NUREG-1736

Consolidated Guidance About Materials Licenses

Consolidated Guidance: Standards for Protection Against Radiation in 10 CFR Part 20

Draft Report for Comment

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555-0001

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NUREG-1736

Consolidated Guidance About Materials Licenses

Consolidated Guidance: Standards for Protection Against Radiation in 10 CFR Part 20

Draft Report for Comment

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ABSTRACT

This document, "Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," consolidates guidance into a single comprehensive source by reference to numerous guidance documents. It complements the NUREG-1556 series, "Consolidated Guidance about Materials Licenses." Since Part 20 applies to all NRC licensees, in varying degrees, it extends beyond the materials scope of NUREG-1556. Each section in "Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," provides the following:

- A statement of the requirement (reflecting revisions published in the *Federal Register* through October 13, 1999)
- A discussion of the requirement
- A statement of the requirement's applicability
- A guidance statement
- A list of existing regulatory guidance (Regulatory Guides, NUREG reports)
- A list of existing implementation guidance (Information Notices, health physics positions, Part 20 questions and answers, etc.).

"Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," also identifies prior guidance, that is now outdated and in some cases subject to withdrawal or revision. Note that this document is strictly for public comment. It is not for use in preparing, reviewing, or implementing licenses until it is published in its final form.

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FOREWORD

The United States Nuclear Regulatory Commission (NRC) is using Business Process Redesign (BPR) techniques to redesign its materials licensing process. This effort is described in NUREG-1539, "Methodology and Findings of the NRC's Materials Licensing Process Redesign," dated April 1996. Consolidating and updating numerous guidance documents into a NUREG series of reports is a critical element of this new process.

This document, "Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," consolidates numerous guidance documents into a single, comprehensive source. It complements the NUREG-1556 series, "Consolidated Guidance about Materials Licenses." Since Part 20 applies to all NRC licensees, in varying degrees, the applicability of this document extends beyond the materials scope of the NUREG-1556 series. This document is intended for use by applicants, licensees, Part 76 certificate holders[1], NRC license reviewers and inspectors, and other NRC personnel. It combines references to the guidance for applicants and licensees previously found in various Regulatory Guides, NUREG reports, Information Notices, etc.

Each section provides the following:

- A statement of the requirement (reflecting revisions published in the *Federal Register* through October 13, 1999);
- A discussion of the requirement;
- A statement of the requirement's applicability;
- A guidance statement;
- A list of existing regulatory guidance (Regulatory Guides, NUREG reports);
- A list of existing implementation guidance (Information Notices, health physics positions, Part 20 questions and answers, etc.).

This document also identifies prior guidance, which is now outdated. For those "Existing Regulatory Guidance Documents" that are designated as "outdated," plans will be underway for withdrawal or revision prior to this document being published in its final form. Documents in this category are limited to Regulatory Guides. [None of the NUREG reports listed as regulatory guidance documents were designated as "outdated."] "Implementing Guidance Documents," or document sections, that are designated as "outdated" are considered historical and are presently not subject to updating or augmenting. This "outdated" guidance is being superceded by the guidance contained herein. Documents in this category include Health Physics Positions (HPPOS), Part 20 Questions and Answers (Q&As), and Circulars.

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[1] Part 20 also applies to Part 76 certificate holders. In this document, the term "licensees" includes Part 76 certificate holders.

FOREWORD

A team of NRC staff from Headquarters and Regional Offices drafted this document. This team drew upon their collective experience in radiation safety for creating this guidance document. A representative of NRC's Office of the General Counsel provided a legal perspective.

This document represents a step in the transition from the current paper-based process to the new electronic process. This draft document is available on the Internet at the following address: <http://www.nrc.gov/NRC/NUREGS/XXXXXXXXXXXXXXXXXXXX/index.html>.

This draft report is strictly for public comment. It is not for use in preparing, reviewing, or implementing licenses until it is published in its final form. It is being distributed for comment to encourage public participation during its development. NRC is requesting comments on the information provided, including feedback on the prior guidance designated as "outdated." Please submit comments within 90 days of the draft report's publication. Comments received after that time will be considered if practicable.

Address comments to: Chief, Rules and Directives Branch, Division of Administrative Services, Office of Administration, U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Hand deliver comments to 11545 Rockville Pike, Rockville, MD, between 7:15 a.m. and 4:30 p.m. on Federal workdays. Comments may also be submitted through the Internet by sending electronic mail to dlm1@nrc.gov.

"Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," dated September 2000, is not a substitute for NRC regulations, and compliance is not required. The approaches and methods described in this draft report are provided for information and comment only.

Donald A. Cool, Director
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ABBREVIATIONS

AEC	United States Atomic Energy Commission
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
ANSI	American National Standards Institute
APF	assigned protection factor
bkg	background
BPR	business process redesign
Bq	Becquerel
CDE	committed dose equivalent
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
Ci	Curie
cpm	counts per minute
DAC	derived air concentration
DDE	deep-dose equivalent
DOE	United States Department of Energy
DOELAP	Department of Energy Laboratory Accreditation Program
DOP	dioctyl pthalate
DOT	United States Department of Transportation
DPW	declared pregnant woman
EDO	Executive Director for Operations, United States Nuclear Regulatory Commission
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
FDA	United States Food and Drug Administration
G	giga (10^9), a prefix
G-M	Geiger-Mueller
GPO	Government Printing Office
Gy	Gray
HEPA	high efficiency particulate (air)
HPPOS	NUREG/CR-5569, ORNL/TM-12067, Rev. 1, "Health Physics Positions Database"

ABBREVIATIONS

HRA	high radiation area
ICRP	International Commission on Radiation Protection
ISFI	independent spent fuel storage installation
IN	Information Notice
k	kilo (10^3), a prefix
LDE	lens-dose equivalent
LSA	low specific activity
LTP	license termination plan
MARSSIM	multi-agency radiation survey and site investigation manual
mGy	milligray
MMR	mask mounted regulator
mR	milliroentgen
mrem/yr	millirem(s) per year
MSA	Mine Safety Appliance Company
MSHA	Mine Safety and Health Administration
mSv	millisievert
NARM	accelerator-produced radioactive material
NCRP	National Council on Radiation Protection and Measurements
ND	not determined
NESHAPS	National Environmental Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMSS	Office of Nuclear Materials Safety and Safeguards
NOED	notice of enforcement discretion
NORM	naturally occurring radioactive material
NOV	notice of violation
NR	not recorded
NRC	United States Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration

PAPR	powered air purifying respirator
PSE	planned special exposure
PWR	pressurized water reactor
Q&A	NUREG/CR-6204, "Questions and Answers Based on Revised 10 CFR Part 20"
QA	quality assurance
QLFT	qualitative fit test
QNFT	quantitative fit test
R	Roentgen
RG	Regulatory Guide
RQ	reportable quantities
RSO	radiation safety officer
SAR	supplied-air respirator
SCBA	self-contained breathing apparatus
SDE	shallow-dose equivalent
SDMP	Site Decommissioning Management Plan
SI	International System of Units (abbreviated SI from the French Le Système Internationale d'Unites)
SSD	sealed source and device
std	standard
Sv	Sievert
TAR	technical assistance request
TEDE	total effective dose equivalent
TI	transportation index
TLD	thermoluminescent dosimeters
TODE	total organ dose equivalent
VHRA	very high radiation area
WL	working level
WLM	working level month

USING THE INTERNET TO OBTAIN COPIES OF NRC DOCUMENTS AND OTHER INFORMATION

In an effort to make NRC documents and information readily available to licensees and the general public, NRC is placing documents and information on its internet web site.

Many of the reference sections of this draft NUREG refer to a world wide web address on the internet (e.g.,<http://www.nrc.gov>). Applicants and licensees who have internet access may use the referenced address to find more information on a topic, the referenced document, or information on obtaining the referenced document.

To access the referenced site, type the address into the location box of the internet browser software and press the [enter] key. Sometimes the given address does not go directly to the necessary page; however, the addressed page will have links to the information referenced in this draft NUREG. Generally, links appear either as blue text or as a picture in the document. To use a link, place the pointer on the blue text or picture. The pointer will change from an arrow to a hand with the index finger extended. By double-clicking the mouse on the blue text or picture, the internet browser will go to the selected page. For example, if you wanted to review the definitions in 10 CFR Part 20, type <http://www.nrc.gov> in the location box of your browser and press the [enter] key. After the NRC home page comes up, place the pointer on the reference library icon. The arrow will change to a hand with the index finger extended. Double-click the pointing device button. Next, place the pointer on the blue text, "Title 10 of the Code of Federal Regulations" and double-click the mouse. Place the pointer on the blue text "20" and double-click. Finally, place the pointer on the blue text "Definitions" and double-click.

There are two documents that are referenced repeatedly in Implementing Guidance lists for the various chapters. One is NUREG/CR-6204, "Questions and Answers Based on Revised 10 CFR Part 20," published in May, 1994. References from this publication are abbreviated as "Q&A." The other is NUREG/CR-5569, Rev. 1, "Health Physics Positions Data Base," published in February, 1994. References from this publication are abbreviated as "HPPOS." Both references are available at the above web site, in the "Radiation Protection and Emergency Response" section.

1 PURPOSE OF DRAFT REPORT

This document is strictly for public comment. It is *not* for use in preparing or reviewing applications for licenses, or for other purposes until this document is published in its final form.

This draft report consolidates numerous guidance documents relating to 10 CFR Part 20, "Standards for Protection Against Radiation," into a single, comprehensive source by reference to numerous guidance documents. "Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," applies to all NRC licensees, in varying degrees. The draft report, once published in final form, is intended for use by applicants, licensees, NRC license reviewers and inspectors, and other NRC personnel.

The format, within this document, for each item of technical information, i.e., for each section in Part 20, is as follows:

- A statement of the requirement (reflecting revisions published in the *Federal Register* through October 13, 1999);
- A discussion of the requirement;
- A statement of its applicability;
- A guidance statement;
- A list of existing regulatory guidance (Regulatory Guides, NUREG reports);
- A list of existing implementation guidance (Information Notices, health physics positions, Part 20 questions and answers, etc.).

This report also identifies prior guidance, which is now outdated. For those "Existing Regulatory Guidance Documents" that are designated as "outdated," plans will be underway for withdrawal or revision prior to this document being published in its final form. Documents in this category are limited to Regulatory Guides. [None of the NUREG reports listed as regulatory guidance documents were designated as "outdated."] "Implementing Guidance Documents," or document sections, that are designated as "outdated" are considered historical and are presently not subject to updating or augmenting. Documents in this category include Health Physics Positions (HPPOS), Part 20 Questions and Answers (Q&As), and Circulars.

In this document, "dose" or "radiation dose" means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent. These terms are defined in Part 20. Rem and its SI equivalent Sievert (1 rem = 0.01 Sievert (Sv)) are used to describe units of radiation exposure or dose. This is because Part 20 sets dose limits in terms of rem, not rad or roentgen.

2 AGREEMENT STATES

Certain states, called Agreement States (see Figure 2.1), have entered into agreements with NRC that give them the authority to license and to inspect byproduct, source, or special nuclear materials used or possessed within their borders. Agreement State licensees with specific questions on guidance referenced in this NUREG should contact the responsible officials in their Agreement State. Agreement State contacts are listed on the Office of State and Tribal Programs' web site at <http://www.hsrd.ornl.gov/nrc/home.html>.

In general, NRC's materials licensees who wish to conduct operations at temporary job sites in an Agreement State should contact that State's radiation control program office for information about State regulations. To ensure compliance with Agreement State reciprocity requirements, a licensee should request authorization well in advance of scheduled use.

In the special situation of work at Federally-controlled sites in Agreement States, it is necessary to know the jurisdictional status of the land to determine whether NRC or the Agreement State has regulatory authority. NRC has regulatory authority over land determined to be "exclusive Federal jurisdiction," while the Agreement State has jurisdiction over non-exclusive Federal jurisdiction land. Licensees are responsible for finding out, in advance, the jurisdictional status of the specific areas where they plan to conduct licensed operations. NRC recommends that licensees ask their local contact for the Federal Agency controlling the site (e.g., contract officer, base environmental health officer, district office staff member) to help determine the jurisdictional status of the land and to provide the information in writing, so that licensees can comply with NRC or Agreement State regulatory requirements, as appropriate. Additional guidance on determining jurisdictional status is found in the All Agreement States Letter, SP-96-022, dated February 16, 1996, which is available from NRC upon request.

Table 2.1 provides a quick way to determine which agency has regulatory authority.

Table 2.1 Who Regulates the Activity?

Applicant and Proposed Location of Work	Regulatory Agency
Federal Agency, regardless of location (except that, under most circumstances, Department of Energy [DOE] and its prime contractors are exempt from licensing [e.g., 10 CFR 30.12, 40.11, 70.11])	NRC
Non-Federal entity in non-Agreement State, U.S. territory, or possession	NRC
Non-Federal entity in Agreement State at non-Federally controlled site	Agreement State
Non-Federal entity in Agreement State at Federally-controlled site not subject to exclusive Federal jurisdiction	Agreement State
Non-Federal entity in Agreement State at Federally-controlled site subject to exclusive Federal jurisdiction	NRC

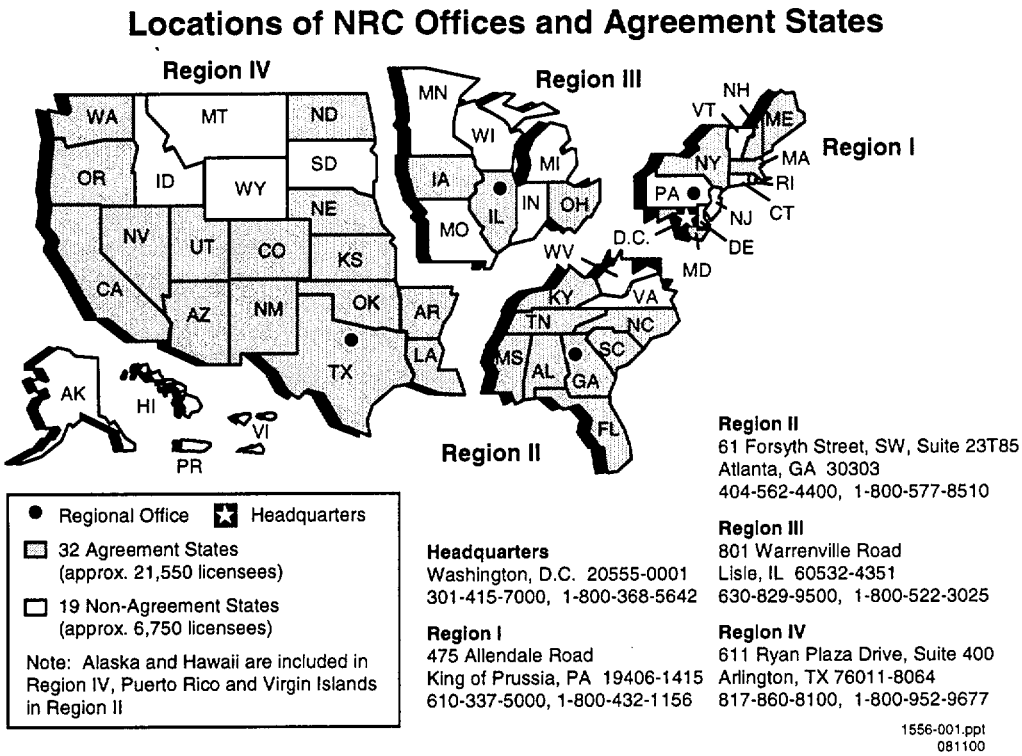

Figure 2.1 U.S. Map. ***Location of NRC Offices and Agreement States.***

Reference: A current list of Agreement States (including names, addresses, and telephone numbers of responsible officials) is available by choosing "Directories" on the NRC Office of State and Tribal Programs' (STP's) Home Page, <http://www.hsrd.ornl.gov/nrc/home.htm>, or by requesting the list from NRC's Regional Offices.

The All Agreement States Letter, SP-96-022, on determining jurisdictional status at a Federal facility, dated February 16, 1996, is available on STP's Home Page, <http://www.hsrd.ornl.gov/nrc/home.htm>. From the Home Page, choose "NRC-State Communications" then choose "All of the Above" and follow the directions for submitting a query for "SP96022." Applicants can also request the letter from STP by calling NRC's toll free number, (800) 368-5642, extension 415-3340.

3 PART 20

3.20.1001 PURPOSE

Statement of Requirement:
(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.

Discussion:
NRC derives its authority to regulate the use of certain radioactive materials and radiation sources from two acts of Congress, known as the Atomic Energy Act and the Energy Reorganization Act. NRC evolved from the Atomic Energy Commission, which was established by the Atomic Energy Act in 1954 and abolished by the Energy Reorganization Act in 1974. The 1974 Act, at the same time, established NRC and gave it the regulatory authority that previously was exercised by the AEC.

NRC regulations are codified in Title 10 of the Code of Federal Regulations (CFR). The Code of Federal Regulations has 50 titles encompassing all areas affected by Federal regulation. Title 10 is the part of the Code that is concerned with energy regulation, and it includes both NRC and Department of Energy regulations Title 10 is divided into several chapters, and Chapter I contains NRC's regulations. Chapter I, in turn, is subdivided into 200 parts, each part dealing with one or a few related areas regulated by NRC. For example, Part 20 deals with Standards for Protection Against Radiation, Part 30 deals with by-product materials licensing, and Part 50 deals with reactor licensing.

Statement of Applicability:
All NRC Licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

Statement of Requirement:
(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.

Discussion:
Part 20 establishes regulations that are designed to keep doses to workers and to members of the public within specified dose limits. The annual dose limits specified in this part apply to all doses received by the worker, both at the NRC licensee's facility and at other facilities in which the worker may have received exposure, regardless of whether the other facilities are NRC licensees or whether they are licensed by other entities, such as the State.

This section also makes clear that Part 20 regulations do not apply to licensee activities performed in order to mitigate potential health and safety consequences from accidents or from other incidents involving radioactive material. They also do not apply to emergency actions taken by personnel engaged in the NRC-licensed activity. An example would be fire fighting by employees of a city fire department at an NRC-licensed facility. Nothing in Part 20 should be interpreted as limiting any activity or action taken to protect public health and safety, such as lifesaving or maintaining confinement of radioactive materials. However, efforts should be made to adhere to these requirements during responses to emergencies, because the requirements were designed to protect the health and safety of workers and the general public.

Statement of Applicability:
All licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 5	Who is responsible for regulating radon
Q&A 407	Does Part 20 apply to emergency response personnel

3.20.1002 SCOPE

Statement of Requirement:
The regulations in this part apply to persons licensed by the Commission to receive, possess, use, transfer, or dispose of by-product, source, or special nuclear material, or to operate a production or utilization facility under Parts 30 through 36, 39, 40, 50, 60, 61, 70, or 72 of this chapter, and, in accordance with 10 CFR 76.60, to persons required to obtain a certificate of compliance or an approved compliance plan under Part 76 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, to exposure from individuals administered radioactive material and released in accordance with §35.75, or to exposure from voluntary participation in medical research programs.

Discussion:
The rules in Part 20 apply to all NRC licensees and to Part 76 certificate holders. However, the following exemptions are in effect:

- Exposure received from naturally occurring background radiation;
- Patients receiving treatments with radiation or radioactive materials;
- Any member of the public who may receive radiation exposure from patients who are released in accordance with §35.75, following the administration of radioactive materials;
- Doses received by persons who voluntarily take part in medical research involving exposure to radiation or to the administration of radioactive materials.

However, if the sources of radiation, or the radioactive materials, are being used under an NRC license, the rules apply to the licensee personnel administering these treatments or tests, as well as to members of the public.

It should also be noted that NRC's authority to regulate the use of radiation sources and radioactive materials extends only to those materials specified in the Atomic Energy Act. For historical reasons, the Act restricted this authority to materials that are involved in the nuclear fuel cycle. In practice, this includes the following:

- Certain uranium and thorium ores, known as source materials;
- Materials produced in a nuclear reactor from fission or from activation by reactor neutrons, known as by-product materials;
- Other important materials that may be used as fuels for nuclear reactors, known as special nuclear materials, such as enriched uranium, plutonium, and other similar materials that may be specified by the Commission.

For example, NRC will regulate the use of cobalt in teletherapy units and technetium use in nuclear medicine because both are byproduct materials that are produced in nuclear reactors. However, it does not regulate the use of other isotopes used in medical applications, such as certain isotopes of thallium, since these isotopes are produced in an accelerator, and therefore do not fall under NRC jurisdiction. NRC also does not regulate the use of X-ray machines or accelerators, for the same reason. Radioactive materials and sources of radiation that fall outside NRC's mandate are usually regulated by the state in which these sources and materials are used. However, note the discussion in §20.1001(b) regarding dose limits to radiation workers who receive exposure from both NRC-licensed and other sources of exposure.

Statement of Applicability:
All NRC Licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 5	Regulation of radium
HPPOS-038	Request for Interpretation of Applicability of DOT[2] Regulations to NRC-Licensed State or Federal Entities
HPPOS-197	Authority to Regulate States Concerning Their Licensees Working at DOE Facilities
HPPOS-265	Policy and Guidance Directive FC 83-19, Jurisdiction at Reactor Facilities
HPPOS-198	Licensing of Nuclear Materials for Use on the High Seas and in Antarctica
HPPOS-199	NRC's Jurisdiction at U.S. Armed Forces Bases Abroad

[2] U.S. Department of Transportation

3.20.1003 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.

Discussion:
Note that if an individual remains in the area for 12 hours during a week, then the two conditions above are equivalent, i.e., an area with an airborne concentration of 1 DAC will also result in an intake of 12 DAC-hours to such an individual. If the stay time is longer than 12 hours, the area must be posted at a lower airborne concentration than a DAC. On the other hand, if the stay time is less than 12 hours, then posting will be required at airborne concentrations above a DAC. Note also that condition (2) is based on an intake estimate that does not make any allowance for the use of respiratory protection equipment. In other words, credit for use of a respirator is not taken when assessing the need to post the area, although credit may be taken when assessing intakes by workers who worked in that area.

Air-purifying respirator means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

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.

Discussion:
Note that "dose" in this context means the total effective dose equivalent (TEDE), which includes both internal and external doses. Internal and external doses are not minimized separately, and ALARA efforts are directed at minimizing their sum, the TEDE. The use of TEDE in ALARA is based on the assumption that a rem of dose results in the same stochastic risk, independently of whether the dose was delivered by an external field or by internally deposited radioactive materials.

Most ALARA efforts do not involve large capital outlays, and ALARA analyses in such cases are qualitative. Examples include: working in the most efficient manner, using mock-ups to train workers, making sure that proper tools and materials are available when needed, using shields wherever practical, keeping areas clean, minimizing contamination, and similar measures.

In cases involving large capital investments, such as the construction of large and complex shields or large permanent containments, a quantitative assessment of ALARA options may be required. In such cases, NRC has recommended using a monetary value for the man-rem of $2000 to aid in making such quantitative assessments.

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.)

Discussion:
"ALI" is the quantity of radioactive material taken into the body through inhalation or ingestion that will result in an effective dose of 5 rem or an organ dose of 50 rem. ALI is a derived limit. The fundamental limit is the annual dose limit, which is 5 rem for the effective dose and 50 rem for the organ doses. The ALI is derived from the dose limits by applying internal dosimetry models that permit calculation of the intake of a radioactive material that would deliver specified, internal effective and organ doses. The ALI is included in Part 20 for the convenience of the licensee, so that internal dosimetry models do not have to be used repeatedly to establish internal dose control measures.

The dose received from an intake is directly proportional to the size of that intake for a given radioactive material. Therefore, if an intake of an ALI results in an effective dose of 5 rem, then an intake of 10% of an ALI results in an effective dose of 500 mrem.

Assigned protection factor (APF) means the expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF.

Atmosphere-supplying respirator means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Background radiation means radiation from cosmic sources; naturally occurring radioactive material, 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 or from past nuclear accidents (such as Chernobyl) that contribute to background radiation and are not under the control of the licensee. "*Background radiation*" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission.

Discussion:
Radiation from the same type of radioactive material may be considered "background" or subject to regulatory control, depending on the circumstances. A licensee whose work areas are in a concrete basement may experience substantial radon exposures because of radon diffusion into the structure from the ground. This exposure is not subject to regulation, and is considered background. However, if that same licensee also stores licensed uranium close to the work area, the uranium will emit radon that will contribute to worker exposure. This exposure must be evaluated because it does not arise from natural sources but from the storage of the uranium in the workplace.

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.

Discussion:
"*In vivo* counting" refers to whole body counting as well as specific organ counting, such as thyroid counting or lung counting. *In vitro* counting is a term that refers to bioassay by analysis of bodily excretions, such as urine, feces, sweat, exhaled breath, saliva, nasal smears, and sometimes blood, for radioactive content. The method of choice will depend on many factors, but mainly it will depend on the isotope involved in the intake, its chemical form, and the desired sensitivity.

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.

Discussion:
The classes that apply to different materials are listed in Appendix B to Part 20. Note that most materials can exist in all three classes, depending on the chemical compound in which they are incorporated. If the guidance in Appendix B is insufficient to enable a reliable classification in a specific situation, then other references must be used, or laboratory tests may be conducted in an attempt to obtain an accurate classification. The classification of the material into one of the three classes has a major effect on the internal dose assessed following the intake of that material. It also has a profound effect on the design of an appropriate bioassay program. For further information, see ICRP Publication Nos. 10, 10A, 30.

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.

Discussion:
"Collective dose" is the dose used in making ALARA assessments in work situations. The object is to reduce stochastic risks to the group involved in the activity as a whole and not to any one member of the group. When collective dose is minimized, collective cancer risk for the entire group is minimized.

It should be noted that ALARA analysis may minimize the collective dose but may result in one or a few members of the group receiving significantly higher doses than the rest of the group. There is no regulatory requirement against such an uneven distribution, but many licensees attempt to provide approximate dose equity for their workers over the monitoring year.

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.

Discussion:
The dose from an intake may be delivered over a period of weeks, years, or throughout the individual's lifetime. However, when assigning the dose from the intake, all of the dose that will be delivered over the 50 years following the intake is assigned to the year in which the intake occurs. This is done because it simplifies dose recordkeeping and the movement of workers among different work locations, which otherwise would be very difficult.

NRC imposes limits on the dose to each organ to guard against nonstochastic effects. The committed dose is only one component of the dose to the organ. If there is external irradiation, then the organ will also receive a dose from the external field, and that dose must be added to the committed dose to obtain the total organ dose. The regulatory limit on organ dose applies to this sum of internal and external dose components.

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. ($H_{E,50} = \Sigma j\ W_T\ H_{T,50}$).

Discussion:
The "effective dose equivalent" is defined such that it is determined not only by the dose received by each organ, but also by the relative risk that the organ will develop cancer from the radiation dose. The relative risk is expressed through the weighting factors. The dose limit on effective dose equivalent is based on: the minimization of the risks of cancer and hereditary effects; the assumption that there is no low dose threshold for the risk of such effects; and that the risk increases linearly with the dose, that is, it is directly proportional to the dose.

Constraint (dose constraint) means a value above which specified licensee actions are required.

Discussion:
The difference between a "constraint" and a "limit" is in the actions taken when they are exceeded. Exceeding the constraint requires corrective actions to prevent recurrence. Exceeding a limit also requires corrective action to prevent recurrence, but enforcement action may also be taken against the licensee. NRC currently imposes only one constraint, which is on air emissions from licensed facilities. Although the NRC dose limit to the public from such air emissions is 100 mrem/yr, assuming that these air emissions are the only exposure pathway, a constraint of 10 mrem/yr is imposed on that dose. The constraint was imposed to achieve compatibility with the U.S. Environmental Protection Agency's (EPA's) National Environmental Standards for Hazardous Air Pollutants (NESHAPS) regulations.

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.

Discussion:
Some sections of 10 CFR Part 20 require the observation of certain security measures for licensed material that is stored or that is being used in controlled or unrestricted areas. An area may be designated as a controlled area for security reasons, for the presence of industrial hazards, or for any reason other than radiological. If an area must be controlled for radiological reasons, then it becomes a restricted area.

Critical Group means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

Discussion:
The concept of the "critical group" is most often used in connection with the assessment of doses to members of the public from licensed operations. In such situations, the critical group is the one that receives the highest dose, and it is also the most sensitive to the effects of radiation. In some cases, it may be the group that lives closest to the site, but in others it may be children of a specified age.

Declared pregnant woman means a woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

Discussion:
It should be noted that a written declaration of pregnancy is not equivalent to informing the licensee that the woman is pregnant. Rather, it is a request by the woman to be subject to reduced dose limits, as specified in NRC's regulations, during the period of the pregnancy. The woman's obvious pregnancy is not to be confused with the declaration of pregnancy, and such an obvious pregnancy, unless accompanied by a written declaration, has no relevance in establishing dose limits for that worker.

Decommission means to remove a facility or site safely from service and reduce residual radioactivity to a level that permits:

1. Release of the property for unrestricted use and termination of the license; or
2. Release of the property under restricted conditions and termination of the license.

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).

Discussion:
Because the effective dose equivalent is not a measurable quantity, in the case of external irradiation, NRC uses the deep-dose equivalent as a measurable surrogate for that dose. NRC does not define effective dose equivalent for external radiation exposures, as is the case in ICRP publications.

Demand respirator means an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

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.

Discussion:
The "derived air concentration" is provided by NRC in Appendix B as a convenience to licensees. It is not a derived limit, in the same sense that ALI is a derived limit. There are no penalties for exceeding the DAC in the workplace, at any time, provided that the applicable limits, such as ALI or the committed doses, are not exceeded, and provided that ALARA is implemented.

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).

Disposable respirator means a respirator for which maintenance is not intended and that is designed to be discarded after excessive breathing resistance, sorbent exhaustion, physical damage, or end-of-service-life renders it unsuitable for use. Examples of this type of respirator are a disposable half-mask respirator or a disposable escape-only self-contained breathing apparatus (SCBA).

Distinguishable from background means that the detectable concentration of a radionuclide is statistically different from the background concentration of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

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).

Discussion:
The value of the "other necessary modifying factors" has been redefined as unity, that is, modifying factors are not currently taken into account and may be ignored.

Dosimetry processor means an individual or organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the equipment.

Discussion:
If the licensee obtains personal monitoring devices, such as film or thermoluminescent dosimeters (TLDs), from a vendor, and returns them to the vendor for processing, then the processor is the vendor. If the licensee has an on-site processing facility, the licensee is also the processor.

Effective dose equivalent (H_g) 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 ($H_g = \Sigma\, w_T H_T$).

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.

Filtering facepiece (dust mask) means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps.

Fit factor means a quantitative estimate of the fit of a particular respirator to a specific individual and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit test means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

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].

Helmet means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

High radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body 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 30 centimeters from any surface that the radiation penetrates.

Discussion:
A key element in this definition is that the area must be accessible to individuals. Open ports in vessels and similar structures within which high radiation fields exist, and into which a person may insert an arm, are also considered accessible. An area that is completely enclosed with no access point would not be considered accessible. In considering the posting of such inaccessible areas, good practice would have a warning posted in case forcible entry into the area is required, such as in the case of a fire.

Hood means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

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, thermoluminescence 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.

Lens-dose equivalent (LDE) 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).

Discussion:
The lens-dose limit is based on the threshold for the development of cataracts. The cell layer in which cataracts may develop is below a surface cell layer that is 0.3 cm thick. The value of 300 mg/cm^2 is obtained by multiplying the thickness, in this case 0.3 cm, by the density of the material, in this case taken as 1 gm/cm^3. The result is 0.3 gm/cm^2.

License means a license issued under the regulations in Parts 30 through 36, 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.

Discussion:
The dose limits are "never-to-be-exceeded" values. However, they should not be viewed as the doses up to which persons may be routinely exposed, provided the limits are not exceeded. Limits should be viewed as restrictions placed on ALARA. The doses to which workers may be routinely exposed are determined by ALARA analysis of the work and by the exposure situation.

However, if ALARA analysis results in one or a few of the workers receiving doses in excess of the limits to minimize the collective dose, then the limits are applied to override the analysis. There are few situations in which workers are routinely exposed to more than a small fraction of the annual limits. Situations in which these fractions are high should be carefully examined and justified.

Loose-fitting facepiece means a respiratory inlet covering that is designed to form a partial seal with the face.

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 any individual except when that individual is receiving an occupational dose.

Discussion:
The determination of "occupational" doses is based on whether the person's work is connected to the licensed activity, or whether it is only remotely connected (or not connected) to such activities. An administrative person who is not doing any radiological work, but whose office must be in a restricted area in which low levels of radiation exist as a result of the licensed activity is considered to be occupationally exposed. On the other hand, a delivery person, or a person who visits the site routinely to restock vending machines is not occupationally exposed at that site. For further information, see NUREG/CR 6204, Question 26(a) through (d), Pages 4-7.

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.

Negative pressure respirator (tight fitting) means a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

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).

Discussion:
The organ dose limit of 50 rem/yr, the eye dose limit of 15 rem/yr, and the skin dose limit of 50 rem/yr are all based on nonstochastic effects and are set at levels believed to be below the thresholds for these effects over a lifetime of exposure. Nonstochastic effects are now referred to in the technical literature as deterministic effects.

NRC means the Nuclear Regulatory Commission or its duly authorized representatives.

Occupational dose means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or 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, from any medical administration the individual has received, from exposure to individuals administered radioactive materials and released in accordance with §35.75, from voluntary participation in medical research programs, or as a member of the 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.

Positive pressure respirator means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Powered air-purifying respirator (PAPR) means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Pressure demand respirator means a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

Public dose means the dose received by a member of the public from exposure to radiation or radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to

individuals administered radioactive material and released in accordance with §35.75, or from voluntary participation in medical research programs.

Qualitative fit test (QLFT) means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

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.

Quantitative fit test (QNFT) means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Quarter means a period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive 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.

Discussion:
"Reference Man," also called "Standard Man," is a set of standardized physical parameters (such as organ weights and volumes) and physical characteristics (such as inhalation and exhalation rates and metabolic parameters). Reference Man has both male and female organs, such as ovaries, testes, and female breasts. The characteristics of Reference Man are used mostly in internal dose calculations, because such dose calculations require data such as inhalation and excretion rates, organ masses, geometrical relationships among organs, and other metabolic parameters. In an intake situation, the doses calculated using Reference Man data are the doses to a person conforming to these physical characteristics. Doses to the actual exposed individual will most likely not conform to the Reference Man. However, in most cases, these doses are sufficiently accurate, and they are acceptable for demonstrating compliance with regulatory

requirements. However, adjustments may be necessary to take into account the characteristics of the exposed person, if these differ substantially from those of Reference Man, especially in cases of large intakes.

Rem [See §20.1004].

Residual radioactivity means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20.

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.

Discussion:
Access to a "restricted area" must be controlled to prevent unauthorized entry. However, the controls need not be physical barriers, such as locked doors, but may include administrative controls such as surveillance.

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.

Self-contained breathing apparatus (SCBA) means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

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 per cent (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.

Discussion:
The limit on the effective dose equivalent is intended to keep the risk of stochastic effects to a level that is sufficiently low, so the risk is considered acceptable by most experts in the field. However, according to the linear-no-threshold hypothesis, the risks resulting from doses below the regulatory limit for the effective dose equivalent are not zero.

Supplied-air respirator (SAR) or airline respirator means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Survey means an evaluation 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.

Discussion:
In Part 20, the meaning of "survey" differs somewhat from that commonly used in the nuclear industry to mean the measurement of dose rates using a survey instrument. In Part 20, the meaning of survey is broader and includes any activity using available relevant information, including data obtained from field measurements to assess the radiation hazards. Note that performing surveys in the field with a survey instrument without assessing the resulting data to

evaluate hazards would not be considered as having satisfied the requirement to perform an adequate survey.

Tight-fitting facepiece means a respiratory inlet covering that forms a complete seal with the face.

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).

Discussion:
The definition of "TEDE" given here differs from that used in the health physics literature in that it does not define the dose from external irradiation in terms of an effective dose, but rather in terms of the deep-dose equivalent. This precludes the use of weighting factors for external exposure, and it also precludes taking credit for the use of shielding over parts of the body, such as the use of a lead apron in radiology work. Furthermore, it precludes taking credit for highly non-uniform external fields, such as fields coming from underfoot that result mostly in extremity exposures and in little whole-body dose. Taking credit for all such situations requires prior approval from NRC on a case-by-case basis. See also the footnote to the table of weighting factors below.

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.

User seal check (fit check) means an action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.

Very high radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body 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 1 meter 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).

Discussion:
The footnote to this definition stems from the fact that the "rem" is defined as the product of the dose in "rads" and the "quality factor." However, quality factors vary widely depending on the end point of interest. In radiation protection work, the rem is defined using the quality factor for cancer as the end point of concern, which is a stochastic effect. In cases of high, acute exposures, such as in an accident, the end point of concern is not cancer but deterministic effects, commonly known as "radiation sickness." The quality factors for such effects may be substantially different from those for cancer, and the calculated dose equivalent in rem may, therefore, not be a valid measure to use in selecting the appropriate mitigation, such as in medical care, in therapy, or in determining prognosis.

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:

Table 1003.1. 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 surface	0.03
Remainder	0.30[a]
Whole Body	1.00[b]

[a] 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.

[b] 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.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1004 UNITS OF RADIATION DOSE

Statement of Requirement:
(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 Monoenergenic Neutrons

	Neutron energy (MeV)	Quality factor[a] (Q)	Fluence per unit dose equivalent[b] (neutrons cm^{-2} rem^{-1})
(thermal).....	$2.5x10^{-8}$	2	$980x10^6$
	$1x10^{-7}$	2	$980x10^6$
	$1x10_{-6}$	2	$810x10^6$
	$1x10^{-5}$	2	$810x10^6$
	$1x10^{-4}$	2	$840x10^6$
	$1x10^{-3}$	2	$980x10^6$
	$1x10^{-2}$	2.5	$1010x10^6$
	$1x10^{-1}$	7.5	$170x10^6$
	$5x10^{-1}$	11	$39x10^6$
	1	11	$27x10^6$
	2.5	9	$29x10^6$
	5	8	$23x10^6$
	7	7	$24x10^6$
	10	6.5	$24x10^6$
	14	7.5	$17x10^6$
	20	8	$16x10^6$
	40	7	$14x10^6$
	60	5.5	$16x10^6$
	$1x10^2$	4	$20x10^6$
	$2x10^2$	3.5	$19x10^6$
	$3x10^2$	3.5	$16x10^6$
	$4x10^2$	3.5	$14x10^6$

[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.

Discussion:
The roentgen (R) is no longer defined in 10 CFR Part 20. This follows international conventions, which no longer recommend the use of the R. In addition, the U.S. National Institute of Standards and Technology (NIST) no longer provides instrument calibrations in R units. The quantity kerma, which has the same units as the dose, is used in place of the R. Instruments reading in units of R may still be used, with the assumption that the R is numerically equal to the rad and to the rem. The abbreviation for sievert is Sv.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1005 UNITS OF RADIOACTIVITY

Statement of Requirement:
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.

1. One becquerel = 1 disintegration per second (s^{-1}).
2. One curie = 3.7×10^{10} disintegrations per second = 3.7×10^{10} becquerels = 2.22×10^{12} disintegrations per minute.

Discussion:
Submultiples of the Ci and Bq frequently used in radiation applications include:

- Millicurie = 10^{-3} Ci
- Microcurie = 10^{-6} Ci
- Nanocurie = 10^{-9} Ci
- Picocurie = 10^{-12} Ci

Statement of Applicability:
All NRC licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1006 INTERPRETATIONS

Statement of Requirement:
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.

Discussion:
Licensees may have questions regarding the meaning or the applicability of sections of this regulation to specific situations. One way to get information is to discuss the matter with an NRC representative, such as the NRC inspector or the licensing staff member, or with other Regional or Headquarters NRC personnel. Although such information may be useful, and may help clarify the situation, NRC does not officially recognize such informal guidance by its staff, and licensees will be held responsible for any compliance violations, even if the action was based on discussions with NRC representatives. The only recognized method of obtaining an interpretation that is binding is to obtain it, in writing, from NRC's Office of the General Counsel. It is acceptable to send questions or requests for interpretation of regulations in specific scenarios, in writing, to Regional or Headquarters staff. The staff will obtain "no legal objection" from the Office of the General Counsel on their written response to the licensee's request. The Commission may authorize deviations from this process, but such authorizations are invoked only in unusual circumstances. Notwithstanding this caution, most questions that licensees raise regarding the applicability and meaning of regulations are satisfactorily resolved through informal discussions with appropriate NRC representatives.

Note that although this regulation authorizes the General Counsel to issue formal, written interpretations that are recognized as binding on the Commission, this authority is exercised sparingly and only in instances involving major policy or legal questions. Following issuance, these interpretations are codified in 10 CFR Part 8; to date, only four such written interpretations have been issued.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1007 COMMUNICATIONS

Statement of Requirement:
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.

Discussion:
This section simply states that communications, i.e., letters or other correspondence, reports or applications having to do with any aspects of 10 CFR Part 20, should be addressed to, or delivered in person to, the Office of the Executive Director for Operations (EDO).

Statement of Applicability:
This section is applicable to all NRC licensees.

Guidance Statement:
Communications or correspondence with NRC regarding license or compliance issues, such as license applications, are normally addressed to the appropriate Regional Office. This section simply states that correspondence pertaining to Part 20 should be forwarded to the Office of the EDO.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1008 IMPLEMENTATION

Statement of Requirement:
(a) [Reserved]

(b) The applicable section of §§20.1001 - 20.2402 must be used in lieu of requirements in the standards for protection against radiation in effect prior to January 1, 1994[3] that are 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 - 20.2402 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 requirement in the standards for protection against radiation in effect prior to January 1, 1994[3], it continues to exempt a licensee from the corresponding provision of §§20.1001 - 20.2402.

(e) If a license condition cites provisions in requirements in the standards for protection against radiation in effect prior to January 1, 1994[3] and there are no corresponding provisions in §§20.1001 - 20.2402, 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.

Discussion:
In 1994, a major revision of Part 20 became effective. For licensees whose licenses may reference earlier provisions of Part 20 (previous Part 20), this section requires that licensees follow the current provisions of Part 20 (revised Part 20) rather than the referenced provisions. However, if the license condition or the technical specification concerns a provision that is more restrictive that the revised Part 20 provision, that condition or specification will remain in effect until the license is amended or until the technical specification is changed. By the same token, if a license condition or a technical specification specifically exempts a licensee from some provision of the previous Part 20, that exemption remains in effect. If a license condition references a provision in the previous Part 20 and there is no corresponding provision in the revised Part 20, the license condition remains in force until it is amended.

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[3] See §§20.1 - 20.602 codified as of January 1, 1993.

Statement of Applicability:
This section applies to those licensees whose license or technical specifications reference provisions of the previous Part 20.

Guidance Statement:
None required.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 30	Implementation of the revised Part 20
Q&A 58	Embryo/Fetus
Q&A 65	OMB approval of the revised Part 20 provisions

3.20.1009 REPORTING, RECORDING, AND APPLICATION REQUIREMENTS: OMB APPROVAL

Statement of Requirement:
(a) The Nuclear Regulatory Commission has submitted the information collection requirements contained in this part to the Office of Management and Budget (OMB) for approval as required by the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*). NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. OMB has approved the information collection requirements contained in this part under control number 3150-0014.

(b) The approved information collection requirements contained in this part appear in §§20.1003, 20.1101, 20.1202, 20.1203, 20.1204, 20.1206, 20.1208, 20.1301, 20.1302, 20.1403, 20.1404, 20.1406, 20.1501, 20.1601, 20.1703, 20.1901, 20.1902, 20.1904, 20.1905, 20.1906, 20.2002, 20.2004, 20.2006, 20.2102, 20.2103, 20.2104, 20.2105, 20.2106, 20.2107, 20.2108, 20.2110, 20.2201, 20.2202, 20.2203, 20.2204, 20.2205, 20.2206, 20.2301, and Appendix G to 10 CFR Part 20.

(c) This part contains information collection requirements in addition to those approved under the control number specified in Paragraph (a) of this section. These information collection requirements and the control numbers under which they are approved are as follows:

1. In §20.2104, NRC Form 4 is approved under control number 3150-0005.
2. In §§20.2106 and 20.2206, NRC Form 5 is approved under control number 3150-0006.
3. In §20.2006 and Appendix G to 10 CFR Part 20, NRC Form 540 and 540A is approved under control number 3150-0164.
4. In §20.2006 and Appendix G to 10 CFR Part 20, NRC Form 541 and 541A is approved under control number 3150-0166.
5. In §20.2006 and Appendix G to 10 CFR Part 20, NRC Form 542 and 542A is approved under control number 3150-0165.

Discussion:
In order for a rule to incorporate a requirement for licensees to report or to otherwise provide written information to NRC, or to maintain written records of their licensed activities, that requirement must first be approved by OMB. If approval is given, it is accompanied by an OMB control number. The activities covered under this rule include such things as documenting the radiation control program, maintaining exposure records, maintaining calibration and survey records, reporting personnel doses to NRC, and filing incident reports. The OMB control numbers for the information collection requirements in Part 20 are listed above.

PART 20

Statement of Applicability:
All NRC licensees.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1101 RADIATION PROTECTION PROGRAMS

Statement of Requirement:
(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.)

Discussion:
A licensee must have a written radiation protection program. The extent of the program depends on the magnitude and the complexity of the program operations, and on the degree of risk to the workers and the public from its operation.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
Licensees are required to document their programs. Written procedures are generally the chief vehicle for licensee management to establish methods and processes to ensure proper and consistent implementation of their radiation protection programs. Procedures can include policy and technical issues, and are reviewed and approved by licensee management. A nuclear power plant licensee would be expected to have a considerably larger, more complex program than a materials licensee using only sealed sources.

List of Existing Regulatory Guidance Documents:

Reg. Guide 1.33	Revision 2, Appendix A, "Quality Assurance Program Requirements"
NUREG-1556	Consolidated Guidance About Materials Licenses, all applicable volumes

List of Implementing Guidance:

HPPOS 128	Interpretation – RG 1.33, Meaning of "Procedure Implementation...," STS Section 6.8.1. (Explains the meaning of the requirement to "implement" procedures at nuclear power plants.)
HPPOS 129	Humboldt Bay Radiation Protection Procedures. (Specific reading on meaning of "maintaining" procedures at a now-decommissioned nuclear power plant)
Q&A 7	What a radiographer has to do to comply with this requirement
Q&A 11	Answers administrative nature of documentation of plan
Q&A 99	Explains relationship of nuclear power plant emergency plans to this requirement
Q&A 134	Focuses on audit and review portions of this requirement
Q&A 381	Provides reason DG-8004 was not issued as final

Statement of Requirement:
(b) The licensee shall use, to the extent practical, 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).

Discussion:
Each licensee is required to use reasonable practices and controls to strive to maintain doses to the workers and to the public ALARA.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
Compliance with this requirement will be judged on whether the licensee has incorporated measures to track and, if necessary, to reduce exposures to workers and the public; it does not require doses to be an absolute minimum or that the licensee use all possible methods to reduce exposures. 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.

List of Existing Regulatory Guidance Documents:

Reg. Guide 8.8	"Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Plants Will Be As Low As Is Reasonably Achievable," Revision 3
Reg. Guide 8.10	"Operating Philosophy for Maintaining Occupational Radiation Exposures as Low As Is Reasonably Achievable," Revision 2
Reg. Guide 8.18	"Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable"
Reg. Guide 8.31	"Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable"
Reg. Guide 8.37	"ALARA Levels for Effluents from Material Facilities"
Reg. Guide 8.39	"Release of Patients Administered Radioactive Materials"
Reg. Guide 3.56	"General Guidance for Designing, Testing, and Operating, and Maintaining Emission Control Devices at Uranium Mills"

List of Implementing Guidance:

HPPO 091	Lead Shielding Attached to Safety-related Systems Without 10 CFR 50.59 Evaluations (Alerts nuclear power plant licensees of the need to analyze for impact of shielding placed on plant safety systems)
Q&A 60	Clarifies what records are needed for evaluations required by 20.1703 TEDE ALARA

Q&A 62	Provides inspection plans in ALARA area for nuclear power plants
Q&A 133	Explains meaning of "practicable," relative to the ALARA requirement
Q&A 381	Discusses status of outdated Regulatory Guides

Statement of Requirement:
(c) The licensee shall periodically (at least annually) review the radiation protection program content and implementation.

Statement of Applicability:
All NRC licensees.

Discussion:
At least once each year, each licensee shall review the radiation protection program content and determine if the written program is being implemented.

Guidance:
The review should be conducted at least once every 12 months by qualified persons who do not have direct responsibility over the program (independent of programmatic responsibility). The review should cover procedural compliance, technical adequacy, implementation and effectiveness of the program. Lessons learned and suggested improvements from these reviews should be considered for program improvements.

List of Existing Regulatory Guidance Documents:

Reg. Guide 10.8	"Guide for the Preparation of Applications for Medical Use Programs," Revision 2
NUREG-1556	Consolidated Guidance About Materials Licenses, all applicable volumes

List of Implementing Guidance:

Q&A 118	Allows some relief on the requirement to review the entire program each year, and describes and gives guidance on audits
Q&A 134	Gives some insight on recordkeeping and this section's relationship to other audit requirements for Part 50 licensees

Statement of Requirement:
(d) To implement the ALARA requirements of §20.1101 (b), and notwithstanding the requirements in §20.1301 of this part, a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, shall be established by licensees other than those subject to §50.34a, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem (0.1 mSv) per year from these emissions. If a licensee subject to this requirement

exceeds this dose constraint, the licensee shall report the exceedance as provided in §20.2203 and promptly take appropriate corrective action to ensure against recurrence.

Discussion:
While the dose limits for individual members of the public are given in 20.1301, each licensee must also implement the ALARA requirements of 20.1101(b). To ensure that this ALARA requirement is met, each licensee (power reactors are exempt) shall establish a dose constraint of no more than 10 mrem in one year from airborne radioactive material releases. The licensee shall determine the individual member of the public who is most likely to receive the highest TEDE from airborne releases and keep that person's dose at or below 10 mrem. TEDE from Radon-222 releases (and all its daughter decay products) are not to be counted in the dose determination.

If the dose constraint is exceeded, the licensee must send NRC a written report describing the event. Additionally, the licensee must take actions to correct the cause of excessive releases so that the dose constraint is not exceeded again.

Statement of Applicability:
All NRC licensees other than power reactors.

Guidance Statement:
The dose constraint applies only to release of airborne radioactive effluents to the environment, and thus, generally the TEDE to the nearest member of the public. If the constraint is exceeded, NRC will review and approve the licensee's corrective actions. Exceeding the dose constraint will not result in a notice of violation (NOV), but failure to report the exceedance would result in an NOV, as would failure to institute agreed-to corrective actions to prevent reoccurrence.

Many licensees, like radiographers, well loggers and other users of sealed sources (in a form that would not cause airborne material releases to the environment) need not take any actions to demonstrate compliance with the constraint on releases.

List of Existing Regulatory Guidance:
Reg. Guide 4.20 "Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees Other Than Power Reactors"

List of Implementing Guidance:
N/A.

3.20.1201 OCCUPATIONAL DOSE LIMITS FOR ADULTS

Statement of Requirement:
(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) A lens-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, lens-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 Part 20 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 Part 20).

(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)).

Discussion:
All NRC licensees are required to control radiation doses to individuals working in licensed activities, who receive occupational exposure as a result of licensed and unlicensed activities. This section establishes the numerical limits on doses to these individuals, including limits on doses to individual organs of the body.

The exposure to any level of radiation is assumed to carry with it a certain amount of risk. In the absence of scientific certainty regarding the relationship between low dose exposure and health effects, and as a conservative assumption for radiation protection purposes, the scientific community generally assumes that any exposure to ionizing radiation may cause undesirable biological effects and that the likelihood of these effects increases as the dose increases. At the total occupational dose limit of 5 rem (0.05 Sv) per year, the risk is believed to be very low.

Paragraph (b) of this section concerns the situation where an individual's dose exceeds an annual limit. Section 20.1206 allows an individual to receive an additional 5 rem (0.05 Sv) in a year and 25 rem (0.25 Sv) in a lifetime during "planned special exposures." Paragraph (b) states that in the event that an individual receives an occupational dose (whether during routine work, accidents, emergencies, or planned special exposures) exceeding the annual limit, the excess must be subtracted from the total that is allowed under "planned special exposures."

With regard to monitoring the doses received by individuals, personnel dosimeters measure doses received by only a small portion of the body. It is possible for the body to be exposed to collimated or non-uniform radiation fields, or the body could shield the dosimeter. If so, the dosimeter may not record the highest dose received by the individual. Paragraph (c) of this section requires that, in monitoring, the dose recorded must reflect the highest dose received. If the dosimeter is not representative of the maximum dose, surveys or other measurements must be used to assess the actual maximum dose. This applies to whole body deep doses as well as shallow (skin) doses and doses to the lens of the eye.

For those individuals who are subject to work environments where the inhalation or ingestion of radioactive material is possible, Paragraph (d) addresses a mechanism that may be used for demonstrating compliance with the annual dose limits. Air concentration values and quantities of intake are provided that indicate the amount of radioactive material that can be taken into the body that would result in a dose equal to the annual dose limits.

Paragraph (f) of this section concerns doses received by individuals who may receive doses from activities at more than one employer. The total dose to an individual includes all doses received from all sources except background and non-occupational radiation exposure associated with medical care. If a radiation worker is required to be monitored for exposure by two or more employers, each licensee must account for all of the radiation doses received by the employee from all the other employers, even if the doses were derived from non-licensed activities. The total dose must not exceed the applicable NRC limit.

Statement of Applicability:
Paragraph (a) is applicable to all NRC licensees.

Paragraph (b) is only applicable in those cases where individuals receive planned special exposures under §20.1206.

Paragraph (c) is applicable to all NRC licensees required to monitor radiation doses.

Paragraph (d) is applicable to those NRC licensees who are required to assess internal doses.

Paragraph (f) is applicable to NRC licensees who have employees who receive occupational doses from other employment.

Guidance Statement:
Paragraph (a) establishes an annual limit on the TEDE (see definitions in §20.1003) of 5 rem (0.05 Sv). For most licensees, the TEDE is equivalent to the Deep-Dose Equivalent (DDE), which is commonly reported on personnel dosimetry reports. If your licensed program involves the potential for internal dose due to ingestion or inhalation of radioactive material, you may have to consider performing a more detailed evaluation of TEDE involving the summation of the DDE and the committed effective dose equivalent from intakes. The annual limit for any individual organ or tissue dose is 50 rems (0.5 Sv). This limit is the Total Organ Dose Equivalent (TODE). TODE is the sum of the Committed Dose Equivalent (CDE) from intakes and the DDE. Likewise, if a licensee's program involves the potential for significant dose to the lens of the eye, the skin, or any extremity, additional evaluations must be performed to assess those doses.

NRC considers 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), for 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, introduced a number of significant modifications to existing concepts and recommendations of the ICRP. The ICRP approach provides for selecting dose limits based on estimated risks comparing health risks in the nuclear industry with health risks in other industries and risks to members of the public with everyday risks, and adding doses from dissimilar exposure modes to obtain the total risk. NRC has adopted the basic tenets of the ICRP system of dose limitation. The current radiation protection standards on Part 20 are based on the following: 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 5 rem (0.05 Sv) annual dose limit represents a total mortality risk of 8×10^{-4}. A more complete description of the health

risks from occupational radiation exposure and the information that should be provided to workers is provided in Regulatory Guide 8.29.

The definition of shallow-dose equivalent (SDE) refers to two distinct areas of the body: the skin of the whole body and the skin of the extremities. The dose limits apply to any specified region of the skin, and the doses to different regions of the skin are not additive. This means that if an area on the abdomen receives an SDE during one job, and an area on the back receives an SDE during another job, the two doses need not be added to show compliance, but may be tracked separately through the dose monitoring period, which is one year.

The same considerations apply to the extremities. This means that each arm and each lower leg may be exposed separately up to 50 rem (0.5 Sv) SDE. This method is advantageous in cases of skin contamination or in exposures to highly non-uniform fields. It does not apply to whole body exposures to penetrating radiation because virtually all of the skin of the body receives a dose from such exposures, even on body surfaces away from the source, such as, for example, the back when the source is in front of the worker.

Paragraph (f) is applicable to NRC licensees who have employees who receive occupational doses from other employment. Consider the case of a radiation worker, employed by an NRC licensee, assigned to an X-ray unit at a local hospital to perform X-ray calibrations. The X-ray machines are regulated by the State – not by NRC. Any dose received by the worker during the X-ray activity must be added to the doses received at the NRC-licensed facility to show compliance with the Part 20 dose limit, even though some of this dose was received at a facility not licensed by NRC. The responsibility to show compliance is with the worker's employer, who, in this example, is the NRC licensee. The dose limits in Part 20 apply to the total dose received by the worker from both NRC-licensed and other work activities, regardless of the proportion of the total dose received from the NRC-licensed activity. The licensee may provide the employee with appropriate dosimetry to use during the outside work assignment, or the licensee may arrange with the hospital to monitor the worker during the assigned work and to provide the dose results to the licensee at the end of the assignment or at the end of the monitoring year, whichever comes first.

List of Existing Regulatory Guidance Documents:

Reg. Guide 8.13	Instruction Concerning Prenatal Radiation Exposure
Reg. Guide 8.19	Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants – Design Stage Man-Rem Estimates
Reg. Guide 8.29	Instruction Concerning Risks from Occupational Radiation Exposure
Reg. Guide 8.34	Monitoring Criteria and Methods to Calculate Occupational Radiation Doses

List of Implementing Guidance:

HPPO-002	Overexposure of Diver During Work in Fuel Storage Pool
HPPO-186	Determination of Radiation Exposure from Dosimeters
HPPO-246	Enforcement Policy For Hot Particle Exposure – Answers to Three Questions
HPPO-273	Technical Assistance Request, Evaluation of Comments on NRC Information Notice for Ophthalmic Applicators
IN No. 84-40	Emergency Worker Doses
IN No. 86-23	Excessive Skin Exposures Due to Contamination With Hot Particles
Q&A 2	Dose from non-NRC-licenses sources
Q&A 3	Hot particles
Q&A 6	Previous occupational exposure
Q&A 31	Student and volunteer exposures
Q&A 33	Dose limit for visitors
Q&A 34	Radiation limits in a controlled area
Q&A 41	Exposures from multiple employers
Q&A 45	Eye dose equivalent – Use of glasses
Q&A 46	Eye dose equivalent tissue depth
Q&A 77	Protected area vs. controlled area
Q&A 97	Doses received during accident/emergencies
Q&A 100	Monitoring of eye dose equivalent
Q&A 123	Annual limit = year
Q&A 172	Limit to the head vs. eye dose equivalent
Q&A 175	Whole body dose when lead apron used
Q&A 176	Shallow-dose equivalent to multiple locations on body
Q&A 177	Annual limit on exposure to the head
Q&A 217	Radiation exposure at another facility
Q&A 414	Additional exposure above 5 rem (0.05 Sv) in a year
Q&A 415	Frequency of monitoring
Q&A 435	Deep-dose equivalent from hot particles
Q&A 436	Occupational dose received from another facility

3.20.1202 COMPLIANCE WITH REQUIREMENTS FOR SUMMATION OF EXTERNAL AND INTERNAL DOSES

Statement of Requirement:
(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[4] 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.

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[4] An organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factor, w_T, and the committed dose equivalent, $H_{T,50}$, per unit intake is greater than 10 percent of the maximum weighted value of $H_{T,50}$, (i.e., $w_T H_{T,50}$) per unit intake for any organ or tissue.

Discussion:
Almost every exposure of the body involves the irradiation of more than one tissue and, therefore, NRC believes that it is appropriate to express radiation dose limits in terms of the total risk of all tissue irradiated. This means setting a single dose limit for uniform irradiation of the whole body. These dose limits are based on a system that is designed to ensure that the total risk from irradiation of parts of the body does not exceed that from uniform irradiation of the whole body. This involves the summation of doses from external irradiation of the body and the doses from the deposition of radioactive material in the body.

Statement of Applicability:
For most licensees, radiation exposure will be almost exclusively from sources of internal or external radiation. For example, individuals using sealed sources, such as radiographers or gauge users, receive their radiation dose from sources that are external to the body. Since it is unlikely that these workers will receive any occupational internal exposure that would affect their overall radiation risk, it is unnecessary for such licensees to sum internal and external doses. There are, however, certain categories of licensees where workers are subject to internal as well as external exposure. In such cases, if the exposure is at a level where monitoring is required for both internal and external, then summation of these exposures is required.

Guidance Statement:
The first step in determining whether licensees need to sum internal and external doses is to determine if the licensees are required to monitor for both internal and external exposure. See the discussion under §20.1502 to determine if you are required to monitor for internal or external exposure.

NRC does not use the ALI in the regulation of worker exposures because allowable annual intakes may be substantially below the ALI if there are internal and external radiation exposures. This is because the ALI is calculated on the assumption that the external dose is zero, and the maximum intakes must be reduced below the ALI to allow for any external exposures. For example, if the external dose for the year is 1 rem (10 mSv), the intake that would deliver an effective dose equivalent of 1 rem (10 mSv) is 20% of an ALI, and the allowable intake for that year is, therefore, 80% of the ALI. In no case, however, is the total TEDE to exceed 5 rems per year.

List of Existing Regulatory Guidance:
N/A.

List of Current Implementing Guidance:

Q&A 9	Summing the dose when internal exposure is less than 10% of the limit
Q&A 38	Use of bioassay results to determine if summing is required
Q&A 86	Definition of "per unit intake"
Q&A 101	Evaluations of exposure through skin

Q&A 180 Oral ingestion in addition to inhalation

Q&A 438 Summation of "voluntary" monitoring of internal exposure

List of Outdated Implementing Guidance:

Q&A 179 Evaluations of TEDE before July 1993

3.20.1203 DETERMINATION OF EXTERNAL DOSE FROM AIRBORNE RADIOACTIVE MATERIALS

Statement of Requirement:
Licensees shall, when determining the dose from airborne radioactive material, include the contribution to the deep-dose equivalent, lens-dose equivalent, and shallow-dose equivalent from external exposure to the radioactive cloud (see Appendix B to Part 20, 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.

Discussion:
This section requires that for situations where an individual is working in an area where airborne radioactive material exists, the licensee must consider the contribution that the airborne radioactivity makes to the total external exposure that the individual receives, i.e., calculating internal dose from concentrations in air is insufficient because the submersion dose needs to be taken into consideration.

Statement of Applicability:
This section applies to all licensees who have workers in areas where airborne concentrations of radioactivity exist.

Guidance Statement:
The regulation requires that the licensee consider the contribution of the airborne radioactivity to the total external dose (deep-dose equivalent). In most cases, this can be assessed through the use of normal personnel monitoring equipment or survey instrumentation. For example, for individuals present in atmospheres containing noble gases, the dose contribution from the noble gases cannot be assessed by the normal methods of measuring intakes. The preferred method of determining worker exposure to noble gases is by radiation dose measurements using personnel dosimeters. When the noble gas is a weak beta emitter, it is necessary to calculate the skin dose using measurements of the concentration of the gas to which the workers were exposed.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
Q&A 50 Exposures to noble gases

3.20.1204 (a)(b) DETERMINATION OF INTERNAL EXPOSURE

Statement of Requirement:
(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
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.

Discussion:
To determine worker exposures from intakes, licensees must either measure the airborne radioactivity in work areas or perform bioassay measurements, or a combination of the two. Bioassay measurements may be performed by either directly determining the radioactivity in the worker's body (e.g., whole body counting, thyroid monitoring, or *in vivo* monitoring) or indirectly assessing the intake of radioactive material by determining the radioactivity in excreta (e.g., urine or *in vitro* monitoring).

If workers do not use respirators in airborne radioactivity areas, and if bioassay measurements are not performed, licensees must use the concentration of airborne radioactivity in work areas when determining dose from intakes for those workers.

Statement of Applicability:
All licensees who are required to monitor worker doses from intakes in accordance with 10 CFR 20.1502(b).

Guidance Statement:
In conjunction with 10 CFR 20.1502(b), which requires licensees to monitor for likely intakes, 10 CFR 20.1204(a) and (b) prescribe how information obtained through monitoring is to be used when assessing exposures to workers from intakes.

NRC recommends that licensees consider the methods described in Reg. Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program," for estimating intakes of radionuclides, and NUREG-1400, "Air Sampling in the Workplace," for determining the frequency of bioassay measurements.

List of Existing Regulatory Guidance:

Reg. Guide 8.9	Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program
Reg. Guide 8.15	Acceptable Programs for Respiratory Protection
Reg. Guide 8.25	Air Sampling in the Workplace
Reg. Guide 8.34	Monitoring Criteria and Methods to Calculate Occupational Radiation Doses
Reg. Guide 8.36	Radiation Dose to the Embryo/Fetus
NUREG-0938	Information for Establishing Bioassay Measurements and Evaluations of Tritium Exposure
NUREG-1400	Air Sampling in the Workplace
NUREG/CR 4884	Interpretation of Bioassay Measurements

List of Outdated Regulatory Guidance:

Reg. Guide 8.11	Applications of Bioassay for Uranium
Reg. Guide 8.20	Applications of Bioassay for I-125 and I-131
Reg. Guide 8.22	Bioassay at Uranium Mills
Reg. Guide 8.26	Applications of Bioassay for Fission and Activation Products
Reg. Guide 8.32	Criteria for Establishing a Tritium Bioassay Program

List of Implementing Guidance:

HPPO 47	Personnel Monitoring Requirements for an NRC/Agreement State-Licensed Contractor Working at a Part 50-Licensed Facility
HPPO 94	Guidance Concerning 10 CFR 20.103 and Use of Pressure Demand SCBAs
HPPO 233	Applicability of Regulatory Position 1.3 of Regulatory Guide 8.32 to Nuclear Reactor Facilities
HPPO 255	Airborne Thorium from Welding Rods
IN 97-36	Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials and External Exposure Due to Inadequate Control of Work
IN 96-18	Compliance with 10 CFR Part 20 for Airborne Thorium
IN 95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material
Q&A 43	Prospective Analyses
Q&A 44	Annual Prospective Analyses

Q&A 54	Respiratory Protection Credit
Q&A 75	Transient Worker – Internal Dose Recordkeeping
Q&A 98	Historical Basis to Require Internal Monitoring at Power Plants
Q&A 114	Transient Worker – Internal Dose Recordkeeping
Q&A 126	Inclusion of External Doses from Effluents
Q&A 372	"Suitable and Timely" Measurements
Q&A 375	Acceptable Bioassay Frequency
Q&A 398	Transient Worker Internal Dose Recordkeeping

3.20.1204 (c) ADJUSTMENTS TO DACS AND ALIS

Statement of Requirement:
(c) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of 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 Part 20) to the committed effective dose equivalent.

Discussion:
The ALIs and the DACs listed in Appendix B to 10 CFR Part 20 are based on generalized metabolic and biochemical properties. They are useful in determining the resultant dose to the reference man from a given intake, with the understanding that the physical and chemical forms of some radionuclides may behave differently in the body of a real person and result in a different dose. With this in mind, NRC will allow licensees to assign a committed effective dose equivalent that is different than that resulting from the use of ALI or DAC in Part 20, if the licensee has specific information regarding the behavior of the radionuclide. This approach may be used for calculating doses to a single worker, to a group of workers, or to an entire facility, based on the specific characteristics of the radionuclides used by the licensee. A licensee must receive prior NRC approval before adjusting the DAC or ALI for a radionuclide, based on specific information, such as known particle size and distribution from a specific licensee operation. In addition, licensees are not required to assume that intakes of radionuclides are a single solubility class when calculating the committed effective dose equivalent, if they know the fractional distribution. However, the licensee must have specific knowledge of the solubility class distribution of the intakes in order to use this approach.

Statement of Applicability:
This section is applicable to those licensees who wish to assign a dose based on specific physical, chemical, or behavioral properties of radionuclides used in their facilities.

Guidance Statement:
Although the ALIs and DACs listed in Appendix B to 10 CFR Part 20 are based on the metabolic modeling used by the ICRP in Publication 30, NRC recognizes that these are general considerations using standard chemical forms and reference man metabolic modeling. Each individual's physiological characteristics and biochemical processes may be different. In addition, the particulars of the exposure situation, such as particle size and solubility class

distribution, will affect the lung compartment deposition fractions and the resultant biological clearances. Individual specific retention and excretion rates may be used in developing biokinetic models that differ from the reference man modeling. The quality and quantity of data used for this type of individual specific modeling should be sufficient to justify the revised model. Licensees should not attempt to develop individual specific retention and excretion fractions in the absence of actual biochemical and particle size information.

List of Existing Regulatory Guidance:

Reg. Guide 8.9	Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program
Reg. Guide 8.25	Air Sampling in the Workplace
NUREG-1400	Air Sampling in the Workplace
NUREG/CR 4884	Interpretation of Bioassay Measurements

List of Implementing Guidance:

Q&A 47	Guidance on Adjusting DACs and ALIs
Q&A 458	"Weighted" and "Effective" DACs to Determine Dose

3.20.1204 (d) DOSE FROM CLASS Y MATERIALS

Statement of Requirement:
(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.

Discussion:
Due to the relatively slow elimination rate of Solubility Class Y materials, licensees may take the extra time specified to perform additional bioassay measurements, either *in vivo*, *in vitro*, or both, in order to refine their calculations of the dose equivalent from intakes of those materials. However, if the licensee determines, based on initial air sampling and/or bioassay results, that a worker has received a committed effective dose equivalent or a committed dose equivalent that exceeds NRC's limit, the licensee may not delay reporting and notification to NRC to allow for the additional measurements.

Statement of Applicability:
This section is applicable to those licensees who must assign dose equivalent from intakes of Class Y materials.

Guidance Statement:
No further guidance is necessary.

List of Existing Regulatory Guidance Documents:
N/A.

List of Implementing Guidance:
Q&A 183 Assignment of Dose from Class Y Materials

3.20.1204 (e)(f)(g) DETERMINATION OF DAC FOR RADIONUCLIDES IN A MIXTURE

Statement of Requirement:
(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 Part 20 for each radio-nuclide 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.

Discussion:
Licensees have two options for determining the fraction of the DAC for a mixture of known radionuclides in air. The first option is to total the fractional contributions of each radionuclide (see Note 4 to Appendix B, 10 CFR Part 20) in the mixture. The other option is to compare the total concentration of all the radionuclides in the mixture against the radionuclide with the smallest DAC. Although using the second option will conservatively overestimate the DAC fraction, it will indicate whether further evaluation of the airborne concentration and any resultant committed effective dose equivalent is necessary. Scenarios 1 and 2, below, highlight the possible results of using these different options in a particular case.

If the licensee has identified all of the radionuclides in a mixture but has not determined the concentration of one or more of the radionuclides, then the ratio of the total concentration to the smallest DAC value of the radionuclides is the fraction of the DAC for the mixture. This is true even if the smallest DAC value is for one of the radionuclides of known concentration in the mixture.

If a portion of the radionuclides in a mixture in air comprises only a small fraction of the total concentration, the licensee is not required to determine the DAC fractions and the dose contributions for those radionuclides. This approach is allowed, provided that the individual radionuclides and the total fractions disregarded do not exceed 10% and 30%, respectively. In addition, the total concentration of the mixture must include the contributions from any disregarded radionuclides, when determining compliance with the dose limits and the monitoring requirements.

Statement of Applicability:
This section is applicable to those licensees who monitor airborne concentrations involving mixtures of radionuclides.

Guidance Statement:
The following three scenarios are provided to aid in explaining the requirements in 10 CFR 20.1204(e), (f), and (g).

SCENARIO 1: A licensee performs air sampling analysis and identifies the following six radionuclides in the indicated concentrations (in microcuries per milliliter):

Isotope	Measured Concentration (microcuries per milliliter)	Derived Air Concentration, Table 1, Col. 3, App. B, 10 CFR Part 20 (microcuries per milliliter)
Cobalt-60, Y Class	$6x10^{-10}$	$1x10^{-8}$
Iodine-131	$8x10^{-10}$	$2x10^{-8}$
Iodine-133	$2x10^{-8}$	$1x10^{-7}$
Cesium -134	$2x10^{-9}$	$4x10^{-8}$
Cesium-137	$3x10^{-9}$	$6x10^{-8}$
Tantalum-183, Y Class	$8x10^{-8}$	$4x10^{-7}$

The licensee could either divide the concentration of each identified radionuclide by its DAC listed in Appendix B to Part 20, which would give a DAC fraction of:

$$\frac{6x10^{-10}}{1x10^{-8}} + \frac{8x10^{-10}}{2x10^{-8}} + \frac{2x10^{-8}}{1x10^{-7}} + \frac{2x10^{-9}}{4x10^{-8}} + \frac{3x10^{-9}}{6x10^{-8}} + \frac{8x10^{-8}}{4x10^{-7}} = 0.6 \text{ DAC}$$

Or the licensee could divide the entire concentration of the mixture ($1.064x10^{-7}$) by the most restrictive DAC for the listed radionuclides ($1x10^{-8}$, for cobalt-60, Class Y), which gives a

conservative DAC fraction of 10.64. The licensee may use either DAC fraction for calculating DAC-hours to assess worker dose.

SCENARIO 2: The licensee performs air sampling analysis and identifies the same six radionuclides as in Scenario 1, but does not know the concentration of iodine-131 and tantalum-183. The total concentration of the mixture is also the same as in the previous scenario (1.064×10^{-7}). In this instance, the licensee must use the most restrictive DAC value of the radionuclides in the mixture (1×10^{-8}, for cobalt-60, Class Y) and determine a DAC fraction of 10.64. The licensee must use this DAC fraction for calculating DAC-hours to assess worker dose.

SCENARIO 3: The licensee performs air sampling analysis in a workplace and identifies a mixture of six radionuclides, having a total concentration of 1×10^{-7} microcuries per milliliter. The analysis determines that 80 percent of the total radioactivity is Radionuclide A, which has a DAC listed in Appendix B to Part 20 of 1×10^{-7} microcuries per milliliter. The concentrations and DAC values of the radionuclides present are:

Isotope	Measured Concentration (microcuries per milliliter)	Derived Air Concentration, Table 1, Col. 3, App. B, 10 CFR Part 20 (microcuries per milliliter)
Radionuclide A	8×10^{-8}	1×10^{-7}
Radionuclide B	1×10^{-8}	1×10^{-6}
Radionuclide C	2×10^{-9}	3×10^{-8}
Radionuclide D	3×10^{-9}	5×10^{-8}
Radionuclide E	2×10^{-9}	3×10^{-8}
Radionuclide F	3×10^{-9}	6×10^{-8}

To ease the calculation of dose and to determine further requirements for personnel monitoring, the licensee may disregard the radionuclides listed in the table, since each radionuclide is present at less than 10 percent of its respective DAC, and the total amount of the percentage disregarded is less than 30 percent of the total concentration. In this example, the licensee would take the entire concentration (1×10^{-7}) and use the DAC for Radionuclide A (1×10^{-7}) to arrive at a DAC fraction of 1.0 for determining the dose.

List of Existing Regulatory Guidance Documents:
N/A.

List of Implementing Guidance:

Q&A 121	Radionuclide Mixtures in Air
Q&A 146	Radionuclide Mixtures in Air
Q&A 437	Radionuclide Mixtures in Air
Q&A 453	Radionuclide Mixtures in Air

3.20.1204 (h) CALCULATION OF COMMITTED EFFECTIVE DOSE EQUIVALENT

Statement of Requirement:
(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 Part 20. 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.

Discussion:
Paragraph (1) defines an intake of 1 ALI to be equal to the inhalation of 2000 DAC-hours, which are both equal to 5 rems committed effective dose equivalent, when the ALI for a radionuclide is based on the stochastic dose limit.

Paragraph (2) allows licensees to calculate the committed effective dose equivalent from worker intakes based on the stochastic ALI, even in those cases when the nonstochastic ALI is the limiting value. If this approach is taken, the licensee must still determine that the TODE (CDE plus the DDE to the target organ) is less than 50 rems.

Statement of Applicability:
The requirements in Paragraph (1) are applicable to all licensees who are required to monitor worker intakes and to assign committed effective dose equivalents to those intakes.
Paragraph (2) is limited to those licensees who: (a) are required to monitor worker intakes from radionuclides with ALIs based on the nonstochastic value; and (b) who choose to use the stochastic ALI of those radionuclides for ease of calculating committed effective dose equivalents from those intakes. The approach described in Paragraph (2) is optional. Licensees may chose to use the nonstochastic when assigning committed effective dose equivalents from intakes.

Guidance Statement:
Paragraph (1) defines the regulatory relationship between committed effective dose equivalent and the ALI and DACs for the radionuclides listed in Appendix B to Part 20. The ALI and DAC values are based on ICRP 26 methodology and are rounded to one significant figure from the values listed in ICRP 30. This rounding will result in committed effective dose equivalents that are greater than or less than the stochastic limit of 5 rems if the values were used in dose calculation equations based on ICRP 26 methodology.

For example, the stochastic ALI for iodine-131 in ICRP 30 is 162 microcuries. The stochastic ALI for this radionuclide in Appendix B to Part 20 is 200 microcuries. If we used an intake of 200 microcuries of iodine-131 in a year to calculate a worker's committed effective dose equivalent using equations based on ICRP 26 methodology, we would arrive at a dose of 6.2 rems. In order to compensate for these inherent differences due to rounding, Part 20 defines an intake of 200 microcuries of iodine-131 as 5 rems committed effective dose equivalent.

Paragraph (2) allows licensees to use the stochastic ALI for a radionuclide to simplify the calculation of the committed effective dose equivalent, although a more limiting nonstochastic ALI is listed. When using this approach, the licensee must also ensure that the total organ dose equivalent for the target organ is less than 50 rems. For example, the limiting ALI for iodine-131 is the nonstochastic value of 50 microcuries, and the target organ is the thyroid. The stochastic ALI for iodine-131 is 200 microcuries. If a licensee determines through bioassay, air monitoring, or a combination of the two, that a worker takes in 49 microcuries of iodine-131 during the year, the licensee could use the stochastic ALI to arrive at a committed effective dose equivalent of (49/200)*5 rems = 1.225 rems. If the worker also receives a DDE of 3 rems, totaling the internal and external dose contributions results in a TEDE of 4.225 rems, which is less than the NRC limit.

Paragraph (2) also requires that the licensee ensure that the TODE is less than 50 rems. The 49 microcurie intake results in a CDE of (49/50)*50 rems = 49 rems. Adding the DDE of 3 rems to that results in a TODE of 52 rems, which would be an overexposure.

List of Existing Regulatory Guidance Documents:
N/A.

List of Implementing Guidance:
Q&A 461 Applicable ALIs

3.20.1206 PLANNED SPECIAL EXPOSURES

Statement of Requirement:
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 dose estimated to result from the planned special 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).

Discussion:
A planned special exposure (PSE) is an infrequent exposure to radiation, separate from and in addition to the radiation received under the annual occupational limits. NRC recognizes that there may be exceptional situations at licensee's facilities where it may be necessary for an individual to receive these radiation exposures to accomplish some special task that is essential to the safe operation of the licensee's facility. A licensee can authorize, in any one year, an additional dose that is equal to the annual occupational dose limit, as long as the individual's total dose from PSEs does not exceed five times the annual dose limit during the individual's lifetime. The licensee must be able to demonstrate that the alternatives, e.g., spreading the work out among a number of individuals, are unavailable or impractical.

Statement of Applicability:
The requirements in this section are applicable to all NRC licensees. Because of the exceptional nature of the situations that would lead to such exposures, it is anticipated that few licensees will use these provisions.

Guidance Statement:
The purpose of the PSE rule is to provide licensees some degree of operational flexibility with regard to occupational dose. This flexibility is required because there may be special situations that could result in higher exposures than normally allowed and that, if not provided for, could create a severe problem in a licensee's operations, such as unscheduled facility shutdowns or high radiation levels that impede operations important to safety. For example, a situation may develop at a power plant that requires the special skills of a particular individual to address. It may be more practical for this single individual to accomplish the required task than to divide the task among three less-skilled individuals. This may be true even though the single individual would receive a greater dose than would any one of the other three individuals. In this situation, the collective dose, in terms of person-rem, may be higher for the three individuals than for the single individual. Reduction in collective dose should not be the sole justification for allowing a PSE, but it should always be considered as part of the justification.

The licensee must specifically authorize each PSE in writing before the exposure occurs. The licensee must also ensure that the individuals involved are: 1) informed of the purpose of the planned operation; 2) informed of the expected radiation levels, estimated doses, and associated risks or other conditions that may be involved in performing the task; and 3) instructed in measures to be taken to keep the dose ALARA while considering other risks that may be present. More specific regulatory guidance regarding PSEs is provided in Regulatory Guide 8.35.

List of Existing Regulatory Guidance:
Reg. Guide 8.35 Planned Special Exposures

List of Implementing Guidance:

Q&A 8	Circumstances where PSEs are permitted
Q&A 24	Routine use of PSEs by vendors or consultants
Q&A 63	Previous doses and 25-rem lifetime limit for PSEs
Q&A 109	PSEs and emergency medical procedures
Q&A 110	Source retrieval in radiography and PSEs
Q&A 135	PSEs as method of reducing collective dose
Q&A 136	Informing individuals regarding risk of PSEs
Q&A 137	NRC review of alternative analyses for PSEs
Q&A 191	Separate dosimeters for PSEs
Q&A 192	Dose limits as applicable to PSEs

3.20.1207 OCCUPATIONAL DOSE LIMITS FOR MINORS

Statement of Requirement:
The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adult workers in §20.1201.

Discussion:
Scientific evidence has shown that the radiation response in humans differs according to the age of the individual. There are critical periods of organ development between birth and maturity where the effects of radiation exposure are more significant. For example, susceptibility to the induction of certain malignancies (e.g., leukemia) appears to be higher during childhood periods than during adult life. For these reasons, individuals under the age of 18 are limited to annual doses that are 10% of the adult limits.

Statement of Applicability:
This requirement is applicable to all licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1208 DOSE TO AN EMBRYO/FETUS

Statement of Requirement:
(a) The licensee shall ensure that the dose equivalent to the embryo/fetus during the entire pregnancy, due to the 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 equivalent to the embryo/fetus is the sum of:

1. The deep-dose equivalent to the declared pregnant woman; and
2. The dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose equivalent 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 equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

Discussion:
The relatively high radiosensitivity of the human embryo is well known. There are critical periods of organ development during the prenatal period when the effects of radiation exposure are more significant. For example, susceptibility to the induction of certain malignancies (e.g., leukemia) appears to be higher during the prenatal period than during adult life.

This section requires that each licensee ensure that the dose to an embryo/fetus during an entire pregnancy, from occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv). Paragraph (b) requires that the licensee make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 0.5 rem (5 mSv) limit. Monthly exposures that are less than 100 millirem (1 mSv) are considered acceptable. The dose to the embryo/fetus is the sum of: (1) the DDE to the declared pregnant woman; and (2) the dose to the embryo/fetus from radionuclides in the embryo/fetus and from radionuclides in the declared pregnant woman. In the event that an embryo/fetus has already received 0.45 rem (4.5 mSv) or more by the time the woman declares her pregnancy, the licensee may allow the embryo/fetus to receive an additional dose equivalent of 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

Statement of Applicability:
In order for a pregnant worker to take advantage of the lower exposure limit and the dose monitoring provisions specified in this section, the woman must declare her pregnancy, in writing, to the licensee. A separate written declaration should be submitted for each pregnancy.

Guidance Statement:
The magnitude of the risk of childhood cancer following *in utero* exposure is uncertain in that the results from various studies have been inconclusive. However, the data from many of these studies "are consistent with a lifetime cancer risk resulting from exposure during gestation which is two to three times that for the adult" (NCRP Report No. 116). NRC has reviewed the available scientific literature and has concluded that the 0.5 rem (5 mSv) limit specified in this section provides adequate protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers associated with radiation exposure during pregnancy. Specific guidance for determining the radiation dose to the embryo/fetus is provided in Regulatory Guide 8.36.

It is important to remember that a woman's decision to declare her pregnancy is entirely voluntary. 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 declare her pregnancy to her employer derives from legal, not from health, considerations. The licensee is only required to limit a pregnant worker's dose to 0.5 rem (5 mSv), if she chooses to declare her pregnancy. Even in the case where it is quite evident that the worker is pregnant, if she chooses not to declare her pregnancy, the licensee has no responsibility or authority to limit her dose or, in any other way, to restrict her activities. A declared pregnant woman also has the right to "undeclare" her pregnancy. In this event, the licensee must withdraw any restrictive measures or enhanced monitoring established to comply with the embryo/fetus dose limits. 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, but there is no regulatory requirement to do so.

List of Existing Regulatory Guidance:

Reg. Guide 8.13	Instruction Concerning Prenatal Radiation Exposure
Reg. Guide 8.36	Radiation Dose to the Embryo/Fetus

List of Implementing Guidance:

Q&A 59	Effect on UAW v. Johnson on Regulatory Guide 8.13
Q&A 84	Medical proof of declared pregnancy
Q&A 120	Dose received after declaration of pregnancy
Q&A 382	Undeclaring a pregnancy

Q&A 416 Frequency and duration of declarations

Q&A 439 Declaration made to contractor of licensee

Q&A 440 Declaration of termination of pregnancy

Q&A 441 When date of conception encompasses previous employment

Q&A 442 Advising personnel other than radiation workers

Q&A 443 Advising personnel who do not work in or frequent a restricted area

3.20.1301 DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC

Statement of Requirement:
(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 millisievert) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with §35.75, from voluntary participation in medical research programs, and 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, exclusive of the dose contributions from patients administered radioactive material and released in accordance with §35.75, does not exceed 0.002 rem (0.02 millisievert) 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.

Discussion:
This section specifies the limits for public dose from licensed activities, including dose from transient activities (i.e., dose in any one hour) and cumulative activities over a year, and lists the

sources of exposure that are excluded from the public dose limits. The section also provides a mechanism for obtaining NRC's specific approval of a higher annual public dose limit.

Statement of Applicability:
This regulation is applicable to all NRC licensees whose activities may result in exposure to members of the public.

Guidance Statement:
NRC specifies two limits on public dose from licensed activities. One limit is 2 millirem in any one hour, which is usually associated with transient activities. Such activities may include the controlled use of licensed material in the public domain (e.g., temporary job site activities by radiographers or portable gauge users) and activities near restricted area boundaries at fixed facilities that result in elevated radiation levels in unrestricted or controlled areas (e.g., hallways) for short periods of time. This limit means that doses in unrestricted areas may not exceed 2 millirem in any period of 60 consecutive minutes, regardless of the instantaneous dose rates within that period of time. For example, a licensee's activities may result in an instantaneous dose rate in an unrestricted area of 120 millirem per hour, provided that the dose rate did not exist for more than one minute (1/60th of an hour). This would be allowable as long as the dose rate in the unrestricted area did not exceed background levels for the next 59 minutes, so that the total dose in that hour did not exceed 2 millirem. This limit applies to unrestricted areas, regardless of whether or not exposure occurs to an individual member of the public.

The other limit applies to the annual, cumulative dose to individual members of the public from licensed operations. In the example used above, if the unrestricted area in question was an office of a worker who was not occupationally exposed, and the worker was exposed to 2 millirem from each operation, the licensee would be limited to performing the activity 50 times in a year (120 millirem per hour times 1/60th of an hour per operation times 50 operations per year equals 100 millirem in a year). Although the employee is exposed to radiation while at work, he or she is subject to the public dose limits and not the higher occupational limits unless the exposure is an integral part of his or her duties.

For the purposes of this regulation, public dose does not include contributions from: background radiation, radiation associated with the medical administration of licensed materials to the individual, exposure to individuals administered radioactive material and released in accordance with 10 CFR 35.75, voluntary participation in medical research programs, and the licensee's disposal of radioactive material into sanitary sewerage in accordance with 10 CFR 20.2003.

The requirements for licensees demonstrating compliance with these public dose limits are contained in 10 CFR 20.1302.

List of Existing Regulatory Guidance:

Reg. Guide 8.37	ALARA Levels for Effluents from Materials Facilities
NUREG-1556	Consolidated Guidance About Materials Licenses, all applicable final volumes

List of Implementing Guidance:

HPPOS-042	Contaminated Soil at Big Rock Point
HPPOS-127	Transfer and/or Disposal of Spent Generators
HPPOS-196	Explosive Detectors for Use at Airports
HPPOS-251	Redefinition of Restricted Area Boundaries to Exclude an Area to be Used for Residential Quarters
HPPOS-286	Technical Assistance Request, Angell Memorial Animal Hospital, Boston, MA; Release to Unrestricted Area of Animals Containing Iodine-131
HPPOS-317	Technical Assistance Request, Use of Portable Shields for a High Dose Rate Afterloader Facility at Washington Hospital Center, Washington, D.C.
Q&A 42	Dose to breastfeeding infant due to intakes of iodine-131 by a technologist
Q&A 48	Meaning of "0.002 rem in any one hour"
Q&A 105	Demonstration of compliance with 2 mrem in any one hour limit
Q&A 106	Airborne radioactivity concentration limits in controlled areas
Q&A 111	Authorization for radiation levels in unrestricted areas above 100 millirem in a year
Q&A 125	Dose terms applicable to unrestricted area limits
Q&A 201	Basis for exclusion of dose from sanitary sewer releases from public dose limit
Q&A 203	Allowable dose in unrestricted areas not accessible to the public
Q&A 204	Periods of time that higher public dose limits will be authorized
Q&A 205	Application of "in any one hour" to dose limits
Q&A 206	Dose rates in unrestricted areas
Q&A 384	Impact of 10 CFR 20.1301 on nuclear power plants
IN 97-04	Implementation of a New Constraint on Radioactive Air Effluents
IN 94-09	Release of Patients with Residual Radioactivity from Medical Treatment and Control of Areas Due to Presence of Patients Containing Radioactivity Following Implementation of Revised 10 CFR Part 20

IN 91-16	Unmonitored Release Pathways from Slightly Contaminated Recycle and Recirculation Water at a Fuel Facility
IN 82-33	Control of Radiation Levels in Unrestricted Areas Adjacent to Brachytherapy Patients

3.20.1302 COMPLIANCE WITH DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC

Statement of Requirement:
(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 Part 20; and
   (ii) If an individual were continuously 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 Part 20, Table 2, for members of the public, to take into account the actual physical and chemical characteristics of the effluents (e.g., aerosol size distribution, solubility, density, radioactive decay equilibrium, chemical form).

Discussion:
This section requires licensees to either take actions or have actions taken on their behalf to ensure that their licensed operations do not result in doses to individual members of the public in excess of the limits specified in 10 CFR 20.1301. The section provides for two principal means of demonstrating compliance with the annual dose limit for members of the public.

Statement of Applicability:
NRC licensees.

Guidance Statement:
This section provides licensees with two different methods for showing compliance with the public dose limit of 100 mrem in a year. The first method relies on any combination of calculations and measurements of the dose that is received by the member of the public receiving the highest dose from the licensed activity. That dose may result from any combination of external and internal exposures. The licensee must make an effort to determine who, or what

group, receives the highest exposure. Depending on the details of the facility's operation, and the combination of external and internal doses, that person or group may be those living or working closest to the site, those living downwind of the plant, those who frequent the controlled or restricted areas and who may receive non-occupational exposures, or those of a particular age group.

For licensees whose expected public dose contributions from the licensed operation are significantly below the dose limits, it may be easier to show compliance using the second method. That method relies on showing that two conditions have both been met: the concentrations of radioactive materials released to the environment, when averaged over a year, do not exceed those listed in Table (2) of Appendix B, and the external dose that would be received by anyone continuously present anywhere in the unrestricted area is less than 2 mrem in any one hour and less than 50 mrem in a year.

The concentrations of released materials are to be measured at the boundary of the unrestricted area. For many facilities, this means at the point of release to the atmosphere, such as the top of the stack, for airborne releases, and at the point of discharge to a body of water for liquid releases. For large facilities in which the stack may be some distance from the site boundary and where there are no unrestricted areas within that site boundary, application of the regulation would not normally be at the point of release from the stack. The dose of 2 mrem in any one hour is not a dose rate but a dose in a period of an hour. This allows for short duration bursts of radiation that may produce dose rates much higher than 2 mrem/hr but that, when averaged over an hour, will be less than 2 mrem. Note that when showing compliance with external dose limits, occupancy factors are not permitted. In other words, even though no person is known to be continuously present in the unrestricted area, such a continuously present person must be assumed.

Although this section of the regulations addresses only the requirement to show compliance with the dose limits to members of the public, the regulations elsewhere (10 CFR 20.1101) require that the licensee also make every effort to keep the dose to members of the public as far below the 100 mrem/yr limit as possible. The annual dose from air emissions is also subject to a separate constraint of 10 mrem/yr (10 CFR 20.1101).

List of Existing Regulatory Guidance Documents:

Reg. Guide 1.21	Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants
Reg. Guide 1.109	Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I
Reg. Guide 1.111	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors

Reg. Guide 1.112	Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors
Reg. Guide 1.113	Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I
Reg. Guide 3.51	Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations
Reg. Guide 4.14	Radiological Effluent and Environmental Monitoring at Uranium Mills
Reg. Guide 4.15	Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment
Reg. Guide 4.16	Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants
Reg. Guide 4.20	Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees other than Power Reactors
Reg. Guide 8.37	ALARA Levels for Effluents from Materials Facilities
NUREG-1556	Consolidated Guidance About Materials Licenses, all applicable final volumes

List of Implementing Guidance:

Q&A 28	Annual Average Concentrations
Q&A 29	Public Dose Inside Controlled Areas
Q&A 68	Occupancy Factor
Q&A 69	Enforcement Policy Examples
Q&A 72	Unrestricted Area Monitoring for Materials Licensees
Q&A 102	Occupancy Factors
Q&A 103	External Sources of Radiation
Q&A 104	Public Dose Inside Controlled Areas
Q&A 207	Occupancy Factors
Q&A 208	Choice of Methods Used to Demonstrate Compliance
Q&A 417	Definition of Controlled Area
Q&A 427	External Sources of Radiation

HPPOS 052	Effluent Reporting Requirements Per 10 CFR 20.405(a), "Reports of Overexposures and Excessive Levels and Concentrations"
HPPOS 088	Corrections for Sample Conditions for Air and Gas Monitoring
HPPOS 212	Dissolved Noble Gases in Liquid Effluents and Compliance with Technical Specifications 3.11.1
HPPOS 251	Redefinition of Restricted Area Boundaries to Exclude an Area to be Used for Residential Quarters
HPPOS 285	Technical Assistance Request Dated September 11, 1992, Regarding the University of Pittsburgh Incinerator Ash Disposal Request and New Information Applicable on August 6, 1991
HPPOS 317	Technical Assistance Request, Use of Portable Shields for a High Dose Rate Afterloader Facility at Washington Hospital Center, Washington, D.C.
IN 97-04	Implementation of a New Constraint on Radioactive Air Effluents
IN 94-09	Release of Patients with Residual Radioactivity from Medical Treatment and Control of Areas Due to Presence of Patients Containing Radioactivity Following Implementation of Revised 10 CFR Part 20
IN 91-16	Unmonitored Release Pathways from Slightly Contaminated Recycle and Recirculation Water at a Fuel Facility
IN 82-33	Control of Radiation Levels in Unrestricted Areas Adjacent to Brachytherapy Patients

3.20.1400 SUBPART E – RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION

3.20.1401 GENERAL PROVISIONS AND SCOPE

Statement of Requirement:
(a) The criteria in this subpart apply to the decommissioning of facilities licensed under Parts 30, 40, 50, 60, 61, 70, and 72 of this chapter, as well as other facilities subject to the Commission's jurisdiction under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. For high-level and low-level waste disposal facilities (10 CFR Parts 60 and 61), the criteria apply only to ancillary surface facilities that support radioactive waste disposal activities. The criteria do not apply to uranium and thorium recovery facilities already subject to Appendix A to 10 CFR Part 40 or to uranium solution extraction facilities.

(b) The criteria in this subpart do not apply to sites which:

1. Have been decommissioned prior to the effective date of the rule in accordance with criteria identified in the Site Decommissioning Management Plan (SDMP) Action Plan of April 16, 1992 (57 FR 13389);
2. Have previously submitted and received Commission approval on a license termination plan (LTP) or decommissioning plan that is compatible with the SDMP Action Plan criteria; or
3. Submit a sufficient LTP or decommissioning plan before August 20, 1998 and such LTP or decommissioning plan is approved by the Commission before August 20, 1999 and in accordance with the criteria identified in the SDMP Action Plan, except that if an EIS is required in the submittal, there will be a provision for day-for-day extension.

(c) After a site has been decommissioned and the license terminated in accordance with the criteria in this subpart, the Commission will require additional cleanup only if, based on new information, it determines that the criteria of this subpart were not met and residual radioactivity remaining at the site could result in significant threat to public health and safety.

(d) When calculating TEDE to the average member of the critical group the licensee shall determine the peak annual TEDE dose expected within the first 1000 years after decommissioning.

Discussion:
This rule specifies which NRC licensees are subject to the other requirements contained in Subpart E to Part 20. This rule also limits NRC's ability to require former licensees to complete additional decontamination of facilities formerly licensed by NRC and terminated in accordance with previously established release criteria.

Statement of Applicability:
This regulation specifically states to whom it applies. In general, all licensees who received an NRC license for the first time after the rule went into effect (August 20, 1997) are subject to the regulations in Subpart E of 10 CFR Part 20. Those former licensees who successfully completed decommissioning in accordance with an NRC-approved decommissioning plan prior to August 20, 1997 and those who have received NRC approval prior to August 20, 1999 of a site decommissioning plan submitted before August 20, 1998, are not subject to the requirements in Subpart E. If NRC determines that the radioactivity remaining on a previously decommissioned site subject to the criteria of this Subpart could result in a significant threat to public health and safety, NRC could require further clean up.

Guidance Statement:
No additional guidance necessary.

List of Existing Regulatory Guidance Documents:
Reg. Guide DG-4006 "Demonstrating Compliance with the Radiological Criteria for License Termination" (Draft)

List of Implementing Guidance:
N/A.

3.20.1402 RADIOLOGICAL CRITERIA FOR UNRESTRICTED USE

Statement of Requirement:
A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

Discussion:
NRC will consider a licensee's request to terminate its license if the residual radioactivity from licensed operations will not result in a TEDE to a member of the public in excess of the dose specified above and the licensee has made efforts to reduce the radioactivity to levels that are ALARA.

Statement of Applicability:
See the guidance provided for 10 CFR 20.1401, which specifies the licensees to whom the regulations in Subpart E to 10 CFR Part 20 apply.

Guidance Statement:
No additional guidance necessary.

List of Existing Regulatory Guidance:

Reg. Guide DG-4006	"Demonstrating Compliance with the Radiological Criteria for License Termination" (Draft)
NUREG/CR-5849	Manual for Conducting Radiological Surveys in Support of License Termination
NUREG-1575	Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

List of Implementing Guidance:
N/A.

3.20.1403 CRITERIA FOR LICENSE TERMINATION UNDER RESTRICTED CONDITIONS

Statement of Requirement:
A site will be considered acceptable for license termination under restricted conditions if:

(a) The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of §20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA. Determination of the levels which are ALARA must take into account consideration of any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal;

(b) The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 mSv) per year;

(c) The licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site. Acceptable financial assurance mechanisms are:

1. Funds placed into an account segregated from the licensee's assets and outside the licensee's administrative control as described in §30.35(f)(1) of this chapter;
2. Surety method, insurance, or other guarantee method as described in §30.35(f)(2) of this chapter;
3. A statement of intent in the case of Federal, State, or local Government licensees, as described in §30.35(f)(4) of this chapter; or
4. When a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by such governmental entity.

(d) The licensee has submitted a decommissioning plan or License Termination Plan (LTP) to the Commission indicating the licensee's intent to decommission in accordance with §§30.36(d), 40.42(d), 50.82 (a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee intends to decommission by restricting use of the site. The licensee shall document in the LTP or decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.

1. Licensees proposing to decommission by restricting use of the site shall seek advice from such affected parties regarding the following matters concerning the proposed decommissioning:

   (i) Whether provisions for institutional controls proposed by the licensees:

   (A) Will provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 mSv) TEDE per year;

   (B) Will be enforceable; and

   (C) Will not impose undue burdens on the local community or other affected parties.

   (ii) Whether the licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

3. In seeking advice on the issues identified in §20.1403(d)(1), the licensee shall provide for:

   (i) Participation by representatives of a broad cross-section of community interests who may be affected by the decommissioning;

   (ii) An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

   (iii) A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

(e) Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either:

1. 100 mrem (1 mSv) per year; or
2. 500 mrem (5 mSv) per year provided that the licensee:

   (i) Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem/y (1 mSv/y) value of Paragraph (e)(1) of this section are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;

   (ii) Makes provisions for durable institutional controls;

   (iii) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, both to carry out periodic rechecks of the site no less frequently than every 5 years to assure that

the institutional controls remain in place as necessary to meet the criteria of §20.1403(b) and to assume and carry out responsibilities for any necessary control and maintenance of those controls. Acceptable financial assurance mechanisms are those in Paragraph (c) of this section.

Discussion:
This regulation provides for NRC approval of license termination in those rare instances when licensees are unable to reduce residual radioactivity onsite below those levels that would result in a TEDE to members of the public of 25 millirem. The regulation specifies the types of compensatory measures necessary to release such facilities and terminate the license.

Statement of Applicability:
See the guidance provided for 10 CFR 20.1401, which specifies the licensees to whom the regulations in Subpart E to 10 CFR Part 20 apply.

Guidance Statement:
No additional guidance necessary.

List of Existing Regulatory Guidance Documents:
Reg. Guide DG-4006 "Demonstrating Compliance with the Radiological Criteria for License Termination" (Draft)

List of Implementing Guidance:
N/A.

3.20.1404 ALTERNATE CRITERIA FOR LICENSE TERMINATION

Statement of Requirement:
(a) The Commission may terminate a license using alternate criteria greater than the dose criterion of §§20.1402, 20.1403(b), and 20.1403(d)(1)(i)(A), if the licensee:

1. Provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 1 mSv/y (100 mrem/y) limit of subpart D, by submitting an analysis of possible sources of exposure;
2. Has employed to the extent practical restrictions on site use according to the provisions of §20.1403 in minimizing exposures at the site; and
3. Reduces doses to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal;
4. Has submitted a decommissioning plan or License Termination Plan (LTP) to the Commission indicating the licensee's intent to decommission in accordance with §§30.36(d), 40.42(d), 50.82 (a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee shall document in the decommissioning plan or LTP how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice. In seeking such advice, the licensee shall provide for:
   - (i) Participation by representatives of a broad cross-section of community interests who may be affected by the decommissioning;
   - (ii) An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and
   - (iii) A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues.

(b) The use of alternate criteria to terminate a license requires the approval of the Commission after consideration of the NRC staff's recommendations that will address any comments provided by the Environmental Protection Agency and any public comments submitted pursuant to §20.1405.

Discussion:
Licensees may use alternate criteria for obtaining NRC approval to terminate their licenses when the residual contamination remaining after decommissioning results in a calculated dose to members of the public in excess of 25 millirem per year. In order to use this alternate criteria, licensees must ensure that 1) the maximum dose to members of the public will not exceed

100 millirem per year; 2) use of the property has been restricted as much as practical; 3) the contamination is as low as is reasonably achievable; and 4) community advice has been solicited on its license termination plans and has been factored into its plans. Decisions to accept proposed alternate decommissioning criteria are made by the NRC Commissioners, based on input from the NRC staff, the EPA, and the public. It is expected that these alternate criteria for license termination will see only limited use.

Statement of Applicability:
See the guidance provided for 10 CFR 20.1401, which specifies the licensees to whom the regulations in Subpart E to 10 CFR Part 20 apply.

Guidance Statement:
No additional guidance necessary.

List of Existing Regulatory Guidance:
Reg. Guide DG-4006 "Demonstrating Compliance with the Radiological Criteria for License Termination" (Draft)

List of Implementing Guidance
N/A.

3.20.1405 PUBLIC NOTIFICATION AND PUBLIC PARTICIPATION

Statement of Requirement:
Upon the receipt of an LTP or decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to §§20.1403 or 20.1404, or whenever the Commission deems such notice to be in the public interest, the Commission shall:

(a) Notify and solicit comments from:

1. Local and State governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and
2. The Environmental Protection Agency for cases where the licensee proposes to release a site pursuant to §20.1404.

(b) Publish a notice in the *Federal Register* and in a forum, such as local newspapers, letters to State or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

Discussion:
NRC will solicit input from the community near a site proposed by a licensee for release under restricted conditions and from the EPA when it is likely that release of the site proposed will result in doses to members of the public in excess of 25 millirem per year.

Statement of Applicability:
See the guidance provided for 10 CFR 20.1401, which specifies the licensees to whom the regulations in Subpart E to 10 CFR Part 20 apply.

Guidance Statement:
No additional guidance necessary.

List of Existing Regulatory Guidance:
Reg. Guide DG-4006 "Demonstrating Compliance with the Radiological Criteria for License Termination" (Draft)

List of Implementing Guidance:
N/A.

3.20.1406 MINIMIZATION OF CONTAMINATION

Statement of Requirement:
Applicants for licenses, other than renewals, after August 20, 1997, shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

Discussion:
When designing facilities and developing procedures for their safe use, applicants need to think ahead and consider how to minimize radioactive contamination during operation, decontamination and decommissioning efforts, and radioactive waste generation.

Statement of Applicability:
See the guidance provided for 10 CFR 20.1401, which specifies the licensees to whom the regulations in Subpart E to 10 CFR Part 20 apply.

Guidance Statement:
This regulation is intended to minimize the potential impact and costs associated with decommissioning activities, beginning with the application process for new licenses. To achieve this goal, new applicants should consider:

- Implementing and adhering to good health physics practices in operations;
- Minimizing areas, to the extent practical, where licensed materials are used and stored;
- Establishing a frequency and scope of surveys that will identify and minimize the spread of contamination;
- Choosing short half-life isotopes for use and considering the chemical composition, whenever practical;
- Ensuring filtration of effluent streams;
- Using non-porous materials in radioactive material use and storage areas;
- Employing ventilation stacks and ductwork with minimal lengths and minimal abrupt changes in direction;
- Using appropriate plumbing materials with minimal pipe lengths and traps;
- Minimizing the number of sites (sinks and drains) where liquid waste is disposed.

List of Existing Regulatory Guidance:

Reg. Guide DG-4006 "Demonstrating Compliance with the Radiological Criteria for License Termination" (Draft)

List of Implementing Guidance:

N/A.

3.20.1500 SUBPART F – SURVEYS AND MONITORING

3.20.1501 (a) GENERAL

Statement of Requirement:
(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 magnitude and extent of radiation levels; and
   (ii) Concentrations or quantities of radioactive material; and
   (iii) The potential radiological hazards.

Discussion:
Each licensee is required to perform surveys of the actual and potential radiological hazards presented by their activities involving radioactive materials. These activities include the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. The surveys may include the use of radiation detection or monitoring instruments to perform measurements of radiation or concentrations of radioactive material. In addition, surveys may include measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present. Surveys are typically necessary to demonstrate that the licensee complies with specific requirements in 10 CFR Part 20.

Statement of Applicability:
This section is applicable to all licensees. The number, type, and scope of surveys that are necessary and reasonable to demonstrate compliance with the requirements in 10 CFR Part 20 vary by licensee depending on the nature of activities performed.

Guidance Statement:
Typical surveys may include such things as: routine radiological surveys in work areas (e.g., prejob surveys), so that administrative stay time limits may be set to ensure that occupational doses are as low as reasonably achievable, in accordance with 10 CFR 20.1101 and 20.1201; analyses of liquid radioactive wastes prior to discharge to the sanitary sewer to ensure that the concentration and total quantity discharged are within the limits specified in 10 CFR 20.2003; and evaluations of the kinds and quantities of radioactive materials handled by workers to determine if bioassays are necessary to assess worker doses from intakes in accordance with 10 CFR 20.1204 and 20.1502.

This requirement has, by its very nature, broad applications. Below are examples of the types of surveys that are reasonable and necessary to comply with the requirements in Part 20:

10 CFR 20.1201. This requirement limits the doses to workers, and therefore, licensees must be familiar with the radiation levels in work areas. Conducting routine surveys in restricted areas usually provides this information. The frequency of the surveys is dependent on the variability and magnitude of the radiation levels in restricted areas and on the transient nature of work with radioactive materials or sources of radiation. It is unacceptable for a licensee to simply issue personnel monitoring devices (film badges or thermoluminescent dosimeters) to workers without a thorough understanding of the radiological conditions in which they work.

10 CFR 20.1301. Comparable to the requirement discussed above, this regulation limits doses to members of the public; therefore, licensees must be familiar with the radiation levels in unrestricted areas and with the concentrations of radioactive effluents at the site boundary or other unrestricted area marker. Surveys to ensure that public doses are within regulatory limits may include routine radiation level surveys in unrestricted areas, the use of environmental thermoluminescent dosimeters to assess cumulative dose in appropriate unrestricted areas, and monitoring or calculations of public dose from effluents. Depending on the nature of the licensee's activities, it may be appropriate to place monitoring devices in or near neighboring businesses and residential areas. This would require discussions with those neighbors to obtain permission for the monitoring.

10 CFR 20.1502. This regulation requires that licensees monitor worker exposures if the workers are likely to exceed 10 percent of the applicable limits for internal or external exposure. This necessitates a physical survey or calculation of likely exposures to identify those workers for whom the licensee must provide monitoring, such as personnel dosimetry, air sampling in the workplace, or performing bioassay measurements. Although some licensees may monitor the exposure of many or all of their workers, it may be beneficial to determine the workers for whom monitoring is required by NRC regulations versus those workers that the licensee monitors for other reasons, such as liability, or at the worker's request.

These examples are not intended to be exhaustive, but are meant to illustrate types of surveys that may be necessary and reasonable for licensee compliance with Part 20 requirements.

List of Existing Regulatory Guidance:

Reg. Guide 8.21	Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants
Reg. Guide 8.23	Radiation Safety Surveys at Medical Institutions
Reg. Guide 8.24	Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication
Reg. Guide 8.30	Health Physics Surveys in Uranium Mills
NUREG-1556	Consolidated Guidance About Materials Licenses, all applicable final volumes

List of Implementing Guidance:

HPPO 2	Overexposure of Diver During Work in Fuel Storage Pool
HPPO 7	Monitoring of Radioactive Release Via Storm Drains
HPPO 10	10 CFR 20.201(b), "Surveys," Final Rule – Effective November 20, 1981
HPPO 13	Averaging of Radiation Levels Over the Detector Probe Area
HPPO 47	Personnel Monitoring Requirements for an NRC/Agreement State Licensed Contractor Working at a Part 50-Licensed Facility
HPPO 71	Control of Radioactively Contaminated Material
HPPO 72	Guide on "How Hard You Have to Look" as Part of Radioactive Contamination Control Program
HPPO 73	Surveys of Wastes from Nuclear Reactor Facilities Before Disposal
HPPO 79	Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to the Environment
HPPO 88	Corrections for Sample Conditions for Air and Gas Monitoring
HPPO 106	Use of Hydro Nuclear Service Dry Active Waste Disposal
HPPO 122	Clarification of Regulatory Guide 1.21, Section C.10, "Sensitivity"
HPPO 138	Interpretation of 10 CFR 20.201(b), "Survey Requirements"
HPPO 186	Determination of Radiation Exposure from Dosimeters
HPPO 223	Consideration of Measurement Uncertainty When Measuring Radiation Levels Approaching Regulatory Limits
HPPO 233	Applicability of Regulatory Position 1.3 of Regulatory Guide 8.32 to Nuclear Reactor Facilities
HPPO 250	Monitoring at Nuclear Power Plants for Contamination by Radionuclides that Decay by Electron Capture
HPPO 255	Airborne Thorium From Welding Rods
HPPO 296	Technical Assistance Request Concerning Posting per 10 CFR 34.42 and Surveys per 10 CFR 20.201
HPPO 300	Letter Dated May 20, 1992, Regarding Alternative Method of Disposal for Contaminated Plastic Test Tubes
HPPO 318	Technical Assistance Request, Authorization of Employee Eating and Drinking Areas in Labs at Veterans Administration Medical Center, Martinez, California
IN 98-18	Recent Contamination Incidences Resulting from Failure to Perform Adequate Surveys

IN 97-36	Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials And External Exposure Due to Inadequate Control of Work
IN 96-18	Compliance with 10 CFR Part 20 for Airborne Thorium
IN 95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material
IN 94-16	Recent Incidents Resulting in Offsite Contamination
IN 93-39	Radiation Beams From Power Reactor Biological Shields
IN 91-30	Inadequate Calibration of TLDs Utilized to Monitor Extremity Dose at Uranium Processing and Fabrication Facilities
IN 83-59	Dose Assignment for Workers in Non-Uniform Radiation Fields
Bulletin 80-10	Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to the Environment (See HPPO 79)
Q&A 98	Historical Basis to Require Internal Monitoring at Power Plants
Q&A 458	"Weighted" and "Effective" DACs to Determine Dose

3.20.1501 (b) INSTRUMENT CALIBRATION

Statement of Requirement:
(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.

Discussion:
Licensees must ensure that instruments used to measure radiation levels or analyze for radioactivity are capable of accurately detecting the radiation or radioactivity of interest. This is normally accomplished by periodically comparing an instrument's output (e.g., scale reading) against a known quantity of radiation or radioactivity and adjusting the output to indicate values that are within acceptable tolerances (e.g., percent error). This comparison is known as a calibration. While this regulation does not specify the frequency of such calibrations, other parts of 10 CFR do specify such frequencies, e.g., 10 CFR 34.25 for industrial radiography licensees.

Statement of Applicability:
This section is applicable to all licensees who are required to perform quantitative radiation measurements, such as area dose rate measurements, surveys for non-fixed radioactive contamination, or concentrations of radioactive materials in effluents.

Guidance Statement:
Instruments used for quantitative measurements must be calibrated to ensure that they are capable of accurately determining the quantity of radiation or radioactivity that may be present. Several NRC guidance documents (e.g., NUREG-1556 series of consolidated guidance for materials licenses) provide model procedures for performing instrument calibrations and suggest frequencies for performing such calibrations. When developing a calibration frequency for its own use, a licensee must consider several factors, including, but not limited to, the stability of the instrument output over time (e.g., direct-reading dosimeters versus electrometers); and the environment in which the instrument will be used (e.g., stationary, laboratory counting equipment versus field radiography survey instruments). NRC has typically recommended that inherently stable instruments that are used with care should be calibrated every 12 months. Instruments that are less stable or are used in rugged environments should be calibrated more frequently.

List of Existing Regulatory Guidance:

Reg. Guide 8.6	Standard Test Procedure for Geiger-Muller Counters
NUREG-1556	Consolidated Guidance About Materials Licenses, all applicable final volumes

List of Implementing Guidance:

HPPO 1	Proposed Guidance for Calibration and Surveillance Requirements to Meet Item II.F.1 of NUREG-0737
HPPO 88	Corrections for Sample Conditions for Air and Gas Monitoring
HPPO 279	Technical Assistance Request Regarding Electronic Calibration of Survey Instruments
HPPO 328	Proper Operation and Use of Alarm Dosimeters at Nuclear Power Plants
IN 93-30	NRC Requirements for Evaluation of Wipe Test Results; Calibration of Count Rate Survey Instruments
Bulletin 97-001	Potential for Erroneous Calibration, Dose Rate, or Radiation Exposure Measurements with Certain Victoreen Model 530 and 53OSI Electrometer/Dose-Meters
Q&A 147	Calibration Frequency
Q&A 209	Calibration Frequency

3.20.1501 (c) DOSIMETRY PROCESSING

Statement of Requirement:
(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.

Discussion:
Licensees who use personnel dosimetry devices (except as noted below) that require processing to determine worker exposures to radiation must have the dosimeters processed by someone who holds the required accreditation. Licensees may process their own dosimeters, as long as they hold the accreditation. The accreditation must be for the type of radiation for which dosimetry is provided. For example, if the exposure is from high energy gamma rays, then the processor's accreditation must include that type of radiation. It is the licensee's responsibility to ensure that the processor holds the appropriate accreditation. Without specific approval from NRC, such as through an exemption, licensees may not use dosimetry to provide required monitoring from processors who do not hold NVLAP accreditation.

Statement of Applicability:
This regulation is applicable to all licensees who are required to provide dosimetry equipment to monitor worker radiation exposures and who use equipment that must be processed in order to determine the dose. Devices used to monitor extremity exposures are excluded from the accreditation requirements. Also excluded are direct and indirect reading pocket ionization chambers.

Guidance Statement:
No additional guidance necessary.

List of Existing Regulatory Guidance:
Reg. Guide 8.4 Direct-Reading and Indirect-Reading Pocket Dosimeters

Reg. Guide 8.14 Personnel Neutron Dosimeters

Reg. Guide 8.28 Audible Alarm Dosimeters

Reg. Guide 8.34 Monitoring Criteria and Methods to Calculate Occupational Radiation Doses

List of Implementing Guidance:

HPPO 186 Determination of Radiation Exposure from Dosimeters

HPPO 224 Blind Spiking of Personnel Dosimeters and the Inspection Program

HPPO 268 Technical Assistance Request, BP International Limited Request for and Exemption from 10 CFR 20.202(c)

HPPO 328 Proper Operation and Use of Alarm Dosimeters at Nuclear Power Plants

Q&A 210 DOELAP Accreditation

3.20.1502 (a) CONDITIONS REQUIRING INDIVIDUAL MONITORING OF EXTERNAL OCCUPATIONAL DOSE

Statement of Requirement:
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 from licensed and unlicensed radiation sources under the control of the licensee 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 likely to receive, in 1 year, from radiation sources external to the body, a deep-dose equivalent in excess of 0.1 rem (1 mSv), a lens-dose equivalent in excess of 0.15 rem (1.5 mSv), or a shallow-dose equivalent to the skin or to the extremities in excess of 0.5 rem (5 mSv);
3. Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep-dose equivalent in excess of 0.1 rem (1 mSv)[5]; and
4. Individuals entering a high or very high radiation area.

Discussion:
Licensees are required to monitor the occupational exposures of workers who are likely to exceed the applicable dose thresholds specified in the regulation. For NRC licensees, the exposure to individuals involved in licensed activities could be from either licensed or unlicensed sources of radiation. Licensed sources include those authorized by either a specific license issued by the Commission or a general license specified in the regulations (e.g., 10 CFR 31.5). Unlicensed sources include radioactive materials distributed to persons exempt from the requirements for a license (e.g., small sources used to check detection instrumentation response to radiation) and electrically produced radiation (e.g., X-ray machines). In addition, individuals entering high or very high radiation areas must be monitored, even though the duration of the entry would not result in a measurable radiation dose.

Statement of Applicability:
This regulation is applicable to all licensees whose activities, both licensed and unlicensed, would likely result in occupational exposures in excess of the specified thresholds or who allow individuals to enter high or very high radiation areas.

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[5] All of the occupational doses in §20.1201 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded.

Guidance Statement:
Licensees typically decide to either monitor all workers who are likely to be exposed to sources of radiation external to the body, regardless of the magnitude of the exposure, or issue monitoring devices to only those individuals who are likely to receive exposures in excess of the specified thresholds. In the latter case, licensees must make a prospective determination, in accordance with 10 CFR 20.1501(a), as to which workers must be monitored. In making that determination, licensees must consider all sources of radiation, including that from byproduct, source, or special nuclear material authorized under a specific license or a general license (licensed sources), as well as from unlicensed sources, such as naturally occurring or accelerator produced radioactive material (also known as NORM or NARM), electrically produced radiation (X-rays), or exempt quantities that are under the control of the licensee.

List of Existing Regulatory Guidance:

Reg. Guide 8.2	Guide for Administrative Practices in Radiation Monitoring
Reg. Guide 8.19	Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants – Design State Man-Rem Estimates
Reg. Guide 8.34	Monitoring Criteria and Methods to Calculate Occupational Radiation Doses
Reg. Guide 8.36	Radiation Dose to the Embryo/Fetus
Reg. Guide 8.38	Control of Access to High and Very High Radiation Areas of Nuclear Plants

List of Implementing Guidance:

Generic Letter 95-09	Monitoring and Training of Shippers and Carriers of Radioactive Materials
Generic Letter 95-09	Monitoring and Training of Shippers and Carriers of Radioactive Materials (Supplement 1)
HPPO 2	Overexposure of Diver During Work in Fuel Storage Pool
HPPO 47	Personnel Monitoring Requirements for an NRC/Agreement State Licensed Contractor Working at a Part 50-Licensed Facility
HPPO 186	Determination of Radiation Exposure from Dosimeters
HPPO 273	Technical Assistance Request, Evaluation of Comments on NRC Information Notice for Ophthalmic Applicators
HPPO 328	Proper Operation and Use of Alarm Dosimeters at Nuclear Power Plants
IN 93-39	Radiation Beams From Power Reactor Biological Shields
IN 91-30	Inadequate Calibration of TLDs Utilized to Monitor Extremity Dose at Uranium Processing and Fabrication Facilities
IN 83-59 Dose	Assignment for Workers in Non-Uniform Radiation Fields

Q&A 81	Monitoring of Declared Pregnant Women (***Note:*** threshold for monitoring raised to 0.1 rem from 0.05 rem since this Q&A published)
Q&A 82	Conditions Requiring Monitoring – Controlled Area
Q&A 100	Conditions Requiring Monitoring – Eye Dose Equivalent
Q&A 114	Conditions Requiring Monitoring – Accounting for Previous Dose
Q&A 126	Conditions Requiring Monitoring
Q&A 211	Monitoring of Declared Pregnant Women
Q&A 212	Improper Use of Monitors by Workers When Dosimetry Not Required
Q&A 213	Monitoring of Service Company Personnel
Q&A 214	Monitoring of Transient Workers
Q&A 215	Monitoring of Workers with Multiple Employers
Q&A 216	Monitoring of Workers with Multiple Employers
Q&A 429	Conditions Requiring Monitoring- External Dose from Effluents
Q&A 444	Conditions Requiring Monitoring
Q&A 445	Conditions Requiring Monitoring
Q&A 446	Discontinuance of Monitoring

3.20.1502 (b) CONDITIONS REQUIRING INDIVIDUAL MONITORING OF INTERNAL OCCUPATIONAL DOSE

Statement of Requirement:
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:

(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 §§20.1001-20.2402;
2. Minors likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.1 rem (1 mSv); and
3. Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 0.1 rem (1 mSv).

Discussion:
Licensees are required to monitor the occupational intakes of workers who are likely to exceed the applicable annual limit on intake or committed effective dose equivalent thresholds specified in the regulation. For NRC licensees, the intakes by individuals involved in licensed activities may be from either licensed or unlicensed materials. Licensed materials include those authorized by either a specific license issued by the Commission or a general license specified in the regulations (e.g., 10 CFR 31.11). Unlicensed sources include radioactive materials distributed to persons exempt from the requirements for a license and naturally occurring or accelerator produced radioactive materials (NORM or NARM). Occupational dose does not include contributions from background radiation or radiation exposure from medical procedures that the worker may receive.

Statement of Applicability:
The regulation is applicable to all licensees whose activities might result in occupational intakes of radioactive material above the thresholds specified in the regulation.

Guidance Statement:
NUREG-1400, "Air Sampling in the Workplace," provides guidance for determining the circumstances in which intakes above 10 percent of an annual limit on intake (ALI) are likely to occur. The guidance in the NUREG suggests that licensees establish a threshold for monitoring workers for intakes based on the quantity of material handled by a worker in a year. The threshold should be based on the ALI of the material(s) handled, multiplied by a modifying factor. This factor must be adjusted to account for the specifics of the process, including the form of the material (e.g., surface contamination, volatile materials, a sealed source), whether some type of energy is introduced that would affect the likelihood of intakes (e.g., grinding,

smelting, exothermic chemical reactions), and the containment of the system in which the material is handled (e.g., open bench top, inside a fume hood or glovebox). When performing these analyses, licensees must consider the total quantity of material expected to be used by the individual in a year and the likelihood and severity of accidental intakes. In addition, licensees may be aware of and should consider other factors that could increase or decrease the likelihood of intakes during normal operations at their facilities. Licensees should consult NUREG-1400 for specific guidance in applying the modifying factors to their analyses.

List of Current Existing Regulatory Guidance:

Reg. Guide 8.9	Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program
Reg. Guide 8.15	Acceptable Programs for Respiratory Protection
Reg. Guide 8.25	Air Sampling in the Workplace
Reg. Guide 8.34	Monitoring Criteria and Methods to Calculate Occupational Radiation Doses
Reg. Guide 8.36	Radiation Dose to the Embryo/Fetus
NUREG-1400	Air Sampling in the Workplace

List of Outdated Existing Regulatory Guidance:

Reg. Guide 8.11	Applications of Bioassay for Uranium
Reg. Guide 8.20	Applications of Bioassay for I-125 and I-131
Reg. Guide 8.22	Bioassay at Uranium Mills
Reg. Guide 8.26	Applications of Bioassay for Fission and Activation Products
Reg. Guide 8.32	Criteria for Establishing a Tritium Bioassay Program

List of Implementing Guidance:

HPPO 47	Personnel Monitoring Requirements for an NRC/Agreement State Licensed Contractor Working at a Part 50-Licensed Facility
HPPO 233	Applicability of Regulatory Position 1.3 of Regulatory Guide 8.32 to Nuclear Reactor Facilities
HPPO 255	Airborne Thorium From Welding Rods
IN 97-36	Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials And External Exposure Due to Inadequate Control of Work
IN 96-18	Compliance with 10 CFR Part 20 for Airborne Thorium
IN 95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material
Q&A 43	Prospective Analyses

Q&A 44	Annual Prospective Analyses
Q&A 54	Respiratory Protection Credit
Q&A 75	Transient Worker Internal Dose Recordkeeping
Q&A 81	Monitoring of Declared Pregnant Women (***Note:*** threshold for monitoring raised to 0.1 rem from 0.05 rem since this Q&A published)
Q&A 98	Historical Basis to Require Internal Monitoring at Power Plants
Q&A 114	Conditions Requiring Monitoring – Accounting for Previous Dose
Q&A 126	Inclusion of External Doses from Effluents
Q&A 211	Monitoring of Declared Pregnant Women
Q&A 213	Monitoring of Service Company Personnel
Q&A 214	Monitoring of Transient Workers
Q&A 372	"Suitable and Timely" Measurements
Q&A 374	Use of Internal Monitoring to Assess Respirator Effectiveness
Q&A 375	Acceptable Bioassay Frequency
Q&A 398	Transient Worker Internal Dose Recordkeeping
Q&A 458	"Weighted" and "Effective" DACs to Determine Dose
Q&A 461	Applicable ALIs

3.20.1601 CONTROL OF ACCESS TO HIGH RADIATION AREAS

Statement of Requirement:
(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.

Discussion:
The regulation provides three options for controlling workers' access to high radiation areas (HRAs). One or more of these options must be used. A licensee can: 1) use a control device to reduce radiation levels when a worker enters the area; or 2) use an alarm to alert the worker and the supervisor of the activity when an entry is made; or 3) keep the areas locked and maintain positive control over each individual entry.

Statement of Applicability:
All licensees whose possession of radioactive materials could result in accessible areas where doses in excess of 100 mrem could be received within 1 hour.

Guidance Statement:
Access to and work within HRAs need to be properly controlled to protect individuals from unplanned, uncontrolled exposures that could lead to overexposures. Maintaining positive control over access to HRAs means limiting entries to the area only to authorized individuals who have been trained and are aware of the radiation hazards. In addition to these access controls for authorized entries, licensees use physical controls (barriers) to prevent unauthorized entries.

List of Existing Regulatory Guidance:
Reg. Guide 8.38 "Control of Access to High and Very High Radiation Areas in Nuclear Power Plants"

List of Implementing Guidance:

HPPOS 002	Overexposure of Diver During Work in Fuel Storage Pool
HPPOS 014	Access Control to High Radiation Areas (provides licensees some latitude as to where access controls can be established for HRAs)
HPPOS 016	Applicability of Access Controls for Spent Fuel Pools (clarifies that access to a spent fuel pools does not have to be controlled as HRAs, unless divers are in the pool)
HPPOS 235	HP Position on Controlling Beam Ports, Thermal Columns, and Flux Traps as High Radiation Areas (discusses need to control radiation beams and beam ports as HRAs)
HPPOS 245	Access Controls for Spent Fuel Storage Pools (discusses controls needed to ensure materials stored underwater in a fuel storage area do not cause unnecessary worker exposures)
Q&A 74	Explains that DDE is the appropriate dose focus in defining HRAs
Q&A 218	Clarifies the "control device" option, relative to when the device should activate
Q&A 373	Provides explanation of what constitutes adequate access restrictions (barriers) to prevent inadvertent or unauthorized HRA entry
Q&A 385	Discusses use of barriers and posting for HRAs at nuclear power plants, relative to individual HRAs within larger HRAs
Q&A 430	Notes that Q&A 373 was directed primarily to nuclear power plants
Q&A 431	Discusses applicability of Q&A 385 to non-power reactor licensees
IE Circular 76-03	"Radiation Exposures in Reactor Cavities"
IE Bulletin 78-08	"Radiation Levels from Fuel Element Transfer Tubes"
IE Bulletin 84-03	"Refueling Cavity Water Seal"
IE IN 82-31	"Overexposure of Diver During Work in Fuel Storage Pool"
IE IN 82-51	"Overexposures in PWR Cavities"
IE IN 84-19	"Two Events Involving Unauthorized Entries into PWR Reactor Cavities"
IE IN 84-61	"Overexposure of Diver in Pressurized Water Reactor (PWR) Refueling Cavity"
IE IN 84-93	"Potential for Loss of Water From the Refueling Cavity"
IE IN 86-107	"Entry into PWR Cavity with Retractable Incore Detector Thimbles Withdrawn"

IE IN 87-13	"Potential for High Radiation Fields Following Loss of Water from Fuel Pool"
IN 87-29	"Recent Safety-related Incidents at Large Irradiators"
IN 88-63	"High Radiation Hazards from Irradiated Incore Detectors and Cables" (includes supplements)
IN 88-79	"Misuse of Flashing Lights for High Radiation Area Controls"
IN 89-82	"Recent Safety-related Incidents at Large Irradiators"
IN 90-33	"Sources of Unexpected Occupational Radiation Exposure at Spent Fuel Storage Pools"
IN 91-14	"Recent Safety-related Incidents at Large Irradiators"
IN 91-23	"Accidental Radiation Overexposures to Personnel Due to Industrial Radiography Accessory Equipment Malfunctions"
IN 91-49	"Enforcement of Safety Requirements For Radiographers"
IN 93-05	"Locking Of Radiography Exposure Devices"
IN 93-39	"Radiation Beams From Power Reactor Biological Shields"
IN 93-69	"Radiography Events at Operating Power Plants"
IN 95-56	"Shielding Deficiency in Spent Fuel Transfer Canal at a Boiling-Water Reactor"
IN 96-25	"Traversing In-Core Probe Overwithdrawn at LaSalle County Station, Unit 1"
IN 97-68	"Loss of Control of Diver in a Spent Fuel Storage Pool"
IN 98-16	"Inadequate Operational Checks of Alarm Ratemeters"
IN 99-04	"Unplanned Radiation Exposures to Radiographers, Resulting From Failures to Follow Proper Radiation Safety Procedures"
NRC Bulletin 93-01	"Release of Patients After Brachytherapy Treatment with Remote Afterloading Devices"

Statement of Requirement:

(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.

Discussion:
Any licensee may use direct (visual) or electronic (e.g., closed-circuit TV) surveillance to prevent unauthorized entry into high radiation areas, instead of the controls in 20.1601(a).

Statement of Applicability:
All licensees whose possession of radioactive materials could result in accessible areas where doses in excess of 100 mrem could be received within 1 hour.

Guidance Statement:
When using electronic surveillance, the licensee must have the ability to remotely prevent entry into the area. The licensee should have the capability to warn individuals that their attempted entry is unauthorized, and then to alert the proper authorities of the improper entry attempt.

List of Existing Regulatory Guidance:
Reg. Guide 8.38 "Control of Access to High and Very High Radiation Areas in Nuclear Power Plants."

List of Implementing Guidance:
N/A.

Statement of Requirement:
(c) A licensee may apply to the Commission for approval of alternative methods for controlling access to high radiation areas.

Discussion:
If the licensee wants to control access to high radiation areas in a manner that differs from that specified in these regulations, it may request approval from NRC.

Statement of Applicability:
This option is available to all licensees whose possession of radioactive materials could result in accessible areas where doses in excess of 100 mrem could be received within 1 hour.

Guidance Statement:
The requirements of 10 CFR 20.1601(a) for access controls to HRAs may cause unnecessary restrictions on the operation of a licensee's facility. Accordingly, under this section, any licensee may apply to NRC for approval of alternative methods for HRA access control. The alternative controls must satisfy 20.1601(d).

List of Existing Regulatory Guidance:
Reg. Guide 8.38 "Control of Access to High and Very High Radiation Areas in Nuclear Power Plants"

List of Implementing Guidance:

HPPOS 014	Access Control to High Radiation Areas – Turkey Point (provides licensees some latitude as to where access controls can be established for HRAs)
HPPOS 015	Safety Evaluation of the Proposed Yankee Atomic Power Company's Modification of their Technical Specifications Relating to High Radiation Areas (provides one early example of nuclear power plant alternative controls for HRA, and includes description of duties of "individuals qualified in radiation protection procedures")
HPPOS 068	Response to Region II Interpretation for Control of High Radiation Areas (explains that radiation protection technician continuous work coverage in a HRA does not mean direct, line-of-sight coverage all the time)
HPPOS 180	Applicability of 10 CFR 20.203(c) [20.1601(c) in current regulations] to Plants With STS 6.12 (clarifies that a licensee with an approved alternative HRA access control program (1601(c)), may still control HRAs in accordance with other provisions of 20.1601)
HPPOS 234	Access Control to High Radiation Areas at Nuclear Power Plants (explains what a "barricade" is, as related to alternative controls for HRA used at nuclear power plants)
HPPOS 237	Request for Comments on Responses to Licensee Questions on High Radiation Area Controls (addresses questions concerning use of temporary shielding and the use of magnetic computer cards (in lieu of mechanical locks)
HPPOS 328	Proper Operation and Use of Alarm Dosimeters at Nuclear Power Plants (discusses proper operation and use of alarm dosimeters at nuclear power plants)
Q&A 373	Provides explanation of what constitutes adequate access restrictions (barriers) to prevent inadvertent or unauthorized HRA entry
Q&A 385	Discusses use of barriers and posting for HRAs at nuclear power plants, relative to individual HRAs within larger HRAs
Q&A 430	Notes that Q&A 373 was directed primarily to power reactor HRA controls
IE Bulletin 78-08	"Radiation Levels from Fuel Element Transfer Tubes"
IE IN 82-31	"Overexposure of Diver During Work in Fuel Storage Pool"
IE IN 82-51	"Overexposures in PWR Cavities"
IE IN 84-19	"Two Events Involving Unauthorized Entries into PWR Reactor Cavities"
IE IN 84-61	"Overexposure of Diver in Pressurized Water Reactor (PWR) Refueling Cavity"
IE IN 84-93	"Potential for Loss of water From the Refueling Cavity"

IE IN 86-107	"Entry into PWR Cavity with Retractable Incore Detector Thimbles Withdrawn"
IE IN 87-13	"Potential for High Radiation Fields Following Loss of Water from Fuel Pool"
IN 88-63	"High Radiation Hazards from Irradiated Incore Detectors and Cables" (includes supplements)
IN 88-79	"Misuse of Flashing Lights for High Radiation Area Controls"
IN 93-39	"Radiation Beams From Power Reactor Biological Shields"
IN 93-69	"Radiography Events At Operating Power Plants"
IN 95-56	"Shielding Deficiency in Spent Fuel Transfer Canal At a Boiling-Water Reactor"
IN 96-25	"Traversing In-Core Probe Overwithdrawn at LaSalle County Station, Unit 1"
IN 97-68	"Loss of Control of Diver in a Spent Fuel Storage Pool"
IN 98-16	"Inadequate Operational Checks of Alarm Ratemeters"

Statement of Requirement:
(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.

Discussion:
If the licensee controls access to an HRA by using a locked or chained accessway (door), then an individual must always be able to open the door from inside the HRA. The access controls used must not trap any individual inside a locked HRA.

Statement of Applicability:
All licensees whose possession of radioactive materials could result in accessible areas where doses in excess of 100 mrem could be received within 1 hour.

Guidance Statement:
One common way licensees satisfy this requirement is by the use of standard inner "crash bars" on locked doors. If the doors are self-locking, then personnel must be able to open them without a key.

List of Existing Regulatory Guidance:

Reg. Guide 8.38	"Control of Access to High and Very High Radiation Areas in Nuclear Power Plants"

List of Implementing Guidance:
N/A.

Statement of Requirement:
(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.

Discussion:
If the HRA is caused only by radioactive materials that are properly packaged and labeled for transport as required by DOT, then the licensee does not have to control the area as an HRA as long as the following conditions are met:

1. The packages ready for shipment are in the area for no more than 3 days.
2. The dose rate one meter from the surface of any of the packages is less than 10 mrem/hr.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
Licensees should be aware that this exception from HRA access controls does not relieve them from maintaining doses ALARA and that all other Part 19 and Part 20 requirements remain in effect.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

Statement of Requirement:
(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.

Discussion:
A licensee does not have to implement HRA access controls for rooms or other areas in hospitals if the only radiation is from patients administered radioactive materials or undergoing treatment using sealed sources. However, the licensee must ensure that visitors and other hospital personnel do not receive doses exceeding the occupational and public dose limits in Part 20. Additionally, the licensee must ensure that attending personnel carry out the ALARA provisions of the radiation protection program.

Statement of Applicability:
All NRC medical licensees.

Guidance Statement:
Licensees should be aware that this exception from HRA access controls does not relieve them from maintaining doses ALARA and that all other Part 19 and Part 20 requirements remain in effect.

List of Existing Regulatory Guidance:
Reg. Guide 10.8 "Guide for the Preparation of Applications for Medical Use Programs (Appendix X)"

List of Implementing Guidance:
Q&A 219 Provides guidance and acceptable controls for the requirement to have "...personnel in attendance..." who will take certain specified precautions

3.20.1602 CONTROL OF ACCESS TO VERY HIGH RADIATION AREAS

Statement of Requirement:
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.

Discussion:
The requirements for HRA access control also apply to very high radiation areas (VHRAs). Licensees must provide additional ways to prevent unauthorized or unintentional access to areas with radiation levels equal to or greater than 500 rads in 1 hour. This dose rate is measured at one meter from the radiation source or one meter away from the surface of the shielding.

Statement of Applicability:
All licensees whose radioactive materials could result in accessible areas where doses are equal to or greater than 500 rads in one hour, measured at one meter from the source of radiation or any surface through which the radiation penetrates, such as walls or shielding. Note that 10 CFR Part 36, Subpart C, *Design and Performance Requirements of Irradiators* provides specific requirements that satisfy this section for irradiators.

Guidance Statement: VHRAs require much stricter controls, since failure to adequately implement effective radiological controls can result in individuals receiving doses that pose significant health risks, or even death. Because of the potential for life-threatening exposures to individuals, licensees must institute additional measures to ensure that individuals are not able to gain unauthorized or inadvertent access to VHRA. To the extent possible, entry should be forbidden unless there is a sound operational or safety reason for entry.

List of Existing Regulatory Guidance:

Reg. Guide 8.38	"Control of Access to High and Very High Radiation Areas in Nuclear Power Plants"

List of Implementing Guidance:

HPPOS 002	Overexposure of Diver During Work in Fuel Storage Pool (discusses diver over exposure during work in fuel storage pool)
HPPOS 016	Applicability of Access Controls for Spent Fuel Pools (clarifies that access to a spent fuel pools does not have to be controlled as HRAs, unless divers are in the pool)
HPPOS 235	HPPOS on Controlling of Beam Ports, Thermal Columns, and Flux Traps as High Radiation Areas (discusses need to control radiation beams and beam ports as HRAs)

HPPOS 245	Access Controls to Spent Fuel Storage Pools (discusses controls needed to ensure materials stored underwater in a fuel storage area do not cause unnecessary worker exposures)
Q&A 49	Refers to draft Regulatory Guide 8.N10, now RG 8.38
Q&A 57	Points out that the absorbed dose of interest for VHRA is the deep-dose equivalent
Q&A 74	Explains that DDE is the appropriate dose focus in defining HRAs
Q&A 92	Agrees with a method used by a nuclear power plant to comply with this requirement, when controlling the primary containment
Q&A 218	Clarifies the "control device" option, relative to when the device should activate
Q&A 220	Discusses and points out that teletherapy rooms and radiography are VHRA when dose rates meet or exceed the criteria
Q&A 373	Provides explanation of what constitutes adequate access restrictions (barriers) to prevent inadvertent or unauthorized HRA entry
Q&A 423	Points out that alternative access controls (under 20.1601(c)) for HRA at nuclear power plants are not adequate to meet the additional controls requirements of this section
Q&A 430	Notes that Q&A 373 was directed primarily to nuclear power plants
Q&A 447	Discusses under what conditions a spent fuel pool is required to be posted and controlled as a VHRA
Q&A 448	Discusses control for irradiated components stored in spent fuel storage pools
IE Circular 76-03	"Radiation Exposures in Reactor Cavities"
IE Bulletin 78-08	"Radiation Levels from Fuel Element Transfer Tubes"
IE IN 82-31	"Overexposure of Diver During Work in Fuel Storage Pool"
IE IN 82-51	"Overexposures in PWR Cavities"
IE Bulletin 84-03	"Refueling Cavity Water Seal"
IE IN 84-19	"Two Events Involving Unauthorized Entries into PWR Reactor Cavities"
IE IN 84-61	"Overexposure of Diver in Pressurized Water Reactor (PWR) Refueling Cavity"
IE IN 84-93	"Potential for Loss of water From the Refueling Cavity"
IE IN 86-107	"Entry into PWR Cavity with Retractable Incore Detector Thimbles Withdrawn"

IE IN 87-13	"Potential for High Radiation Fields Following Loss of Water from Fuel Pool"
IE IN 87-29	"Recent Safety-related Incidents at Large Irradiators"
IN 88-63	"High Radiation Hazards from Irradiated Incore Detectors and Cables" (includes supplements)
IN 89-82	"Recent Safety-related Incidents at Large Irradiators"
IN 90-33	"Sources of Unexpected Occupational Radiation Exposure at Spent Fuel Storage Pools"
IN 91-14	"Recent Safety-related Incidents at Large Irradiators"
IN 93-39	"Radiation Beams From Power Reactor Biological Shields"
IN 95-56	"Shielding Deficiency in Spent Fuel Transfer Canal At a Boiling-Water Reactor"
IN 96-25	"Traversing In-Core Probe Overwithdrawn at LaSalle County Station, Unit 1"
IN 97-68	"Loss of Control of Diver in a Spent Fuel Storage Pool"

3.20.1701 USE OF PROCESS OR OTHER ENGINEERING CONTROLS

Statement of Requirement:
The licensee shall use, to the extent practical, process or other engineering controls (e.g., containment, decontamination or ventilation) to control the concentrations of radioactive material in air.

Discussion:
The licensee must make reasonable efforts to control the concentration of airborne, radioactive materials in the workplace. This should include eliminating or reducing the source of airborne, radioactive materials by exhaust ventilation; or enclosing, containing, or cleaning up the source of those materials.

Statement of Applicability:
All licensees whose operations could result in accessible airborne radioactivity areas or for whom the routine use of respirators is planned to reduce worker intakes or as required by the facility's emergency plan.

Guidance Statement:
Licensees whose activities create airborne hazards are required, to the extent practical, to maintain the internal component of occupational doses ALARA. To achieve this goal, licensees must use work practices and controls, contamination controls, and installed process and portable equipment, to reasonably minimize the level of airborne radioactive materials.

List of Existing Regulatory Guidance:

Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

Q&A 90	Explains why use of potassium iodide is not acceptable process or engineering control
Q&A 115	Describes NRC's reason for adding examples to section
IN 85-87	"Hazards of Inerting Atmospheres"
IN 94-26	"Personnel Hazards and Other Problems From Smoldering Fire-Retardant Material in the Drywell of a Boiling Water Reactor"
IN 96-18	"Compliance with 10 CFR Part 20 for Airborne Thorium"
IN 97-36	"Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials and External Exposure Due to Inadequate Control of Work"
IN 98-20	"Problems with Emergency Preparedness Respiratory Protection Programs"

IN 99-05 "Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

List of Outdated Implementing Guidance:

IN 92-75 "Unplanned Intakes of Airborne Radioactive Material by Individuals at Nuclear Power Plants"

3.20.1702 USE OF OTHER CONTROLS

Statement of Requirement:
(a) When it is not practical 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:

1. Control of access;
2. Limitation of exposure times;
3. Use of respiratory protection equipment; or
4. Other controls.

(b) If the licensee performs an ALARA analysis to determine whether or not respirators should be used, the licensee may consider safety factors other than radiological factors. The licensee should also consider the impact of respirator use on workers' industrial health and safety.

Discussion:
When engineering and processing controls do not reduce the levels of airborne, radioactive materials below 1 DAC (or when a worker could receive 12 DAC-hrs/week), then the licensee must use other methods to protect the worker and, at the same time, to reasonably balance internal and external exposure (keeping the TEDE ALARA). These methods to limit intakes include one or more of the following: 1) limiting and controlling access; 2) limiting stay times; 3) using respirators; and 4) using other reasonable methods.

If the licensee decides to consider the use of respirators, then the licensee may take into account non-radiological factors. The factors that should be considered in this evaluation include heat stress, fall hazards, impaired communication (e.g., visual, voice), and other work safety factors that may be present.

Statement of Applicability:
All licensees whose operations could result in accessible airborne radioactivity areas or for whom the routine use of respirators is planned to reduce worker intakes or as required by the facility's emergency plan.

Guidance Statement:
Engineering controls that reasonably limit airborne radioactive materials are generally preferable to the use of personal respiratory protection. The use of respirators can impose physiological and psychological stresses on workers, reduce worker efficiency, and make communicating difficult. These burdens can increase the risk of physical injury. Licensees may factor these risks into the evaluation and decision-making regarding the use of respirators to maintain the TEDE ALARA.

The NRC staff acknowledges that TEDE ALARA evaluations are not exact, and many assumptions (work efficiency, estimated intakes) are not precisely predictable. Therefore, when the evaluation does not show a clear decision path, then the licensee's professional judgment should be exercised.

List of Existing Regulatory Guidance:

Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

Q&A 145	Discusses uses of the very sensitive personal contamination monitors as check for inadvertent personal intakes
Q&A 387	Allows for the consideration of risk other than from radiation to be considered when doing TEDE ALARA evaluation
Q&A 388	Explains how respirators can be used to reduce radioiodine uptakes
Q&A 449	Discusses and allows licensees to use cost/benefit analysis when deciding whether to use respirators
Q&A 493	Explains how to comply with ALARA requirements, relative to level of effort in controlling airborne concentrations
Circular 80-03	"Protection From Toxic Gas Hazards"
IN 81-26, Part 4	"Personnel Entry Into Inerted Containment"
IN 85-87	"Hazards of Inerting Atmospheres"
IN 94-26	"Personnel Hazards and Other Problems From Smoldering Fire-Retardant Material in the Drywell of a Boiling Water Reactor"
IN 96-18	"Compliance with 10 CFR Part 20 for Airborne Thorium"
IN 97-36	"Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials and External Exposure Due to Inadequate Control of Work"
IN 98-20	"Problems with Emergency Preparedness Respiratory Protection Programs"
IN 99-05	"Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

List of Outdated Implementing Guidance:

Q&A 386	Provides interim NRC policy for allowing issuance of respirators until workers make transition shift
IN 92-75	"Unplanned Intakes of Airborne Radioactive Material by Individuals at Nuclear Power Plants"

3.20.1703 USE OF INDIVIDUAL RESPIRATORY PROTECTION EQUIPMENT

Statement of Requirement:
If the licensee assigns or permits the use of respiratory protection equipment to limit the intake of radioactive material:

(a) The licensee shall use only respiratory protection equipment that is tested and certified by the National Institute for Occupational Safety and Health (NIOSH) except as otherwise noted in this part.

(b) If the licensee wishes to use equipment that has not been tested or certified by NIOSH, or for which there is no schedule for testing or certification, the licensee shall submit an application to NRC for authorized use of that equipment, except as provided in this part. The application must include evidence that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use. This must be demonstrated either by the licensee testing or on the basis of reliable test information.

Discussion:
If the licensee chooses to use respirators to limit worker intakes, then the devices used must be certified by NIOSH. If a licensee identifies a need for a respirator but this device is not NIOSH-certified, then the licensee may request NRC approval to allow the licensee to use the respirator. To get this approval, the licensee must submit evidence for NRC review that the respirator can provide the needed worker protection – that the device's construction and performance is adequate for its intended use. Documentation of the respirator's design and performance must be supported by actual test data.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
Licensees need to evaluate the existing or potential airborne concentrations of radioactive material (from routine operations, likely operational occurrences, and credible emergency conditions) and determine whether a Part 20, Subpart H program would have been required to limit the worker intake. If this analysis shows that respiratory protection would not be needed to protect workers from radiological hazards (limit the intake), then the licensee need not have a respiratory protection program.

Workers are not allowed to use non-NIOSH-certified respirators to limit radioactive material intake, unless NRC has granted specific approval for such use as provided by this section. When requesting such approval, the licensee should explain why no existing NIOSH-certified device meets the licensee's need, and that the use of the respirator will not cause the wearer undue physical or psychological stress or undo hazard. The testing information provided to NRC may

be the work of the licensee, a respiratory manufacturer or a reliable third party (independent testing laboratory). If NRC has previously approved a device for use by another licensee, then the licensee may use the test data from that existing approval.

List of Existing Regulatory Guidance Documents:

Reg. Guide 8.15 "Acceptable Programs For Respiratory Protection (Revision 1)"

NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

*HPPOS 037 Farley 1 & 2 – 10 CFR Part 20 Exemption Request, MSA GMR-I Canister Radioiodine Protection Factor (describes example of NRC approval process to use non-NIOSH approved equipment to protect against radio-iodine gases and vapors)

HPPOS 118 Airflow Measurement and Control for Supplied-Air Respirators (provides guidance to effectively use and control air-line respirators)

HPPOS 147 Respirator User's Notice – Use of Unapproved Subassemblies (NIOSH warns against the use of unapproved subassemblies (parts and components) and unauthorized modification for/of approved respirators)

*HPPOS 226 Intent of the QA Testing of Respirator HEPA Filters, as discussed in NUREG-0041 (provides intent of QA testing of respirator filters prior to use (or reuse))

*Q&A 91 Clarifies the need to comply with programmatic requirements when using respirators

*Q&A 124 Notes that this section's requirements apply to respirators used during emergencies

*Q&A 418 Explains that licensees need a formal program whenever a respirator is used to limit intake

*IN 80-19 "NIOSH Recall of Recirculating-Mode (Closed-Circuit) Self-Contained Breathing Apparatus (Rebreather)"

IN 83-68 "Respirator User Warning: Defective Self-Contained Breathing Apparatus Air Cylinders"

IN 84-34 "Respirator User Warning: Defective Self-Contained Breathing Apparatus Air Cylinders"

IN 84-56 "Respirator Users Notice for Certain 5-Minute Emergency Escape Self-Contained Breathing Apparatus"

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* Needs minor updating, but basic message is still applicable – provides good staff guidance.

IN 85-48	"Respirator User Warning: Defective Self-Contained Breathing Apparatus Air Cylinders"
IN 86-103	"Respirator Coupling Nut Assembly Failures"
IN 89-47	"Potential Problems with Worn or Distorted Hose Clamps on Self-Contained Breathing Apparatus"
IN 94-35	"NIOSH Respirator User Notices, "Inadvertent Separation of the Mask-Mounted Regulator (MMR) from the Facepiece of the Mine Safety Appliance (MSA) Company Self-Contained Breathing Apparatus (SCBA) and Status Update"
IN 95-01	"DOT Safety Advisory: High Pressure Aluminum Seamless and Aluminum Composite Hoop-Wrapped Cylinders"

List of Outdated Implementing Guidance:

HPPOS 225	Footnote g of Appendix A to 10 CFR 20 Concerning Protection Factor for Respirator (discusses NRC policy on use of non-elastomeric (disposable) half-facepieces)
Bulletin 78-07	"Protection Afforded By Airline Respirators and Supplied-Air Hoods"
Circular 79-09	"Occurrences of Split or Punctured Regulator Diaphragms In Certain Self-Contained Breathing Apparatus"
Circular 79-15	"Bursting of High Pressure Hose and Malfunction of Relief Valve and 'O'-Ring In Certain Self-Contained Breathing Apparatus"
IN 83-21	"Defective Emergency-Use Respirator"
IN 82-36	"Respirator User Warning for Certain 5-Minute Emergency Escape SCBA"
IN 83-67	"Emergency-Use Respirator Material Defect Causes Production of Noxious Gas"
IN 84-60	"Failure to Meet Air-Purifying Respirator Filters to Meet Efficiency Requirement"
IN 85-60	"Defective Negative-Pressure, Air-Purifying Full Facepiece Respirators"
IN 86-24	"Respirator User Warning: Increased Inspection Frequency for Certain Defective Self-Contained Breathing Apparatus Air Cylinders"

Statement of Requirement:

(c) The licensee shall implement and maintain a respiratory protection program that includes:

1. Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate doses;
2. Surveys and bioassays, as necessary, to evaluate actual intakes;

3. Testing of respirators for operability (user seal check for face-sealing devices and functional check for others) immediately prior to each use.

Discussion:
The licensee's respiratory protection program must include air sampling so that the airborne hazards can be known and the correct respiratory protective equipment can be available for use, with controls in place to estimate worker intake of radioactive materials, so that worker internal dose can be estimated.

When necessary, the licensee must be able to evaluate actual worker intakes. This will require surveys to adequately evaluate and quantify the levels of workplace hazardous airborne materials and workplace loose contamination levels. In addition, as necessary, the licensee must be able to determine what kinds, how much, and the location of radioactive materials in a worker. This bioassay information may be obtained by direct measurement of the worker and/or from analysis of body waste products (e.g., urine and feces).

Before using a face-sealing (tight-fitting) respirator in the workplace, the user must check to see whether the respirator is properly sealed to his face. If the respirator is not a tight-fitting type (e.g., air-supplied hood), then other personnel must assist in performing an operational check to see that the respirator is functioning properly.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
Air sampling must be representative – sampling in the worker's breathing zone provides the most accurate information (short of bioassay) for evaluating intakes, when coupled with accurate stay-time data. Air sampling must also be timely (relative to the work activity), with the appropriate filter (or other collection media) and of sufficient duration (volume sampled).

See Part 20, Subpart F for survey guidance and 20.1204 for bioassay guidance.

User seal checks just after donning a tight-fitting (full or half-face) respirator help ensure a proper face-to-respirator seal. This check is not a substitute for the required fit test. Various methods are available for checking the seal immediately prior to use, and these are part of the required worker training program.

Functional checks are required for non-face-sealing respirators to ensure proper operation of the devices. For example, on a hood supplied by an airline, the functional check should include support people ensuring proper air flow to the hood and that the wearer feels comfortable that the hood is supplying adequate air.

List of Existing Regulatory Guidance:

Reg. Guide 8.9	"Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program"
Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
Reg. Guide 8.25	"Air Sampling in the Workplace (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"
NUREG-1400	"Air Sampling in the Workplace"

List of Implementing Guidance:

HPPOS 118	Airflow Measurement and Control for Supplied-Air Respirators (provides guidance to effectively use and control airline respirators)
*Q&A 91	Clarifies the need to comply with programmatic requirements when using respirators
*Q&A 124	Notes that this section's requirements apply respirators used during emergencies
*Q&A 131	Relates how user seal check can be performed
*Q&A 132	Explains how to comply with requirement to "potential hazards" when sampling for airborne radioactive materials
*Q&A 374	Provides NRC views on how a licensee can monitor their program's effectiveness
*Q&A 418	Explains that licensees need a formal program whenever a respirator is used to limit intake
Q&A 479	Discussed increased likelihood of facial contaminations as the use of respirators decreases
IN 79-08	"Interconnection of Contaminated Systems with Service Air Systems Used as the Source of Breathing Air"
IN 81-26, Part 4	"Personnel Entry Into Inerted Containment"
*IN 84-24	"Physical Qualification of Individuals to Use Respiratory Protective Devices"
IN 84-34	"Respirator User Warning: Defective Self-Contained Breathing Apparatus Air Cylinders"
IN 84-56	"Respirator Users Notice for Certain 5-Minute Emergency Escape Self-Contained Breathing Apparatus"

* Needs minor updating, but basic message is still applicable – provides good staff guidance.

IN 85-06	"Contamination of Breathing Air Systems"
IN 85-87	"Hazards of Inerting Atmospheres"
IN 86-43	"Problems With Silver Zeolite Sampling of Airborne Radioiodine"
*IN 92-75	"Unplanned Intakes of Airborne Radioactive Material by Individuals at Nuclear Power Plants"
IN 94-26	"Personnel Hazards and Other Problems From Smoldering Fire-Retardant Material in the Drywell of a Boiling Water Reactor"
IN 96-18	"Compliance with 10 CFR Part 20 for Airborne Thorium"
IN 97-36	"Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials and External Exposure Due to Inadequate Control of Work"
IN 99-05	"Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

List of Outdated Implementing Guidance:

HPPOS 146	Updated Guidance on Fit Testing of Biopak 60-P Respirator Users (provides specific guidance and acceptance criteria for fit testing users of a positive pressure, recirculating SCBA)
IN 84-60	"Failure to Meet Air-Purifying Respirator Filters to Meet Efficiency Requirement"

Statement of Requirement:

(c)(4) Written procedures regarding:

(i) Monitoring, including air sampling and bioassays;

(ii) Supervision and training of respirator users;

(iii) Fit testing;

(iv) Respirator selection;

(v) Breathing air quality;

(vi) Inventory and control;

(vii) Storage, issuance, maintenance, repair, testing and quality assurance of respiratory protection equipment;

(viii) Recordkeeping; and

(ix) Limitations on periods of respirator use and relief from respirator use.

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* Needs minor updating, but basic message is still applicable – provides good staff guidance.

Discussion:
If the licensee is going to use respirators to limit workers' intake of radioactive materials, then the licensee program must have implementing procedures that include each of the above line items.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
These implementing procedures should be reviewed and approved by the supervisor or staffer responsible as the program administrator. Part 20.1101 requires an annual review of the radiation program, and this section's procedures are part of that program. As such, the procedures should be periodically revised and upgraded when needed. Each required line item above need not have its own, separate procedure.

List of Existing Regulatory Guidance:

Reg. Guide 8.9	"Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program"
Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
Reg. Guide 8.25	"Air Sampling in the Workplace (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"
NUREG-1400	"Air Sampling in the Workplace"

List of Implementing Guidance:

*HPPOS 226	Intent of the QA Testing of Respirator HEPA Filters, as discussed in NUREG-0041 (provides intent of QA testing of respirator filters prior to use (or reuse))
*Q&A 91	Clarifies the need to comply with programmatic requirements when using respirators
*Q&A 124	Notes that this section's requirements apply respirators used during emergencies
*Q&A 131	Relates how user seal check can be performed
*Q&A 132	Explains how to comply with requirement to "potential hazards" when sampling for airborne radioactive materials

* Needs minor updating, but basic message is still applicable – provides good staff guidance.

*Q&A 374	Provides NRC views on how a licensee can monitor their program's effectiveness
*Q&A 418	Explains that licensees need a formal program whenever a respirator is used to limit intake
Q&A 479	Discussed increased likelihood of facial contaminations as the use of respirators decreases
Q&A 480	Discusses methods to provide facial protection from contamination.
IN 79-08	"Interconnection of Contaminated Systems with Service Air Systems Used as the Source of Breathing Air"
*Circular 80-03	"Protection From Toxic Gas Hazards"
IN 81-26, Part 4	"Personnel Entry Into Inerted Containment"
*IN 84-24	"Physical Qualification of Individuals to Use Respiratory Protective Devices"
IN 85-06	"Contamination of Breathing Air Systems"
IN 85-87	"Hazards of Inerting Atmospheres"
IN 86-43	"Problems With Silver Zeolite Sampling of Airborne Radioiodine"
IN 86-46	"Improper Cleaning and Decontamination of Respiratory Protection Equipment"
*IN 92-75	"Unplanned Intakes of Airborne Radioactive Material by Individuals at Nuclear Power Plants"
IN 94-26	"Personnel Hazards and Other Problems From Smoldering Fire-Retardant Material in the Drywell of a Boiling Water Reactor"
IN 96-18	"Compliance with 10 CFR Part 20 for Airborne Thorium"
IN 97-36	"Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials and External Exposure Due to Inadequate Control of Work"
IN 98-20	"Problems with Emergency Preparedness Respiratory Protection Programs"
IN 99-05	"Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

List of Outdated Implementing Guidance:

HPPOS 146	Updated Guidance on Fit Testing of Biopak 60-P Respirator Users (provides specific guidance and acceptance criteria for fit testing users of a positive pressure, recirculating SCBA)

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* Needs minor updating, but basic message is still applicable – provides good staff guidance.

HPPOS 175 Acceptability of New Technology Respirator Fit Testing Devices (provides NRC position on acceptability of fit testing methods)

IN 83-67 "Emergency-Use Respirator Material Defect Causes Production of Noxious Gas"

Statement of Requirement:
(c)(5) Determination by a physician that the individual user is medically fit to use respiratory protection equipment before:

(i) The initial fitting of a face-sealing respirator;

(ii) Before the first field use of non-face-sealing respirators; and

(iii) Either every 12 months thereafter or periodically at a frequency determined by a physician.

Discussion:
Before a worker is fit-tested for a face-sealing (tight-fitting) respirator or uses a non-face-sealing respirator, a medical doctor must decide that the worker is medically fit to use a respirator. This fitness determination is repeated every 12 months, or periodically as directed by the doctor.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
The use of respirators does impose additional physical and psychological stresses on workers. Physicians decide what constitutes minimum health standards for respirator wearers. These standards vary as a function of the type of respirator used, physical conditions, type of work and environment, and other factors. A medical evaluation program should be carried out either by the physician or by a certified, medically trained individual (under the physician's direction and oversight). This evaluation should effectively screen out individuals from using respirators, without further evaluation from the responsible physician. After a reevaluation, the physician may then decide that a worker may not use any respiratory equipment, or may simply allow use of only one specific type of respirator.

List of Existing Regulatory Guidance:
Reg. Guide 8.15 "Acceptable Programs For Respiratory Protection (Revision 1)"

NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:
HPPOS 061 Guidance Regarding Physicians' Determination of Physical Qualification of Respiratory Equipment Users (provides guidance on physician's fitness determination responsibility for the worker)

*HPPOS 103	Request for Clarification of Guidance Regarding Physicians Determination for Physical Qualification of Respiratory Equipment Users (clarifies administrative questions and degree of involvement of responsible physician for worker fitness determination for respirator use)
*IN 84-24	"Physical Qualification of Individuals to Use Respiratory Protective Devices"
IN 98-20	"Problems with Emergency Preparedness Respiratory Protection Programs"
IN 99-05	"Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

List of Outdated Implementing Guidance:

HPPOS 117	Medical Surveillance for Respirator Users (medical examination guidance for users)

Statement of Requirement:

(c)(6) Fit testing, with fit factor ≥ 10 times the APF for negative pressure devices, and a fit factor ≥ 500 for any positive pressure, continuous flow and pressure-demand devices, before the first field use of tight fitting, face-sealing respirators and periodically thereafter at a frequency not to exceed 1 year. Fit testing must be performed with the facepiece operating in the negative pressure mode.

Discussion:

Each worker must be able to get a good fit with a face-sealing (tight-fitting) respirator before using that respirator in the field (in actual work place conditions) to limit radioactive material intake. For negative pressure respirators (the user breaths in and creates negative pressure inside the mask), the fit test result must be greater than or equal to 10 times the assigned protection factor (APF). For example, for a half-face respirator (APF=10), a worker's fit factor results must be greater than or equal to 100.

For positive pressure, continuous flow, or pressure-demand face-sealing respirators, the worker must obtain a fit factor of 500 or greater. All respirator user fits must be periodically re-checked, and the time between retests shall not exceed 12 months.

Statement of Applicability:

All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:

Fit testing should be conducted after the user has been trained in how to don and use the respirator properly. When a worker successfully passes a fit test (performed in a controlled, laboratory environment), then the licensee can be confident that the worker can obtain and

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* Needs minor updating, but basic message is still applicable – provides good staff guidance.

maintain the assumed APF (in the working environment), given that other programmatic factors have been adequately accomplished [e.g., user training, adequate user seal check, mask maintenance and quality assurance (QA)/quality control (QC)].

List of Existing Regulatory Guidance:

Reg. Guide 8.15 "Acceptable Programs for Respiratory Protection (Revision 1)"

NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

*HPPOS 037 Farley 1 & 2 – 10 CFR Part 20 Exemption Request, MSA GMR-I Canister Radioiodine Protection Factor (describes example of NRC approval process to use non-NIOSH approved equipment to protect against radio-iodine gases and vapors)

*Q&A 131 Relates how user seal check can be performed.

List of Outdated Implementing Guidance:

HPPOS 146 Updated Guidance on Fit Testing of Biopak 60-P Respirator Users (provides specific guidance and acceptance criteria for fit testing users of a positive pressure, recirculating SCBA)

HPPOS 175 Acceptability of New Technology Respirator Fit Testing Devices (provides NRC position on acceptability of fit testing methods)

Statement of Requirement:

(d) 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.

Discussion:

The licensee must tell each worker that if any of the following events occur while wearing a respirator, the worker may the leave the work area and take off the respirator:

1. The respirator doesn't work properly;
2. The worker feels physically ill (sick) or claustrophobic (doesn't like being confined in respirator);
3. The work is not going as planned or understood, and work conditions continue to deteriorate;

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* Needs minor updating, but basic message is still applicable – provides good staff guidance.

4. The worker cannot communicate with fellow workers or others, when needed;
5. Any other similar situation or problem.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
Given the additional stress and burdens placed on respirator wearers, each such user must be informed of their right to exit the "respiratory protection required" work area, if problems occur. However, the worker should be instructed and understand that (for given situations) you must keep your respirator on until your clear the area. For example, if a worker is inside a highly contaminated tent and his powered air-purifying respirator (PAPR) battery runs low and blower stops, the worker should leave the facepiece on and use the respirator in the negative pressure-mode until he leaves the tent.

List of Existing Regulatory Guidance:
Reg. Guide 8.15 "Acceptable Programs For Respiratory Protection (Revision 1)"

NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:
N/A.

Statement of Requirement:
(e) The licensee shall also consider limitations appropriate to the type and mode of use. When selecting respiratory devices the licensees shall provide for vision correction, adequate communications, low temperature work environments, and concurrent use of other safety or radiological protection equipment. The licensee shall use equipment in such a way as not to interfere with the proper operation of the respirator.

Discussion:
The licensee must consider working conditions when selecting and issuing respirators. Each worker should be able to see well and speak to fellow workers. If the workplace is at or below freezing, then the likelihood of respirator problems must be considered and controlled. When other safety equipment must be used at the same time as a respirator, this additional equipment must not get in the way of or hinder the proper operation of the worker's respirator.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
It is vital that a respirator wearer be able to see clearly and communicate well with fellow workers and supervision. Vision spectacle kits specific for each respirator types are available, and contact lens are allowed to be used. When using respirators in low temperature environs, lens fogging/frosting can occur unless compensatory measures are taken. Cold temperatures can cause another serious problem; exhalation valve freezing, which (if in the "open" position) could allow contaminant penetration into the mask (and other problems, specific to the type of respirator).

When additional safety equipment is required, the use of such equipment shall not interfere with the form, fit or function of the respirator. For example, unless the communication device is specifically approved for use by the manufacture (and thus part of the NIOSH approval process), if the device is attached to the respirator, it is likely to void the certification.

List of Existing Regulatory Guidance:

Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

Q&A 479	Discusses increased likelihood of facial contaminations as the use of respirators decreases.
Q&A 480	Discusses methods to provide facial protection from contamination.
IN 96-18	"Compliance with 10 CFR Part 20 for Airborne Thorium"
IN 97-66	"Failure to Provide Special Lenses for Operators Using Respirator or Self-Contained Breathing Apparatus During Emergency Operations"
IN 98-20	"Problems with Emergency Preparedness Respiratory Protection Programs"
IN 99-05	"Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

List of Outdated Implementing Guidance:

HPPOS 162	Use of Contact Lenses with Respirators (removed prohibition of using contact lenses (***Note:*** RG 8.15, Rev 1 now supports use)).

Statement of Requirement:
(f) Standby rescue persons are required whenever one-piece atmosphere-supplying suits, or any combination of supplied air respiratory protection device and personnel protective equipment, are used from which an unaided individual would have difficulty extricating himself or herself. The standby persons must be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards. The standby rescue persons shall observe or otherwise

maintain continuous communication with the workers (visual, voice, signal line, telephone, radio, or other suitable means), and be immediately available to assist them in case of a failure of the air supply or for any other reason that requires relief from distress. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and to provide effective emergency rescue if needed.

Discussion:
Sufficient numbers of rescue people must be ready to provide immediate help to get workers out of air-supplied, one-piece body suits (or other hoods that are hard take off out by oneself). These rescuers must have their own respirators and other safety equipment to do the job and must be at all times in some form of close communication with the respirator users.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
When the external air supply fails to a one-piece suit or tightly worn (tucked-in seal) hood, the user has no more than about one minute to get out of the respirator (or get fresh air in) before oxygen depletion and carbon dioxide buildup cause a potential life-threatening situation. The standby rescuers should be trained on how to provide the immediate aid and be fully cognizant of the time-sensitive dangers to the respirator user.

List of Existing Regulatory Guidance:

Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

HPPOS 118	Airflow Measurement and Control for Supplied-Air Respirators (provides guidance to effectively use and control airline respirators).
IN 97-66	"Failure to Provide Special Lenses for Operators Using Respirator or Self-Contained Breathing Apparatus During Emergency Operations"
IN 98-20	"Problems with Emergency Preparedness Respiratory Protection Programs"
IN 99-05	"Inadvertent Discharge of Carbon Dioxide Fire Protection System and Gas Migration"

Statement of Requirement:
(g) Atmosphere-supplying respirators must be supplied with respirable air of grade D quality or better as defined by the Compressed Gas Association in publication G-7.1, "Commodity Specification for Air," 1997.

Discussion:
Respirator-provided air that is separate from the normal air in the workplace must be as good or better than Grade D air. The United States Department of Labor's Occupational Safety and Health Administration (OSHA) requires Grade D air, which has limits on oil levels (condensed hydrocarbons) and carbon dioxide and monoxide, and must not have any detectable odor. Oxygen must be within normal levels and below a certain percentage (to avoid the chance of a fire on or inside the respirator).

Statement of Applicability:
All licensees that use supplied air respirators to limit worker intakes of radioactive materials.

Guidance Statement:
Breathing air is normally supplied by two modes. Compressed air is provided for individual SCBA bottles, and airline respirators are fed from an installed air distribution system (compressor) or a cascade of air cylinders. In any case, the license must assure at least Grade D air quality either by contractor assurance (for air bottles filled offsite) or sampling the onsite air compressor output. When using an installed air distribution system, licensees are cautioned to take steps to avoid contaminating the system internals.

List of Existing Regulatory Guidance:

Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

HPPOS 118	Airflow Measurement and Control for Supplied-Air Respirators (provides guidance to effectively use and control airline respirators)
*Q&A 124	Notes that this section's requirements apply respirators used during emergencies
IN 79-08	"Interconnection of Contaminated Systems with Service Air Systems Used as the Source of Breathing Air"
IN 85-06	"Contamination of Breathing Air Systems"
IN 85-87	"Hazards of Inerting Atmospheres"
IN 94-26	"Personnel Hazards and Other Problems From Smoldering Fire-Retardant Material in the Drywell of a Boiling Water Reactor"

* Needs minor updating, but basic message is still applicable – provides good staff guidance.

Statement of Requirement:
(h) The licensee shall ensure that no objects, materials or substances, such as facial hair, or any conditions that interfere with the face-facepiece seal or valve function, and that are under the control of the respirator wearer, are present between the skin of the wearer's face and the sealing surface of the tight-fitting respirator facepiece.

Discussion:
When using a tight-fitting respirator, the user must be clean-shaven, and nothing is allowed to interfere with the face sealing area or the operation of any inlet or exhalation valves.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
This prohibition includes all types of respirators, including air purifying and atmosphere supplying respirators that are tight-fitting. A single strand of hair can cause an exhalation valve malfunction, which would allow for serious degradation of respirator function. Maintaining a good face-to-respirator facepiece fit is vital to ensure that an adequate degree of protection is provided – any interference in this interface area could seriously degrade wearer protection.

Workers assigned to emergency response teams (e.g., fire brigade) that must provide immediate response should not be allowed to grow and maintain beards. Given the nature and timing of the response required, it is not acceptable to take the time to shave the beard before responding.

List of Existing Regulatory Guidance:

Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Current Implementing Guidance:

IN 97-66	"Failure to Provide Special Lenses for Operators Using Respirator or Self-Contained Breathing Apparatus During Emergency Operations"

List of Outdated Implementing Guidance:

HPPOS 094	Guidance Concerning 10 CFR 20.1703 and use of Pressure Demand SCBAs (discussed problems with facial hair, when using SCBA (current rule prohibits beards, etc. in seal area))
HPPOS 116	OSHA Interpretation: Beards and Tight-Fitting Respirators (provides technical, safety basis for not allowing bearded respirator users)
HPPOS 162	Use of Contact Lenses with Respirators (removes prohibition of using contact lenses (***Note:*** RG 8.15, Rev 1 now supports use))

Statement of Requirement:
(i) In estimating the dose to individuals from intake of airborne radioactive materials, the concentration of radioactive material in the air that is inhaled when respirators are worn is initially assumed to be the ambient concentration in air without respiratory protection, divided by the assigned protection factor. If the dose is later found to be greater than the estimated dose, the corrected value must be used. If the dose is later found to be less than the estimated dose, the corrected value may be used.

Discussion:
When the licensee is making the initial estimate of dose received by workers using respirators, the licensee must divide the measured workplace airborne radioactive material concentration (without any respiratory protection) by the APF of the respirator. If the dose is later found to be greater, the licensee must record the higher corrected dose. If the dose is later found to be lower, then the licensee may (but is not required to) use the lower corrected value as dose of record.

Statement of Applicability:
All licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
For personnel who must be monitored for internal dose (per 10 CFR 20.1502, likely to receive 10% of an ALI in a year), any intake (dose) must be recorded as specified in 10 CFR 20.1204.

List of Existing Regulatory Guidance:

Reg. Guide 8.9	"Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program"
Reg. Guide 8.15	"Acceptable Programs For Respiratory Protection (Revision 1)"
Reg. Guide 8.25	"Air Sampling in the Workplace (Revision 1)"
Reg. Guide 8.34	"Monitoring Criteria and Methods to Calculate Occupational Radiation Dose"
NUREG-0041	"Manual of Respiratory Protection Against Airborne Radioactive Materials"
NUREG-1400	"Air Sampling in the Workplace"

List of Implementing Guidance:

*Q&A 60	Provides guidance for required records of TEDE ALARA evaluations
*Q&A 132	Explains how to comply with requirement to "potential hazards" when sampling for airborne radioactive materials

* Needs minor updating, but basic message is still applicable – provides good staff guidance.

*Q&A 374	Provides NRC views on how a licensee can monitor their program's effectiveness
Q&A 479	Discusses increased likelihood of facial contaminations as the use of respirators decreases
Q&A 480	Discusses methods to provide facial protection from contamination
IN 85-06	"Contamination of Breathing Air Systems"
IN 86-43	"Problems With Silver Zeolite Sampling of Airborne Radioiodine"
*IN 92-75	"Unplanned Intakes of Airborne Radioactive Material by Individuals at Nuclear Power Plants"
IN 97-36	"Unplanned Intakes by Worker of Transuranic Airborne Radioactive Materials and External Exposure Due to Inadequate Control of Work"

* Needs minor updating, but basic message is still applicable – provides good staff guidance.

3.20.1704 FURTHER RESTRICTIONS ON THE USE OF RESPIRATORY PROTECTION EQUIPMENT

Statement of Requirement:
The Commission may impose restrictions in addition to those in §§20.1702, 20.1703, and Appendix A to Part 20 to:

(a) Ensure that the respiratory protection program of the licensee is adequate to limit doses to individuals from intakes of airborne radioactive materials consistent with maintaining total effective dose equivalent ALARA; and

(b) Limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

Discussion:
In addition to all the requirements imposed on licensees who wish to use respirators, NRC may impose additional restrictions to ensure that the licensee's program is adequate to protect workers from airborne, radioactive materials and, at the same time, to properly balance external and internal exposure. NRC may also limit the licensee's ability to use respirators, if the licensee is not making good use of the preferred engineering controls (e.g., decontamination, containment, and ventilation).

Statement of Applicability:
All licensees whose operations could result in accessible airborne radioactivity areas or for whom the routine use of respirators is planned to reduce worker intakes or as required by the facility's emergency plan.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1705 APPLICATION FOR USE OF HIGHER ASSIGNED PROTECTION FACTORS

Statement of Requirement:
The licensee shall obtain authorization from the Commission before using assigned respiratory protection factors in excess of those specified in Appendix A to Part 20. The Commission may authorize a licensee to use higher protection factors on receipt of an application that:

(a) Describes the situation for which a need exists for higher protection factors; and

(b) Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

Discussion:
A licensee may request NRC to approve and to allow the use of APFs greater than those listed in Appendix A. However; the licensee must explain the need for the higher APFs; and the licensee must show that the respirator will provide the higher degree of protection when used under the conditions expected.

Statement of Applicability:
Any licensees may apply for specific approval to use higher APFs.

Guidance Statement:
None.

List of Existing Regulatory Guidance Documents:
Regulatory Guide 8.15; Revision 1; "Acceptable Programs For Respiratory Protection"

NUREG-0041; "Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:
N/A.

3.20.1801 SECURITY OF STORED MATERIAL

Statement of Requirement:
The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

Discussion:
For licensed material in storage, licensees shall take measures (e.g., providing locks) to ensure that unauthorized individuals cannot access or remove licensed material from storage.

Statement of Applicability:
This section is applicable to all NRC-licensed programs, including some general licensees (i.e., those that fall under 10 CFR 31.3 and 31.8). It is also important to note that, unlike the requirements for posting and for labeling, the requirement to secure material is unrelated to the quantity of licensed material involved.

Guidance Statement:
"Securing licensed material from unauthorized removal" means taking measures to prevent the unauthorized removal of the material. Passively controlling access to the material (e.g., by using ropes or posting signs) does not physically secure stored material from unauthorized removal or from access, in accordance with this requirement. Only active measures, such as locking the door to a room or locking a refrigerator (and controlling the distribution of the key to the locks) would be sufficient to demonstrate compliance with this requirement. In addition, individuals who are authorized to enter a particular area where licensed material is present may not necessarily be authorized to remove or to access the licensed material.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

IE Circular No. 78-01	Loss of Well Logging Source
IN No. 95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material
IN No. 98-01	Thefts of Portable Gauges
Q&A 129	Quantities of material where requirement imposed
Q&A 419	Same as Q&A 129
Q&A 450	Security of licensed materials in controlled areas

3.20.1802 CONTROL OF MATERIAL NOT IN STORAGE

Statement of Requirement:
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.

Discussion:
This section, unlike the previous section, pertains to licensed material in controlled or unrestricted areas that is *not* in storage. Such material must, at all times, be under the control of the licensee. If the material is not under the direct, physical control of the licensee, constant visual surveillance must be maintained.

Statement of Applicability:
This section applies to all licensees.

Guidance Statement:
Many reports of loss or theft of licensed material, or of damage to devices containing licensed material, are the result of licensees not maintaining the appropriate control and surveillance over licensed material when it is not in storage. If licensed material is being used in a controlled or in an unrestricted area, the licensee must have physical control over it at all times, and the licensee must maintain visual contact. A typical example of this is when a portable gauge user at a temporary job site walks back to his or her truck, or when he or she turns to talk to someone while the gauge is in use. For the purposes of this regulation, while the gauge user's back is turned on the device, the user is not maintaining constant surveillance and has lost control of the gauge. While this may seem to be a rigorous requirement, it does not take long for a device or for material to be lost or damaged with potentially significant consequences. The frequency of these events dictates that security receive the utmost attention by licensees.

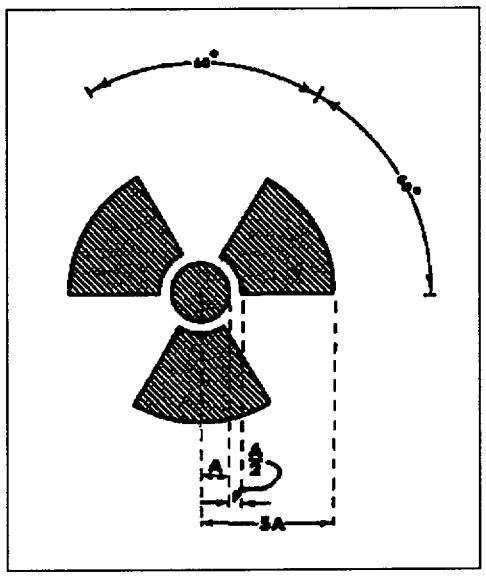
List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

IE Circular No. 81-07	Control of Radioactively Contaminated Material
IN No. 85-57	Lost Iridium-192 Source Resulting in the Death of Eight Persons in Morocco
IN No. 87-55	Portable Moisture/Density Gauges: Recent Incidents of Portable Gauges Being Stolen or Lost
IN No. 88-02	Lost or Stolen Gauges
IN No. 89-35	Loss and Theft of Unsecured Licensed Material
IN No. 93-18	Portable Moisture-Density Gauge User Responsibilities During Field Operations

3.20.1901 CAUTION SIGNS

Statement of Requirement:
(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:



Part20-0001
6/15/00

Figure 1901.1. 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.

Discussion:
The standard radiation symbol had remained unchanged for decades. Recent changes to NRC regulations have allowed the use of black, as well as magenta or purple.

Statement of Applicability:
The section is applicable to all licensees.

Guidance Statement:
No further guidance is necessary. The applicability of the exemption stated in 20.1901(b) will be determined during the licensing process.

List of Outdated Existing Regulatory Guidance:
Reg. Guide 8.1 Radiation Symbol

List of Implementing Guidance:
N/A.

3.20.1902 POSTING REQUIREMENTS

Statement of Requirement:
(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 Part 20 with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

Discussion:
The purpose of this section is to specify those areas of a licensee's facility that are required to be posted with warning signs. The intent is to alert personnel to the presence of radiological hazards and to aid them in minimizing exposures. The circumstances of each case must be evaluated to ensure that posting practices do not detract from this intent by: (1) desensitizing personnel through over-posting; or (2) failing to sufficiently alert personnel to the presence and location of radiological hazards. Thus, these postings should warn individuals of specific radiological hazards in the immediate vicinity.

Statement of Applicability:
The requirements of this section are applicable to all licensees. More specific requirements regarding posting appear in other parts of the regulations (e.g., Part 34 for industrial radiography and Part 36 for irradiators).

Guidance Statement:
The precise location and extent of posting is subjective and depends on the circumstances of each posting situation. For example, posting only the entrance to a building or other large area may meet the literal requirements of this section, but this may fail to adequately inform workers of the

radiological hazards in their work areas. It is counter-productive to post areas with caution signs when the areas do not contain the radiological hazards described by the postings. Since the regulations do not provide implementing details such as whether a room or building containing a radiation area may be posted at the entrance or whether every discrete radiation area must be posted, the following is provided as guidance: Posting the entrances to a very large room or building is inappropriate if most of the area is not a radiation area and only discrete areas or individual rooms actually meet the criteria for a radiation area. If discrete areas or rooms within a large area or building can be reasonably posted to alert individuals to radiation areas, these discrete areas or rooms should be posted individually.

Licensees may establish controls, such as posting, at locations beyond the immediate boundaries of an area to take advantage of natural or existing barriers. For example, it may be appropriate for a licensee to post a reactor containment as a high radiation area even though only certain areas of containment are high radiation areas. In such a circumstance, the licensee would have to maintain administrative controls (i.e., controlling personnel access and keeping the entrance locked) as though the entire containment was a high radiation area.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

HPPOS-014	Access Control to High Radiation Areas
HPPOS-036	Posting of Entrances to a Large Room or Building as a Radiation Area
HPPOS-066	Guidance for Posting Radiation Areas
HPPOS-210	Hot Spot Interpretation
HPPOS-242	Health Physics Position of Posting of High Radiation Areas
IN No. 84-82	Guidance for Posting Radiation Areas
Q&A 53	Posting requirement for packages labeled for transport
Q&A 85	Posting based on which "dose equivalent"
Q&A 221	Posting for low energy beta radiation
Q&A 379	Posting of airborne radioactivity areas and noble gases
Q&A 459	Same as Q&A 379
Q&A 460	Use of stochastic DAC's for posting purposes

List of Outdated Implementing Guidance:

Q&A 27	Posting of controlled areas

3.20.1903 EXCEPTIONS TO POSTING REQUIREMENTS

Statement of Requirement:
(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 the patient could be released from licensee control pursuant to §35.75 of this chapter.

(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.

(d) Rooms in hospitals or clinics that are used for teletherapy are exempt from the requirement to post caution signs under §20.1902 if:

1. Access to the room is controlled pursuant to 10 CFR 35.615; and
2. Personnel in attendance take necessary precautions to prevent the inadvertent exposure of workers, other patients, and members of the public to radiation in excess of the limits established in this part.

Discussion:
NRC recognizes that in certain circumstances, posting may not be necessary. This section provides specific scenarios in which posting of caution signs is not required.

Statement of Applicability:
This requirement is applicable to all licensees who would normally be subject to the posting requirements of 10 CFR 20.1902. Note that, pursuant to 10 CFR Part 34, these exemptions do not apply to industrial radiography licensees.

Guidance Statement:
Licensees who work with radioactive materials for short periods of time (less than 8 hours) are not required to post caution signs such as the "Caution-Radioactive Materials" sign. However, the licensee must ensure that the materials are constantly attended by someone adequately trained to take precautions necessary to prevent the exposure of individuals to radiation or radioactive materials in excess of Part 20 limits.

For hospitals, 10 CFR Part 35 allows licensees to release patients containing radiopharmaceuticals or implants when the dose to any other individual is not likely to exceed 0.5 rem (5 millisieverts). For this reason, rooms occupied by these patients would not need to be posted if that person remained hospitalized for some reason unrelated to the radiation.

Also, rooms used for teletherapy must meet certain requirements regarding access control. If the licensee meets these requirements, adequate precautions regarding exposure will exist, and the licensee is not subject to the posting requirements of 20.1902.

Lastly, if the presence of a sealed source of licensed material results in a small radiation risk, i.e., the radiation level near the surface of the source container is less than 5 millirem (0.05 millisieverts) per hour, the posting of the room with a caution sign would be of limited value and is therefore unnecessary.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 223	Exemption from posting at temporary field sites
Q&A 224	"Danger" vs. "Caution" for very high radiation areas

List of Outdated Implementing Guidance:

Q&A 35	Posting of hospital rooms

3.20.1904 LABELING CONTAINERS

Statement of Requirement:
(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.

Discussion:
The purpose of this section is to ensure that adequate information is available to workers to enable them to handle radioactive materials safely and minimize exposure. The section also addresses the importance of removing or defacing labels on empty containers, since labels on such containers found in the public domain may cause undue alarm on the part of the public.

Statement of Applicability:
This section applies to all NRC licensees. Note that certain licensees are required to follow other regulatory requirements regarding labeling (e.g. Part 35 for syringe and vial shields).

Guidance Statement:
A label required pursuant to 10 CFR 20.1904 must bear the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL", as well as provide sufficient information, including the radiation levels, kinds of material, estimates of activity, date the activity was estimated, mass enrichment, etc. This is required to permit individuals handling or using the container or working in the area to take necessary precautions to avoid or minimize exposure and ensure worker safety.

Since there is no special definition of "container" in 10 CFR Part 20, the usual (dictionary) meaning of the term applies (i.e., a container is "a thing in which material is held or carried"). For example, in a laboratory situation, vials, beakers, bottles and other such containers need to be labeled to ensure that everyone knows what is present. In general, a container should be labeled when the radioactive material is added to it. However, NRC acknowledges that certain conditions may exist when the addition of appropriate information to the label may necessitate some delay. For example, dose rate information may not be available to add to the label until the container is filled, or the final dose rate information may not be available until the container can be moved to a low-background area for measurement.

The removal or defacing of labels on empty containers is of particular importance. Licensees and regulatory agencies have responded to numerous events involving labeled containers found in the public domain that were later determined to be free of any radioactive material. In addition to unnecessarily raising public alarm, such responses have an impact on the radiation safety resources of licensees and regulatory agencies.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

HPPOS-027	10 CFR 20.203 (f) Enforcement Guidance for Container Labels
HPPOS-028	Further Guidance on Labeling Requirements
IN 97-03	Defacing of Labels to Comply with 10 CFR 20.1904 (b)
Q&A 127	Labeling fission and activation product containers
Q&A 128	Labeling of low specific activity (LSA) packages
Q&A 226	Definition of "container"

3.20.1905 EXEMPTIONS TO LABELING REQUIREMENTS

Statement of Requirement:
A licensee is not required to label:

(a) Containers holding licensed material in quantities less than the quantities listed in Appendix C to Part 20; or

(b) Containers holding licensed material in concentrations less than those specified in Table 3 of Appendix B to Part 20; 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[7], 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.

Discussion:
This section provides exemptions from labeling requirements for situations where: 1) the amount of radioactivity is small enough not to present a significant radiation hazard; 2) packages are labeled pursuant to other applicable regulations (i.e., DOT) that provide for adequate labeling; or 3) equipment for which the type of equipment or the type of accessibility of the equipment may make labeling impractical.

Statement of Applicability:
This section applies to all NRC licensees.

Guidance Statement:
No additional guidance is required.

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[7] 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.

PART 20

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.1906 PROCEDURES FOR RECEIVING AND OPENING PACKAGES

Statement of Requirement:
(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:

1. Monitor the external surfaces of a labeled[8] package for radioactive contamination unless the package contains only radioactive material in the form of a gas or in special form as defined in 10 CFR 71.4;
2. Monitor the external surfaces of a labeled[8] package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in §71.4 and Appendix A to Part 71 of this chapter; and
3. Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, 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 practical 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 the NRC Operations Center (301-816-5100), by telephone, 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.

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[8] Labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436 - 440.

(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.

Discussion:
This section describes the requirements for receiving packages containing radioactive materials. It includes the necessity for making arrangements to receive packages at the licensee's facility or to pick up packages at the carrier's facility in a timely manner. This section also establishes the occasions when packages are to be monitored upon receipt and/or upon opening.

Statement of Applicability:
The requirements of this section are applicable to all specific licensees.

Guidance Statement:
The purpose of Paragraph (a) of this regulation is to ensure that packages containing licensed materials in excess of Type A quantities are promptly transferred by the carrier to the licensee so the package does not enter the public domain. For example, a package that is delivered by a commercial service may not be placed in a location outside of the licensee's controlled area. This reduces the likelihood of theft or mishandling of the package by unauthorized individuals. Also, packages left at a carrier's terminal may be more subject to being lost or to being misdirected.

The requirements for monitoring packages containing licensed material are described in the table below.

Table 1906.1. Package Monitoring Requirements

Package	Contents	Survey Type	Survey Time[a]
Labeled (White I, Yellow II, Yellow III)	Gas or Special Form Greater Than Type A	Radiation Level	As soon as practicable, but not later than 3 hours after receipt of package
Labeled (White I, Yellow II, Yellow III)	Not Gas Nor Special Form Greater Than Type A	Contamination Radiation Level	As soon as practicable, but not later than 3 hours after receipt of package
Labeled (White I, Yellow II, Yellow III)	Gas or Special Form Less Than Type A	None	None
Labeled (White I, Yellow II, Yellow III)	Not Gas Nor Special Form Less Than Type A	Contamination	As soon as practicable, but not later than 3 hours after receipt of package
Not Labeled	Licensed Material	None	None
Damaged	Licensed Material	Contamination Radiation Level	As soon as practicable, but not later than 3 hours after receipt of package

[a] Assumes packages are received during normal working hours. If packages are received outside of normal working hours, the licensee has three hours after the beginning of the next work day to perform the required surveys.

If contamination surveys reveal levels exceeding ten times the values in Table 11 of 49 CFR 173.443, the licensee must notify the carrier and NRC. The contamination limits of Table 11 of 49 CFR 173.443 (below) apply to all non-exclusive use shipments of radioactive material packages. For packages shipped as exclusive-use shipments by rail or highway, the removable radioactive surface contamination at any time during transport may not exceed 10 times the limits for non-exclusive use shipments. 49 CFR 173.433(a)(1) requires the wiping of an area of 300 cm^2. 49 CFR 173.433(a)(2) provides for the use of other methods of assessment of equal or of greater efficiency, in which case the efficiency of the method used must be taken into account. If a 100 cm^2 area is wiped, the total activity of the wipe could not exceed 22000 dpm [22 dpm/cm^2 (from Table 11) X 100 (for the 100 cm^2 area wiped) X 10 ("factor of 10" value for non-fixed contamination)]. In either case, the licensee must also account for the counting efficiency of the instrumentation used. Non-fixed surface contamination must not exceed 10 times the limits of Table 11.

Table 1906.2. Table 11 of 49 CFR 173.443

Contaminant	Maximum permissible limits		
	Bq/cm^2	$\mu Ci/cm^2$	dpm/cm^2
Beta and gamma emitters and low toxicity alpha emitters	0.4	10^{-5}	22
All other alpha emitting radionuclides	0.04	10^{-6}	2.2

Likewise, for radiation-level surveys indicating levels above 200 millirem/hour (2 millisieverts/hour) at the surface of the package or 10 millirem/hour (0.1 millisieverts/hour) at one meter from the package, the licensee must notify the carrier and NRC. For exclusive-use shipments, see the requirements of 10 CFR 71.47 (b).

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

IN No. 85-07 Contaminated Radiography Source Shipments

IN No. 85-46 Clarification of Several Aspects of Removable Radioactive Surface Contamination Limits for Transport Packages

Q&A 36 Monitoring labeled packages

Q&A 108 Surveys to show compliance with 20.1906(f)

Q&A 227 Surveying gauge packages

Q&A 228 Surveys of licensee-transported material

Q&A 229 Wipe test vs. leak test upon receipt

Q&A 230 Monitoring Type A packages

3.20.2001 GENERAL REQUIREMENTS

Statement of Requirement:
(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

Discussion:
An authorized recipient is a person or an organization licensed to possess the material being transferred in the form and in the quantity being transferred. The licensee is responsible for ensuring that the recipient is authorized to receive the material being transferred. This may be done by reviewing the recipient's license or, if that leaves doubt, by contacting the NRC Regional or applicable Agreement State Office that issued the recipient's license. Other approved methods of verifying licensure are covered in 10 CFR 30.41, 40.51, 70.42, and 76.83.

Statement of Requirement:

2. By decay in storage; or

Discussion:
"Decay in storage" means that the material is stored at the licensee's facility or under the licensee's control for a period sufficiently long that the activity decays to levels that permit the use of other disposal options or that permit disposal of the material as ordinary, non-radioactive waste. Disposal in the latter case is permitted only after surveys show no detectable radioactivity. The length of time that the material may be stored for decay is not specified in this part, but license conditions or other parts of NRC's regulations may specify time limits and half-lives for materials that may be decayed in storage. The licensee must, therefore, review the applicable regulations and the license conditions to determine if time or half-life limitations are applicable. No specific license amendment or NRC approval is required for decay in storage. However, the material must be stored in a manner that ensures radiological safety for the workers and for the general public.

It should also be pointed out that decay in storage should not be used as an on-site storage option, pending the availability of disposal sites. Such on-site storage is subject to specific NRC requirements and is not considered decay in storage. Although the regulation does not specify the dividing line between decay in storage and on-site storage pending disposal, NRC's position has been that any storage for decay that is expected to exceed 5 years becomes subject to the requirements of on-site storage.

Statement of Requirement:

3. By release in effluents within the limits in §20.1301; or

Discussion:
In this context, "effluents" means releasing the radioactive material into the atmosphere if it is in gaseous form or in airborne particulate form, or into a body of water if it is in liquid form. Releases to the sanitary sewer, as discussed below, are not considered effluents and are subject to their own specific requirements. However, disposal by incineration is considered to produce air effluents, which are then subject to restrictions by NRC and EPA. The ash produced by the incineration of licensed material may be disposed of in landfills, provided it complies with NRC's rules and ash disposal guidance.

Statement of Requirement:

4. As authorized under §§20.2002, 20.2003, 20.2004, and 20.2005.

Discussion:
It should be noted that the four options listed in this paragraph are the only methods approved by NRC for disposing of licensed material, regardless of the amount of such material. Other options for disposal must be approved by NRC on a case-by-case basis.

Statement of Requirement:
(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.

Discussion:
It is acceptable for a licensee to transfer licensed material to another person or entity who, in turn, disposes of that material in an NRC-approved manner. However, the person or entity receiving the licensed material must be authorized by an NRC license to receive such material in the form and in the quantity being transferred.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
NRC does not permit the disposal of licensed material in any manner other than those methods listed above. If the licensee wishes to use a method that is not listed, then an application must be submitted to NRC for authorization. The application should fully describe the proposed method and its expected environmental impacts. Licensed materials that may have decayed or whose activity may have otherwise diminished below an exempt quantity listed in another part of the regulation are not exempt from this section. Exemption of certain types, quantities, or concentrations of materials from the licensing requirements applies to the initial decision of whether or not the material should be licensed. However, once licensed, no quantity of that material, however small, is exempt from the applicable regulations in this section.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

HPPOS 131	No License is Required for a Person to Receive Exempt Quantity Byproduct Material
HPPOS 189	Transfer of Exempt Quantities of By product Material from a Nuclear Power Plant
HPPOS 190	Disposal of Exempt Quantities of Byproduct Material
HPPOS 203	Transfer of Reactor-Activated Materials to Exempt Persons
HPPOS 239	Clarification of Generic Letter 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites"
HPPOS 278	Technical Assistance Request, Department of the Interior, Salt lake City, UT, Apparent Request to Store Low-Level Waste Decay for More Than Five Years

3.20.2002 METHOD FOR OBTAINING APPROVAL OF PROPOSED DISPOSAL PROCEDURES

Statement of Requirement:
A licensee or applicant for a license may apply to the Commission for approval of proposed procedures, not 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.

Discussion:
This section permits licensees to apply to NRC for authorization to dispose of licensed material in a manner not listed in this subpart. The submittal must contain sufficient information to permit NRC to perform an independent assessment of the possible impacts of the proposed method on members of the public, on the environment, and on any other groups or facilities that may be affected by the proposed method.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.2003 DISPOSAL BY RELEASE INTO SANITARY SEWERAGE

Statement of Requirement:
(a) A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

Discussion:
This section of the regulations applies to disposal to public sanitary disposal facilities but not to private sewer disposal facilities that the licensee may be operating on site or that are under the licensee's control.

Statement of Requirement:

1. The material is readily soluble (or is readily dispersible biological material) in water; and

Discussion:
"Readily soluble" has not been defined in the regulations, but NRC requires that an evaluation be made by any appropriate means to determine the solubility, in water, of the material to be disposed to the sewers. As indicated in NRC guidance, the evaluation may be theoretical, i.e., based on knowing the chemical characteristics of the compounds to be disposed, or on experimental determinations conducted by the licensee or any other reliable entity.

Guidance Statement:
Readily dispersible biological material was included in the regulation to permit disposal of certain research waste products, such as animal carcasses or tissues that have been finely ground. Such biological material is not normally water soluble, but the regulations permit its disposal if it is in a form that will disperse in the sewer water.

The intent of this part of the regulation is to minimize reconcentration of the disposed material in the sewage system. Such reconcentration may cause a radiological hazard to treatment plant and other workers and the general public, as well as require extensive effort to decontaminate. The sludge produced by sewage treatment has economic value, but may not be useable if contaminated. If in doubt about the effects of disposals to the sewers, and to avoid future problems, it may be advantageous to consult with the sewerage treatment facility.

Some NRC licensees have been limited in their ability to dispose of licensed material to the sewers by the treatment plant operators, and in some cases such disposal was forbidden by the sewerage treatment facility. Although it remains unclear whether sewerage treatment plants have the legal authority to take such action, it is appropriate for NRC licensees to be aware of the rules and operating procedures of their local sewerage treatment facility.

Statement of Requirement:

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 Part 20; and

Discussion:
The average monthly volume of water released is specified in this paragraph because the evaluation of the average concentration must be conducted prior to actual releases. The licensee must therefore have an estimate of the water volume that will dilute the licensed material disposed during the month.

Guidance Statement:
The average monthly volume of water must, to the licensee's knowledge, be representative of the actual expected flow during that month. If sewer flow at the licensee's facility has changed substantially, then allowances must be made for such a change when estimating the average monthly flow.

If the licensee's sewer system is such that there is more than one sewer system branch, with each branch flowing to a different site outflow, then each branch must be treated separately. The reason is that the values in Table 3 of Appendix B were established using certain assumptions regarding the use of the water at the site outfall as a source of drinking water, and the dose resulting from such use. Because each site outfall may be used independently for drinking water, each must be assessed separately for concentration.

Statement of Requirement:

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 Part 20 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 Part 20; and

   (ii) The sum of the fractions for each radionuclide required by Paragraph (a)(3)(i) of this section does not exceed unity; and

Discussion:
This condition may be expressed as follows:

$$C_1/\text{Tabulated Value}_1 + C_2/\text{Tabulated Value}_2 + \ldots \leq 1$$

where C_i is the average monthly concentration of nuclide i, and Tabulated Value_i is the value of the concentration of that radionuclide listed in Table 3 of Appendix B to Part 20.

Statement of Requirement:

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.

Discussion:
In addition to limiting the average monthly concentrations to those shown in Table 3, Appendix B, and as described in (3)(i) and (3)(ii) above, the licensee must also limit the total quantities of radioactive material released to the sewer during the year to those stated in this paragraph. (***Note:*** 1 GBq = 10^9 Bq.)

Statement of Requirement:
(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.

Discussion:
This section applies to members of the public who are administered licensed material. The administered radioactive material will be excreted from the body via the urine or feces over periods that vary in duration from days to weeks depending on the material and its chemical form. These excreta, most of which are voided at the patient's house, are not subject to this section of the regulations.

Statement of Applicability:
All NRC licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 39	Biological Materials
Q&A 376	Decay in Storage
Q&A 432	Decay in Storage for Non-power Reactors
HPPOS-158, 10 CFR 20.303(d)	Disposal by Release Into Sanitary Sewerage Systems
IN 94-07	Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR Part 20

3.20.2004 TREATMENT OR DISPOSAL BY INCINERATION

Statement of Requirement:
(a) A licensee may treat or dispose of licensed material by incineration only:

1. As authorized by Paragraph (b) of this section; or
2. If the material is in a form and concentration specified in §20.2005; or
3. As specifically approved by the Commission pursuant to §20.2002.

Discussion:
This section specifies that incineration of licensed material is not permitted without case-by-case approval from NRC, except for specific situations for which prior approval is not required. These specific situations are listed in (1) and (2) of this paragraph. Item (1) applies to incineration of certain types of lubricating oil used in nuclear reactors, and item (2) applies to liquid scintillation fluids and animal wastes that contain low concentrations of tritium or carbon-14.

Statement of Applicability:
All NRC Licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
Policy and Guidance Directive PG 8-10, Disposal of Incineration Ash as Ordinary Waste.

Statement of Requirement:
(b) (1) Waste oils (petroleum derived or synthetic oils used principally as lubricants, coolants, hydraulic or insulating fluids, or metalworking oils) that have been radioactively contaminated in the course of the operation or maintenance of a nuclear power reactor licensed under Part 50 of this chapter may be incinerated on the site where generated provided that the total radioactive effluents from the facility, including the effluents from such incineration, conform to the requirements of Appendix I to Part 50 of this chapter and the effluent release limits contained in applicable license conditions other than effluent limits specifically related to incineration of waste oil. The licensee shall report any changes or additions to the information supplied under §§50.34 and 50.34a of this chapter associated with this incineration pursuant to §50.71 of this chapter, as appropriate. The licensee shall also follow the procedures of §50.59 of this chapter with respect to such changes to the facility or procedures.

(2) Solid residues produced in the process of incinerating waste oils must be disposed of as provided by §20.2001.

(3) The provisions of this section authorize onsite waste oil incineration under the terms of this section and supersede any provision in an individual plant license or technical specification that may be inconsistent.

Discussion:
This section applies to incineration of oil that was contaminated as a result of use in a nuclear reactor facility. It is very specific and does not apply to any other situation involving contaminated oils.

Statement of Applicability:
Part 50 reactor licensees.

Guidance Statement:
The contaminated oil may be disposed of by incineration on site. This is often accomplished by adding the contaminated oil to the fuel used for on-site auxiliary boilers. The effluents from the boilers, or other incineration facility, must comply with the off-site dose restrictions specified in Appendix I to Part 50 and any other applicable restrictions or license conditions on effluents, but the constraint on effluents in 10 CFR Part 20.1101(d) does not apply.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.2005 DISPOSAL OF SPECIFIC WASTES

Statement of Requirement:
(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.

Discussion:
This section states that liquid scintillation fluids and animal tissues containing less than 50 nCi/gm hydrogen-3 or carbon-14 may be considered to be nonradioactive for the purposes of disposal. The licensee may dispose of these wastes in any appropriate manner, subject to any restrictions based on the chemical nature of the materials. Calculation of the specific activity, or activity-per-unit weight of material, is to be based on the weight of the scintillation fluid containing the radioactive material or the weight of the entire contaminated animal but may not include the weight of any packaging material or container. (***Note:*** 1kBq = 10^3 Bq.)

An additional restriction on the disposal of contaminated animals is that the licensee must be sure that the disposed animal will not be used as food in the human food chain, either by direct consumption or by consumption of products from animals fed on the disposed material.

Statement of Applicability:
All NRC Licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
HPPOS-150 Disposal Requirements for Specific and Exempt Licensed Smoke Detectors

HPPOS-127 Transfer and/or Disposal of Spent Generators

HPPOS-043 Disposal of Exempt Quantities of Radioactive Materials

3.20.2006 TRANSFER FOR DISPOSAL AND MANIFESTS

Statement of Requirement:
(a) The requirements of this section and Appendix G to 10 CFR Part 20 are designed to:

1. Control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor licensee, as defined in this part, who ships low-level waste either directly, or indirectly through a waste collector or waste processor, to a licensed low-level waste land disposal facility (as defined in Part 61 of this chapter);
2. Establish a manifest tracking system; and
3. Supplement existing requirements concerning transfers and recordkeeping for those wastes.

(b) Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility must document the information required on NRC's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee in accordance with Appendix G to 10 CFR Part 20.

(c) Each shipment manifest must include a certification by the waste generator as specified in Section II of Appendix G to 10 CFR Part 20.

(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 G to 10 CFR Part 20.

Discussion:
This section states that all waste transferred to a land disposal facility, either directly from the licensee to that facility or through one or more intermediaries, must be accompanied by a shipping manifest. Intermediaries include any waste processors, such as facilities that package the waste in suitable form, compact the waste, or provide some other form of waste treatment that makes it suitable for land disposal. This manifest must accompany the shipment until it reaches its destination at the land disposal facility and must be provided even if the carrier is part of the licensee's organization. The manifest must provide descriptions of the waste, its classification for land disposal, packages and other relevant shipping specifications, and a telephone number and other means of contacting the shipper in case of questions or emergencies during shipment. The information required to be included in the manifest is described in detail in Appendix G of Part 20.

Appendix G also describes some minor exceptions for shipments that do not require manifests. An example is the shipment of low-level wastes to a processor, if the waste is to be returned to the licensee after processing. Another example is the transfer of waste to another licensee, who then assumes responsibility for proper disposal of the waste.

Statement of Applicability:
All NRC Licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

HPPOS-127	Transfer and/or Disposal of Spent Generators
HPPOS-131	No License is Required for a Person to Receive Exempt Quantity Byproduct Material
HPPOS-142	Licensing of Dial Painting Activities by Jewelers and Watch Repairers
HPPOS-189	Transfer of Exempt Quantities of By-product Material from a Nuclear Power Plant
HPPOS-203	Transfer of Reactor Activated Materials to Persons Exempt

3.20.2007 COMPLIANCE WITH ENVIRONMENTAL AND HEALTH PROTECTION REGULATIONS

Statement of Requirement:
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.

Discussion:
N/A.

Statement of Applicability:
All NRC Licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.2101 GENERAL PROVISIONS

Statement of Requirement:
(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) In the records required by this part, the licensee may record quantities in SI units in parentheses following each of the units specified in Paragraph (a) of this section. However, all quantities must be recorded as stated in Paragraph (a) of this section.

(c) Not withstanding the requirements of Paragraph (a) of this section, when recording information on shipment manifests, as required in §20.2006(b), information must be recorded in the International System of Units (SI) or in SI and units as specified in Paragraph (a) of this section.

(d) 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, lens-dose equivalent, deep-dose equivalent, committed effective dose equivalent).

Discussion:
The section provides the units that the licensee must use on records, as required by Part 20. Licensees must use the special units on records required by Part 20 but may also use the SI units in parentheses following each of the special units. **Note that the use of SI units are not in lieu of the special units.** The exception to this is shipping manifests required by 20.2006. SI units, or SI and special units, must be used on shipping manifests, but not solely special units.

Statement of Applicability:
All licensees must comply with this section.

Guidance Statement
Licensees should note that the use of special units on records required by Part 20 is not consistent with the NRC's metrification policy, which requires that dual units be used, noting the SI units first followed by the special units in parentheses.

List of Existing Regulatory Guidance
Reg. Guide 8.7 Instructions for Recording and Reporting Occupational Radiation Exposure Data

List of Implementing Guidance:
Q&A 96 Use of special units

Q&A 117 Use of curies versus dpm

Q&A 428 Use of special units

3.20.2102 RECORDS OF RADIATION PROTECTION PROGRAMS

Statement of Requirement:
(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.

Discussion:
All licensees must keep records of their radiation protection programs, complete with the program's provisions (e.g., policies and procedures) and its audits and reviews. The records of program provisions must be kept until the license is terminated. Records of audits and reviews must be kept for three years.

Statement of Applicability:
All licensees must comply with this section.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
All applicable Series 8 Regulatory Guides.

List of Implementing Guidance:

Q&A Subpart B	Radiation Protection Programs
HPPOS 205	Record Retention at Ex-Licensee After License has been Terminated

3.20.2103 RECORDS OF SURVEYS

Statement of Requirement:
(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. This includes those records of 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 required under the standards for protection against radiation in effect prior to January 1, 1994; 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. This includes those records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose required under the standards for protection against radiation in effect prior to January 1, 1994; and
3. Records showing the results of air sampling, surveys, and bioassays required pursuant to §20.1703(a)(3) (i) and (ii). This includes those records showing the results of air sampling, surveys, and bioassays required under the standards for protection against radiation in effect prior to January 1, 1994; and
4. Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment. This includes those records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment required under the standards for protection against radiation in effect prior to January 1, 1994.

Discussion:
This section specified the record retention requirements for surveys conducted to show compliance with Part 20. All licensees must keep these records until the license is terminated who conduct radiation surveys to determine the dose from external sources, in the absence of or in combination with individual monitoring data and in the assessment of individual dose equivalents; who perform measurements and calculations used to determine individual intakes of radioactive material used in the assessment of internal dose; who perform air sampling, surveys, and bioassays; and who perform measurements and calculations used to evaluate the release of radioactive effluents to the environment. This includes all records of surveys, measurements, calculations, and bioassays conducted or performed prior to January 1, 1994.

Statement of Applicability:
This section applies to all licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
Reg. Guide 8.7 Instructions for Recording and Reporting Occupational Radiation Exposure Data

List of Implementing Guidance:
HPPOS 205 Record Retention at Ex-Licensee After License has been Terminated

3.20.2104 DETERMINATION OF PRIOR OCCUPATIONAL DOSE

Statement of Requirement:
(a) For each individual who 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 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 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 of each individual, as required by Paragraph (a) of this section, on NRC Form 4, or other clear and legible record, including all of the information required by NRC Form 4[9].

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. This includes records required under the standards for protection against radiation in effect prior to January 1, 1994.

Discussion:
All licensees must obtain records of the current-year dose for those individuals who are likely to exceed 500 mrem occupational exposure. Acceptable records of current-year dose may be: (1) a written, signed statement from the individual or that individual's previous employer that notes the nature and amount of any occupational dose received during the year; (2) an up-to-date NRC Form 4, signed by the individual and countersigned by an official of the most recent employer; (3) a phone call, telegram, electronic media, or letter from the individual's most recent or current employer.

Licensees must have complete records of prior years' dose for those individuals participating in PSEs, or those individuals cannot participate. These licensees must also determine the internal and external doses from all previous PSEs, and all doses in excess of the limits during the lifetime of the individual. In both cases, the information must be recorded on an NRC Form 4.

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[9] Licensees are not required to partition historical dose between external dose equivalent(s) and internal committed dose equivalent(s). Further, occupational exposure histories obtained and recorded on NRC Form 4 before January 1, 1994, might not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

If complete records cannot be obtained for the current year, then the licensee must decrease the individual's allowable dose for the remainder of the current year by 1.25 rem per quarter. If complete records for an individual cannot be obtained for the current and previous years, then this individual cannot perform any PSEs.

NRC Form 4s must be retained until the license is terminated. Records used in the preparation of NRC Form 4 must be retained for three years.

Statement of Applicability:
This section is applicable to all licensees who hire new employees or contract workers who will likely receive occupational exposures in excess of 10% of the applicable limits.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:

Reg. Guide 8.7	Instructions for Recording and Reporting Occupational Radiation Exposure Data

List of Implementing Guidance:

Q&A 6	DOE Employee Exposure Records for NRC Licensees
Q&A 10	Form 4 Requirement
Q&A 51	Occupational dose received prior to revision of Part 20
Q&A 55	Pro-rating dose for other annual limits
*Q&A 63	Doses in excess of Part 20 from the time period prior to the revision of Part 20
Q&A 64	Records of lifetime cumulative dose
Q&A 76	Former DOE lab worker internal exposures
Q&A 83	Former DOE lab worker internal exposures
Q&A 113	Former DOE lab worker exposures
Q&A 139	Incorrect in-vivo measurements
Q&A 142	Acceptable attempt to obtain records
Q&A 143	Obtaining data from the most recent facility
Q&A 192	Determination of Prior Dose for a PSE
Q&A 371	False written signed statements of dose from workers that result in overexposures

* This Q&A is no longer relevant because the revised Part 20 has been in effect for the past 6 years.

Q&A 408	Use of TEDE for prior year's exposures
Q&A 414	Assessment of 5 rem dose for the year that would restrict any further occupational exposure
Q&A 420	Generic use of "dose"
Q&A 436	What to do when dose categories on NRC Form 5 are left blank or "not recorded" (NR) or "not determined" (ND) is used
Q&A 441	Determination of dose for a declared pregnant woman (DPW)
Q&A 451	Use of NR and ND
HPPOS 050	Guidance – Use of NRC Form 4 – Listing of Exposure Periods
HPPOS 047	Personnel Monitoring Requirements for an NRC/Agreement State Licensed Contractor Working at a Part 50-Licensed Facility

List of Outdated Implementing Guidance:

Q&A 179	Evaluation of internal dose prior for the purpose of determining TEDE for the year

3.20.2105 RECORDS OF PLANNED SPECIAL EXPOSURES

Statement of Requirement:
(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.

Discussion:
This requirement discusses those issues that need to be documented and recorded for planned special exposures authorized by the licensee.

These records must be retained until the license is terminated.

Statement of Applicability:
Any licensee who authorizes a planned special exposure must comply with this section.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
Reg. Guide 8.35 Planned Special Exposures

List of Implementing Guidance:

Q&A 6	DOE Employee Exposure Records for NRC Licensees
Q&A 8	Circumstances for PSEs
Q&A 24	Routine use of PSEs not permitted
Q&A 109	Cardiologists use of PSEs

Q&A 110	Radiographic source retrieval and PSEs
Q&A 135	Trying to justify a PSE based on reduction of collective dose
Q&A 136	Informed decision to participate in a PSE
Q&A 137	Obtaining a ruling from the Region prior to approving a PSE
Q&A 191	Use of separate dosimeters during a PSE
Q&A 192	Not permitting participation in PSEs if prior doses exceed PSE limit
Q&A 414	Assessment of 5 rem dose for the year that would restrict any further occupational exposure

List of Outdated Implementing Guidance:

Q&A 63	Doses in excess of Part 20 from the time period prior to the revision of Part 20
Q&A 179	Evaluation of internal dose prior for the purpose of determining TEDE for the year

3.20.2106 RECORDS OF INDIVIDUAL MONITORING RESULTS

Statement of Requirement:
(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[10] must include, when applicable:

1. The deep-dose equivalent to the whole body, lens-dose equivalent, shallow-dose equivalent to the skin, and shallow-dose equivalent to the extremities;
2. The estimated intake of radionuclides (see §20.1202);
3. The committed effective dose equivalent assigned to the intake of radionuclides;
4. The specific information used to assess the committed effective dose equivalent pursuant to §20.1204(a) and (c), and when required by §20.1502;
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 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 the required form or record until the Commission terminates each pertinent license requiring this record. This includes records required under the standards for protection against radiation in effect prior to January 1, 1994.

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[10] Assessments of dose equivalent and records made using units in effect before the licensee's adoption of this part need not be changed.

Discussion:
All licensees must keep records of exposure for those individuals for whom monitoring was required in accordance with 20.1502, whether the exposure occurred during normal operations, planned special exposures, accidents, or emergency conditions. The records must include the deep-dose equivalent to the whole body, lens-dose equivalent, shallow-dose equivalent to the skin, and shallow-dose equivalent to the extremities. The records must also include the estimated intake of radionuclides, and the committed effective dose equivalent assigned to the intake of radionuclides. In addition, the record must include the specific information used to assess the committed effective dose equivalent. Finally, the record must include either the total effective dose equivalent or the highest total organ-dose equivalent, whichever is more limiting.

The above information must be entered into these records at least once a year.

NRC Form 5 or REMIT are the suggested methods for maintaining these records.

Individual monitoring records are covered by various State privacy laws and cannot be made public without the individual's written consent. If these records are received by NRC, they are covered by the Privacy Act of 1974.

Records of embryo/fetus dose and declared pregnant woman dose must also be kept. The declaration may be kept in another file from the dose records.

All of the records described in this section, including those made before January 1, 1994, must be retained until the license is terminated.

Statement of Applicability:
All licensees who provide required monitoring.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
Reg. Guide 8.7 Instructions for Recording and Reporting Occupational Radiation Exposure Data

List of Implementing Guidance:
Q&A 399 Use of multiple license numbers on NRC Form 5

Q&A 400 Use "V" for Vapor on NRC Form 5

Q&A 401 Use of signature on file for NRC Form 5

Q&A 402 Use of the comment block on NRC Form 5

Q&A 403 Cutoff in the calculation of committed effective dose equivalent (CEDE)

Q&A 404	Use of intake data by NRC
HPPOS 047	Personnel Monitoring Requirements for an NRC/Agreement State Licensed Contractor Working at a Part 50-Licensed Facility

3.20.2107 RECORDS OF DOSE TO INDIVIDUAL MEMBERS OF THE PUBLIC

Statement of Requirement:
(a) Each licensee shall maintain records sufficient to demonstrate compliance with the dose limit for 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.

Discussion:
All licensees must keep records to show that they have maintained doses to the public that are at, or below, 100 mrem of the total effective dose equivalent.

These records must be retained until the license is terminated.

Statement of Applicability:
All licensees must comply with this section.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
Q&A 391 Records to demonstrate compliance with 20.2107

3.20.2108 RECORDS OF WASTE DISPOSAL

Statement of Requirement:
(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[11].

(b) The licensee shall retain the records required by Paragraph (a) of this section until the Commission terminates each pertinent license requiring the record. Requirements for disposition of these records, prior to license termination, are located in §§30.51, 40.61, 70.51, and 72.80 for activities licensed under these parts.

Discussion:
This section pertains to the maintenance and to the retention of waste disposal records. These records must be retained until the license is terminated.

Statement of Applicability:
All licensees who dispose of radioactive waste in accordance with the regulations in Part 20.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
HPPOS 035 Scope of Exemption in 10 CFR 20.303(d) for Disposal of Patient Excreta in Sanitary Sewers

[11] A previous §20.304 permitted burial of small quantities of licensed materials in soil before January 28, 1981, without specific Commission authorization.

3.20.2109 RESERVED

3.20.2110 FORM OF RECORDS

Statement of Requirement:
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.

Discussion:
All licensees must keep applicable records in a format that can be read over the length of the retention period.

Statement of Applicability:
All licensees must comply with this requirement.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
Q&A 141 Electronic systems of records

3.20.2201 REPORTS OF THEFT OR LOSS OF LICENSED MATERIAL

Statement of Requirement:
(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 Part 20 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 Part 20 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 by telephone to the NRC Operations Center (301-951-0550).

Discussion:
Licensees must notify NRC immediately after discovery that significant quantities of licensed material are lost, stolen, or missing under circumstances when exposure in unrestricted areas may occur. The degree of exposure is not specified.

Licensees must notify NRC within 30 days after lesser quantities of licensed materials are discovered to be lost, stolen, or missing and that are still missing at this time.

Statement of Requirement:
(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 Part 20.

Discussion:
Thirty-Day Written Reports – Licensees that have made a telephone report or a report using the Emergency Notification System must also submit a written report within 30 days of the initial report. The written report must contain the who, what, where, and when, of the loss; how much material was lost, stolen or missing; and how much exposure was received by anyone involved. The written report must also include actions taken to prevent recurrence.

Statement of Requirement:
(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.

Discussion:
If a licensee is required by some other part of the regulations to send in a report, then it does not have to send in the report required by this part.

Statement of Requirement:
(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.

Discussion:
If significant information relating to the event becomes known, it must be reported to NRC within 30 days.

Statement of Requirement:
(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.

Discussion:
Licensees must include personal privacy information as a separable part of these reports.

Statement of Applicability:
All licensees involved in such situations must comply with these requirements.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

HPPOS 153	Lost or Stolen Radioactive Sources Involved in Transportation
IN 89-35	Loss and Theft of Unsecured Licensed Material

3.20.2202 NOTIFICATION OF INCIDENTS

Statement of Requirement:
(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) A lens-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 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).

Discussion:
The licensee must notify NRC immediately if an event occurs that causes or may cause an exposure in excess of five times any occupational dose limit.

Statement of Requirement:
(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) A lens-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
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).

Discussion:
The licensee must notify NRC within 24 hours, if an event occurs that causes, or may cause, an exposure exceeding any occupational dose limit. For the purposes of this requirement, the exposure must occur within a period of 24 hours.

Statement of Requirement:
(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.

Discussion:
Licensees must include personal privacy information as a separable part of these reports.

Statement of Requirement:
(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 (301) 816-5100.

(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.

Discussion:
N/A.

Statement of Applicability:
All licensees involved in such situations must comply with these requirements.

Guidance Statement:
In instances where the inspector points out the reportable incident, the licensee is still required to make notification in accordance with §2202(d).

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 56	Periodically patrolled areas
HPPOS 236	The Meaning of "... May Have Caused or Threatens to Cause..." in 10 CFR 20.403

3.20.2203 REPORTS OF EXPOSURES, RADIATION LEVELS, AND CONCENTRATIONS OF RADIOACTIVE MATERIAL EXCEEDING THE CONSTRAINTS OR LIMIT

Statement of Requirement:

(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
   - (vi) The ALARA constraints for air emissions established under §20.1101(d); 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, ALARA constraints, generally applicable environmental standards, and associated license conditions.

2. Each report filed pursuant to Paragraph (a) of this section must include for each occupationally overexposed[12] individual: 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 Part 20.

Discussion:
Licensees who have made notifications in accordance with 10 CFR 20.2202 must also submit a written report of the event within 30 days. In addition, a written report is required for the following:

- Doses in excess of dose limits
- Levels of materials in excess of applicable limits
- Release material in excess of environmental limits.

Licensees must include information on the exposure of individuals by:

- Estimate of dose
- Amount of material involved
- Cause of dose
- Corrective actions taken.

As stated in previous sections for individuals who were exposed to radiation, licensees must provide those individuals' names, Social Security numbers, and dates of birth as a separable part of the report. Reactor licensees subject to the reporting requirements in 10 CFR 50.73 do not need to submit a duplicate report to satisfy this section requirement. All other licensees must submit reports to the Document Control Desk at Headquarters and to their respective Regional Offices.

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[12] With respect to the limit for the embryo-fetus (§20.1208), the identifiers should be those of the declared pregnant woman.

Statement of Applicability:
Any licensee who has made notification in accordance with 10 CFR 20.2202.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:

Q&A 122	Effluent release and public exposure limits
HPPOS 236	The Meaning of "... May Have Caused or Threatens to Cause..." in 10 CFR 20.403

3.20.2204 REPORTS OF PLANNED SPECIAL EXPOSURES

Statement of Requirement:
The licensee shall submit a written report to the Administrator of the appropriate NRC Regional Office listed in Appendix D to Part 20 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.

Discussion:
A licensee who conducts a PSE must submit a report to the Regional Administrator who administers licenses, within 30 days of the PSE. The report must include the date of the PSE and all of the information required by 10 CFR 20.2105.

Statement of Applicability:
This section is applicable to any licensee who has conducted a PSE.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:

Reg. Guide 8.7	Instructions for Recording and Reporting Occupational Radiation Exposure Data
Reg. Guide 8.35	Planned Special Exposures

List of Implementing Guidance:

Q&A 383	Reports of Planned Special Exposures

3.20.2205 REPORTS TO INDIVIDUALS OF EXCEEDING DOSE LIMITS

Statement of Requirement:
When a licensee is required, pursuant to the provisions of §§20.2203, 20.2204, or 20.2206, to report to the Commission any exposure of an identified occupationally exposed individual, or an identified member of the public, to radiation or radioactive material, the licensee shall also provide a copy of the report submitted to the Commission to the individual. This report must be transmitted at a time no later than the transmittal to the Commission.

Discussion:
Licensees must send a copy of an individual's exposure report to the individual when a copy is sent to the Commission, whether that individual was exposed occupationally or as a member of the public.

Statement of Applicability:
All licensees who are required to report exposures to NRC, whether associated with routine occupational exposure or events involving exposure in excess of any limit.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.2206 REPORTS OF INDIVIDUAL MONITORING

Statement of Requirement:

(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, by-product material in quantities exceeding any one of the following quantities:

Radionuclide	Quantity of radionuclide[a] 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

[a] 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 REIRS Project Manager, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Discussion:
Commercial nuclear power reactors; fuel processors and fabricators; independent, spent fuel storage facilities; industrial radiographers; manufacturers and distributors of specified quantities of by-product material; or operators of low-level waste disposal sites must submit occupational radiation exposure reports by April 30 of each year, following the year in which the exposures occurred. These reports must be submitted for each individual who was provided monitoring.

Statement of Applicability:
This section is applicable to commercial nuclear power reactors, fuel processors and fabricators, independent spent fuel storage facilities, industrial radiographers, manufacturers and distributors of specified quantities of by-product material, and low-level waste disposal site operators.

Guidance Statement:
Separate NRC Form 5s must be submitted for each individual who was provided monitoring; otherwise a 3½" disk or a compact disk must be submitted that contains all of the information contained on an NRC Form 5 for each individual in separate records on the disk. Licensees should use a disk to submit this information and follow the recommended data format presented in Appendix A of Regulatory Guide 8.7. Submitting the reports in this manner will prevent data entry errors that may occur with reports submitted on paper. Also, NRC has provided two key pieces of software to help with these submittals. The first is REMIT, a database that will generate Form 5s in electronic format. The second is REIRView, which permits review of electronic data files prior to submitting them to NRC. This software is available free of charge from NRC's radiation exposure web site at <http://www.saic.com:80/home/nrc_rad>.

List of Existing Regulatory Guidance:

Reg. Guide 8.7	Instructions for Recording and Reporting Occupational Radiation Exposure Data
NUREG/CR-6050	Radiation Exposure Monitoring and Information Transmittal System, REMIT

List of Implementing Guidance:

Q&A 383	Reports of Planned Special Exposures
Q&A 392	Monitoring Period
Q&A 393	Reporting of Monitoring Results That Were Performed But Not Required
Q&A 394	Declared Pregnant Woman and Embryo/Fetus Dose Records
Q&A 395	Transient Workers

3.20.2300 SUBPART N – EXEMPTIONS AND ADDITIONAL REQUIREMENTS

3.20.2301 APPLICATIONS FOR EXEMPTIONS

Statement of Requirement:
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.

Discussion:
None required.

Statement of Applicability:
This section is applicable to any licensee who believes that its operations warrant an exemption from certain requirements of 10 CFR Part 20.

Guidance Statement:
When requesting exemptions from specific requirements of 10 CFR Part 20, licensees and applicants should provide basic information to facilitate NRC's review of the request. The request should include the specific requirement from which the licensee or the applicant requests the exemption. The request should also include the reason that the licensee or the applicant cannot meet the requirement and the compensatory measures proposed by the licensee or the applicant that provide a margin of safety equivalent to that which would have afforded compliance with the original requirement. On a case-by-case basis, NRC may ask the licensee or the applicant for additional information, in order to properly evaluate the exemption request.

List of Existing Regulatory Guidance Documents:
N/A.

List of Implementing Guidance:

HPPO 268	Technical Assistance Request, BP International Limited Request for and Exemption from 10 CFR 20.202(c)
HPPO 296	Technical Assistance Request Concerning Posting per 10 CFR 34.42 and Surveys per 10 CFR 20.201

3.20.2302 ADDITIONAL REQUIREMENTS

Statement of Requirement:
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.

Discussion:
N/A.

Statement of Applicability:
As determined necessary by NRC staff.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:
N/A.

List of Implementing Guidance:
N/A.

3.20.2401 VIOLATIONS

Statement of Requirement:
(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; and
   - (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.

Discussion:
N/A.

Statement of Applicability:
All licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:

NUREG-1600	Enforcement Policy (Rev. 1)
NUREG/BR-0195	Enforcement Manual (Rev. 1)

Inspection Manual The NRC Inspection Manual includes procedures for issuing Notices of Enforcement Discretion (NOEDs) for Power Reactors and Gaseous Diffusion Plants. Manual Chapter 9900

Implementing Procedures for Power Reactor NOEDs

Implementing Procedures for Gaseous Diffusion Plant NOEDs

List of Implementing Guidance:
N/A.

3.20.2402 CRIMINAL PENALTIES

Statement of Requirement:
(a) Section 223 of the Atomic Energy Act of 1954, as amended, provides for criminal sanctions for willful violation of, attempted violation of, or conspiracy to violate, any regulation issued under Sections 161b, 161i, or 161o of the Act. For purposes of Section 223, all the regulations in §§20.1001 through 20.2402 are issued under one or more of Sections 161b, 161i, or 161o, except for the sections listed in Paragraph (b) this section.

(b) The regulations in §§20.1001 through 20.2402 that are not issued under Sections 161b, 161i, or 161o for the purposes of Section 223 are as follows: §§20.1001, 20.1002, 20.1003, 20.1004, 20.1005, 20.1006, 20.1007, 20.1008, 20.1009, 20.1405, 20.1704, 20.1903, 20.1905, 20.2002, 20.2007, 20.2301, 20.2302, 20.2401, and 20.2402.

Discussion:
N/A.

Statement of Applicability:
All licensees.

Guidance Statement:
N/A.

List of Existing Regulatory Guidance:

NUREG-1600	Enforcement Policy (Rev. 1)
NUREG/BR-0195	Enforcement Manual (Rev. 2)

List of Implementing Guidance:
N/A.

Appendix A

Protection Factors for Respirators

Statement of Requirement:

Table A.1. Appendix A to Part 20 – Protection Factors for Respirators[a]

	Operating mode	Assigned Protection Factors
I. Air-Purifying Respirators [Particulate[b] only][c]:		
Filtering facepiece disposable[d]	Negative Pressure	([d])
Facepiece, half[e]	Negative Pressure	10
Facepiece, full	Negative Pressure	100
Facepiece, half	Powered air-purifying respirators	50
Facepiece, full	Powered air-purifying respirators	1000
Helmet/hood	Powered air-purifying respirators	1000
Facepiece, loose-fitting	Powered air-purifying respirators	25
II. Atmosphere supplying respirators [particulate, gases and vapors[f]]:		
1. Air-line respirator:		
Facepiece, half	Demand	10
Facepiece, half	Continuous Flow	50
Facepiece, half	Pressure Demand	50
Facepiece, full	Demand	100
Facepiece, full	Continuous Flow	1000
Facepiece, full	Pressure Demand	1000
Helmet/hood	Continuous Flow	1000
Facepiece, loose-fitting	Continuous Flow	25
Suit	Continuous Flow	([g])
2. Self-Contained Breathing Apparatus (SCBA):		
Facepiece, full	Demand	[h]100
Facepiece, full	Pressure Demand	[i]10,000

	Operating mode	Assigned Protection Factors
Facepiece, full	Demand, Recirculating	[h]100
Facepiece, full	Positive Pressure Recirculating	[i]10,000
III. Combination Respirators:		
Any combination of air-purifying and atmosphere-supplying respirators	(1) Assigned protection factor for type and mode of operation as listed above.	

[a] These assigned protection factors apply only in a respiratory protection program that meets the requirements of this Part. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances must also comply with Department of Labor regulations.

Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix B to Part 20 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.

[b] Air-purifying respirators with APF <100 must be equipped with particulate filters that are at least 95 percent efficient. Air-purifying respirators with APF = 100 must be equipped with particulate filters that are at least 99 percent efficient. Air-purifying respirators with APFs >100 must be equipped with particulate filters that are at least 99.97 percent efficient.

[c] The licensee may apply to the Commission for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors (e.g., radioiodine).

[d] Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use user seal check on this type of device. All other respiratory protection program requirements listed in §20.1703 apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to 10 may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

[e] Under-chin type only. No distinction is made in this Appendix between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece (e.g., disposable or reusable disposable). Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95 percent efficient and all other requirements of this Part are met.

[f] The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external (submersion) dose considerations.

[g] No NIOSH approval schedule is currently available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met (i.e., §20.1703).

[h] The licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health (IDLH).

[i] This type of respirator may 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 shall be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

Discussion:
Appendix A to Part 20, Subpart H, provides the APFs for respirators. The information is provided in a table, with footnotes provided for explanation. The APFs are listed for each broad class of respirators (e.g., air-purifying). Each class is subdivided into respirator types (e.g., full facepiece). Each type is characterized by how it operates (operating mode, e.g., negative pressure).

Statement of Applicability:
The information in this appendix applies to all licensees that use respirators to limit worker intakes of radioactive materials.

Guidance Statement:
Licensees may use APF values only if the requirements of Subpart H are met. Lower APFs may be assigned by the licensee without prior notification and approval by NRC. The use of higher APFs must have prior approval by NRC. The definitions for the table's respirator classes, types and modes of operation are found in §20.1003, Definitions. Appendix A APFs are only applicable to airborne radiological hazards, and may not be appropriate for chemical or other non-radiological respiratory hazards. See specific guidance on OSHA, Department of Labor respiratory requirements in NRC's Regulatory Guide, 8.15 Revision 1.

List of Existing Regulatory Guidance:

Reg. Guide 8.15 "Acceptable Programs For Respiratory Protection (Revision 1)"

NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials"

List of Implementing Guidance:

HPPOS 037 Farley 1 & 2 – 10 CFR Part 20 Exemption Request, MSA GMR-I Canister Radioiodine Protection Factor (describes example of NRC approval process to use non-NIOSH approved equipment to protect against radio-iodine gases and vapors)

HPPOS 118 Airflow Measurement and Control for Supplied-Air Respirators (provides guidance to effectively use and control airline respirators)

Q&A 91 Clarifies the need to comply with programmatic requirements when using respirators

List of Outdated Implementing Guidance:

HPPOS 225 Footnote g of Appendix A to 10 CFR 20 Concerning Protection Factor for Respirator (discusses NRC policy on use of non-elastomeric (disposable) half-facepieces)

Appendix B

Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage

Statement of Requirement:

Note: The accompanying tables (3) and footnotes/notes that comprise the rest of Appendix B can be found on the web at: <http://www.nrc.gov/NRC/CFR/TABLES/ISOTOPES/PART020-APPB/radionuclides.html>.

Appendix B to Part 20 — 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 m 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 D, for W from 10 to 100 days, and for Y greater than 100 days. The class (D, W, or Y) given in the column headed "Class" applies only to the inhalation ALIs and DACs given in Table 1, columns 2 and 3. 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 $6x10^{-2}$ or 0.06, 6E+2 represents $6x10^{2}$ or 600, and 6E+0 represents $6x10^{0}$ or 6.

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, and 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., (intake (in μCi) of each radionuclide/ALI_{ns}) <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.

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)/(2,000 hours per working year x 60 minutes/hour x 2 x 10^4 ml per minute) = [ALI/2.4 x 10^9] μCi/ml, where 2 x 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.

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 2.4×10^9ml, 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 one of the listed radionuclides cannot be definitely excluded either from knowledge of the radionuclide composition of the source or from actual measurements.

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 7.3×10^6(ml). The factor of 7.3×10^6 (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	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

Name	Atomic	
	Symbol	No.
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
Gallium	Ga	31
Germanium	Ge	32
Gold	Au	79
Hafnium	Hf	72
Holmium	Ho	67
Hydrogen	H	1
Indium	In	49
Iodine	I	53

Name	Atomic	
	Symbol	No.
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

Name	Atomic	
	Symbol	No.
Radium	Ra	88
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
Thulium	Tm	69
Tin	Sn	50
Titanium	Ti	22
Tungsten	W	74
Uranium	U	92

Name	Atomic	
	Symbol	No.
Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40

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)
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	2E+2	6E-8	2E-10	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{7}Be	-	1E+1	6E-9	2E-11	-	-
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	7E+4	3E-5	1E-7	-	-
			(5E+4)	-	-	-	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

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	-	-
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 LLI wall	2E+2	1E-7	3E-10	-	-
			(3E+3)	-	-	-	4E-5	4E-4
		W, see ^{31}Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{31}Si	-	5E+0	2E-9	2E-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	Phosphorous-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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4 LLI wall	2E+4	7E-6	2E-8	-	-
			(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	-	-
17	Chlorine-38[2]	D, see ^{36}Cl	2E+4 St. wall	4E+4	2E-5	6E-8	-	-
			(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 St. wall	5E+4	2E-5	7E-8	-	-
			(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

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)
19	Potassium-44[2]	D, all compounds	2E+4 St. wall	7E+4	3E-5	9E-8	-	-
			(4E+4)	-	-	-	5E-4	5E-3
19	Potassium-45[2]	D, all compounds	3E+4 St. wall	1E+5	5E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3 Bone Surf	4E+3 Bone Surf	2E-6	-	-	-
			(4E+3)	(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 LLI wall	3E+3	1E-6	4E-9	-	-
			(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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
23	Vanadium-47[2]	D, all compounds except those given for W	3E+4 St. wall	8E+4	3E-5	1E-7	-	-
			(3E+4)	-	-	-	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	3E+4 Bone Surf	1E-5	-	-	-
			(9E+4)	(3E+4)	-	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	9E+4	4E-5	1E-7	-	-
			(4E+4)	-	-	-	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	-	-

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)
25	Manganese-53	D, see ^{51}Mn	5E+4	1E+4 Bone Surf	5E-6	-	7E-4	7E-3
			-	(2E+4)	-	3E-8	-	-
		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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
27	Cobalt-60m[2]	W, see ^{55}Co	1E+6 St. wall	4E+6	2E-3	6E-6	-	-
			(1E+6)	-	-	-	2E-2	2E-1
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	-	-
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	2E+5	7E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	-	-
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 ^{55}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	6E+3	3E-6	9E-9	-	-
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	-	-

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)
28	Nickel-66	D, see ^{56}Ni	4E+2 LLI wall	2E+3	7E-7	2E-9	-	-
			(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 St. wall	9E+4	4E-5	1E-7	-	-
			(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 St. wall	7E+4	3E-5	9E-8	-	-
			(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, call compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
31	Gallium-65[2]	D, all compounds except those given for W	5E+4 St. wall	2E+5	7E-5	2E-7	-	-
			(6E+4)	-	-	-	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	-	-
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	2E+5	7E-5	2E-7	-	-
			(7E+4)	-	-	-	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	9E+4	4E-5	1E-7	-	-
			(4E+4)	-	-	-	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	-	-

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)
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	8E+4	3E-5	1E-7	-	-
			(7E+4)	-	-	-	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	9E-6	3E-8	-	-
			(2E+4)	-	-	-	3E-4	3E-3
		W, see ^{66}Ge	-	2E+4	9E-6	3E-8	-	-
33	Arsenic-69[2]	W, all compounds	3E+4 St. wall	1E+5	5E-5	2E-7	-	-
			(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 LLI wall	5E+3	2E-6	7E-9	-	-
			(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

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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, se ^{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 St. wall	2E+5	9E-5	3E-7	-	-
			(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	-	-
35	Bromine-74m[2]	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4 St. wall	4E+4	2E-5	5E-8	-	-
			(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	-	-

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)
35	Bromine-74[2]	D, see ^{74m}Br	2E+4 St. Wall	7E+4	3E-5	1E-7	-	-
			(4E+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 St. wall	5E+4	2E-5	7E-8	-	-
			(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 St. wall	2E+5	8E-5	3E-7	-	-
			(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	6E-9	4E-5	4E-4
		W, see ^{74m}Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m}Br	5E+4 St. wall	6E+4	3E-5	9E-8	-	-
			(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 St. wall	6E+4	2E-5	8E-8	-	-
			(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	-	-
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 St. wall	1E+5	5E-5	2E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
37	Rubidium-81m[2]	D, all compounds	2E+5 St. wall	3E+5	1E-4	5E-7	-	-
			(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 St. wall	6E+4	3E-5	9E-8	-	-
			(3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89[2]	D, all compounds	4E+4 St. wall	1E+5	6E-5	2E-7	-	-
			(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	-	-

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)
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 LLI wall	4E+2	2E-7	6E-10	-	-
			(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	-	-
38	Strontium-89	D, see ^{80}Sr	6E+2 LLI wall	8E+2	4E-7	1E-9	-	-
			(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 Bone Surf	2E+1 Bone Surf	8E-9	-	-	-
			(4E+1)	(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 LLI wall	7E+2	3E-7	9E-10	-	-
			(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 LLI wall	2E+2	7E-8	2E-10	-	-
			(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 St. wall	8E+4	3E-5	1E-7	-	-
			(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 St. wall	2E+5	6E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{86m}Y	-	1E+5	6E-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	Inhalation				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (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	6E+0 Bone Surf	3E-9	-	-	-
			(3E+3)	(2E+1)	-	2E-11	4E-5	4E-4
		W, see ^{86}Zr	-	2E+1 Bone Surf	1E-8	-	-	-
			-	(6E+1)	-	9E-11	-	-
		Y, see ^{86}Zr	-	6E+1 Bone Surf	2E-8	-	-	-
			-	(7E+1)	-	9E-11	-	-
40	Zirconium-95	D, see ^{86}Zr	1E+3	1E+2 Bone Surf	5E-8	-	2E-5	2E-4
			-	(3E+2)	-	4E-10	-	-
		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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
41	Niobium-88[2]	W, all compounds except those given for Y	5E+4 St. wall	2E+5	9E-5	3E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89m[2] (66min)	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 (122min)	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	2E+3	8E-7	3E-9	-	-
			(1E+4)	-	-	-	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	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{88}Nb	-	2E+3	9E-7	3E-9	-	-
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	-	-

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)
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 LLI wall	3E+3	1E-6	4E-9	-	-
			(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 St. wall	1E+5	6E-5	2E-7	-	-
			(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 St. wall	3E-6	-	6E-5	6E-4
			-	(7E+3)	-	1E-8	-	-
		W, see ^{93m}Tc	-	1E+3	5E-7	2E-9	-	-
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 St. wall	2E-6	-	6E-5	6E-4
			-	(6E+3)	-	8E-9	-	-
		W, see ^{93m}Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101[2]	D, see ^{93m}Tc	9E+4 St. wall	3E+5	1E-4	5E-7	-	-
			(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 St. wall	7E+4	3E-5	1E-7	-	-
			(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	-	-

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)
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 LLI wall	9E+1	4E-8	1E-10	-	-
			(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-99m	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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	5E+2	2E-7	7E-10	-	-
			(1E+3)	-	-	-	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	1E+4	5E-6	2E-8	-	-
			(4E+3)	-	-	-	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	2E+5	1E-4	3E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
		W, see ^{99m}Rh	-	3E+5	1E-4	4E-7	-	-
		Y, see ^{99m}Rh	-	3E+5	1E-4	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)
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	6E+3	3E-6	9E-9	-	-
			(7E+3)	-	-	-	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	2E+4 Kidneys	9E-6	-	-	-
			(4E+4)	(2E+4)	-	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	-	-
46	Palladium-109	D, see ^{100}Pd	2E+3	6E+3	3E-6	9E-6	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 St. wall	2E+5	8E-5	2E-7	-	-
			(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 St. wall	2E+5	8E-5	3E-7	-	-
			(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 LLI wall	2E+3 Liver	6E-7	-	-	-
			(1E+3)	(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	-	-

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)
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	-	-
47	Silver-115[2]	D, see ^{102}Ag	3E+4 St. wall	9E+4	4E-5	1E-7	-	-
			(3E+4)	-	-	-	4E-4	4E-3
		W, see ^{102}Ag	-	9E+4	4E-5	1E-7	-	-
		Y, see ^{102}Ag	-	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+1 Kidneys	1E-8	-	-	-
			(4E+2)	(5E+1)	-	7E-11	6E-6	6E-5
		W, see ^{104}Cd	-	1E+2 Kidneys	5E-8	-	-	-
			-	(1E+2)	-	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
48	Cadmium-113m	D, see ^{104}Cd	2E+1 Kidneys	2E+0 Kidneys	1E-9	-	-	-
			(4E+1)	(4E+0)	-	5E-12	5E-7	5E-6
		W, see ^{104}Cd	-	8E+0 Kidneys	4E-9	-	-	-
			-	(1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
48	Cadmium-113	D, see ^{104}Cd	2E+1 Kidneys	2E+0 Kidneys	9E-10	-	-	-
			(3E+1)	(3E+0)	-	5E-12	4E-7	4E-6
		W, see ^{104}Cd	-	8E+0 Kidneys	3E-9	-	-	-
			-	(1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1 Kidneys	2E-8	-	4E-6	4E-5
			-	(8E+1)	-	1E-10	-	-
		W, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	6E-8	2E-10	-	-
48	Cadmium-115	D, see ^{104}Cd	9E+2 LLI wall	1E+3	6E-7	2E-9	-	-
			(1E+3)	-	-	-	1E-5	1E-4
		W, see ^{104}Cd	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
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	-	-
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] (69.1min)	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	-	-

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)
49	Indium-110 (4.9h)	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	6E+1	3E-8	9E-11	-	-
			(4E+2)	-	-	-	5E-6	5E-5
		W, see ^{109}In	-	1E+2	4E-8	1E-10	-	-
49	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	1E+5	5E-5	2E-7	-	-
			(5E+4)	-	-	-	7E-4	7E-3
		W, see ^{109}In	-	1E+5	6E-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	Inhalation				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	-	-
50	Tin-113	D, see ^{110}Sn	2E+3 LLI wall	1E+3	5E-7	2E-9	-	-
			(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 LLI wall	1E+3 Bone Surf	5E-7	-	-	-
			(2E+3)	(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 LLI wall	2E+3	1E-6	3E-9	-	-
			(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 LLI wall	9E+2	4E-7	1E-9	-	-
			(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 LLI wall	2E+4	6E-6	2E-8	-	-
			(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	-	-

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)
50	Tin-123	D, see ^{110}Sn	5E+2 LLI wall	6E+2	3E-7	9E-10	-	-
			(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 LLI wall	9E+2	4E-7	1E-9	-	-
			(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 St. wall	3E+5	1E-4	4E-7	-	-
			(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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 (16min)	D, see ^{115}Sb	1E+5 St. wall	4E+5	2E-4	6E-7	-	-
			(2E+5)	-	-	-	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	2E+3	1E-6	3E-9	-	-
			(8E+2)	-	-	-	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	2E+5	8E-5	3E-7	-	-
			(7E+4)	-	-	-	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	2E+3	9E-7	3E-9	-	-
			(8E+2)	-	-	-	1E-5	1E-4
		W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	-	-

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)
51	Antimony-128[2] (10.4min)	D, see ^{115}Sb	8E+4 St. wall	4E+5	2E-4	5E-7	-	-
			(1E+5)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	4E+5	2E-4	6E-7	-	-
51	Antimony-128 (9.01h)	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 Thyroid	1E-5	-	-	-
			(2E+4)	(4E+4)	-	6E-8	2E-4	2E-3
		W, see ^{115}Sb	-	2E+4 Thyroid	1E-5	-	-	-
			-	(4E+4)	-	6E-8	-	-
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	2E+2 Bone Surf	8E-8	-	-	-
			(7E+2)	(4E+2)	-	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	2E+2 Bone Surf	9E-8	-	-	-
			(1E+3)	(5E+2)	-	8E-10	1E-5	1E-4
		W, see ^{116}Te	-	5E+2	2E-7	8E-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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
52	Tellurium-123	D, see ^{116}Te	5E+2 Bone Surf	2E+2 Bone Surf	8E-8	-	-	-
			(1E+3)	(5E+2)	-	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	4E+2 Bone Surf	2E-7	-	-	-
			(1E+3)	(1E+3)	-	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	4E+2 Thyroid	2E-7	-	-	-
			(6E+2)	(1E+3)	-	2E-9	8E-6	8E-5
		W, see ^{116}Te	-	4E+2 Thyroid	2E-7	-	-	-
			-	(9E+2)	-	1E-9	-	-

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)
52	Tellurium-131[2]	D, see ^{116}Te	3E+3 Thyroid	5E+3 Thyroid	2E-6	-	-	-
			(6E+3)	(1E+4)	-	2E-8	8E-5	8E-4
		W, see ^{116}Te	-	5E+3 Thyroid	2E-6	-	-	-
			-	(1E+4)	-	2E-8	-	-
52	Tellurium-132	D, see ^{116}Te	2E+2 Thyroid	2E+2 Thyroid	9E-8	-	-	-
			(7E+2)	(8E+2)	-	1E-9	9E-6	9E-5
		W, see ^{116}Te	-	2E+2 Thyroid	9E-8	-	-	-
			-	(6E+2)	-	9E-10	-	-
52	Tellurium-133m[2]	D, see ^{116}Te	3E+3 Thyroid	5E+3 Thyroid	2E-6	-	-	-
			(6E+3)	(1E+4)	-	2E-8	9E-5	9E-4
		W, see ^{116}Te	-	5E+3 Thyroid	2E-6	-	-	-
			-	(1E+4)	-	2E-8	-	-
52	Tellurium-133[2]	D, see ^{116}Te	1E+4 Thyroid	2E+4 Thyroid	9E-6	-	-	-
			(3E+4)	(6E+4)	-	8E-8	4E-4	4E-3
		W, see ^{116}Te	-	2E+4 Thyroid	9E-6	-	-	-
			-	(6E+4)	-	8E-8	-	-
52	Tellurium-134[2]	D, see ^{116}Te	2E+4 Thyroid	2E+4 Thyroid	1E-5	-	-	-
			(2E+4)	(5E+4)	-	7E-8	3E-4	3E-3
		W, see ^{116}Te	-	2E+4 Thyroid	1E-5	-	-	-
			-	(5E+4)	-	7E-8	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
53	Iodine-120m[2]	D, all compounds	1E+4 Thyroid	2E+4	9E-6	3E-8	-	-
			(1E+4)	-	-	-	2E-4	2E-3
53	Iodine-120[2]	D, all compounds	4 E+3 Thyroid	9E+3 Thyroid	4E-6	-	-	-
			(8E+3)	(1E+4)	-	2E-8	1E-4	1E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid	2E+4 Thyroid	8E-6	-	-	-
			(3E+4)	(5E+4)	-	7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid	6E+3 Thyroid	3E-6	-	-	-
			(1E+4)	(2E+4)	-	2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid	8E+1 Thyroid	3E-8	-	-	-
			(2E+2)	(3E+2)	-	4E-10	2E-6	2E-5
53	Iodine-125	D, all compounds	4E+1 Thyroid	6E+1 Thyroid	3E-8	-	-	-
			(1E+2)	(2E+2)	-	3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	2E+1 Thyroid	4E+1 Thyroid	1E-8	-	-	-
			(7E+1)	(1E+2)	-	2E-10	1E-6	1E-5
53	Iodine-128[2]	D, all compounds	4E+4 St. wall	1E+5	5E-5	2E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid	9E+0 Thyroid	4E-9	-	-	-
			(2E+1)	(3E+1)	-	4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid	7E+2 Thyroid	3E-7	-	-	-
			(1E+3)	(2E+3)	-	3E-9	2E-5	2E-4

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)
53	Iodine-131	D, all compounds	3E+1 Thyroid	5E+1 Thyroid	2E-8	-	-	-
			(9E+1)	(2E+2)	-	2E-10	1E-6	1E-5
53	Iodine-132m[2]	D, all compounds	4E+3 Thyroid	8E+3 Thyroid	4E-6	-	-	-
			(1E+4)	(2E+4)	-	3E-8	1E-4	1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid	8E+3 Thyroid	3E-6	-	-	-
			(9E+3)	(1E+4)	-	2E-8	1E-4	1E-3
53	Iodine-133	D, all compounds	1E+2 Thyroid	3E+2 Thyroid	1E-7	-	-	-
			(5E+2)	(9E+2)	-	1E-9	7E-6	7E-5
53	Iodine-134[2]	D, all compounds	2E+4 Thyroid	5E+4	2E-5	6E-8	-	-
			(3E+4)	-	-	-	4E-4	4E-3
53	Iodine-135	D, all compounds	8E+2 Thyroid	2E+3 Thyroid	7E-7	-	-	-
			(3E+3)	(4E+3)	-	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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
54	Xenon-138[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
55	Cesium-125[2]	D, all compounds	5E+4 St. wall	1E+5	6E-5	2E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
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 St. wall	2E+5	8E-5	3E-7	-	-
			(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 St. wall	1E+5	6E-5	2E-7	-	-
			(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 St. wall	6E+4	2E-5	8E-8	-	-
			(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 St. wall	1E+6	6E-4	2E-6	-	-
			(5E+5)	-	-	-	7E-3	7E-2
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4

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)
56	Barium-133m	D, all compounds	2E+3 LLI wall	9E+3	4E-6	1E-8	-	-
			(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 LLI wall	1E+3	6E-7	2E-9	-	-
			(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	-	-
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	-	-

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)
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 St. wall	1E+5	4E-5	1E-7	-	-
			(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 LLI wall	7E+2	3E-7	1E-9	-	-
			(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 LLI wall	4E+3	2E-6	6E-9	-	-
			(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 LLI wall	7E+2	3E-7	1E-9	-	-
			(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 LLI wall	2E+3	8E-7	3E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{134}Ce	-	2E+3	7E-7	2E-9	-	-

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)
58	Cerium-144	W, see ^{134}Ce	2E+2 LLI wall	3E+1	1E-8	4E-11	-	-
			(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 St. wall	2E+5	1E-4	3E-7	-	-
			(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 LLI wall	8E+2	3E-7	1E-9	-	-
			(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 St. wall	1E+5	5E-5	2E-7	-	-
			(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
59	Praseodymium-147[2]	W, see ^{136}Pr	5E+4 St. wall	2E+5	8E-5	3E-7	-	-
			(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	-	-
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 LLI wall	9E+2	4E-7	1E-9	-	-
			(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 St. wall	2E+5	8E-5	3E-7	-	-
			(6E+4)	-	-	-	8E-4	8E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-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	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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 Bone Surf	7E-8	-	1E-4	1E-3
			-	(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 LLI wall	1E+2 Bone Surf	5E-8	-	-	-
			(5E+3)	(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 LLI wall	5E+2	2E-7	8E-10	-	-
			(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 LLI wall	2E+3	8E-7	3E-9	-	-
			(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	-	-
62	Samarium-141m(2)	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
62	Samarium-141[2]	W, all compounds	5E+4 St. wall	2E+5	8E-5	2E-7	-	-
			(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 Bone Surf	4E-2 Bone Surf	1E-11	-	-	-
			(3E+1)	(6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1 Bone Surf	4E-2 Bone Surf	2E-11	-	-	-
			(3E+1)	(7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4 LLI wall	1E+2 Bone Surf	4E-8	-	-	-
			(1E+4)	(2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155[2]	W, all compounds	6E+4 St. wall	2E+5	9E-5	3E-7	-	-
			(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 (12.62h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2y)	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

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)
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 Bone Surf	4E-8	-	5E-5	5E-4
			-	(1E+2)	-	2E-10	-	-
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
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 St. wall	2E+5	6E-5	2E-7	-	-
			(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 Bone Surf	8E+3 Bone Surf	3E-12	-	-	-
			(2E+1)	(2E+2)	-	2E-14	3E-7	3E-6
		W, see ^{145}Gd	-	3E-2 Bone Surf	1E-11	-	-	-
			-	(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 Bone Surf	2E-7	-	9E-5	9E-4
			-	(6E+2)	-	9E-10	-	-
		W, see ^{145}Gd	-	1E+3	5E-7	2E-9	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
64	Gadolinium-152	D, see ^{145}Gd	2E+1 Bone Surf	1E-2 Bone Surf	4E-12	-	-	-
			(3E+1)	(2E-2)	-	3E-14	4E-7	4E-6
		W, see ^{145}Gd	-	4E-2 Bone Surf	2E-11	-	-	-
			-	(8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ^{145}Gd	5E+3	1E+2 Bone Surf	6E-8	-	6E-5	6E-4
			-	(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 (5.0h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
65	Terbium-156m (24.4h)	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	3E+2 Bone Surf	1E-7	-	-	-
			(5E+4)	(6E+2)	-	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

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)
65	Terbium-161	W, all compounds	2E+3 LLI wall	2E+3	7E-7	2E-9	-	-
			(2E+3)	-	-	-	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	7E+2	3E-7	1E-9	-	-
			(8E+2)	-	-	-	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	2E+6	1E-3	3E-6	-	-
			(8E+5)	-	-	-	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	6E+5	3E-4	9E-7	-	-
			(2E+5)	-	-	-	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	2E+3	7E-7	2E-9	-	-
			(9E+2)	-	-	-	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	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
68	Erbium-169	W, all compounds	3E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(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 LLI wall	1E+3	6E-7	2E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
69	Thulium-162[2]	W, all compounds	7E+4 St. wall	3E+5	1E-4	4E-7	-	-
			(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 LLI wall	2E+3	8E-7	3E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
69	Thulium-170	W, all compounds	8E+2 LLI wall	2E+2	9E-8	3E-10	-	-
			(1E+3)	-	-	-	1E-5	1E-4
69	Thulium-171	W, all compounds	1E+4 LLI wall	3E+2 Bone Surf	1E-7	-	-	-
			(1E+4)	(6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2 LLI wall	1E+3	5E-7	2E-9	-	-
			(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 St. wall	3E+5	1E-4	4E-7	-	-
			(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 LLI wall	4E+3	1E-6	5E-9	-	-
			(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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	-	-
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 Bone Surf	4E-9	-	2E-5	2E-4
			-	(2E+1)	-	3E-11	-	-
		W, see ^{170}Hf	-	4E+1 Bone Surf	2E-8	-	-	-
			-	(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 Bone Surf	4E-7	-	4E-5	4E-4
			-	(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 Bone Surf	5E-10	-	3E-6	3E-5
			-	(2E+0)	-	3E-12	-	-
		W, see ^{170}Hf	-	5E+0 Bone Surf	2E-9	-	-	-
			-	(9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2 Bone Surf	1E-7	-	1E-5	1E-4
			-	(6E+2)	-	8E-10	-	-
		W, see ^{170}Hf	-	6E+2	3E-7	8E-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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 Bone Surf	7E-8	-	2E-5	2E-4
			-	(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 Bone Surf	8E-1 Bone Surf	3E-10	-	-	-
			(4E+2)	(2E+0)	-	2E-12	5E-6	5E-5
		W, see ^{170}Hf	-	3E+0 Bone Surf	1E-9	-	-	-
			-	(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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	5E+5	2E-4	8E-7	-	-
			(2E+5)	-	-	-	3E-3	3E-2
		Y, see ^{172}Ta	-	4E+5	2E-4	6E-7	-	-
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	5E-7	2E-9	-	-
			(1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{172}Ta	-	1E+3	4E-7	1E-9	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
73	Tantalum-186[2]	W, see ^{172}Ta	5E+4 St. wall	2E+5	1E-4	3E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2
		Y, see ^{172}Ta	-	2E+5	9E-5	3E-7	-	-
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
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 LLI wall	7E+3	3E-6	9E-9	-	-
			(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 LLI wall	1E+3	5E-7	2E-9	-	-
			(5E+2)	-	-	-	7E-6	7E-5
75	Rhenium-177[2]	D, all compounds except those given for W	9E+4 St. wall	3E+5	1E-4	4E-7	-	-
			(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 St. wall	3E+5	1E-4	4E-7	-	-
			(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 (12.7h)	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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
75	Rhenium-182 (64.0h)	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 St. wall	2E+3 St. wall	7E-7	-	-	-
			(2E+3)	(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 St. wall	4E-4	-	8E-3	8E-2
			-	(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	-	-
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 LLI wall	2E+3	9E-7	3E-9	-	-
			(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 LLI wall	5E+3	2E-6	6E-9	-	-
			(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 LLI wall	4E+1	2E-8	6E-11	-	-
			(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	-	-

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)
77	Iridium-182[2]	D, all compounds except those given for W and Y	4E+4 St. wall	1E+5	6E-5	2E-7	-	-
			(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	-	-
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 LLI wall	5E+3	2E-6	7E-9	-	-
			(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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
78	Platinum-193m	D, all compounds	3E+3 LLI wall	6E+3	3E-6	8E-9	-	-
			(3E+4)	-	-	-	4E-5	4E-4

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
78	Platinum-193	D, all compounds	4E+4 LLI wall	2E+4	1E-5	3E-8	-	-
			(5E+4)	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3 LLI wall	4E+3	2E-6	6E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
78	Platinum-197m(2)	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-199(2)	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, halides and nitrates	-	2E+4	9E-6	3E-8	-	-
		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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
79	Gold-199	D, see ^{193}Au	3E+3 LLI wall	9E+3	4E-6	1E-8	-	-
			(3E+3)	-	-	-	4E-5	4E-4
		W, see ^{193}Au	-	4E+3	2E-6	6E-9	-	-
		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+4	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 St. wall	2E+5	9E-5	3E-7	-	-
			(9E+4)	-	-	-	1E-3	1E-2
		W, see ^{193}Au	-	2E+5	1E-4	3E-7	-	-
		Y, see ^{193}Au	-	2E+5	9E-5	3E-7	-	-
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	-	-

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-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 St. wall	2E+5	7E-5	2E-7	-	-
			(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 St. wall	2E+5	6E-5	2E-7	-	-
			(7E+4)	-	-	-	1E-3	1E-2

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)
81	Thallium-194[2]	D, all compounds	3E+5 St. wall	6E+5	2E-4	8E-7	-	-
			(3E+5)	-	-	-	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	2E+1 Bone Surf	1E-10	-	-	-
			(1E+0)	(4E-1)	-	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	3E+1	1E-8	5E-11	-	-
			(1E+2)	-	-	-	2E-6	2E-5

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)
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	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, all other compounds	-	1E+5	4E-5	1E-7	-	-
83	Bismuth-201[2]	D, see ^{200}Bi	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{200}Bi	-	4E+4	2E-5	5E-8	-	-
83	Bismuth-202[2]	D, see ^{200}Bi	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{200}Bi	-	8E+4	3E-5	1E-7	-	-
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	5E+0 Kidneys	2E-9	-	-	-
			(6E+1)	(6E+0)	-	9E-12	8E-7	8E-6
		W, see ^{200}Bi	-	7E-1	3E-10	9E-13	-	-
83	Bismuth-210	D, see ^{200}Bi	8E+2	2E+2 Kidneys	1E-7	-	1E-5	1E-4
			-	(4E+2)	-	5E-10	-	-
		W, see ^{200}Bi	-	3E+1	1E-8	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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
83	Bismuth-214[2]	D, see ^{200}Bi	2E+4 St. wall	8E+2	3E-7	1E-9	-	-
			(2E+4)	-	-	-	3E-4	3E-3
		W, see ^{200}Bi	-	9E-2	4E-7	1E-9	-	-
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	-	-
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

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)
88	Radium-223	W, all compounds	5E+0 Bone Surf	7E-1	3E-10	9E-13	-	-
			(9E+0)	-	-	-	1E-7	1E-6
88	Radium-224	W, all compounds	8E+0 Bone Surf	2E+0	7E-10	2E-12	-	-
			(2E+1)	-	-	-	2E-7	2E-6
88	Radium-225	W, all compounds	8E+0 Bone Surf	7E-1	3E-10	9E-13	-	-
			(2E+1)	-	-	-	2E-7	2E-6
88	Radium-226	W, all compounds	2E+0 Bone Surf	6E-1	3E-10	9E-13	-	-
			(5E+0)	-	-	-	6E-8	6E-7
88	Radium-227(2)	W, all compounds	2E+4 Bone Surf	1E+4 Bone Surf	6E-6	-	-	-
			(2E+4)	(2E+4)	-	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E+0 Bone Surf	1E+0	5E-10	2E-12	-	-
			(4E+0)	-	-	-	6E-8	6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3 LLI wall	3E+1 Bone Surf	1E-8	-	-	-
			(2E+3)	(4E+1)	-	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	3E-1 Bone Surf	1E-10	-	-	-
			(5E+1)	(5E-1)	-	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	-	-

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)
89	Actinium-226	D, see ^{224}Ac	1E+2 LLI wall	3E+0 Bone Surf	1E-9	-	-	-
			(1E+2)	(4E+0)	-	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-4 Bone Surf	2E-13	-	-	-
			(4E-1)	(8E-4)	-	1E-15	5E-9	5E-8
		W, see ^{224}Ac	-	2E-3 Bone Surf	7E-13	-	-	-
			-	(3E-3)	-	4E-15	-	-
		Y, see ^{224}Ac	-	4E-3	2E-12	6E-15	-	-
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 Bone Surf	2E-8	-	-	-
			-	(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	2E+2	6E-8	2E-10	-	-
			(5E+3)	-	-	-	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-2 Bone Surf	4E-12	-	-	-
			(1E+1)	(2E-2)	-	3E-14	2E-7	2E-6
		Y, see ^{226}Th	-	2E-2	7E-12	2E-14	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
90	Thorium-229	W, see ^{226}Th	6E-1 Bone Surf	9E-4 Bone Surf	4E-13	-	-	-
			(1E+0)	(2E-3)	-	3E-15	2E-8	2E-7
		Y, see ^{226}Th	-	2E-3 Bone Surf	1E-12	-	-	-
			-	(3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ^{226}Th	4E+0 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(9E+0)	(2E-2)	-	2E-14	1E-7	1E-6
		Y, see ^{226}Th	-	2E-2 Bone Surf	6E-12	-	-	-
			-	(2E-2)	-	3E-14	-	-
90	Thorium-231	W, see 226Th	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	1E-3 Bone Surf	5E-13	-	-	-
			(2E+0)	(3E-3)	-	4E-15	3E-8	3E-7
		Y, see ^{226}Th	-	3E-3 Bone Surf	1E-12	-	-	-
			-	(4E-3)	-	6E-15	-	-
90	Thorium-234	W, see ^{226}Th	3E+2 LLI wall	2E+2	8E-8	3E-10	-	-
			(4E+2)	-	-	-	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	5E-9	-	2E-5	2E-4
			-	(2E+1)	-	3E-11	-	-
		Y, see ^{227}Pa	-	1E+1	5E-9	2E-11	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
91	Protactinium-230	W, see ^{227}Pa	6E+2 Bone Surf	5E+0	2E-9	7E-12	-	-
			(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 Bone Surf	2E-3 Bone Surf	6E-13	-	-	-
			(5E-1)	(4E-3)	-	6E-15	6E-9	6E-8
		Y, see ^{227}Pa	-	4E-3 Bone Surf	2E-12	-	-	-
			-	(6E-3)	-	8E-15	-	-
91	Protactinium-232	W, see ^{227}Pa	1E+3	2E+1 Bone Surf	9E-9	-	2E-5	2E-4
			-	(6E+1)	-	8E-11	-	-
		Y, see ^{227}Pa	-	6E+1 Bone Surf	2E-8	-	-	-
			-	(7E+1)	-	1E-10	-	-
91	Protactinium-233	W, see ^{227}Pa	1E+3 LLI wall	7E+2	3E-7	1E-9	-	-
			(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 Bone Surf	4E-1 Bone Surf	2E-10	-	-	-
			(6E+0)	(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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
92	Uranium-231	D, see ^{230}U	5E+3 LLI wall	8E+3	3E-6	1E-8	-	-
			(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 Bone Surf	2E-1 Bone Surf	9E-11	-	-	-
			(4E+0)	(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 Bone Surf	1E+0 Bone Surf	5E-10	-	-	-
			(2E+1)	(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 Bone Surf	1E+0 Bone Surf	5E-10	-	-	-
			(2E+1)	(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-235[3]	D, see ^{230}U	1E+1 Bone Surf	1E+0 Bone Surf	6E-10	-	-	-
			(2E+1)	(2E+0)	-	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	1E+0 Bone Surf	5E-10	-	-	-
			(2E+1)	(2E+0)	-	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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
92	Uranium-237	D, see ^{230}U	2E+3 LLI wall	3E+3	1E-6	4E-9	-	-
			(2E+3)	-	-	-	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	1E+0 Bone Surf	6E-10	-	-	-
			(2E+1)	(2E+0)	-	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	1E+0 Bone Surf	5E-10	-	-	-
			(2E+1)	(2E+0)	-	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	-	-
93	Neptunium-232[2]	W, all compounds	1E+5	2E+3 Bone Surf	7E-7	-	2E-3	2E-2
			-	(5E+2)	-	6E-9	-	-
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	8E+2 Bone Surf	3E-7	-	-	-
			(2E+4)	(1E+3)	-	2E-9	3E-4	3E-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)
93	Neptunium-236 (1.15E+5y)	W, all compounds	3E+0 Bone Surf	2E-2 Bone Surf	9E-12	-	-	-
			(6E+0)	(5E-5)	-	8E-14	9E-8	9E-7
93	Neptunium-236m (22.5h)	W, all compounds	3E+3 Bone Surf	3E+1 Bone Surf	1E-8	-	-	-
			(4E+3)	(7E+1)	-	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone Surf	4E-3 Bone Surf	2E-12	-	-	-
			(1E+0)	(1E-2)	-	1E-14	2E-8	2E-7
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone Surf	3E-8	-	2E-5	2E-4
			-	(2E+2)	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3 LLI wall	2E+3	9E-7	3E-9	-	-
			(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 Bone Surf	2E-2 Bone Surf	8E-12	-	-	-
			(4E+0)	(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 Bone Surf	7E-3 Bone Surf	3E-12	-	-	-
			(2E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	8E-12	2E-14	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
94	Plutonium-239	W, see ^{234}Pu	8E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone Surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-240	W, see ^{234}Pu	8E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone Surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-241	W, see ^{234}Pu	4E+1 Bone Surf	3E-1 Bone Surf	1E-10	-	-	-
			(7E+1)	(6E-1)	-	8E-13	1E-6	1E-5
		Y, see ^{234}Pu	-	8E-1 Bone Surf	3E-10	-	-	-
			-	(1E+0)	-	1E-12	-	-
94	Plutonium-242	W, see ^{234}Pu	8E-1 Bone Surf	7E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone Surf	7E-12	-	-	-
			-	(2E-2)	-	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	7E-3 Bone Surf	3E-12	-	-	-
			(2E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone Surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-

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)
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	3E+2	1E-7	4E-10	-	-
			(4E+2)	-	-	-	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	1E-6	-	5E-4	5E-3
			-	(6E+3)	-	9E-9	-	-
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	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242m	W, all compounds	8E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	4E+3	8E+1 Bone Surf	4E-8	-	5E-5	5E-4
			-	(9E+1)	-	1E-10	-	-
95	Americium-243	W, all compounds	8E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
95	Americium-244m[(2)]	W, all compounds	6E+4 St. wall	4E+3 Bone Surf	2E-6	-	-	-
			(8E+4)	(7E+3)	-	1E-8	1E-3	1E-2
95	Americium-244	W, all compounds	3E+3	2E+2 Bone Surf	8E-8	-	4E-5	4E-4
			-	(3E+2)	-	4E-10	-	-
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			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
95	Americium-246m[2]	W, all compounds	5E+4 St. wall	2E+5	8E-5	3E-7	-	-
			(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 Bone Surf	6E-1 Bone Surf	2E-10	-	-	-
			(8E+1)	(6E-1)	-	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	1E+3	3E+1 Bone Surf	1E-8	-	2E-5	2E-4
			-	(4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1 Bone Surf	3E-1 Bone Surf	1E-10	-	-	-
			(5E+1)	(3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0 Bone Surf	9E-3 Bone Surf	4E-12	-	-	-
			(2E+0)	(2E-2)	-	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	1E+0 Bone Surf	1E-2 Bone Surf	5E-12	-	-	-
			(3E+0)	(2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
96	Curium-246	W, all compounds	7E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	2E-7
96	Curium-247	W, all compounds	8E-1 Bone Surf	6E-3 Bone Surf	3E-12	-	-	-
			(1E+0)	(1E-2)	-	2E-14	2E-8	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	Inhalation				
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
96	Curium-248	W, all compounds	2E-1 Bone Surf	2E-3 Bone Surf	7E-13	-	-	-
			(4E-1)	(3E-3)	-	4E-15	5E-9	5E-8
96	Curium-249[2]	W, all compounds	5E+4	2E+4 Bone Surf	7E-6	-	7E-4	7E-3
			-	(3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2 Bone Surf	3E-4 Bone Surf	1E-13	-	-	-
			(6E-2)	(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 Bone Surf	4E-3 Bone Surf	2E-12	-	-	-
			(1E+0)	(9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2 Bone Surf	2E+0 Bone Surf	7E-10	-	-	-
			(5E+2)	(4E+0)	-	5E-12	6E-6	6E-5
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	-	-

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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	-	-

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)
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
99	Einsteinium-254m	W, all compounds	3E+2 LLI wall	1E+1	4E-9	1E-11	-	-
			(3E+2)	-	-	-	4E-6	4E-5
99	Einsteinium-254	W, all compounds	8E+0 Bone Surf	7E-2 Bone Surf	3E-11	-	-	-
			(2E+1)	(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 Bone Surf	2E-1 Bone Surf	7E-11	-	-	-
			(4E+1)	(2E-1)	-	3E-13	5E-7	5E-6
101	Mendelevium-257	W, all compounds	7E+3	8E+1 Bone Surf	4E-8	-	1E-4	1E-3
			-	(9E+1)	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1 Bone Surf	2E-1 Bone Surf	1E-10	-	-	-
			(5E+1)	(3E-1)	-	5E-13	6E-7	6E-6

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				Monthly Average Concentration (μCi/ml)
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
-	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 submission 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-7μCi/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-236, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U U-depleted

SA = [0.4 + 0.38 (enrichment) + 0.0034 (enrichment)^2] E-6, enrichment $\geq$ 0.72

where enrichment is the percentage by weight of U-235, expressed in percent.

APPENDIX B

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 the appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentration 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				Monthly Average Concentration (μCi/ml)
Radionuclide	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (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	-	-	-
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	-	-

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 Concentration (μCi/ml)
	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 (10μm 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-11μCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11μCi 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:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} < 1$$

Discussion:
The data tabulated in this appendix is intended to be used to show compliance with a number of sections of Part 20 that refer to one or more of the tables in the appendix. For example, monitoring of workers for intakes is required when annual intakes may exceed specified fractions of Columns (2) and (3) of Table (1). Licensees may show compliance, in part, with public dose limits for doses resulting from effluents by referring to the concentrations listed in Columns (1) and (2) of Table (2). Compliance with sewer release limits is shown, in part, by using the values in Table (3). In addition, certain requirements such as area posting, respiratory protection, and incident reporting use Appendix B values as triggers for these actions. Table (1) is based on occupational dose limits, Table (2) on dose limits to members of the public, and Table (3) is a special case of exposure to members of the public.

The values tabulated in Appendix B are all secondary limits or derived quantities, and each column in the appendix is based on a primary limit, which in this case is a dose. A secondary limit, such as the DAC, is derived from a primary limit. The difference is that the primary limit is absolute in that it is not to be exceeded in any routine situation. The secondary limit is not absolute in the sense that it is applicable only if certain conditions are met. It is not valid as a limit if these conditions are not met. For example, the ALI is a limit if there are no external exposures during the monitoring year and the only source of exposure is internal. If there are external exposures, limiting annual intakes to an ALI will lead to exceeding the primary dose limit, and hence a violation of NRC requirements. The ALI is also not a limit if the ingested or inhaled radioactive material contains more than one type of radionuclide. In such cases, the ALIs of each of the components must be adjusted to take account of the presence of the other components.

A derived quantity, such as the DAC, is not a limit at all, and may be exceeded at any time provided certain restrictions apply. The DAC is tabulated for convenience and because it is an easily measured quantity. It is easily calculated from the ALI by assuming a suitable breathing rate and exposure time. Part 20 does not limit airborne concentrations at any given time to values below the DAC, and requirements in Part 20 that are specified in terms of airborne concentrations generally use only time-averaged concentrations and not instantaneous values.

In this appendix, the daughter products of the radionuclides listed were not included in the intake when calculating the tabulated values of ALI and DAC for the parent. However, the effects of the daughters that are produced in the body after intake of the parent are included in the calculations. For example, uranium decays in a long decay chain that includes many radioactive daughter products. When considering the inhalation of uranium, the calculations of ALIs and DACs for the tables assume that only the parent uranium isotope is inhaled, and no daughters are considered with the uranium inhalation. The daughters produced in the body after the uranium is taken into the body are included in estimating the dose resulting from the intake. To properly account for the dose from a parent that produces one or more daughters, the parent and each of the daughters must be treated as separately inhaled or ingested radionuclides, and the dose from each added to produce a total dose. The parent and its daughters that may be in the inhaled air or

in the ingested material are considered as a mixture of radionuclides and not as members of one chain.

One exception to this rule is the case in which the half-life of the daughter is very short (usually less than about 20 minutes) and much shorter than that of the parent. In this case, the tabulated values assume that the daughter is in secular equilibrium with the parent and that both are always inhaled or ingested together. The daughter in this case need not be considered separately in determining the ALI from the table, because it has been already included in calculating the ALI for the parent. In such situations, you will not find data in the table pertaining to short-lived daughters of tabulated radionuclides. In such cases, assume that the data for the missing daughter has been included in the data for the parent.

Column (1) in the appendix is the ALI for ingestion by occupationally exposed workers. Ingestion means taking in the material by mouth via food or drink or as solid or liquid contamination in the workplace. The values are based on an annual dose limit of 5 rem effective dose equivalent (called the stochastic dose limit) or 50 rem organ dose equivalent (called the non-stochastic, or deterministic, dose limit), whichever is more limiting. Internal dose models described in ICRP Publication 30 were used to calculate the effective and organ doses that would result from intake of unit activity of each of the radionuclides listed in the table. The intakes that would lead to an effective dose of 5 rem or an organ dose of 50 rem are then calculated. The highest intake that does not result in exceeding any organ limit or the effective dose equivalent limit is then selected as the ALI and tabulated in Column (1). If the ALI is based on an organ dose, the organ is specified under the tabulated ALI, and the ALI that would result in an effective dose equivalent of 5 rem is listed in parentheses under that organ name. The stochastic ALI is specified in parentheses because it is sometimes needed to show compliance when several radionuclides are present in the ingested material. If the ALI is based on the effective dose equivalent, then only that value is listed, with no other information.

Column (2) in Table (1) is calculated in the same manner as that used for Column (1), except that the intake is by inhalation of airborne material rather than ingestion. The methods of calculation are the same, but the dosimetric models are those for inhalation rather than for ingestion. In addition, inhaled material is classified into one of three classes, called D, W, or Y, depending on how rapidly the material is cleared from the lungs after it is inhaled. Class D is cleared most rapidly, within a matter of days, and Class Y is cleared most slowly, within months or years. Class W is intermediate. The same radionuclide may exist in one or more classes depending on its chemical and physical characteristics. For example, uranium as a fluoride is a Class D material, but some of its oxide forms are Class W, and other oxide forms are Class Y. Licensees should make a concerted effort to accurately classify the airborne material present at their sites because such classification will determine the ALI and the dose received by a worker following an intake.

The first step in classification is to know the chemical form of the airborne radioactive material. With that knowledge, the licensee may refer to the listing in Appendix B, which specifies the classification of the most frequently encountered compounds of each radionuclide. If the specific

compound is not listed, then other references may be used, such as the tabulations by the ICRP. See Reference {1} listed below.

Note also that the values of the ALI are based on the assumption that the airborne radioactive material is in the form of particles with an activity median aerodynamic diameter of 1 micrometer, or micron. If the median particle size on site is known and is substantially different from 1 micron, for example 5 microns, then the ALIs may be adjusted accordingly, but only after obtaining approval from NRC. The method of adjustment is described in References {1} and {2}, listed below. If the particle size is not known, then 1 micron is assumed.

The values in Column (3), Table (1), the derived air concentrations (DACs), are calculated directly from Column (2) by dividing the respective ALIs by the breathing rate of a standard person (1.2 m^3/hr) and the number of working hours per year, taken to be 2,000 hr/yr. Exceptions to this method are those airborne radionuclides that pose an external rather than an internal hazard, and for which ALIs are not given, such as the isotopes of xenon and krypton. In such cases, the DACs are calculated directly from the external doses, assuming immersion in a semi-infinite cloud of the gas.

The values in Table (2) differ from those in Table (1) in two major respects: they do not include values that are based on non-stochastic radiation effects, because the public dose limits are so low that such effects are no longer of concern; and they are based on a stochastic dose limit of 100 mrem/yr effective dose equivalent rather than 5 rem/yr. The concentrations in Column (1) of Table (2) were obtained by dividing the stochastic ALIs in Table (1) by the breathing rate of 2,400 m^3/yr, then dividing by 3 to take into account the fact that members of the public breathe the air 24 hours per day all year, rather than 8 hr/day during work days, as is assumed for occupational exposure, and also to adjust for differences in inhalation rates between persons at work and members of the public. The result is then divided by 50 to adjust the values from a dose limit of 5,000 mrem/yr to 100 mrem/yr. Because the occupational ALIs were calculated for healthy adult workers, but members of the public include groups that may be of varying health conditions as well as children, the results are again divided by a safety factor of 2 to allow for this effect.

In the case of radionuclides that pose an external hazard, the concentrations in Column (1) of Table (2) were obtained by adjusting the occupational DACs in Table (1) for the difference in dose limits, that is, by dividing by a factor of 50, and then adjusting for differences in exposure duration from 8 hours per day during work days to 24 hours per day every day.

The concentrations for liquid effluents in Column (2) of Table (2) were obtained by using the most restrictive value in Column (1) of Table (1) and then adjusting it in the same manner as that used to adjust the air values.

The monthly average concentrations in Table (3) were obtained by assuming that a person obtains all of his water from the licensee's sewer outfall, and then calculating the average concentration that would result in an annual ingestion dose of 500 mrem. Averaging the

concentrations over a month rather than a year avoids excessive short-term peak discharges by seasonal discharges.

References:

1. International Commission on Radiological Protection, Publication 30 and addenda, Pergamon Press, Fairview Park, Elmsford, NY 10523
2. NRC Regulatory Guide 8.9, Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program.

Appendix C

Quantities of Licensed Material Requiring Labeling

Statement of Requirement:

Table C.1. Appendix C to Part 20 – Quantities[1] of Licensed Material Requiring Labeling

Radionuclide	Abbreviation	Quantity (μCi)
Hydrogen-3	H-3	1,000
Beryllium-7	Be-7	1,000
Beryllium-10	Be-10	1
Carbon-11	C-11	1,000
Carbon-14	C-14	100
Fluorine-18	F-18	1,000
Sodium-22	Na-22	10
Sodium-24	Na-24	100
Magnesium-28	Mg-28	100
Aluminum-26	Al-26	10
Silicon-31	Si-31	1,000
Silicon-32	Si-32	1
Phosphorus-32	P-32	10
Phosphorus-33	P-33	100
Sulfur-35	S-35	100
Chlorine-36	Cl-36	10
Chlorine-38	Cl-38	1,000
Chlorine-39	Cl-39	1,000
Argon-39	Ar-39	1,000
Argon-41	Ar-41	1,000

[1] The quantities listed above were derived by taking $^{1}/_{10}$th 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 μCi. Values of 100 μCi have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years (except rhenium, 1,000 μCi) to take into account their low specific activity.

Radionuclide	Abbreviation	Quantity (µCi)
Potassium-40	K-40	100
Potassium-42	K-42	1,000
Potassium-43	K-43	1,000
Potassium-44	K-44	1,000
Potassium-45	K-45	1,000
Calcium-41	Ca-41	100
Calcium-45	Ca-45	100
Calcium-47	Ca-47	100
Scandium-43	Sc-43	1,000
Scandium-44m	Sc-44m	100
Scandium-44	Sc-44	100
Scandium-46	Sc-46	10
Scandium-47	Sc-47	100
Scandium-48	Sc-48	100
Scandium-49	Sc-49	1,000
Titanium-44	Ti-44	1
Titanium-45	Ti-45	1,000
Vanadium-47	V-47	1,000
Vanadium-48	V-48	100
Vanadium-49	V-49	1,000
Chromium-48	Cr-48	1,000
Chromium-49	Cr-49	1,000
Chromium-51	Cr-51	1,000
Manganese-51	Mn-51	1,000
Manganese-52m	Mn-52m	1,000
Manganese-52	Mn-52	100

Radionuclide	Abbreviation	Quantity (µCi)
Manganese-53	Mn-53	1,000
Manganese-54	Mn-54	100
Manganese-56	Mn-56	1,000
Iron-52	Fe-52	100
Iron-55	Fe-55	100
Iron-59	Fe-59	10
Iron-60	Fe-60	1
Cobalt-55	Co-55	100
Cobalt-56	Co-56	10
Cobalt-57	Co-57	100
Cobalt-58m	Co-58m	1,000
Cobalt-58	Co-58	100
Cobalt-60m	Co-60m	1,000
Cobalt-60	Co-60	1
Cobalt-61	Co-61	1,000
Cobalt-62m	Co-62m	1,000
Nickel-56	Ni-56	100
Nickel-57	Ni-57	100
Nickel-59	Ni-59	100
Nickel-63	Ni-63	100
Nickel-65	Ni-65	1,000
Nickel-66	Ni-66	10
Copper-60	Cu-60	1,000
Copper-61	Cu-61	1,000
Copper-64	Cu-64	1,000
Copper-67	Cu-67	1,000

Radionuclide	Abbreviation	Quantity (μCi)
Zinc-62	Zn-62	100
Zinc-63	Zn-63	1,000
Zinc-65	Zn-65	10
Zinc-69m	Zn-69m	100
Zinc-69	Zn-69	1,000
Zinc-71m	Zn-71m	1,000
Zinc-72	Zn-72	100
Gallium-65	Ga-65	1,000
Gallium-66	Ga-66	100
Gallium-67	Ga-67	1,000
Gallium-68	Ga-68	1,000
Gallium-70	Ga-70	1,000
Gallium-72	Ga-72	100
Gallium-73	Ga-73	1,000
Germanium-66	Ge-66	1,000
Germanium-67	Ge-67	1,000
Germanium-68	Ge-68	10
Germanium-69	Ge-69	1,000
Germanium-71	Ge-71	1,000
Germanium-75	Ge-75	1,000
Germanium-77	Ge-77	1,000
Germanium-78	Ge-78	1,000
Arsenic-69	As-69	1,000
Arsenic-70	As-70	1,000
Arsenic-71	As-71	100
Arsenic-72	As-72	100

Radionuclide	Abbreviation	Quantity (µCi)
Arsenic-73	As-73	100
Arsenic-74	As-74	100
Arsenic-76	As-76	100
Arsenic-77	As-77	100
Arsenic-78	As-78	1,000
Selenium-70	Se-70	1,000
Selenium-73m	Se-73m	1,000
Selenium-73	Se-73	100
Selenium-75	Se-75	100
Selenium-79	Se-79	100
Selenium-81m	Se-81m	1,000
Selenium-81	Se-81	1,000
Selenium-83	Se-83	1,000
Bromine-74m	Br-74m	1,000
Bromine-74	Br-74	1,000
Bromine-75	Br-75	1,000
Bromine-76	Br-76	100
Bromine-77	Br-77	1,000
Bromine-80m	Br-80m	1,000
Bromine-80	Br-80	1,000
Bromine-82	Br-82	100
Bromine-83	Br-83	1,000
Bromine-84	Br-84	1,000
Krypton-74	Kr-74	1,000
Krypton-76	Kr-76	1,000
Krypton-77	Kr-77	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Krypton-79	Kr-79	1,000
Krypton-81	Kr-81	1,000
Krypton-83m	Kr-83m	1,000
Krypton-85m	Kr-85m	1,000
Krypton-85	Kr-85	1,000
Krypton-87	Kr-87	1,000
Krypton-88	Kr-88	1,000
Rubidium-79	Rb-79	1,000
Rubidium-81m	Rb-81m	1,000
Rubidium-81	Rb-81	1,000
Rubidium-82m	Rb-82m	1,000
Rubidium-83	Rb-83	100
Rubidium-84	Rb-84	100
Rubidium-86	Rb-86	100
Rubidium-87	Rb-87	100
Rubidium-88	Rb-88	1,000
Rubidium-89	Rb-89	1,000
Strontium-80	Sr-80	100
Strontium-81	Sr-81	1,000
Strontium-83	Sr-83	100
Strontium-85m	Sr-85m	1,000
Strontium-85	Sr-85	100
Strontium-87m	Sr-87m	1,000
Strontium-89	Sr-89	10
Strontium-90	Sr-90	0.1
Strontium-91	Sr-91	100

Radionuclide	Abbreviation	Quantity (µCi)
Strontium-92	Sr-92	100
Yttrium-86m	Y-86m	1,000
Yttrium-86	Y-86	100
Yttrium-87	Y-87	100
Yttrium-88	Y-88	10
Yttrium-90m	Y-90m	1,000
Yttrium-90	Y-90	10
Yttrium-91m	Y-91m	1,000
Yttrium-91	Y-91	10
Yttrium-92	Y-92	100
Yttrium-93	Y-93	100
Yttrium-94	Y-94	1,000
Yttrium-95	Y-95	1,000
Zirconium-86	Zr-86	100
Zirconium-88	Zr-88	10
Zirconium-89	Zr-89	100
Zirconium-93	Zr-93	1
Zirconium-95	Zr-95	10
Zirconium-97	Zr-97	100
Niobium-88	Nb-88	1,000
Niobium-89m (66 min)	Nb-89m	1,000
Niobium-89 (122 min)	Nb-89	1,000
Niobium-90	Nb-90	100
Niobium-93m	Nb-93m	10
Niobium-94	Nb-94	1
Niobium-95m	Nb-95m	100

Radionuclide	Abbreviation	Quantity (µCi)
Niobium-95	Nb-95	100
Niobium-96	Nb-96	100
Niobium-97	Nb-97	1,000
Niobium-98	Nb-98	1,000
Molybdenum-90	Mo-90	100
Molybdenum-93m	Mo-93m	100
Molybdenum-93	Mo-93	10
Molybdenum-99	Mo-99	100
Molybdenum-101	Mo-101	1,000
Technetium-93m	Tc-93m	1,000
Technetium-93	Tc-93	1,000
Technetium-94m	Tc-94m	1,000
Technetium-94	Tc-94	1,000
Technetium-96m	Tc-96	1,000
Technetium-96	Tc-96	100
Technetium-97m	Tc-97m	100
Technetium-97	Tc-97	1,000
Technetium-98	Tc-98	10
Technetium-99m	Tc-99m	1,000
Technetium-99	Tc-99	100
Technetium-101	Tc-101	1,000
Technetium-104	Tc-104	1,000
Ruthenium-94	Ru-94	1,000
Ruthenium-97	Ru-97	1,000
Ruthenium-103	Ru-103	100
Ruthenium-105	Ru-105	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Ruthenium-106	Ru-106	1
Rhodium-99m	Rh-99m	1,000
Rhodium-99	Rh-99	100
Rhodium-100	Rh-100	100
Rhodium-101m	Rh-101m	1,000
Rhodium-101	Rh-101	10
Rhodium-102m	Rh-102m	10
Rhodium-102	Rh-102	10
Rhodium-103m	Rh-103m	1,000
Rhodium-105	Rh-105	100
Rhodium-106m	Rh-106m	1,000
Rhodium-107	Rh-107	1,000
Palladium-100	Pd-100	100
Palladium-101	Pd-101	1,000
Palladium-103	Pd-103	100
Palladium-107	Pd-107	10
Palladium-109	Pd-109	100
Silver-102	Ag-102	1,000
Silver-103	Ag-103	1,000
Silver-104m	Ag-104m	1,000
Silver-104	Ag-104	1,000
Silver-105	Ag-105	100
Silver-106m	Ag-106m	100
Silver-106	Ag-106	1,000
Silver-108m	Ag-108m	1
Silver-110m	Ag-110m	10

Radionuclide	Abbreviation	Quantity (µCi)
Silver-111	Ag-111	100
Silver-112	Ag-112	100
Silver-115	Ag-115	1,000
Cadmium-104	Cd-104	1,000
Cadmium-107	Cd-107	1,000
Cadmium-109	Cd-109	1
Cadmium-113m	Cd-113m	0.1
Cadmium-113	Cd-113	100
Cadmium-115m	Cd-115m	10
Cadmium-115	Cd-115	100
Cadmium-117m	Cd-117m	1,000
Cadmium-117	Cd-117	1,000
Indium-109	In-109	1,000
Indium-110 (69.1 min.)	In-110	1,000
Indium-110 (4.9h)	In-110	1,000
Indium-111	In-111	100
Indium-112	In-112	1,000
Indium-113m	In-113m	1,000
Indium-114m	In-114m	10
Indium-115m	In-115m	1,000
Indium-115	In-115	100
Indium-116m	In-116m	1,000
Indium-117m	In-117m	1,000
Indium-117	In-117	1,000
Indium-119m	In-119m	1,000
Tin-110	Sn-110	100

Radionuclide	Abbreviation	Quantity (µCi)
Tin-111	Sn-111	1,000
Tin-113	Sn-113	100
Tin-117m	Sn-117m	100
Tin-119m	Sn-119m	100
Tin-121m	Sn-121m	100
Tin-121	Sn-121	1,000
Tin-123m	Sn-123m	1,000
Tin-123	Sn-123	10
Tin-125	Sn-125	10
Tin-126	Sn-126	10
Tin-127	Sn-127	1,000
Tin-128	Sn-128	1,000
Antimony-115	Sb-115	1,000
Antimony-116m	Sb-116m	1,000
Antimony-116	Sb-116	1,000
Antimony-117	Sb-117	1,000
Antimony-118m	Ab-118m	1,000
Antimony-119	Ab-119	1,000
Antimony-120 (16 min.)	Ab-120	1,000
Antimony-120 (5.76d)	Ab-120	100
Antimony-122	Ab-122	100
Antimony-124m	Ab-124m	1,000
Antimony-124	Ab-124	10
Antimony-125	Ab-125	100
Antimony-126m	Ab-126m	1,000
Antimony-126	Ab-126	100

Radionuclide	Abbreviation	Quantity (µCi)
Antimony-127	Ab-127	100
Antimony-128 (10.4 min.)	Ab-128	1,000
Antimony-128 (9.01h)	Ab-128	100
Antimony-129	Ab-129	100
Antimony-130	Ab-130	1,000
Antimony-131	Ab-131	1,000
Tellurium-116	Te-116	1,000
Tellurium-121m	Te-121m	10
Tellurium-121	Te-121	100
Tellurium-123m	Te-123m	10
Tellurium-123	Te-123	100
Tellurium-125m	Te-125m	10
Tellurium-127m	Te-127m	10
Tellurium-127	Te-127	1,000
Tellurium-129m	Te-129m	10
Tellurium-129	Te-129	1,000
Tellurium-131m	Te-131m	10
Tellurium-131	Te-131	100
Tellurium-132	Te-132	10
Tellurium-133m	Te-133m	100
Tellurium-133	Te-133	1,000
Tellurium-134	Te-134	1,000
Iodine-120m	I-120m	1,000
Iodine-120	I-120	100
Iodine-121	I-121	1,000
Iodine-123	I-123	100

Radionuclide	Abbreviation	Quantity (µCi)
Iodine-124	I-124	10
Iodine-125	I-125	1
Iodine-126	I-126	1
Iodine-128	I-128	1,000
Iodine-129	I-129	1
Iodine-130	I-130	10
Iodine-131	I-131	1
Iodine-132m	I-132m	100
Iodine-132	I-132	100
Iodine-133	I-133	10
Iodine-134	I-134	1,000
Iodine-135	I-135	100
Xenon-120	Xe-120	1,000
Xenon-121	Xe-121	1,000
Xenon-122	Xe-122	1,000
Xenon-123	Xe-123	1,000
Xenon-125	Xe-125	1,000
Xenon-127	Xe-127	1,000
Xenon-129m	Xe-129m	1,000
Xenon-131m	Xe-131m	1,000
Xenon-133m	Xe-133m	1,000
Xenon-133	Xe-133	1,000
Xenon-135m	Xe-135m	1,000
Xenon-135	Xe-135	1,000
Xenon-138	Xe-138	1,000
Cesium-125	Cs-125	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Cesium-127	Cs-127	1,000
Cesium-129	Cs-129	1,000
Cesium-130	Cs-130	1,000
Cesium-131	Cs-131	1,000
Cesium-132	Cs-132	100
Cesium-134m	Cs-134m	1,000
Cesium-134	Cs-134	10
Cesium-135m	Cs-135m	1,000
Cesium-135	Cs-135	100
Cesium-136	Cs-136	10
Cesium-137	Cs-137	10
Cesium-138	Cs-138	1,000
Barium-126	Ba-126	1,000
Barium-128	B-128	100
Barium-131m	Ba-131m	1,000
Barium-131	Ba-131	100
Barium-133m	Ba-133m	100
Barium-133	Ba-133	100
Barium-135m	Ba-135m	100
Barium-139	Ba-139	1,000
Barium-140	Ba-140	100
Barium-141	Ba-141	1,000
Barium-142	Ba-142	1,000
Lanthanum-131	La-131	1,000
Lanthanum-132	La-132	100
Lanthanum-135	La-135	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Lanthanum-137	La-137	10
Lanthanum-138	La-138	100
Lanthanum-140	La-140	100
Lanthanum-141	La-141	100
Lanthanum-142	La-142	1,000
Lanthanum-143	La-143	1,000
Cerium-134	Ce-134	100
Cerium-135	Ce-135	100
Cerium-137m	Ce-137m	100
Cerium-137	Ce-137	1,000
Cerium-139	Ce-139	100
Cerium-141	Ce-141	100
Cerium-143	Ce-143	100
Cerium-144	Ce-144	1
Praseodymium-136	Pr-136	1,000
Praseodymium-137	Pr-137	1,000
Praseodymium-138m	Pe-138m	1,000
Praseodymium-139	Pe-139	1,000
Praseodymium-142m	Pe-142m	1,000
Praseodymium-142	Pe-142	100
Praseodymium-143	Pe-143	100
Praseodymium-144	Pe-144	1,000
Praseodymium-145	Pe-145	100
Praseodymium-147	Pe-147	1,000
Neodymium-136	Nd-136	1,000
Neodymium-138	Nd-138	100

Radionuclide	Abbreviation	Quantity (µCi)
Neodymium-139m	Nd-139m	1,000
Neodymium-139	Nd-139	1,000
Neodymium-141	Nd-141	1,000
Neodymium-147	Nd-147	100
Neodymium-149	Nd-149	1,000
Neodymium-151	Nd-151	1,000
Promethium-141	Pm-141	1,000
Promethium-143	Pm-143	100
Promethium-144	Pm-144	10
Promethium-145	Pm-145	10
Promethium-146	Pm-146	1
Promethium-147	Pm-147	10
Promethium-148m	Pm-148m	10
Promethium-148	Pm-148	10
Promethium-149	Pm-149	100
Promethium-150	Pm-150	1,000
Promethium-151	Pm-151	100
Samarium-141m	Sm-141m	1,000
Samarium-141	Sm-141	1,000
Samarium-142	Sm-142	1,000
Samarium-145	Sm-145	100
Samarium-146	Sm-146	1
Samarium-147	Sm-147	100
Samarium-151	Sm-151	10
Samarium-153	Sm-153	100
Samarium-155	Sm-155	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Samarium-156	Sm-156	1,000
Europium-145	Eu-145	100
Europium-146	Eu-146	100
Europium-147	Eu-147	100
Europium-148	Eu-148	10
Europium-149	Eu-149	100
Europium-150 (12.62h)	Eu-150	100
Europium-150 (34.2y)	Eu-150	1
Europium-152m	Eu-152m	100
Europium-152	Eu-152	1
Europium-154	Eu-154	1
Europium-155	Eu-155	10
Europium-156	Eu-156	100
Europium-157	Eu-157	100
Europium-158	Eu-158	1,000
Gadolinium-145	Gd-145	1,000
Gadolinium-146	Gd-146	10
Gadolinium-147	Gd-147	100
Gadolinium-148	Gd-148	0.001
Gadolinium-149	Gd-149	100
Gadolinium-151	Gd-151	10
Gadolinium-152	Gd-152	100
Gadolinium-153	Gd-153	10
Gadolinium-159	Gd-159	100
Terbium-147	Tb-147	1,000
Terbium-149	Tb-149	100

Radionuclide	Abbreviation	Quantity (µCi)
Terbium-150	Tb-150	1,000
Terbium-151	Tb-151	100
Terbium-153	Tb-153	1,000
Terbium-154	Tb-154	100
Terbium-155	Tb-155	1,000
Terbium-156m (5.0h)	Tb-156m	1,000
Terbium-156m (24.4h)	Tb-156m	1,000
Terbium-156	Tb-156	100
Terbium-157	Tb-157	10
Terbium-158	Tb-158	1
Terbium-160	Tb-160	10
Terbium-161	Tb-161	100
Dysprosium-155	Dy-155	1,000
Dysprosium-157	Dy-157	1,000
Dysprosium-159	Dy-159	100
Dysprosium-165	Dy-165	1,000
Dysprosium-166	Dy-166	100
Holmium-155	Ho-155	1,000
Holmium-157	Ho-157	1,000
Holmium-159	Ho-159	1,000
Holmium-161	Ho-161	1,000
Holmium-162m	Ho-162m	1,000
Holmium-162	Ho-162	1,000
Holmium-164m	Hp-164m	1,000
Holmium-164	Ho-164	1,000
Holmium-166m	Ho-166m	1

Radionuclide	Abbreviation	Quantity (µCi)
Holmium-166	Ho-166	100
Holmium-167	Ho-167	1,000
Erbium-161	Er-161	1,000
Erbium-165	Er-165	1,000
Erbium-169	Er-169	100
Erbium-171	Er-171	100
Erbium-172	Er-172	100
Thulium-162	Tm-162	1,000
Thulium-166	Tm-166	100
Thulium-167	Tm-167	100
Thulium-170	Tm-170	10
Thulium-171	Tm-171	10
Thulium-172	Tm-172	100
Thulium-173	Tm-173	100
Thulium-175	Tm-175	1,000
Ytterbium-162	Yb-162	1,000
Ytterbium-166	Yb-166	100
Ytterbium-167	Yb-167	1,000
Ytterbium-169	Yb-169	100
Ytterbium-175	Yb-175	100
Ytterbium-177	Yb-177	1,000
Ytterbium-178	Yb-178	1,000
Lutetium-169	Lu-169	100
Lutetium-170	Lu-170	100
Lutetium-171	Lu-171	100
Lutetium-172	Lu-172	100

Radionuclide	Abbreviation	Quantity (µCi)
Lutetium-173	Lu-173	10
Lutetium-174m	Lu-174m	10
Lutetium-174	Lu-174	10
Lutetium-176m	Lu-176m	1,000
Lutetium-176	Lu-176	100
Lutetium-177m	Lu-177m	10
Lutetium-177	Lu-177	100
Lutetium-178m	Lu-178m	1,000
Lutetium-178	Lu-178	1,000
Lutetium-179	Lu-179	1,000
Hafnium-170	Hf-170	100
Hafnium-172	Hf-172	1
Hafnium-173	Hf-173	1,000
Hafnium-175	Hf-175	100
Hafnium-177m	Hf-177m	1,000
Hafnium-178m	Hf-178m	0.1
Hafnium-179m	Hf-179m	10
Hafnium-180m	Hf-180m	1,000
Hafnium-181	Hf-181	10
Hafnium-182m	Hf-182m	1,000
Hafnium-182	Hf-182	0.1
Hafnium-183	Hf-183	1,000
Hafnium-184	Hf-184	100
Tantalum-172	Ta-172	1,000
Tantalum-173	Ta-173	1,000
Tantalum-174	Ta-174	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Tantalum-175	Ta-175	1,000
Tantalum-176	Ta-176	100
Tantalum-177	Ta-177	1,000
Tantalum-178	Ta-178	1,000
Tantalum-179	Ta-179	100
Tantalum-180m	Ta-180m	1,000
Tantalum-180	Ta-180	100
Tantalum-182m	Ta-182m	1,000
Tantalum-182	Ta-182	10
Tantalum-183	Ta-183	100
Tantalum-184	Ta-184	100
Tantalum-185	Ta-185	1,000
Tantalum-186	Ta-186	1,000
Tungsten-176	W-176	1,000
Tungsten-177	W-177	1,000
Tungsten-178	W-178	1,000
Tungsten-179	W-179	1,000
Tungsten-181	W-181	1,000
Tungsten-185	W-185	100
Tungsten-187	W-187	100
Tungsten-188	W-188	10
Rhenium-177	Re-177	1,000
Rhenium-178	Re-178	1,000
Rhenium-181	Re-181	1,000
Rhenium-182 (12.7h)	Re-182	1,000
Rhenium-182 (64.0h)	Re-182	100

Radionuclide	Abbreviation	Quantity (μCi)
Rhenium-184m	Re-184m	10
Rhenium-184	Re-184	100
Rhenium-186m	Re-186m	10
Rhenium-186	Re-186	100
Rhenium-187	Re-187	1,000
Rhenium-188m	Re-188m	1,000
Rhenium-188	Re-188	100
Rhenium-189	Re-189	100
Osmium-180	Os-180	1,000
Osmium-181	Os-181	1,000
Osmium-182	Os-182	100
Osmium-185	Os-185	100
Osmium-189m	Os-189m	1,000
Osmium-191m	Os-191m	1,000
Osmium-191	Os-191	100
Osmium-193	Os-193	100
Osmium-194	Os-194	1
Iridium-182	Ir-182	1,000
Iridium-184	Ir-184	1,000
Iridium-185	Ir-185	1,000
Iridium-186	Ir-186	100
Iridium-187	Ir-187	1,000
Iridium-188	Ir-188	100
Iridium-189	Ir-189	100
Iridium-190m	Ir-190m	1,000
Iridium-190	Ir-190	100

Radionuclide	Abbreviation	Quantity (µCi)
Iridium-192 (73.8d)	Ir-192	1
Iridium-192m (1.4 min.)	Ir-192m	10
Iridium-194m	Ir-194m	10
Iridium-194	Ir-194	100
Iridium-195m	Ir-195m	1,000
Iridium-195	Ir-95	1,000
Platinum-186	Pt-186	1,000
Platinum-188	Pt-188	100
Platinum-189	Pt-189	1,000
Platinum-191	Pt-191	100
Platinum-193m	Pt-193m	100
Platinum-193	Pt-193	1,000
Platinum-195m	Pt-195m	100
Platinum-197m	Pt-197m	1,000
Platinum-197	Pt-197	100
Platinum-199	Pt-199	1,000
Platinum-200	Pt-200	100
Gold-193	Au-193	1,000
Gold-194	Au-194	100
Gold-195	Au-195	10
Gold-198m	Au-198m	100
Gold-198	Au-198	100
Gold-199	Au-199	100
Gold-200m	Au-200m	100
Gold-200	Au-200	1,000
Gold-201	Au-201	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Mercury-193m	Hg-193m	100
Mercury-193	Hg-193	1,000
Mercury-194	Hg-194	1
Mercury-195m	Hg-195m	100
Mercury-195	Hg-195	1,000
Mercury-197m	Hg-197m	100
Mercury-197	Hg-197	1,000
Mercury-199m	Hg-199m	1,000
Mercury-203	Hg-203	100
Thallium-194m	Tl-194m	1,000
Thallium-194	Tl-194	1,000
Thallium-195	Tl-195	1,000
Thallium-197	Tl-197	1,000
Thallium-198m	Tl-198m	1,000
Thallium-198	Tl-198	1,000
Thallium-199	Tl-199	1,000
Thallium-200	Tl-200	1,000
Thallium-201	Tl-201	1,000
Thallium-202	Tl-202	100
Thallium-204	Tl-204	100
Lead-195m	Pb-195m	1,000
Lead-198	Pb-198	1,000
Lead-199	Pb-199	1,000
Lead-200	Pb-200	100
Lead-201	Pb-201	1,000
Lead-202m	Pb-202m	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Lead-202	Pb-202	10
Lead-203	Pb-2023	1,000
Lead-205	Pb-205	100
Lead-209	Pb-209	1,000
Lead-210	Pb-210	0.01
Lead-211	Pb-211	100
Lead-212	Pb-212	1
Lead-214	Pb-214	100
Bismuth-200	Bi-200	1,000
Bismuth-201	Bi-201	1,000
Bismuth-202	Bi-202	1,000
Bismuth-203	Bi-203	100
Bismuth-205	Bi-205	100
Bismuth-206	Bi-206	100
Bismuth-207	Bi-207	10
Bismuth-210m	Bi-210m	0.1
Bismuth-210	Bi-210	1
Bismuth-212	Bi-212	10
Bismuth-213	Bi-213	10
Bismuth-214	Bi-214	100
Polonium-203	Po-203	1,000
Polonium-205	Po-205	1,000
Polonium-207	Po-207	1,000
Polonium-210	Po-210	0.1
Astatine-207	At-207	100
Astatine-211	At-211	10

Radionuclide	Abbreviation	Quantity (µCi)
Radon-220	Rn-220	1
Radon-222	Rn-222	1
Francium-222	Fr-222	100
Francium-223	Fr-223	100
Radium-223	Ra-223	0.1
Radium-224	Ra-224	0.1
Radium-225	Ra-225	0.1
Radium-226	Ra-226	0.1
Radium-227	Ra-227	1,000
Radium-228	Ra-228	0.1
Actinium-224	Ac-224	1
Actinium-225	Ac-225	0.01
Actinium-226	Ac-226	0.1
Actinium-227	Ac-227	0.001
Actinium-228	Ac-228	1
Thorium-226	Th-226	10
Thorium-227	Th-227	0.01
Thorium-228	Th-228	0.001
Thorium-229	Th-229	0.001
Thorium-230	Th-230	0.001
Thorium-231	Th-231	100
Thorium-232	Th-232	100
Thorium-234	Th-234	10
Thorium-natural		100
Protactinium-227	Pa-227	10
Protactinium-228	Pa-228	1

Radionuclide	Abbreviation	Quantity (µCi)
Protactinium-230	Pa-230	0.01
Protactinium-231	Pa-231	0.001
Protactinium-232	Pa-232	1
Protactinium-233	Pa-233	100
Protactinium-234	Pa-234	100
Uranium-230	U-230	0.01
Uranium-231	U-231	100
Uranium-232	U-232	0.001
Uranium-233	U-233	0.001
Uranium-234	U-234	0.001
Uranium-235	U-235	0.001
Uranium-236	U-236	0.001
Uranium-237	U-237	100
Uranium-238	U-238	100
Uranium-239	U-239	1,000
Uranium-240	U-240	100
Uranium-natural		100
Neptunium-232	Np-232	100
Neptunium-233	Np-233	1,000
Neptunium-234	Np-234	100
Neptunium-235	Np-235	100
Neptunium-236 (1.15×10^5y)	Np-236	0.001
Neptunium-236 (22.5h)	Np-236	1
Neptunium-237	Np-237	0.001
Neptunium-238	Np-238	10
Neptunium-239	Np-239	100

Radionuclide	Abbreviation	Quantity (μCi)
Neptunium-240	Np-240	1,000
Plutonium-234	Pu-234	10
Plutonium-235	Pu-235	1,000
Plutonium-236	Pu-236	0.001
Plutonium-237	Pu-237	100
Plutonium-238	Pu-238	0.001
Plutonium-239	Pu-239	0.001
Plutonium-240	Pu-240	0.001
Plutonium-241	Pu-241	0.01
Plutonium-242	Pu-242	0.001
Plutonium-243	Pu-243	1,000
Plutonium-244	Pu-244	0.001
Plutonium-245	Pu-245	100
Americium-237	Am-237	1,000
Americium-238	Am-238	100
Americium-239	Am-239	1,000
Americium-240	Am-240	100
Americium-241	Am-241	0.001
Americium-242m	Am-242m	0.001
Americium-242	Am-242	10
Americium-243	Am-243	0.001
Americium-244m	Am-244m	100
Americium-244	Am-244	10
Americium-245	Am-245	1,000
Americium-246m	Am-246	1,000
Americium-246	Am-246	1,000

Radionuclide	Abbreviation	Quantity (µCi)
Curium-238	Cm-238	100
Curium-240	Cm-240	0.1
Curium-241	Cm-241	1
Curium-242	Cm-242	0.01
Curium-243	Cm-243	0.001
Curium-244	Cm-244	0.001
Curium-245	Cm-245	0.001
Curium-246	Cm-246	0.001
Curium-247	Cm-247	0.001
Curium-248	Cm-248	0.001
Curium-249	Cm-249	1,000
Berkelium-245	Bk-245	100
Berkelium-246	Bk-246	100
Berkelium-247	Bk-247	0.001
Berkelium-249	Bk-249	0.1
Berkelium-250	Bk-250	10
Californium-244	Cf-244	100
Californium-246	Cf-246	1
Californium-248	Cf-248	0.01
Californium-249	Cf-249	0.001
Californium-250	Cf-250	0.001
Californium-251	Cf-251	0.001
Californium-252	Cf-252	0.001
Californium-253	Cf-253	0.1
Californium-254	Cf-254	0.001

Radionuclide	Abbreviation	Quantity (μCi)
Any alpha emitting radionuclide not listed above or mixtures or alpha emitters of unknown composition		0.001
Einsteinium-250	Es-250	100
Einsteinium-251	Es-251	100
Einsteinium-253	Es-253	0.1
Einsteinium-254m	Es-254m	1
Einsteinium-254	Es-254	0.01
Fermium-252	Fm-252	1
Fermium-253	Fm-253	1
Fermium-254	Fm-254	10
Fermium-255	Fm-255	1
Fermium-257	Fm-257	0.01
Mendelevium-257	Md-257	10
Mendelevium-258	Md-258	0.01
Any radionuclide other than alpha emitter radionuclides not listed above, or mixtures of beta emitters of unknown composition		0.01

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").

Discussion:

Appendix C to Part 20 is a listing of the quantities of licensed material requiring posting pursuant to §20.1902 or exempt from labeling pursuant to §20.1905. These quantities of licensed material are considered to present a minimal radiological hazard. The quantities listed in Appendix C were derived by taking one-tenth of the most restrictive, occupational, annual limit of intake listed in Appendix B, rounding to the nearest factor of ten, and arbitrarily constraining the values listed between 0.001 and 1,000 microcuries (37 and 3.7×10^7 Bq).

Appendix D

United States Nuclear Regulatory Commission Regional Offices

Statement of Requirement:

Table D.1. Appendix D to Part 20 – 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.	(610) 337-5000 **(800) 432-1156**
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	USNRC, Region II, Atlanta Federal Center, 61 Forsyth Street, SW., Suite 23T85, Atlanta, GA 30303.	(404) 562-4400 **(800) 577-8510**
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	USNRC, Region III, 801 Warrenville Road, Lisle, IL 60532-4351.	(708) 829-9500 **(800) 522-3025**
Region IV: Alaska, Arizona, Arkansas, California, Colorado, Hawaii, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, Wyoming, and the U.S. territories and possessions in the Pacific.	USNRC, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, TX 76011.	(817) 860-8100 **(800) 952-9677**

Discussion:
N/A.

Appendix E – F

RESERVED

Appendix G

Requirements for Transfers of Low-Level Radioactive Waste Intended for Disposal at Licensed Land Disposal Facilities and Manifests

Statement of Requirement:

I. Manifest

A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility must prepare a Manifest (OMB Control Numbers 3150-0164, -0165, and -0166) reflecting information requested on applicable NRC Forms 540 (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper)) and 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description)) and, if necessary, on an applicable NRC Form 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation)). NRC Forms 540 and 540A must be completed and must physically accompany the pertinent low-level waste shipment. Upon agreement between shipper and consignee, NRC Forms 541 and 541A and 542 and 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by NRC to comply with the manifesting requirements of this part when they ship:

(a) LLW for processing and expect its return (i.e., for storage under their license) prior to disposal at a licensed land disposal facility;

(b) LLW that is being returned to the licensee who is the "waste generator" or "generator," as defined in this part; or

(c) Radioactively contaminated material to a "waste processor" that becomes the processor's "residual waste."

For guidance in completing these forms, refer to the instructions that accompany the forms.

Copies of manifests required by this appendix may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

NRC Forms 540, 540A, 541, 541A, 542 and 542A, and the accompanying instructions, in hard copy, may be obtained from the Information and Records Management Branch, Office of Information Resources Management, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 415-7232.

This appendix includes information requirements of the Department of Transportation, as codified in 49 CFR Part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency regulations, as codified in 40 CFR Parts 259, 261 or elsewhere, is not addressed in this section, and must be provided on the required EPA forms. However, the required EPA forms must accompany the Uniform Low-Level Radioactive Waste Manifest required by this chapter.

APPENDIX G

As used in this appendix, the following definitions apply:

Chelating agent has the same meaning as that given in §61.2 of this chapter.

Chemical description means a description of the principal chemical characteristics of a low-level radioactive waste.

Computer-readable medium means that the regulatory agency's computer can transfer the information from the medium into its memory.

Consignee means the designated receiver of the shipment of low-level radioactive waste.

Decontamination facility means a facility operating under a Commission or Agreement State license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this part, is not considered to be a consignee for LLW shipments.

Disposal container means a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility (also see "high integrity container"). Note that for some shipments, the disposal container may be the transport package.

EPA identification number means the number received by a transporter following application to the Administrator of EPA as required by 40 CFR Part 263.

Generator means a licensee operating under a Commission or Agreement State license who: (1) is a waste generator as defined in this part; or (2) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (e.g., waste generated as a result of decontamination or recycle activities).

High integrity container (HIC) means a container commonly designed to meet the structural stability requirements of §61.56 of this chapter, and to meet Department of Transportation requirements for a Type A package.

Land disposal facility has the same meaning as that given in §61.2 of this chapter.

NRC Forms 540, 540A, 541, 541A, 542, and 542A are official NRC Forms referenced in this appendix. Licensees need not use originals of these NRC Forms as long as any substitute forms are equivalent to the original documentation in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, NRC Forms 541 (and 541A) and NRC Forms 542 (and 542A) may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

Package means the assembly of components necessary to ensure compliance with the packaging requirements of DOT regulations, together with its radioactive contents, as presented for transport.

Physical description means the items called for on NRC Form 541 to describe a low-level radioactive waste.

Residual waste means low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

Shipper means the licensed entity (i.e., the waste generator, waste collector, or waste processor) who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

Shipping paper means NRC Form 540 and, if required, NRC Form 540A, which includes the information required by DOT in 49 CFR Part 172.

Source material has the same meaning as that given in §40.4 of this chapter.

Special nuclear material has the same meaning as that given in §70.4 of this chapter.

Uniform Low-Level Radioactive Waste Manifest or *uniform manifest* means the combination of NRC Forms 540, 541, and, if necessary, 542, and their respective continuation sheets as needed, or equivalent.

Waste collector means an entity, operating under a Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed land disposal facility.

Waste description means the physical, chemical and radiological description of a low-level radioactive waste as called for on NRC Form 541.

Waste generator means an entity, operating under a Commission or Agreement State license, who (1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use, and (2) transfers this material or component to a licensed land disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a "waste generator" if the transfer of low-level radioactive waste from its facility is defined as "residual waste."

Waste processor means an entity, operating under a Commission or Agreement State license, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive

material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste land disposal facility.

Waste type means a waste within a disposal container having a unique physical description (i.e., a specific waste descriptor code or description; or a waste sorbed on or solidified in a specifically defined media).

Information Requirements

A. General Information

The shipper of the radioactive waste shall provide the following information on the uniform manifest:

1. The name, facility address, and telephone number of the licensee shipping the waste;
2. An explicit declaration indicating whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and
3. The name, address, and telephone number, or the name and EPA identification number for the carrier transporting the waste.

B. Shipment Information

The shipper of the radioactive waste shall provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages/disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment;
5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in special nuclear material, and the total mass of uranium and thorium in source material.

C. Disposal Container and Waste Information

The shipper of the radioactive waste shall provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of any high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container shall be reported;
11. The total radioactivity within each container; and
12. For wastes consigned to a disposal facility, the classification of the waste pursuant to §61.55 of this chapter. Waste not meeting the structural stability requirements of §61.56(b) of this chapter must be identified.

D. Uncontainerized Waste Information

The shipper of the radioactive waste shall provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;

3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;
4. For waste consigned to a disposal facility, the classification of the waste pursuant to §61.55 of this chapter. Waste not meeting the structural stability requirements of §61.56(b) of this chapter must be identified;
5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

E. Multi-Generator Disposal Container Information

This section applies to disposal containers enclosing mixtures of waste originating from different generators. (***Note:*** The origin of the LLW resulting from a processor's activities may be attributable to one or more "generators" (including "waste generators") as defined in this part). It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.

1. For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.
2. For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:

   (a) The volume of waste within the disposal container;

   (b) A physical and chemical description of the waste, including the solidification agent, if any;

   (c) The total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;

   (d) The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in 10 CFR 61.56(b); and

   (e) Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material if contained in the waste.

II. Certification

An authorized representative of the waste generator, processor, or collector shall certify by signing and dating the shipment manifest 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. A collector in signing the certification is certifying that nothing has been done to the collected waste that would invalidate the waste generator's certification.

III. Control and Tracking

A. Any 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 9 of this section. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging shall comply with the requirements of Paragraphs A.4 through 9 of this section. A licensee shall:

1. Prepare all wastes so that the waste is classified according to §61.55 and meets the waste characteristics requirements in §61.56 of this chapter;
2. Label each disposal container (or transport package if potential radiation hazards preclude labeling of the individual disposal container) of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater then Class C waste, in accordance with §61.55 of this chapter;
3. Conduct a quality assurance program to assure compliance with §§61.55 and 61.56 of this chapter (the program must include management evaluation of audits);
4. Prepare the NRC Uniform Low-Level Radioactive Waste Manifest as required by this appendix;
5. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) receipt of the manifest precedes the LLW shipment; or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
6. Include NRC Form 540 (and NRC Form 540A, if required) with the shipment regardless of the option chosen in Paragraph A.5 of this section;
7. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;
8. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 10 CFR Parts 30, 40, and 70 of this chapter; and
9. 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 appendix, 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 shipper within one week of receipt by returning a signed copy of NRC Form 540;

2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this appendix. The waste collector shall ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;

3. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) Receipt of the manifest precedes the LLW shipment; or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;

4. Include NRC Form 540 (and NRC Form 540A, if required) with the shipment regardless of the option chosen in Paragraph B.3 of this section;

5. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;

6. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 10 CFR Parts 30, 40, and 70 of this chapter;

7. 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 appendix, conduct an investigation in accordance with Paragraph E of this appendix; and

8. Notify the shipper and the Administrator of the nearest Commission Regional Office listed in Appendix D of this part when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

C. Any licensed waste processor who treats or repackages waste shall:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of NRC Form 540;

2. Prepare a new manifest that meets the requirements of this appendix. Preparation of the new manifest reflects that the processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest shall identify the waste generators, the preprocessed waste volume, and the other information as required in Paragraph I.E. of this appendix;

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 assurance program to assure compliance with §§61.55 and 61.56 of this chapter (the program shall include management evaluation of audits);
6. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) Receipt of the manifest precedes the LLW shipment; or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
7. Include NRC Form 540 (and NRC Form 540A, if required) with the shipment regardless of the option chosen in Paragraph C.6 of this section;
8. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;
9. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 10 CFR Parts 30, 40, and 70 of this chapter;
10. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
11. Notify the shipper and the Administrator of the nearest Commission Regional Office listed in Appendix D of this part when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

D. The land disposal facility operator shall:

1. Acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of NRC Form 540 to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the Uniform Low-Level Radioactive Waste Manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating the discrepancy;
2. Maintain copies of all completed manifests and electronically store the information required by 10 CFR 61.80(l) until the Commission terminates the license; and
3. Notify the shipper and the Administrator of the nearest Commission Regional Office listed in Appendix D of this part when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

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.

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11. ABSTRACT *(200 words or less)*

This document, "Consolidated Guidance: 10 CFR Part 20 - Standards for Protection Against Radiation," consolidates guidance into a single comprehensive source by reference to numerous guidance documents. It complements the NUREG-1556 series, "Consolidated Guidance about Materials Licenses." Since Part 20 applies to all NRC licensees, in varying degrees, it extends beyond the materials scope of NUREG-1556. Each section in "Consolidated Guidance: 10 CFR Part 20 - Standards for Protection Against Radiation," provides the following:

o A statement of the requirement (reflecting revisions published in the Federal Register through October 13, 1999)
o A discussion of the requirement
o A statement of the requirement's applicability
o A guidance statement
o A list of existing regulatory guidance (Regulatory Guides, NUREG reports)
o A list of existing implementation guidance (Information Notices, health physics positions, Part 20 questions and answers, etc.).

"Consolidated Guidance: 10 CFR Part 20 - Standards for Protection Against Radiation," also identifies prior guidance, that is now outdated and in some cases subject to withdrawal or revision. Note that this document is strictly for public comment. It is not for use in preparing, reviewing, or implementing licenses until it is published in its final form.

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