U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see ^{230}U	-	2E+5	7E-5	2E-7	-	-
		Y, see ^{230}U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see ^{230}U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{230}U	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{230}U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural[3]	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10 -	- 3E-12	- 3E-7	- 3E-6
		W, see ^{230}U	-	8E-1	3E-10	9E-13	-	-
		Y, see ^{230}U	-	5E-2	2E-11	9E-14	-	-
9	Neptunium-232[2]	W, all compounds	1E+5 -	2E+3 Bone surf (5E+2)	7E-7 -	- 6E-9	2E-3 -	2E-2 -
93	Neptunium-233[2]	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	2E+4 LLI wall (2E+4)	8E+2 Bone surf (1E+3)	3E-7 -	- 2E-9	- 3E-4	- 3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	3E+0 Bone surf (6E+0)	2E-2 Bone surf (5E-2)	9E-12 -	- 8E-14	- 9E-8	- 9E-7
93	Neptunium-236m (22.5 h)	W, all compounds	3E+3 Bone surf (4E+3)	3E+1 Bone surf (7E+1)	1E-8 -	- 1E-10	- 5E-5	- 5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (1E-2)	2E-12 -	- 1E-14	- 2E-8	- 2E-7

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
93	Neptunium-238	W, all compounds	1E+3	6E+1	3E-8	-	2E-5	2E-4
			-	Bone surf (2E+2)	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
93	Neptunium-240[2]	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO_2	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO_2	-	2E+2	8E-8	3E-10	-	-
94	Plutonium-235[2]	W, see ^{234}Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
		Y, see ^{234}Pu	-	3E+6	1E-3	3E-6	-	-
94	Plutonium-236	W, see ^{234}Pu	2E+0	2E-2	8E-12	-	-	-
			Bone surf (4E+0)	Bone surf (4E-2)	-	5E-14	6E-8	6E-7
		Y, see ^{234}Pu	-	4E-2	2E-11	6E-14	-	-
94	Plutonium-237	W, see ^{234}Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
		Y, see ^{234}Pu	-	3E+3	1E-6	4E-9	-	-
94	Plutonium-238	W, see ^{234}Pu	9E-1	7E-3	3E-12	-	-	-
			Bone surf (2E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	8E-12	2E-14	-	-
94	Plutonium-239	W, see ^{234}Pu	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-240	W, see ^{234}Pu	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-241	W, see ^{234}Pu	4E+1	3E-1	1E-10	-	-	-
			Bone surf (7E+1)	Bone surf (6E-1)	-	8E-13	1E-6	1E-5
		Y, see ^{234}Pu	-	8E-1	3E-10	-	-	-
			-	Bone surf (1E+0)	-	1E-12	-	-

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
94	Plutonium-242	W, see ^{234}Pu	8E-1 Bone surf (1E+0)	7E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12 -	- 2E-14	- -	- -
94	Plutonium-243	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ^{234}Pu	-	4E+4	2E-5	5E-8	-	-
94	Plutonium-244	W, see ^{234}Pu	8E-1 Bone surf (2E+0)	7E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12 -	- 2E-14	- -	- -
94	Plutonium-245	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		Y, see ^{234}Pu	-	4E+3	2E-6	6E-9	-	-
94	Plutonium-246	W, see ^{234}Pu	4E+2 LLI wall (4E+2)	3E+2 -	1E-7 -	4E-10 -	- 6E-6	- 6E-5
		Y, see ^{234}Pu	-	3E+2	1E-7	4E-10	-	-
95	Americium-237[2]	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238[2]	W, all compounds	4E+4	3E+3 Bone surf (6E+3)	1E-6 -	- 9E-9	5E-4 -	5E-3 -
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
95	Americium-242m	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
95	Americium-242	W, all compounds	4E+3	8E+1 Bone surf (9E+1)	4E-8 -	- 1E-10	5E-5 -	5E-4 -
95	Americium-243	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
95	Americium-244m[2]	W, all compounds	6E+4 St. wall (8E+4)	4E+3 Bone surf (7E+3)	2E-6 -	- 1E-8	- 1E-3	- 1E-2
95	Americium-244	W, all compounds	3E+3	2E+2 Bone surf (3E+2)	8E-8 -	- 4E-10	4E-5 -	4E-4 -
95	Americium-245	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
95	Americium-246m[2]	W, all compounds	5E+4	2E+5	8E-5	3E-7	-	-
			St. wall (6E+4)	-	-	-	8E-4	8E-3
95	Americium-246[2]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
96	Curium-238	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	6E+1	6E-1	2E-10	-	-	-
			Bone surf (8E+1)	Bone surf (6E-1)	-	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	1E+3	3E+1	1E-8	-	2E-5	2E-4
			-	Bone surf (4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1	3E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	1E+0	1E-2	5E-12	-	-	-
			Bone surf (3E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-246	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-247	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-248	W, all compounds	2E-1	2E-3	7E-13	-	-	-
			Bone surf (4E-1)	Bone surf (3E-3)	-	4E-15	5E-9	5E-8
96	Curium-249[2]	W, all compounds	5E+4	2E+4	7E-6	-	7E-4	7E-3
			-	Bone surf (3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2	3E-4	1E-13	-	-	-
			Bone surf (6E-2)	Bone surf (5E-4)	-	8E-16	9E-10	9E-9
97	Berkelium-245	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
97	Berkelium-246	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
97	Berkelium-247	W, all compounds	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2	2E+0	7E-10	-	-	-
			Bone surf (5E+2)	Bone surf (4E+0)	-	5E-12	6E-6	6E-5

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
97	Berkelium-250	W, all compounds	9E+3	3E+2 Bone surf	1E-7	-	1E-4	1E-3
			-	(7E+2)	-	1E-9	-	-
98	Californium-244[2]	W, all compounds except those given for Y	3E+4 St. wall	6E+2	2E-7	8E-10	-	-
			(3E+4)	-	-	-	4E-4	4E-3
		Y, oxides and hydroxides	-	6E+2	2E-7	8E-10	-	-
98	Californium-246	W, see ^{244}Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
		Y, see ^{244}Cf	-	9E+0	4E-9	1E-11	-	-
98	Californium-248	W, see ^{244}Cf	8E+0 Bone surf	6E-2 Bone surf	3E-11	-	-	-
			(2E+1)	(1E-1)	-	2E-13	2E-7	2E-6
		Y, see ^{244}Cf	-	1E-1	4E-11	1E-13	-	-
98	Californium-249	W, see ^{244}Cf	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2 Bone surf	4E-12	-	-	-
			-	(1E-2)	-	2E-14	-	-
98	Californium-250	W, see ^{244}Cf	1E+0 Bone surf	9E-3 Bone surf	4E-12	-	-	-
			(2E+0)	(2E-2)	-	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	4E-14	-	-
98	Californium-251	W, see ^{244}Cf	5E-1 Bone surf	4E-3 Bone surf	2E-12	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2 Bone surf	4E-12	-	-	-
			-	(1E-2)	-	2E-14	-	-
98	Californium-252	W, see ^{244}Cf	2E+0 Bone surf	2E-2 Bone surf	8E-12	-	-	-
			(5E+0)	(4E-2)	-	5E-14	7E-8	7E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	5E-14	-	-
98	Californium-253	W, see ^{244}Cf	2E+2 Bone surf	2E+0	8E-10	3E-12	-	-
			(4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{244}Cf	-	2E+0	7E-10	2E-12	-	-
98	Californium-254	W, see ^{244}Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	2E-2	7E-12	2E-14	-	-
99	Einsteinium-250	W, all compounds	4E+4	5E+2 Bone surf	2E-7	-	6E-4	6E-3
			-	(1E+3)	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2 Bone surf	4E-7	-	1E-4	1E-3
			-	(1E+3)	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Table 1 Occupational Values Col. 2 Inhalation ALI (μCi)	Table 1 Occupational Values Col. 3 Inhalation DAC (μCi/ml)	Table 2 Effluent Concentrations Col. 1 Air (μCi/ml)	Table 2 Effluent Concentrations Col. 2 Water (μCi/ml)	Table 3 Releases to Sewers Monthly Average Concentration (μCi/ml)
99	Einsteinium-254m	W, all compounds	3E+2	1E+1	4E-9	1E-11	-	-
			LLI wall (3E+2)	-	-	-	4E-6	4E-5
99	Einsteinium-254	W, all compounds	8E+0	7E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	2E-13	2E-7	2E-6
100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	2E+1	2E-1	7E-11	-	-	-
			Bone surf (4E+1)	Bone surf (2E-1)	-	3E-13	5E-7	5E-6
101	Mendelevium-257	W, all compounds	7E+3	8E+1	4E-8	-	1E-4	1E-3
			-	Bone surf (9E+1)	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1	2E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	5E-13	6E-7	6E-6
-	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours	Submersion[1]	-	2E+2	1E-7	1E-9	-	-
-	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours	. . . .	-	2E-1	1E-10	1E-12	1E-8	1E-7
-	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known	. . . .	-	4E-4	2E-13	1E-15	2E-9	2E-8

FOOTNOTES:

[1]"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

[2]These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 μCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See § 20.1203.)

[3]For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see § 20.1201(e)). If the percent by weight (enrichment) of U-235 is not greater than 5, the concentration value for a 40-hour workweek is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8E-3 (SA) μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U U-depleted

$$SA = [0.4 + 0.38\ (\text{enrichment}) + 0.0034\ (\text{enrichment})^2]\ E\text{-}6\ ,\quad \text{enrichment} \geq 0.72$$

where enrichment is the percentage by weight of U-235, expressed as percent.

NOTE:

1. If the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.

2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture; or

	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
	Oral Ingestion	Inhalation				
Radionuclide	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
If it is known that Ac-227-D and Cm-250-W are not present	-	7E-4	3E-13	-	-	-
If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present	-	7E-3	3E-12	-	-	-
If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228-W,Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-254-W,Y are not present	-	7E-2	3E-11	-	-	-
If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present	-	7E-1	3E-10	-	-	-

Radionuclide	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
	Oral Ingestion	Inhalation				Monthly Average
	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D,W, La-138-D, Lu-176-W, Hf-178m-D,W, Hf-182-D,W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D,W,Y, Pa-230-W,Y, U-233-D,W, U-234-D,W, U-235-D,W, U-236-D,W, U-238-D,W, Pu-241-Y, Bk-249-W, Cf-253-W,Y, and Es-253-W are not present	-	7E+0	3E-9	-	-	-
If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th-232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present -	-	-		1E-14	-	-
If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present			-	1E-13	-	-
If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not present			-	1E-12	-	-
If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present	-	-	-	-	1E-6	1E-5

3 If a mixture of radionuclides consists of uranium and its daughters in ore dust (10 μm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture: 6E-11 μCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 μCi of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.

4 If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., "unity").

Example: If radionuclides "A," "B," and "C" are present in concentrations C_A, C_B, and C_C, and if the applicable DACs are DAC_A, DAC_B, and DAC_C, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} < 1$$

BILLING CODE 7590-01-C

9. Part 20 is amended by adding appendix C to §§ 20.1001–20.2401 to read as follows:

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)
Hydrogen-3	1,000
Beryllium-7	1,000
Beryllium-10	1
Carbon-11	1,000
Carbon-14	1,000
Fluorine-18	1,000
Sodium-22	10
Sodium-24	100
Magnesium-28	100
Aluminum-26	10
Silicon-31	1,000
Silicon-32	1
Phosphorus-32	10
Phosphorus-33	100
Sulfur-35	100
Chlorine-36	10
Chlorine-38	1,000
Chlorine-39	1,000
Argon-39	1,000
Argon-41	1,000
Potassium-40	100
Potassium-42	1,000
Potassium-43	1,000
Potassium-44	1,000
Potassium-45	1,000
Calcium-41	100
Calcium-45	100
Calcium-47	100
Scandium-43	1,000
Scandium-44m	100
Scandium-44	100
Scandium-46	10
Scandium-47	100
Scandium-48	100
Scandium-49	1,000
Titanium-44	1
Titanium-45	1,000
Vanadium-47	1,000
Vanadium-48	100
Vanadium-49	1,000
Chromium-48	1,000
Chromium-49	1,000
Chromium-51	1,000
Manganese-51	1,000
Manganese-52m	1,000
Manganese-52	100
Manganese-53	1,000
Manganese-54	100
Manganese-56	1,000
Iron-52	100
Iron-55	100
Iron-59	10
Iron-60	1
Cobalt-55	100
Cobalt-56	10
Cobalt-57	100
Cobalt-58m	1,000
Cobalt-58	100
Cobalt-60m	1,000
Cobalt-60	1
Cobalt-61	1,000
Cobalt-62m	1,000
Nickel-56	100
Nickel-57	100
Nickel-59	100
Nickel-63	100
Nickel-65	1,000
Nickel-66	10
Copper-60	1,000
Copper-61	1,000
Copper-64	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Copper-67	1,000
Zinc-62	100
Zinc-63	1,000
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zinc-71m	1,000
Zinc-72	100
Gallium-65	1,000
Gallium-66	100
Gallium-67	1,000
Gallium-68	1,000
Gallium-70	1,000
Gallium-72	100
Gallium-73	1,000
Germanium-66	1,000
Germanium-67	1,000
Germanium-68	10
Germanium-69	1,000
Germanium-71	1,000
Germanium-75	1,000
Germanium-77	1,000
Germanium-78	1,000
Arsenic-69	1,000
Arsenic-70	1,000
Arsenic-71	100
Arsenic-72	100
Arsenic-73	100
Arsenic-74	100
Arsenic-76	100
Arsenic-77	100
Arsenic-78	1,000
Selenium-70	1,000
Selenium-73m	1,000
Selenium-73	100
Selenium-75	100
Selenium-79	100
Selenium-81m	1,000
Selenium-81	1,000
Selenium-83	1,000
Bromine-74m	1,000
Bromine-74	1,000
Bromine-75	1,000
Bromine-76	100
Bromine-77	1,000
Bromine-80m	1,000
Bromine-80	1,000
Bromine-82	100
Bromine-83	1,000
Bromine-84	1,000
Krypton-74	1,000
Krypton-76	1,000
Krypton-77	1,000
Krypton-79	1,000
Krypton-81	1,000
Krypton-83m	1,000
Krypton-85m	1,000
Krypton-85	1,000
Krypton-87	1,000
Krypton-88	1,000
Rubidium-79	1,000
Rubidium-81m	1,000
Rubidium-81	1,000
Rubidium-82m	1,000
Rubidium-83	100
Rubidium-84	100
Rubidium-86	100
Rubidium-87	100
Rubidium-88	1,000
Rubidium-89	1,000
Strontium-80	100
Strontium-81	1,000
Strontium-83	100
Strontium-85m	1,000
Strontium-85	100
Strontium-87m	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Strontium-89	10
Strontium-90	0.1
Strontium-91	100
Strontium-92	100
Yttrium-86m	1,000
Yttrium-86	100
Yttrium-87	100
Yttrium-88	10
Yttrium-90m	1,000
Yttrium-90	10
Yttrium-91m	1,000
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Yttrium-94	1,000
Yttrium-95	1,000
Zirconium-86	100
Zirconium-88	10
Zirconium-89	100
Zirconium-93	1
Zirconium-95	10
Zirconium-97	100
Niobium-88	1,000
Niobium-89m (66 min)	1,000
Niobium-89 (122 min)	1,000
Niobium-90	100
Niobium-93m	10
Niobium-94	1
Niobium-95m	100
Niobium-95	100
Niobium-96	100
Niobium-97	1,000
Niobium-98	1,000
Molybdenum-90	100
Molybdenum-93m	100
Molybdenum-93	10
Molybdenum-99	100
Molybdenum-101	1,000
Technetium-93m	1,000
Technetium-93	1,000
Technetium-94m	1,000
Technetium-94	1,000
Technetium-96m	1,000
Technetium-96	100
Technetium-97m	100
Technetium-97	1,000
Technetium-98	10
Technetium-99m	1,000
Technetium-99	100
Technetium-101	1,000
Technetium-104	1,000
Ruthenium-94	1,000
Ruthenium-97	1,000
Ruthenium-103	100
Ruthenium-105	1,000
Ruthenium-106	1
Rhodium-99m	1,000
Rhodium-99	100
Rhodium-100	100
Rhodium-101m	1,000
Rhodium-101	10
Rhodium-102m	10
Rhodium-102	10
Rhodium-103m	1,000
Rhodium-105	100
Rhodium-106m	1,000
Rhodium-107	1,000
Palladium-100	100
Palladium-101	1,000
Palladium-103	100
Palladium-107	10
Palladium-109	100
Silver-102	1,000
Silver-103	1,000
Silver-104m	1,000
Silver-104	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Silver-105	100
Silver-106m	100
Silver-106	1,000
Silver-108m	1
Silver-110m	10
Silver-111	100
Silver-112	100
Silver-115	1,000
Cadmium-104	1,000
Cadmium-107	1,000
Cadmium-109	1
Cadmium-113m	0.1
Cadmium-113	100
Cadmium-115m	10
Cadmium-115	100
Cadmium-117m	1,000
Cadmium-117	1,000
Indium-109	1,000
Indium-110 (69.1min.)	1,000
Indium-110 (4.9h)	1,000
Indium-111	100
Indium-112	1,000
Indium-113m	1,000
Indium-114m	10
Indium-115m	1,000
Indium-115	100
Indium-116m	1,000
Indium-117m	1,000
Indium-117	1,000
Indium-119m	1,000
Tin-110	100
Tin-111	1,000
Tin-113	100
Tin-117m	100
Tin-119m	100
Tin-121m	100
Tin-121	1,000
Tin-123m	1,000
Tin-123	10
Tin-125	10
Tin-126	10
Tin-127	1,000
Tin-128	1,000
Antimony-115	1,000
Antimony-116m	1,000
Antimony-116	1,000
Antimony-117	1,000
Antimony-118m	1,000
Antimony-119	1,000
Antimony-120 (16min.)	1,000
Antimony-120 (5.76d)	100
Antimony-122	100
Antimony-124m	1,000
Antimony-124	10
Antimony-125	100
Antimony-126m	1,000
Antimony-126	100
Antimony-127	100
Antimony-128 (10.4min.)	1,000
Antimony-128 (9.01h)	100
Antimony-129	100
Antimony-130	1,000
Antimony-131	1,000
Tellurium-116	1,000
Tellurium-121m	10
Tellurium-121	100
Tellurium-123m	10
Tellurium-123	100
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	1,000
Tellurium-129m	10
Tellurium-129	1,000
Tellurium-131m	10
Tellurium-131	100

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Tellurium-132	10
Tellurium-133m	100
Tellurium-133	1,000
Tellurium-134	1,000
Iodine-120m	1,000
Iodine-120	100
Iodine-121	1,000
Iodine-123	100
Iodine-124	10
Iodine-125	1
Iodine-126	1
Iodine-128	1,000
Iodine-129	1
Iodine-130	10
Iodine-131	1
Iodine-132m	100
Iodine-132	100
Iodine-133	10
Iodine-134	1,000
Iodine-135	100
Xenon-120	1,000
Xenon-121	1,000
Xenon-122	1,000
Xenon-123	1,000
Xenon-125	1,000
Xenon-127	1,000
Xenon-129m	1,000
Xenon-131m	1,000
Xenon-133m	1,000
Xenon-133	1,000
Xenon-135m	1,000
Xenon-135	1,000
Xenon-138	1,000
Cesium-125	1,000
Cesium-127	1,000
Cesium-129	1,000
Cesium-130	1,000
Cesium-131	1,000
Cesium-132	100
Cesium-134m	1,000
Cesium-134	10
Cesium-135m	1,000
Cesium-135	100
Cesium-136	10
Cesium-137	10
Cesium-138	1,000
Barium-126	1,000
Barium-128	100
Barium-131m	1,000
Barium-131	100
Barium-133m	100
Barium-133	100
Barium-135m	100
Barium-139	1,000
Barium-140	100
Barium-141	1,000
Barium-142	1,000
Lanthanum-131	1,000
Lanthanum-132	100
Lanthanum-135	1,000
Lanthanum-137	10
Lanthanum-138	100
Lanthanum-140	100
Lanthanum-141	100
Lanthanum-142	1,000
Lanthanum-143	1,000
Cerium-134	100
Cerium-135	100
Cerium-137m	100
Cerium-137	1,000
Cerium-139	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Praseodymium-136	1,000
Praseodymium-137	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Praseodymium-138m	,000
Praseodymium-139	1,000
Praseodymium-142m	1,000
Praseodymium-142	100
Praseodymium-143	100
Praseodymium-144	1,000
Praseodymium-145	100
Praseodymium-147	1,000
Neodymium-136	1,000
Neodymium-138	100
Neodymium-139m	1,000
Neodymium-139	1,000
Neodymium-141	1,000
Neodymium-147	100
Neodymium-149	1,000
Neodymium-151	1,000
Promethium-141	1,000
Promethium-143	100
Promethium-144	10
Promethium-145	10
Promethium-146	1
Promethium-147	10
Promethium-148m	10
Promethium-148	10
Promethium-149	100
Promethium-150	1,000
Promethium-151	100
Samarium-141m	1,000
Samarium-141	1,000
Samarium-142	1,000
Samarium-145	100
Samarium-146	1
Samarium-147	100
Samarium-151	10
Samarium-153	100
Samarium-155	1,000
Samarium-156	1,000
Europium-145	100
Europium-146	100
Europium-147	100
Europium-148	10
Europium-149	100
Europium-150 (12.62h)	100
Europium-150 (34.2y)	1
Europium-152m	100
Europium-152	1
Europium-154	1
Europium-155	10
Europium-156	100
Europium-157	100
Europium-158	1,000
Gadolinium-145	1,000
Gadolinium-146	10
Gadolinium-147	100
Gadolinium-148	0.001
Gadolinium-149	100
Gadolinium-151	10
Gadolinium-152	100
Gadolinium-153	10
Gadolinium-159	100
Terbium-147	1,000
Terbium-149	100
Terbium-150	1,000
Terbium-151	100
Terbium-153	1,000
Terbium-154	100
Terbium-155	1,000
Terbium-156m (5.0h)	1,000
Terbium-156m (24.4h)	1,000
Terbium-156	100
Terbium-157	10
Terbium-158	1
Terbium-160	10
Terbium-161	100
Dysprosium-155	1,000
Dysprosium-157	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Dysprosium-159	100
Dysprosium-165	1,000
Dysprosium-166	100
Holmium-155	1,000
Holmium-157	1,000
Holmium-159	1,000
Holmium-161	1,000
Holmium-162m	1,000
Holmium-162	1,000
Holmium-164m	1,000
Holmium-164	1,000
Holmium-166m	1
Holmium-166	100
Holmium-167	1,000
Erbium-161	1,000
Erbium-165	1,000
Erbium-169	100
Erbium-171	100
Erbium-172	100
Thulium-162	1,000
Thulium-166	100
Thulium-167	100
Thulium-170	10
Thulium-171	10
Thulium-172	100
Thulium-173	100
Thulium-175	1,000
Ytterbium-162	1,000
Ytterbium-166	100
Ytterbium-167	1,000
Ytterbium-169	100
Ytterbium-175	100
Ytterbium-177	1,000
Ytterbium-178	1,000
Lutetium-169	100
Lutetium-170	100
Lutetium-171	100
Lutetium-172	100
Lutetium-173	10
Lutetium-174m	10
Lutetium-174	10
Lutetium-176m	1,000
Lutetium-176	100
Lutetium-177m	10
Lutetium-177	100
Lutetium-178m	1,000
Lutetium-178	1,000
Lutetium-179	1,000
Hafnium-170	100
Hafnium-172	1
Hafnium-173	1,000
Hafnium-175	100
Hafnium-177m	1,000
Hafnium-178m	0.1
Hafnium-179m	10
Hafnium-180m	1,000
Hafnium-181	10
Hafnium-182m	1,000
Hafnium-182	0.1
Hafnium-183	1,000
Hafnium-184	100
Tantalum-172	1,000
Tantalum-173	1,000
Tantalum-174	1,000
Tantalum-175	1,000
Tantalum-176	100
Tantalum-177	1,000
Tantalum-178	1,000
Tantalum-179	100
Tantalum-180m	1,000
Tantalum-180	100
Tantalum-182m	1,000
Tantalum-182	10
Tantalum-183	100
Tantalum-184	100
Tantalum-185	1,000
Tantalum-186	1,000
Tungsten-176	1,000
Tungsten-177	1,000
Tungsten-178	1,000
Tungsten-179	1,000
Tungsten-181	1,000
Tungsten-185	100
Tungsten-187	100
Tungsten-188	10
Rhenium-177	1,000
Rhenium-178	1,000
Rhenium-181	1,000
Rhenium-182 (12.7h)	1,000
Rhenium-182 (64.0h)	100
Rhenium-184m	10
Rhenium-184	100
Rhenium-186m	10
Rhenium-186	100
Rhenium-187	1,000
Rhenium-188m	1,000
Rhenium-188	100
Rhenium-189	100
Osmium-180	1,000
Osmium-181	1,000
Osmium-182	100
Osmium-185	100
Osmium-189m	1,000
Osmium-191m	1,000
Osmium-191	100
Osmium-193	100
Osmium-194	1
Iridium-182	1,000
Iridium-184	1,000
Iridium-185	1,000
Iridium-186	100
Iridium-187	1,000
Iridium-188	100
Iridium-189	100
Iridium-190m	1,000
Iridium-190	100
Iridium-192 (73.8d)	1
Iridium-192m (1.4min.)	10
Iridium-194m	10
Iridium-194	100
Iridium-195m	1,000
Iridium-195	1,000
Platinum-186	1,000
Platinum-188	100
Platinum-189	1,000
Platinum-191	100
Platinum-193m	100
Platinum-193	1,000
Platinum-195m	100
Platinum-197m	1,000
Platinum-197	100
Platinum-199	1,000
Platinum-200	100
Gold-193	1,000
Gold-194	100
Gold-195	10
Gold-198m	100
Gold-198	100
Gold-199	100
Gold-200m	100
Gold-200	1,000
Gold-201	1,000
Mercury-193m	100
Mercury-193	1,000
Mercury-194	1
Mercury-195m	100
Mercury-195	1,000
Mercury-197m	100
Mercury-197	1,000
Mercury-199m	1,000
Mercury-203	100
Thallium-194m	1,000
Thallium-194	1,000
Thallium-195	1,000
Thallium-197	1,000
Thallium-198m	1,000
Thallium-198	1,000
Thallium-199	1,000
Thallium-200	1,000
Thallium-201	1,000
Thallium-202	100
Thallium-204	100
Lead-195m	1,000
Lead-198	1,000
Lead-199	1,000
Lead-200	100
Lead-201	1,000
Lead-202m	1,000
Lead-202	10
Lead-203	1,000
Lead-205	100
Lead-209	1,000
Lead-210	0.0
Lead-211	100
Lead-212	1
Lead-214	100
Bismuth-200	1,000
Bismuth-201	1,000
Bismuth-202	1,000
Bismuth-203	100
Bismuth-205	100
Bismuth-206	100
Bismuth-207	10
Bismuth-210m	0.1
Bismuth-210	1
Bismuth-212	10
Bismuth-213	10
Bismuth-214	100
Polonium-203	1,000
Polonium-205	1,000
Polonium-207	1,000
Polonium-210	0.1
Astatine-207	100
Astatine-211	10
Radon-220	1
Radon-222	1
Francium-222	100
Francium-223	100
Radium-223	0.1
Radium-224	0.1
Radium-225	0.1
Radium-226	0.1
Radium-227	1,000
Radium-228	0.1
Actinium-224	1
Actinium-225	0.01
Actinium-226	0.1
Actinium-227	0.001
Actinium-228	1
Thorium-226	10
Thorium-227	0.01
Thorium-228	0.001
Thorium-229	0.001
Thorium-230	0.001
Thorium-231	100
Thorium-232	100
Thorium-234	10
Thorium-natural	100
Protactinium-227	10
Protactinium-228	1
Protactinium-230	0.1
Protactinium-231	0.001
Protactinium-232	1
Protactinium-233	100
Protactinium-234	100
Uranium-230	0.01
Uranium-231	100
Uranium-232	0.001

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Uranium-233	0.001
Uranium-234	0.001
Uranium-235	0.001
Uranium-236	0.001
Uranium-237	100
Uranium-238	100
Uranium-239	1,000
Uranium-240	100
Uranium-natural	100
Neptunium-232	100
Neptunium-233	1,000
Neptunium-234	100
Neptunium-235	100
Neptunium-236 (1.15x10^{5}y)	0.001
Neptunium-236 (22.5h)	1
Neptunium-237	1.001
Neptunium-238	10
Neptunium-239	100
Neptunium-240	1,000
Plutonium-234	10
Plutonium-235	1,000
Plutonium-236	0.001
Plutonium-237	100
Plutonium-238	0.001
Plutonium-239	0.001
Plutonium-240	0.001
Plutonium-241	0.01
Plutonium-242	0.001
Plutonium-243	1,000
Plutonium-244	0.001
Plutonium-245	100
Americium-237	1,000
Americium-238	100
Americium-239	1,000
Americium-240	100
Americium-241	0.001
Americium-242m	0.001
Americium-242	10
Americium-243	0.001
Americium-244m	100
Americium-244	10
Americium-245	1,000
Americium-246m	1,000
Americium-246	1,000
Curium-238	100
Curium-240	0.1
Curium-241	1
Curium-242	0.01
Curium-243	0.001
Curium-244	0.001
Curium-245	0.001
Curium-246	0.001
Curium-247	0.001
Curium-248	0.001
Curium-249	1,000
Berkelium-245	100
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Californium-244	100
Californium-246	1
Californium-248	0.01
Californium-249	0.001
Californium-250	0.001
Californium-251	0.001
Californium-252	0.001
Californium-253	0.1
Californium-254	0.001
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Einsteinium-250	100
Einsteinium-251	100
Einsteinium-253	0.1
Einsteinium-254m	1
Einsteinium-254	0.01
Fermium-252	1
Fermium-253	1
Fermium-254	10
Fermium-255	1
Fermium-257	0.01
Mendelevium-257	10
Mendelevium-258	0.01
Any radionuclide other than alpha emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01

[1] The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in table 1, columns 1 and 2, of appendix B to §§ 20.1001–20.2401 of this part, rounding to the nearest factor of 10, and arbitrarily constraining the values listed between 0.001 and 1,000 wμCi. Values of 100 wμCi have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years (except rhenium, 1000 wμCi) to take into account their low specific activity.

Note: For purposes of §§ 20.1902(e), 20.1905(a), and 20.2201(a) where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" (i.e., "unity").

10. Part 20 is amended by adding appendix D to §§ 20.1001–20.2401 to read as follows:

Appendix D to §§ 20.1001–20.2401—United States Nuclear Regulatory Commission Regional Offices

	Address	Telephone (24 hour)
Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	USNRC, Region I, 475 Allendale Road, King of Prussia, PA 19406.	(215) 337–5000, (FTS) 346–5000.
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	USNRC, Region II, 101 Marietta Street, NW., Suite 2900, Atlanta, GA 30323.	(404) 331–4503, (FTS) 841–4503.
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	USNRC, Region III, 799 Roosevelt Road, Glen Ellyn, IL 60137.	(708) 790–5500, (FTS) 388–5500.
Region IV: Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.	USNRC, Region IV, 611 Ryan Plaza Drive, Suite 1000, Arlington, TX 76011.	(817) 860–8100, (FTS) 728–8100.
Region IV: Field Office	USNRC, Region IV, Uranium Recovery Field Office, 730 Simms Street, Suite 100a, Golden, CO 80401, Mail: P.O. Box 25325, Denver, CO 80225.	(303) 231–5800, (FTS) 554–2805.
Region V: Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U.S. territories and possessions in the Pacific.	USNRC, Region V, 1450 Maria Lane, Suite 210, Walnut Creek, CA 94596.	(415) 975–0200.

11. Part 20 is amended by adding and reserving appendix E to §§ 20.1001–20.2401.

Appendix E to §§ 20.1001–20.2401 [Reserved]

12. Part 20 is amended by adding appendix F to §§ 20.1001–20.2401 to read as follows:

Appendix F to §§ 20.1001–20.2401—Requirements for Low-Level-Waste Transfer for Disposal at Land Disposal Facilities and Manifests

I. Manifest

The shipment manifest shall contain the name, address, and telephone number of the person generating the waste. The manifest shall also include the name, address, and telephone number or the name and EPA hazardous waste identification number of the person transporting the waste to the land disposal facility. The manifest must also indicate as completely as practicable: a physical description of the waste, the volume, radionuclide identity and quantity, the total radioactivity, and the principal chemical form. The solidification agent must be specified. Waste containing more than 0.1% chelating agents by weight must be identified and the weight percentage of the chelating agent estimated. Wastes classified as Class A, Class B, or Class C in § 61.55 of this

chapter must be clearly identified as such in the manifest. The total quantity of the radionuclides ^{3}H, ^{14}C, ^{99}Tc, and ^{129}I must be shown. The manifest required by this paragraph may be shipping papers used to meet Department of Transportation or Environmental Protection Agency regulations or requirements of the receiver, provided all the required information is included. Copies of manifests required by this section may be legible carbon copies or legible photocopies.

II. Certification

The waste generator shall include in the shipment manifest a certification that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Commission. An authorized representative of the waste generator shall sign and date the manifest.

III. Control and Tracking

A. Any generating licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector shall comply with the requirements in paragraphs A.1 through 8 of this section. Any generating licensee who transfers waste to a licensed waste processor who treats or repackages waste shall comply with the requirements of paragraphs A.4 through 8 of this section. A licensee shall:

1. Prepare all wastes so that the waste is classified according to § 61.55 of this chapter and meets the waste characteristics requirements in § 61.56 of this chapter;

2. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with § 61.55 of this chapter;

3. Conduct a quality control program to ensure compliance with §§ 61.55 and 61.56 of this chapter; the program must include management evaluation of audits;

4. Prepare shipping manifests to meet the requirements of sections I and II of this appendix;

5. Forward a copy of the manifest to the intended recipient, at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation from the collector;

6. Include one copy of the manifest with the shipment;

7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by parts 30, 40, and 70 of this chapter; and

8. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this section, conduct an investigation in accordance with paragraph E of this appendix.

B. Any waste collector licensee who handles only prepackaged waste shall:

1. Acknowledge receipt of the waste from the generator within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation;

2. Prepare a new manifest to reflect consolidated shipments; the new manifest shall serve as a listing or index for the detailed generator manifests. Copies of the generator manifests shall be a part of the new manifest. The waste collector may prepare a new manifest without attaching the generator manifests, provided the new manifest contains for each package the information specified in section I of this appendix. The collector licensee shall certify that nothing has been done to the waste that would invalidate the generator's certification;

3. Forward a copy of the new manifest to the land disposal facility operator at the time of shipment;

4. Include the new manifest with the shipment to the disposal site;

5. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by parts 30, 40, and 70 of this chapter, and retain information from generator manifest until disposition is authorized by the Commission; and

6. For any shipments or any part of a shipment for which acknowledgment of receipt is not received within the times set forth in this section, conduct an investigation in accordance with section III, E of this appendix.

C. Any licensed waste processor who treats or repackages wastes shall:

1. Acknowledge receipt of the waste from the generator within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation;

2. Prepare a new manifest that meets the requirements of sections I and II of this appendix. Preparation of the new manifest reflects that the processor is responsible for the waste;

3. Prepare all wastes so that the waste is classified according to § 61.55 of this chapter and meets the waste characteristics requirements in § 61.56 of this chapter;

4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with §§ 61.55 and 61.57 of this chapter;

5. Conduct a quality control program to ensure compliance with §§ 61.55 and 61.56 of this chapter. The program shall include management evaluation of audits;

6. Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgment of receipt in the form of a signed copy of the manifest or equivalent documentation by the collector;

7. Include the new manifest with the shipment;

8. Retain copies of original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material required by parts 30, 40, and 70 of this chapter; and

9. For any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section, conduct an investigation in accordance with section III. E of this appendix.

D. The land disposal facility operator shall:

1. Acknowledge receipt of the waste within 1 week of receipt by returning a signed copy of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received;

2. Maintain copies of all completed manifests or equivalent documentation until the Commission authorizes their disposition; and

3. Notify the shipper (i.e., the generator, the collector, or processor) and the Administrator of the nearest Commission Regional Office listed in appendix D to this part when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.

E. Any shipment or part of a shipment for which acknowledgment is not received within the times set forth in this section must:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and

2. Be traced and reported. The investigation shall include tracing the shipment and filing a report with the nearest Commission Regional Office listed in appendix D to this part. Each licensee who conducts a trace investigation shall file a written report with the appropriate NRC Regional Office within 2 weeks of completion of the investigation.

Conforming Amendments

The following amendments to other parts of Chapter I of title 10 generally update citations to 10 CFR part 20 that are found in these other parts of the NRC regulations. Two amendments are particularly important as they go beyond updating cross-reference citations. The amendment to 10 CFR part 2 appendix C to §§ 20.1001–20.2401 updates and modifies the examples of the severity levels associated with violations of 10 CFR part 20 (§§ 20.1001–20.2401). The earlier version of the severity levels, which is retained as Part 2, appendix C for §§ 20.1–20.601, will apply until January 1, 1993 or until the licensee adopts the amendments to part 20 in this final rule (§§ 20.1001–20.2401). Because appendix C is a policy statement of the Commission, and not a regulation, the Commission is issuing the amendments to the Commission's enforcement policy in 10 CFR part 2, appendix C in final form without public comment.

The other important change in the conforming amendments is the deletion of "upon request" from § 19.13(b). This has the effect of requiring annual dose reports to all workers rather than only upon a request by the worker. This change conforms to the 1987 Federal Radiation Guidance from the President. The requirement to report doses to the worker at least annually applies to licensees adopting the amendments to part 20 in this final rule (§§ 20.1001–

20.2401) and will apply to all licensees on January 1, 1993.

PART 2—RULES OF PRACTICE FOR DOMESTIC LICENSING PROCEEDINGS

13. The authority citation for part 2 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

14. In appendix C to 10 CFR part 2, supplement IV is amended by revising the existing subject center heading and by adding a new subject center heading and paragraphs F through J to read as follows:

Appendix C—General Statement of Policy and Procedure for NRC Enforcement Actions

* * * * *

Supplement IV—Severity Categories

Health Physics 10 CFR Part 20 (to accompany §§ 20.1–20.601)[15]

* * * * *

Health Physics 10 CFR Part 20 (to accompany §§ 20.1001–20.2401)[15a]

F. Severity I—Violations Involving For Example

1. Single radiation exposure of a worker in excess of 25 rems total effective dose equivalent, 75 rems to the lens of the eye, or 250 rads to the skin of the whole body, or to the feet, ankles, hands or forearms, or to any other organ or tissue;

2. Single radiation exposure of the embryo/fetus of a declared pregnant woman in excess of 2.5 rems total effective dose equivalent;

3. Single radiation exposure of a minor in excess of 2.5 rems total effective dose equivalent, 7.5 rems to the lens of the eye, or 25 rems to the skin of the whole body, or to the feet, ankles, hands or forearms, or to any other organ or tissue;

4. Annual exposure of a member of the public in excess of 2.5 rems total effective dose equivalent;

5. Release of radioactive material to an unrestricted area at concentrations in excess of 50 times the limits or members of the public in table 2 of appendix B of §§ 20.1001–20.2401 of 10 CFR part 20; or

6. Disposal of licensed material in quantities or concentrations in excess of 10 times the limits of 10 CFR 20.2003.

G. Severity II—Violations Involving For Example

1. Single radiation exposure of a worker in excess of 10 rems total effective dose equivalent, 30 rems to the lens of the eye, or 100 rems to the skin of the whole body, or to the feet, ankles, hands or forearms, or to any other organ or tissue;

2. Single radiation exposure of the embryo/fetus of a declared pregnant woman in excess of 1.0 rem total effective dose equivalent;

3. Single radiation exposure of a minor in excess of 1 rem total effective dose equivalent; 3.0 rems to the lens of the eye, or 10 rems to the skin of the whole body, or to the feet, ankles, hands or forearms, or to any other organ or tissue;

4. Annual exposure of a member of the public in excess of 0.5 rem total effective dose equivalent;

5. Release of radioactive material to an unrestricted area at concentrations in excess of 10 times the limits for members of the public in table 2 of appendix B to §§ 20.1001–20.2401 of 10 CFR part 20;

6. Disposal of licensed material in quantities or concentrations in excess of five times the limits of 10 CFR 20.2003; or

7. Failure to make an immediate notification as required by 10 CFR 20.2202 (a)(1) or (a)(2).

H. Severity III—Violations Involving For Example:

1. Single radiation exposure of a worker in excess of 5 rems total effective dose equivalent, 15 rems to the lens of the eye, or 50 rems to the skin of the whole body or to the feet, ankles, hands or forearms, or to any other organ or tissue;

2. Single radiation exposure of the embryo/fetus of a declared pregnant woman in excess of 0.5 rem total effective dose equivalent;

3. Single radiation exposure of a minor in excess of 0.5 rem total effective dose equivalent; 1.5 rems to the lens of the eye, or 5 rems to the skin of the whole body, or to the feet, ankles, hands or forearms, or to any other organ or tissue;

4. Worker exposure above regulatory limits when such exposure reflects a programmatic (rather than an isolated) weakness in the radiation control program;

5. Annual exposure of a member of the public in excess of 0.1 rem total effective dose equivalent (except when operation up to 0.5 rem a year has been approved by the Commission under § 20.1301(c));

6. Release of radioactive material to an unrestricted area at concentrations in excess of two times the effluent concentration limits in table 2 of appendix B to §§ 20.1001–20.2401 of 10 CFR part 20 (except when operation up to 0.5 rem a year has been approved by the Commission under § 20.1301(c));

7. Failure to make a 24-hour notification required by 10 CFR 20.2202(b) or an immediate notification required by 10 CFR 20.2201(a)(1)(i);

8. Substantial potential for exposures or releases in excess of the applicable limits in 10 CFR part 20 §§ 20.1001–20.2401 whether or not such exposure or release occurs (e.g., operation of a radiation facility with a nonfunctioning interlock system or entry into high radiation areas, such as under reactor vessels or in the vicinity of exposed radiographic sources, without having performed an adequate survey);

9. Improper disposal of licensed material not covered in Severity Levels I or II;

10. Release for unrestricted use of contaminated or radioactive material or equipment that poses a realistic potential for exposure of the public to levels or doses exceeding the annual dose for limit for members of the public, or that reflects a programmatic (rather than an isolated) weakness in the radiation control program;

11. Conduct of licensee activities by a technically unqualified person; or

12. Significant failure to control licensed material.

I. Severity IV—Violations Involving For Example:

1. Exposures in excess of the limits of 10 CFR 20.1201, 20.1207, or 20.1208 not constituting Severity Level I, II, or III violations;

2. Release of radioactive material to an unrestricted area at concentrations in excess of the limits for members of the public in appendix B to §§ 20.1001–20.2401 of 10 CFR part 20 (except when operation up to 0.5 rem a year has been approved by the Commission under § 20.1301(c));

3. A radiation dose rate in an unrestricted or controlled area in excess of 0.002 rem in any 1 hour (2 millirem/hour) or 50 millirems in a year;

4. Failure to maintain and implement radiation programs to keep radiation exposures as low as is reasonably achievable;

5. Doses to a member of the public in excess of any EPA generally applicable environmental radiation standards, such as 40 CFR part 190;

6. Failure to make the 30-day notification required by 10 CFR 20.2201(a)(1)(ii) or 20.2203(a);

7. Failure to make a timely written report as required by 10 CFR 20.2201(b), 20.2204, or 20.2206; or

8. Any other matter that has more than a minor safety, health, or environmental significance.

J. Severity V—Violations that are of a Minor Safety, Health, or Environmental Significance

* * * * *

PART 19—NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS; INSPECTIONS

15. The authority citation for part 19 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

16. Section 19.3 is amended by revising the definition for *Restricted area* to read as follows:

§ 19.3 Definitions.

* * * * *

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

* * * * *

[15] Personnel overexposures and associated violations, incurred during a life-saving effort, will be treated on a case-by-case basis.

[15a] See footnote 15.

17. In § 19.13, paragraph (d) is amended by changing the reference to "§ 20.405 and § 20.408" to read "§ 20.405 and § 20.408 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.2202, 20.2203, 20.2204, or § 20.2206," and by revising paragraphs (b), (c), and (e) to read as follows:

§ 19.13 Notifications and reports to individuals.

* * * * *

(b) Each licensee shall advise each worker annually of the worker's dose as shown in records maintained by the licensee pursuant to part 20 (§ 20.401 and § 20.601 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.2106). Prior to January 1, 1993 licensees operating under §§ 20.1–20.601 are required to provide this information only upon request of the worker.

(c) At the request of a worker formerly engaged in licensed activities controlled by the licensee, each licensee shall furnish to the worker a report of the worker's exposure to radiation or radioactive material for each year the worker was required to be monitored under either § 20.107 or § 20.202 or, for licensees implementing the provisions of §§ 20.1001–20.2401, under § 20.1502. Such report shall be furnished within 30 days from the time the request is made, or within 30 days after the exposure of the individual has been determined by the licensee, whichever is later. This report shall cover the period of time that the worker's activities involved exposure to radiation from radioactive materials licensed by the Commission and shall include the date and locations of licensed activities in which the worker participated during this period.

* * * * *

(e) At the request of a worker who is terminating employment with the licensee that involved exposure to radiation or radioactive materials, during the current calendar quarter or the current year, each licensee shall provide at termination to each such worker, or to the worker's designee, a written report regarding the radiation dose received by that worker from operations of the licensee during the current year or fraction thereof. If the most recent individual monitoring results are not available at that time, a written estimate of the dose shall be provided together with a clear indication that this is an estimate. Licensees required by §§ 20.407–20.408 of §§ 20.1–20.601 to provide termination reports and statistical summaries of occupational doses to the Commission shall continue to provide these reports until they adopt the provisions of §§ 20.1001–20.2401, or until January 1, 1993.

PART 30—RULES OF GENERAL APPLICABILITY TO DOMESTIC LICENSING OF BYPRODUCT MATERIAL

18. The authority citation for part 30 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 584) * * *.

19. In § 30.35, paragraph (a) is amended by revising the references to "appendix C to 10 CFR part 20" and "appendix C" to read "appendix C to §§ 20.1–20.601 of 10 CFR part 20"; paragraph (d) is amended by revising the three references to "appendix C of the part 20" to read "appendix C to §§ 20.1–20.601 of 10 CFR part 20"; and by adding a note at the end of the section to read as follows:

§ 30.35 Financial assurance and recordkeeping for decommissioning.

* * * * *

Note: Appendix C of §§ 20.1–20.601 of 10 CFR Part 20 applies for the purpose of estimating decommissioning costs regardless of whether the licensee adopts 10 CFR 20.1001–20.2401 or continues to use 10 CFR 20.1–20.601.

PART 31—GENERAL DOMESTIC LICENSES FOR BYPRODUCT MATERIAL

20. The authority citation for part 31 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201), sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

§ 31.5 [Amended]

21. In § 31.5(c)(10), the reference to "§§ 20.402 and 20.403" is revised to read "§§ 20.402 and 20.403 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.1201 and 20.1202."

§ 31.7 [Amended]

22. In § 31.7(b), the reference to "§§ 20.402 and 20.403" is revised to read "§§ 20.402 and 20.403 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.1201 and 20.1202."

§ 31.10 [Amended]

23. In § 31.10(b)(1), the reference to § 20.301" is revised to read "§ 20.301 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1001."

24. In § 31.10(b)(3) the reference to "§§ 20.301, 20.402, and 20.403" is revised to read "§§ 20.301, 20.402, and 20.403 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.1001, 20.1201, and 20.1202."

§ 31.11 [Amended]

25. In § 31.11(c)(5), the reference to "§ 20.301" is revised to read "§ 20.301 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1001."

26. In § 31.11(f), the reference to "§§ 20.301, 20.402, and 20.403" is revised to read "§§ 20.301, 20.402, and 20.403 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.1001, 20.1201, and 20.1202."

PART 32—SPECIFIC DOMESTIC LICENSES TO MANUFACTURE OR TRANSFER CERTAIN ITEMS CONTAINING BYPRODUCT MATERIAL

27. The authority citation for part 32 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201), sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

28. In § 32.51, paragraphs (a)(2)(ii) and (c) are revised to read as follows:

§ 32.51 Byproduct material contained in devices for use under § 31.5; requirements for license to manufacture, or initially transfer.

(a) * * *

(2) * * *

(ii) Under ordinary conditions of handling, storage, and use of the device, the byproduct material contained in the device will not be released or inadvertently removed from the device, and it is unlikely that any person will receive in any period of 1 calendar quarter a dose in excess of 10 percent of the limits specified in the table in § 20.101(a) of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, will receive in 1 year a dose in excess of 10 percent of the annual limits specified in § 20.1201(a) of this chapter; and

* * * * *

(c) In the event the applicant desires that the general licensee under § 31.5 of this chapter, or under equivalent regulations of an Agreement State, be authorized to install the device, collect the sample to be analyzed by a specific licensee for leakage of radioactive material, service the device, test the on-off mechanism and indicator, or remove the device from installation, the applicant shall include in the application written instructions to be followed by the general licensee, estimated calendar quarter doses associated with such activity or activities, and the bases for

these estimates. The submitted information must demonstrate that performance of this activity or activities by an individual untrained in radiological protection, in addition to other handling, storage, and use of devices under the general license, is unlikely to cause that individual to receive in a calendar quarter a dose in excess of 10 percent of the limits in § 20.101(a) of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, a dose in excess of 10 percent of the annual limits specified in § 20.1201(a) of this chapter.

§ 32.61 [Amended]

29. In § 32.61(d), the reference to "§ 20.203(a)" is revised to read "§ 20.203(a) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1901(a)."

§ 32.71 [Amended]

30. In § 32.71(c)(2), the reference to "§ 20.203(a)(1)" is revised to read "§ 20.203(a)(1) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1901(a)."

31. In § 32.71(e), the reference to "§ 20.301" is revised to read "§ 20.301 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.2001."

PART 34—LICENSES FOR RADIOGRAPHY AND RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHIC OPERATIONS

32. The authority citation for part 34 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

§ 34.29 [Amended]

33. In § 34.29(a), the reference to "§ 20.203(c) (2)(ii), (2)(iii), or (4)" is revised to read "§ 20.203(c) (2)(ii), (2)(iii), or (4) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1601 (a)(2), (a)(3), or (b)."

§ 34.41 [Amended]

34. In § 34.41, the reference to "§ 20.203(c)(2)" is revised to read "§ 20.203(c)(2) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1601 (a)(1), (a)(2), or (a)(3)."

§ 34.42 [Amended]

35. In § 34.42, the reference to § 20.204(c)" is revised to read "§ 20.204(c) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1903" and the reference to "§ 20.203 (b) and (c)(1)" is revised to read "§ 20.203 (b) and (c)(1) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1902 (a) and (b)."

PART 35—MEDICAL USE OF BYPRODUCT MATERIAL

36. The authority citation for part 35 continues to read as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201), sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

§ 35.92 [Amended]

37. In § 35.92, the introductory text of paragraph (a) is amended by revising the reference to "§ 20.301" to read "§ 20.301 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.2001."

§ 35.315 [Amended]

38. In § 35.315(a)(8), the reference to "§ 20.401(c)(1)" is revised to read "§ 20.401(c)(1) of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.2106(a) of this chapter."

§ 35.415 [Amended]

39. In § 35.415(a)(1), the reference to "§ 20.105(b)" is revised to read "§ 20.105(b) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301(a)."

§ 35.630 [Amended]

40. In § 35.630 (a)(1) and (a)(2), the reference to "National Bureau of Standards" is revised to read: "National Institute of Standards and Technology."

§ 35.641 [Amended]

41. In § 35.641(a)(2)(i), the reference to "§ 20.101" is revised to read "§ 20.101 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1201."

42. In § 35.641(a)(2)(ii), the reference to "§ 20.105(b)" is revised to read "§ 20.105(b) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301."

43. In § 35.641(b)(2), the reference to "§ 20.501" is revised to read "§ 20.501 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301."

§ 35.643 [Amended]

44. In § 35.643, the introductory text of paragraph (a) is amended by revising the reference to "§ 20.105(b)" to read "§ 20.105(b) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301."

45. In § 35.643(a)(1), the reference to "§ 20.105(b)" is revised to read "§ 20.105(b) of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301(c) of this chapter."

46. In § 35.643(b), the reference to "§ 20.205(a)" is revised to read "§ 20.205(a) or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301(c)"; and the reference to "§ 20.105(b)" is revised to read "§ 20.105(b) of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301(a) of this chapter."

PART 39—LICENSES AND RADIATION SAFETY REQUIREMENTS FOR WELL LOGGING

47. The authority citation for part 39 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201), sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

§ 39.15 [Amended]

48. In § 39.15(a)(5)(iii)(B), the reference to "§ 20.203" is revised to read "§ 20.203 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1901(a)."

§ 39.31 [Amended]

49. In § 39.31(a)(1), the reference to "§ 20.203" is revised to read "§ 20.203 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1901(a)."

50. In § 39.31(a)(2), the reference to "§ 20.203" is revised to read "§ 20.203 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1901(a)."

§ 39.77 [Amended]

51. In § 39.77(b), the reference to "§§ 20.402, 20.403, and 20.405" is revised to read "§§ 20.402, 20.403, and 20.405 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.2201, 20.2202, and 20.2203."

PART 40—DOMESTIC LICENSING OF SOURCE MATERIAL

52. The authority citation for part 40 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948 as amended (42 U.S.C. 2201), sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

53. Section § 40.34 is amended by revising paragraph (a)(2) to read as follows:

§ 40.34 Special requirements for issuance of specific licenses.

(a) * * *

(2) The applicant submits sufficient information relating to the design,

manufacture, prototype testing, quality control procedures, labeling or marking, proposed uses, and potential hazards of the industrial product or device to provide reasonable assurance that possession, use, or transfer of the depleted uranium in the product or device is not likely to cause any individual to receive in any period of 1 calendar quarter a radiation dose in excess of 10 percent of the limits specified in § 20.101(a) of this chapter, or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, cause any individual to receive in 1 year a radiation dose in excess of 10 percent of the annual limits specified in § 20.2101(a) of this chapter; and

* * * * *

Appendix A to Part 40—[Amended]

54. In the first paragraph of the Introduction to appendix A, the reference to "§ 20.1(c)" is revised to read "§ 20.1(c), or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1003."

PART 50—DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

55. The authority citation for part 50 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

56. In § 50.34, paragraph (f)(2)(viii) is revised to read as follows:

§ 50.34 Contents of applications; technical information.

* * * * *

(f) * * *

(2) * * *

(viii) Provide a capability to promptly obtain and analyze samples from the reactor coolant system and containment that may contain TID–14844 source term radioactive materials without radiation exposures to any individual exceeding 5 rems to the whole body or 75 rems to the extremities or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, 5 rems to the whole body or 50 rems to the extremities. Materials to be analyzed and quantified include certain radionuclides that are indicators of the degree of core damage (e.g., noble gases, iodines and cesiums, and nonvolatile isotopes), hydrogen in the containment atmosphere, dissolved gases, chloride, and boron concentrations. (II.B.3)

* * * * *

57. In § 50.36a, the introductory text of paragraph (a) is amended by revising the reference to "§ 20.106" to read "§ 20.106 or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1301" and paragraph (b) is revised to read as follows:

§ 50.36a Technical specifications on effluents from nuclear power reactors.

* * * * *

(b) In establishing and implementing the operating procedures described in paragraph (a) of this section, the licensee shall be guided by the following considerations: Experience with the design, construction, and operation of nuclear power reactors indicates that compliance with the technical specifications described in this section will keep average annual releases of radioactive material in effluents and their resultant committed effective dose equivalents at small percentages of the dose limits specified in this chapter (§ 20.106 or, for licensees implementing the provisions of §§ 20.1001–20.2401, 20.1301) and in the operating license. At the same time, the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided a dependable source of power even under unusual operating conditions which may temporarily result in releases higher than such small percentages, but still within the dose values specified in § 20.1301 of this chapter and in the operating license. It is expected that in using this operational flexibility under unusual operating conditions, the licensee will exert its best efforts to keep levels of radioactive material in effluents as low as is reasonably achievable. The guides set out in appendix I provide numerical guidance on limiting conditions for operation for light-water-cooled nuclear power reactors to meet the requirement that radioactive materials in effluents released to unrestricted areas be kept as low as is reasonably achievable.

58. In § 50.72 in paragraph (a), Footnote 1, the reference to "§§ 20.205, § 20.403, 50.36, and 73.71" is revised to read "§§ 20.205, 20.403 or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.1906, 20.2202, 50.36, and 73.71" and paragraph (b)(2)(iv) is revised to read as follows:

§ 50.72 Immediate notification requirements for operating nuclear power reactors.

* * * * *

(b) * * *

(2) * * *

(iv)(A) Any airborne radioactive release that, when averaged over a time period of 1 hour, results in concentrations in unrestricted area that exceed 2 times the applicable concentration limits specified in appendix B to §§ 20.1–20.601, table II, column 1 of part 20 of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, 20 times the applicable concentration specified in appendix B to §§ 20.1001–20.2401, table 2, column 1, of part 20 of this chapter.

(B) Any liquid effluent release that, when averaged over a time period of 1 hour, exceeds 2 times the limiting combined concentration limits in appendix B to §§ 20.1–20.601, table II, column 2 (see note 1 to appendix B to §§ 20.1–20.601), or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, exceeds 20 times the applicable concentration specified in appendix B to §§ 20.1001–20.2401, table 2, column 2, of part 20 of this chapter, at the point of entry into the receiving waters (i.e., unrestricted area) for all radionuclides except tritium and dissolved noble gases. (Immediate notifications made under this paragraph also satisfy the requirements of paragraphs (a)(2) and (b)(2) of § 20.403 of this chapter, or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.2202 of this chapter.)

* * * * *

59. In § 50.73, paragraphs (a)(2)(viii) and (a)(2)(ix) are revised to read as follows:

§ 50.73 Licensee event report system.

(a) * * *

(2) * * *

(viii)(A) Any airborne radioactivity release that, when averaged over a time period of 1 hour, resulted in airborne radionuclide concentrations in an unrestricted area that exceeded 2 times the applicable concentration limits specified in appendix B to §§ 20.1–20.601, table II, column 1, of part 20 of this chapter or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, exceeded 20 times the applicable concentration limits specified in appendix B to §§ 20.1001–20.2401, table 2, column 1 of part 20 of this chapter.

(B) Any liquid effluent release that, when averaged over a time period of 1 hour, exceeded 2 times the limiting combined concentration limits in appendix B to §§ 20.1–20.601, table II, column 2 (see note 1 to appendix B to §§ 20.1–20.601), or, for licensees implementing the provisions of §§ 20.1001–20.2401 of this chapter, exceeds 20 times the applicable concentration specified in appendix B to §§ 20.1001–20.2401, table 2, column 2, of part 20 of this chapter at the point of

entry into the receiving waters (i.e., unrestricted area) for all radionuclides except tritium and dissolved noble gases.

(ix) Reports submitted to the Commission in accordance with paragraph (a)(2)(viii) of this section also meet the effluent release reporting requirements of § 20.405(a)(5) of this chapter, or, for licensees implementing the provisions of §§ 20.1001–20.2401, § 20.1203(a)(3) of this chapter.

* * * * *

PART 61—LICENSING REQUIREMENTS FOR LAND DISPOSAL OF RADIOACTIVE WASTE

60. The authority citation for part 61 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

§ 61.52 [Amended]

61. In § 61.52(a)(6), the reference to "§ 20.105" is revised to read "§ 20.105, or, for licensees implementing the provisions of §§ 20.1001–20.2401, §§ 20.301 and 20.302."

PART 70—DOMESTIC LICENSING OF SPECIAL NUCLEAR MATERIAL

62. The authority citation for part 70 continues to read in part as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841) * * *.

Section 70.31 is also issued under sec. 57d, Pub. L. 93–377, 88 Stat. 475 (42 U.S.C. 2077). Sections 70.36 and 70.44 also issued under sec. 184, 68 Stat. 954, as amended (42 U.S.C. 2234). Section 70.61 also issued under secs. 186, 187, 68 Stat. 955 (42 U.S.C. 2236, 2237). Section 70.62 also issued under sec. 106, 68 Stat. 939, as amended (42 U.S.C. 2138).

For the purposes of sec. 223, 68 Stat. 958, as amended, (42 U.S.C. 2273), §§ 70.3, 70.19(c), 70.21(c), 70.22 (a), (b), (d)–(k), 70.24 (a) and (b), 70.32(a) (3), (5), and (6), (d), and (i), 70.36, 70.39 (b) and (c), 70.41(a), 70.42 (a) and (c), 70.56, 70.57 (b), (c), and (d), 70.58 (a)–(g)(3), and (h)–(j) are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201(b)); §§ 70.7, 70.20a (a) and (d), 70.20b (c) and (e), 70.21(c), 70.24(b), 70.32 (a)(6), (c), (d), (e), and (g), 70.36, 70.51 (c)–(g), 70.56, 70.57 (b) and (d), 70.58 (a)–(g)(3) and (h)–(j) are issued under sec. 161i, 68 Stat. 949, as amended (42 U.S.C. 2201(i)); and §§ 70.5, 70.9, 70.20b (d) and (e), 70.38, 70.51 (b) and (f), 70.52, 70.53, 70.54, 70.55, 70.58 (g)(4), (k) and (l), 70.59, and 70.60 (b) and (c) are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

63. In § 70.25, paragraph (a) is amended by revising the references to "appendix C to 10 CFR part 20" and "appendix C" to read "appendix C to §§ 20.1–20.601 of 10 CFR part 20"; paragraph (d) is amended by revising the two references to "appendix C of part 20" to read "appendix C to §§ 20.1–20.601 of 10 CFR part 20"; and by adding a note to the end of the section to read as follows:

§ 70.25 Financial assurance and recordkeeping for decommissioning.

* * * * *

[Note: Appendix C of §§ 20.1–20.601 of 10 CFR part 20 applies for the purpose of estimating decommissioning costs regardless of whether the licensee adopts 10 CFR 20.1001–20.2401 or continues to use 10 CFR 20.1–20.601.]

Dated at Rockville, Maryland, this 2d day of April 1991.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

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