ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 61

[FRL 3504-8]

National Emission Standards for Hazardous Air Pollutants; Regulation of Radionuclides

AGENCY: Environmental Protection Agency.

ACTION: Proposed rule and notice of public hearing.

SUMMARY: On December 8, 1987, the DC Circuit Court granted EPA's motion for a voluntary remand of all radionuclide National Emission Standards for Hazardous Air Pollutants (NESHAPs) and decisions not to regulate certain categories of radionuclide emissions that had been challenged in petitions for review (*EDF v. EPA*). The Court ordered EPA to propose its regulatory decisions for all radionuclide source categories within 180 days and to finalize them within 360 days. On March 17, 1988, the Court modified the order to require EPA to propose regulatory decisions by February 28, 1989 and take final action by August 31, 1989.

This notice presents the Administrator's reexamination of regulatory decisions and issues associated with the use of section 112 of the Clean Air Act to control the emission of radionuclides from the following source categories: DOE Facilities, Licensees of the Nuclear Regulatory Commission and Non-DOE Federal Facilities, Uranium Fuel Cycle Facilities, Elemental Phosphorus Plants, Coal-Fired Boilers, High-level Nuclear Waste Disposal Fecilities, Phosphogypsum Stacks, Underground and Surface Uranium Mines, and Licensed and Inactive Uranium Mill Tailings Piles. It proposes four policy alternatives that could be used in setting NESHAPs following the DC Circuit's decision in *NRDC* v. *EPA*, 824 F.2d 1146 (1987). The decisions that would result from application of each of the policy approaches to the radionuclide source categories are described and the resulting standards are proposed. Also included is a discussion of the issues raised by all the parties to the litigation that has surrounded these regulatory decisions.

Public hearings will be held to provide interested persons an opportunity for oral presentation of data, views, or arguments concerning these proposed actions.

DATES: *Comments.* Comments must be received on or before May 15, 1989.

Public Hearing. Public hearings will be held in Washington, DC on April 10 and 11, 1989 and in Las Vegas, Navada on April 13 and 14, 1989.

Request to Speak at Hearings. Persons wishing to present oral testimony should notify EPA by April 3, 1989.

ADDRESSES: Comments should be submitted (in duplicate if possible) to: Central Docket Section (A-130), Environmental Protection Agency, Attn: Docket No. A-79-11, Washington, DC 20460.

The rulemaking record is contained in Docket No. A-79-11. This docket is located in Room 4, South Conference Center, Central Docket Section, Environmental Protection Agency, 401 M Street SW., Washington, DC 20460. The docket may be inspected between 8 a.m. and 3 p.m. on weekdays. A reasonable fee may be charged for copying.

Single copies of the Draft Background Information Document and Draft Economic Assessment (which, combined, form the draft Environmental Impact Statement (EIS)) have been placed in the docket. Other documents available for review include: A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Federal Facilities (January 1989); NRC Regulatory Guide 3.59, Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Mill Operations (March 1987); Procedures Approved for Demonstrating Compliance with 40 CFR Part 61 Subpart I (January 1989); Screening Techniques for Determining Compliance with Environmental Standards (March 1988); and User's Guide for the COMPLY Code (January 1989). Copies of these documents may be obtained by writing to: Director, Criteria and Standards Division (ANR-460), Office of Radiation Programs, Environmental Protection Agency, Washington DC 20460.

Requests to participate in the public hearings should be made in writing to the Director, Criteria and Standards Division. All requests for participation should include an outline of the topic to be addressed in the opening statement(s), the amount of time requested for the statement(s), and the name of the participants. Statements can be made at the hearings without prior notice, but may be subject to time constraints, at the discretion of the hearing officer. Statements should not repeat information already presented in written comments, but should eddress additional information or issues.

Locations for the hearings are:

In Washington—

Sheraton Inn, 8727 Colesville Rd., Silver Spring, MD 20910.

In Las Vegas—

Thomas M. Mack Center, 4505 South Maryland Parkway, Las Vegas, Nevada 89154.

FOR FURTHER INFORMATION CONTACT: James M. Hardin, Environmental Standards Branch, Criteria and Standards Division (ANR-460), Office of Radiation Programs, Environmental Protection Agency, Washington, DC 20460, (202) 475-9610.

SUPPLEMENTARY INFORMATION:

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I. Definitions

A. Terms

Activity. The amount of a radioactive material. It is a measure of the

transformation rate of radioactive nuclei at a given time. The customary unit of activity, the curie, is 3.7×10^{10} nuclear transformations per second.

Agreement state. Any state with which the Nuclear Regulatory Commission or the Atomic Energy Commission has entered into an effective agreement under subsection 274(b) of the Atomic Energy Act of 1954, as amended 68 Stat. 919.

Annualized cost. The equivalent uniform annual net disbursement.

By-product material. Any radioactive material (except source material and 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 wastes from the processing of ores primarily to recover their source material content.

Effective Dose Equivalent (EDE). A risk-weighted average of the organ dose equivalents. The effective dose equivalent has the same risk (for the model used to derive the weighting factors) as a uniform dose equivalent to all organs and tissues. For the purposes of this standard, "effective dose equivalent" means the result of the calculation used to determine the dose eqivalent to the whole body, by taking into account the specific organs receiving radiation and the radiation effective dose eqivalent to the body as a whole. The method used to calculate the dose is described in detail in the International Commission on Radiological Protection's Publication No. 26.

Half-life. The time in which half the atoms of a particular radioactive substance transform, or decay, to another nuclear form.

Incidence. This term is used to denote the number of fatal cancers in a population. Other health effects (non-fatal cancers, genetic, and developmental) are noted separately.

Maximum individual risk. The additional cancer risk of a person due to exposure for a 70-year lifetime at a point of maximum concentration of a emitted pollutant.

Pathway. A method or way that radionuclides might contaminate the environment or reach people, e.g. air, food.

Radionuclide. A type of atom which spontaneously undergoes radioactive decay.

Source term. The amount of emisssions from a source, either estimated, measured or reported, that is used in the risk assessment.

Transuranic. An element with an atomic number greater than the atomic number of uranium.

Uranium fuel cycle. 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 nculear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy. This definition does not include mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle.

B. Acronyms

AEA—Atomic Energy Act, 42 U.S.C. 2011 *et seq.*
ALARA—As low as reasonably achievable
AMC—American Mining Congress
ANPR—Advanced Notice of Proposed Rulemaking
BACT—Best available control technology
CAA—The Clean Air Act, 42 U.S.C. 7401 *et seq.*
CAP-88—Clean Air Act Assessment Package—1988
CFR—Code of Federal Regulations
BID—The Draft Background Information Document prepared in support of this rulemaking [Volume 1 of the draft EIS]
EIA—The Draft Economic Impact Assessment prepared in support of this rulemaking [Volume 2 of the draft EIS]
EIS—Environmental Impact Statement
DOE—United States Department of Energy
EDF—Environmental Defense Fund
EPA—United States Environmental Protection Agency
fCi—femtocurie, 1×10^{-15} curie
HLW—High-Level Radioactive Waste
ICRP—International Commission on Radiological Protection
MSHA—Mining Safety and Health Administration
mrem—millirem, 1×10^{-3} rem
NAAQS—National Ambient Air Quality Standards
NESHAP—National Emission Standard for Hazardous Air Pollutants
NCRP—National Council on Radiation Protection and Measurements
NRC—United States Nuclear Regulatory Commission
pCi—picocurie, 1×10^{-12} curie
UFC—Uranium Fuel Cycle
UMTRCA—Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. 7901, *et seq.*

II. Overview of Proposed Actions

Under section 112 of the Clean Air Act (CAA), EPA is required to establish emission standards for hazardous air pollutants at a level which provides an ample margin of safety to protect public health. In *Natural Resources Defense Council, Inc. v. EPA*, 824 F.2d 1146 (1987) (hereafter referred to as *Vinyl Chloride*), the Court set out a two-step decision process for EPA to follow in setting NESHAPs under section 112. The two steps are: (1) Determine a "safe" or "acceptable" health risk level and (2) set the standard at the level—which may be lower but not higher than the "safe" or "acceptable" level—that protects public health with an ample margin of safety. The Administrator may instead use only one step to set standards, but if he does this, he may not consider cost or technology.

As discussed in detail in Section VI of this notice, the Agency is, as it did in the proposed Benzene NESHAP, 53 FR 28496, proposing four alternative policy approaches for making these two decisions under section 112. Commentors should understand that the final decision on the NESHAP approach could be one of the four described in this notice or a variation. The final policy approach and the relative weight it gives to the various risk measures and uncertainties may become the framework for future NESHAPs decisions. Consequently, the Agency is interested in comments on general implications of the various policy approaches in addition to comments on the specific applications to the twelve radionuclide source categories.

The framework adopted for NESHAPs does not apply to other Agency programs. The Court's interpretation of the process required for establishing NESHAPs did not extend to regulatory decisions under any other section of the CAA or other statute administered by EPA: therefore, the Agency does not envision applying the process described below to regulatory judgments under other Acts. Regulatory decisions under other Acts will continue to be made using decisional approaches pursuant to those distinct statutory mandates.

The various policy approaches being proposed differ in how the question of acceptable risk is addressed and in how uncertainty in risk measures is considered. The Agency is using both the four proposed approaches and the applications of the approaches to the radionuclide source categories as a means to further frame the public debate on these questions. The Agency believes that the broad ramifications of any

particular approach for establishing acceptable risk levels for all NESHAPs should be subject to informed public debate.

A. Safe or Acceptable Risk Policy Approaches

Each of the four approaches treats the acceptable risk decision differently. The major characteristics of the four proposed approaches to acceptable risk and ample margin of safety decisions are described below.

1. Approach A. Case-by-Case Approach

This is the only approach in which all the health information, risk measures and potential biases, underlying assumptions, and quality of the information (i.e., uncertainties) are considered together in the acceptable risk decision. The preferred level for the maximum individual lifetime risk in this approach is 10^{-4} or less; however, different results for specific source categories may be reached based on consideration of all the available information.

2. Approach B. Incidence-Based Approach

This approach only considers EPA's best estimate of the total incidence of fatal cancer in the acceptable risk decision. The other health information, including individual risk and the uncertainties, are not considered until the ample margin step. The incidence level being proposed as acceptable is no more than 1 case of fatal cancer per year per source category.

3. Approach C. 1×10^{-4} or Less Maximum Individual Risk Approach

For this approach, the only parameter considered in determining acceptable risk is EPA's best estimate of the maximum individual lifetime risk of fatal cancer. The other health information including incidence, and the uncertainties, are considered in the ample margin step. In this approach, a maximum individual lifetime risk of no greater than 1×10^{-4} is acceptable.

4. Approach D. 1×10^{-6} or Less Maximum Individual Risk Approach

This approach is similar to Approach C, however, acceptable risk is defined as a maximum individual lifetime risk of no greater than 1×10^{-6}.

B. Ample Margin of Safety Decision

This decision is made separately after the safe determination has been made. The Administrator considers all the health risk measures as well as the technological feasibility, costs, estimation uncertainties, economic impacts of control technologies and any other relevant information. An issue that arises in this decision is whether to require all technologically feasible controls which are affordable no matter how small the risk reduction.

III. Historical Background of Radiation NESHAPs

On December 27, 1979, EPA listed radionuclides as a hazardous air pollutant under section 112 of the CAA [44 FR 76738 (December 27, 1979)]. EPA determined that radionuclides are a known cause of cancer and genetic damage and that radionuclides cause or contribute to air pollution that may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible or incapacitating reversible illness, constituting a hazardous air pollutant as defined by section 112(a)(1). EPA then determined that radionuclides presented a risk warranting regulation under section 112, and listed the pollutant under that section. Having listed radionuclides as a hazardous air pollutant, EPA was then required by section 112(b)(1)(B) to establish National Emissions Standards for Hazardous Air Pollutants (NESHAPs) at the "level which [in the judgment of the Administrator] provides an ample margin of safety to protect the public health from such hazardous air pollutant," or find that they are not hazardous and delist them.

On April 6, 1983, EPA proposed standards regulating radionuclide emissions from four source categories: (1) Elemental phosphorus plants, (2) DOE facilities, (3) NRC licensed facilities and non-DOE federal facilities (NRC-licensees), and (4) underground uranium mines. The Agency simultaneously proposed its decision not to regulate several other categories: (1) Coal-fired boilers, (2) the phosphate industry, (3) other extraction industries, (4) uranium fuel cycle facilities, (5) uranium mill tailings, (6) high level radioactive waste facilities, and (7) low energy accelerators [48 FR 15076 (April 6, 1983)]. In February 1984, the Sierra Club filed suit in the U.S. District Court for the Northern District of California to compel EPA to take final action on the proposed standards. *Sierra Club v. Ruckelshaus*, No. 84-0656. EPA was subsequently ordered by the Court to promulgate final standards or make a finding that radionuclides are not hazardous air pollutants and delist them.

In October 1984, EPA withdrew the proposed emission standards for elemental phosphorus plants, DOE facilities, and NRC licensees, finding that the control practices already in effect for those categories protected the public from exposure to radionuclides with an ample margin of safety. EPA, therefore, concluded that no additional regulation would be necessary [49 FR 43906 (October 31, 1984)].

In the notice, EPA also withdrew the proposed standard for underground uranium mines but stated its intention to promulgate a different standard for that category and simultaneously published an Advance Notice of Proposed Rulemaking (ANPR) for radon-222 emissions from underground uranium mines to solicit additional information on control methods. EPA also published an ANPR for radon-222 emissions from licensed uranium mills. EPA affirmed its decision not to regulate the other categories: coal-fired boilers, the phosphate industry, other extraction industries, uranium fuel cycle facilities, and high level radioactive waste. The Agency decided not to regulate phosphogypsum stacks under section 112 at that time, but instead to further study the category to determine whether the need for a standard existed.

On December 11, 1984, the U.S. District Court for the Northern District of California found EPA in contempt of its order to promulgate final standards and again directed that EPA issue final radionuclide emission standards for the original four categories or make a finding that radionuclides are not hazardous air pollutants. EPA complied with the court order by promulgating standards for radionuclides emissions from elemental phosphorus plants, DOE facilities, and NRC-licensees [50 FR 7280 (February 6, 1985)] and a work practice standard for radon-222 emissions from underground uranium mines [50 FR 15385 (April 17, 1985)]. On September 24, 1986, EPA promulgated a final rule regulating radon-222 emissions from licensed uranium mill processing sites by establishing work practices for new tailings [51 FR 34056 (September 24, 1986)].

The Environmental Defense Fund (EDF), the Natural Resources Defense Council (NRDC), and the Sierra Club filed petitions for review of the October 1984 withdrawals and final decisions not to regulate, the February 1985 standards for the three source categories and the April 1985 standard for underground uranium mines. The April 1985 standard for underground uranium mines was also challenged by the American Mining Congress (AMC). In November 1986, AMC and EDF filed petitions challenging the standard for licensed uranium mill processing sites.

On July 28, 1987, the U.S. Court of Appeals for the DC Circuit remanded to the Agency an emissions standard for vinyl chloride which had also been promulgated under section 112 of the CAA. The Court in *Vinyl Chloride* concluded that the Agency improperly considered cost and technological feasibility without first making a determination based exclusively on risk to health.

In light of that decision, EPA concluded that the standards for elemental phosphorus plants, DOE facilities, NRC-licensees, and underground uranium mines should be reconsidered and on November 16, 1987, moved the Court for a voluntary remand of those NESHAPs. EPA also agreed to reexamine all issues raised by the parties to the litigation. On December 8, 1987, the Court granted EPA's motion for voluntary remand and established a time schedule for EPA to propose regulatory decisions for all radionuclide source categories within 180 days and finalize them within 360 days. On March 17, 1988, the Court granted a subsequent EPA motion and modified the order to require proposed regulatory decisions by February 28, 1989 and final action by August 31, 1989.

On April 1, 1988, EPA also requested a remand for its standard for licensed uranium mill tailings. On August 3, 1988 the Court granted EPA's motion and put the uranium mill tailings NESHAP on the same schedule as the other radionuclide NESHAPs.

On remand, EPA intends to take a "fresh look" at the risks and issues involved in regulating or not regulating radionuclide emissions under section 112 of the CAA. This means that the Agency is not bound by previous statements, positions or decisions. The Agency will or will not regulate sources based on whether or not their emissions protect public health with an ample margin of safety as determined during this rulemaking.

IV. Characterization of the Risks of Radiation

A. Sources of Radiation

Every day each person is exposed to radiation from a variety of natural and manmade sources. Natural sources of radiation include cosmic rays, radon, and other terrestrial sources. Manmade radiation includes medical and dental X-rays, fallout from above ground nuclear weapons testing and indsutrial sources.

The earth's atmosphere acts as a shield to cosmic rays, absorbing much of the radiation. People receive a higher dose of cosmic rays at higher altitudes because there is less atmosphere to shield them from cosmic rays. For example, people living in the mountains receive a higher dose than people living at sea level, and people are exposed to even higher levels when flying in an airplane. Terrestrial radiation comes from the small amount of radionuclides that are naturally present in all matter: soil, air, food, clothes, and even our bodies.

Radon is a radionuclide that is produced as a radioactive decay product of the radium which is naturally found in soil. Radon is always present in the ambient air where it poses some health risk. In addition, radon often gets trapped in homes, leading to even higher health risks. EPA has issued recommendations to homeowners for reducing these risks.

This rulemaking deals with sources of radionuclide emissions, including radon, from industrial sources. Although the amount of radiation dose that most people receive as a result of these emissions is lower than their natural background dose, the resulting risk can still be signficant. A source does not present an acceptable risk simply by being less than natural background. It is important to note that total background radiation from all sources, including naturally occurring radon, results in a calculated maximum lifetime risk of fatal cancer of approximately 1×10^{-2}. In most cases, little can be done to reduce most of this radiation exposure which people receive from natural background.

Industrial sources of radionuclide emissions in the air include a wide variety of facilities, ranging from nuclear power facilities to hospitals to uranium mill tailing piles. Industry uses hundreds of distinct radionuclides in solid, liquid, and gaseous forms, emitting different types of radiation (alpha, beta, gamma) at various energy levels.

Industrial sources of radionuclide emissions fall into two major categories. The industries that use radioactive materials have emissions as a result of an inability to completely contain the materials they use. For example, hospitals use radionuclides as part of their radiology departments. Since many of the radionuclides they use are gases, liquids capable of evaporation, or solids capable of sublimation, some radionuclides inevitably are released into the environment. The other type of source is that which releases radionuclides (usually radon) as an unintended consequence of other activity, such as mining or milling. An example of this is phosphogypsum stacks. These piles emit radon because radium (from which radon is produced by radioactive decay) is found naturally in the same soils that are the source of phosphate rock.

B. Health Effects of Radiation

The level and type of hazard posed by radionuclides vary, depending on such characteristics as the radionuclide's radioactive half-life, the type of radiation it emits, the energy level of the emission(s), and its ability to concentrate in the body. Different radionuclides will irradiate different parts of the body causing different types of cancers.

There are three major types of long-term health impacts from exposure to radiation: Cancer, hereditary effects, and developmental effects on fetuses such as mental retardation. Since there is such a strong basis for quantifying the risk from fatal cancers, EPA's consideration of fatal cancers is the driving force in this rulemaking. However, it is important to note that other health effects have been considered as well in the rulemaking. The other effects are not specifically addressed in this discussion because none of them pose a more severe risk to health. Therefore, judging the risk of total fatal cancers acceptable is judging the other effects acceptable. In addition, risk distribution of health effects from radiation from most of the sources considered for regulation show that fatal cancers occur much more frequently than non-fatal cancers and cancers generally occur more often than genetic or developmental effects. For sources that emit radon, no genetic or developmental effects and very few non-fatal cancers are expected.

Numerous studies have demonstrated that radiation is a carcinogen. It is assumed that there is no completely risk-free level of exposure of radiation for cancer. The risks from radiation have been observed in studies of workers and of the survivors of Hiroshima and Nagasaki. This information has been verified with studies of animals in the laboratory. However, the effects of doses at low levels of exposure can only be predicted by extrapolating from the observed effects at higher doses since cancers caused by radiation cannot be distinguished from ones with other causes. Some pollutants cause diseases that are unique to the pollutant, for example, asbestos and asbestosis. Radiation, however, causes the same types of cancers that are caused by other factors, such as leukemia and lung and liver cancer. Since these cancers are not unique to radiation effects, it is impossible to differentiate cancers caused by radiation from other cancers.

The second type of effect is the induction of hereditary effects in discendants of exposed persons, which vary in degree and may be fatal. It is assumed that there is no completely risk-free level of exposure for hereditary effects. Although hereditary effects have been observed in experimental animals at high doses, they have not been confirmed at low doses in studies of humans.

Based on extensive scientific evidence, it is prudent to assume that at low levels of exposure, the risk of incurring either cancer or hereditary effects is linearly proportional to the dose received in the revelant tissue. However, the severity of either effect is not related to the amount of dose received. That is, once a cancer or an hereditary effect has been induced, its severity is independent of the dose.

Regarding cancer, there continues to be divided opinion on how to interpolate between the absence of radiation effect at zero dose and the observed effects of radiation (mostly at high doses) in order to estimate the most probable effects at doses that represent small increases above natural background radiation. Most scientists believe that available data best support use of a linear model for estimating such effects. Others, however, believe that other models, which usually predict somewhat lower risk, provide better estimates. These differences of opinion have not been resolved to data by studies of the effects of radiation in humans, the most important of which are those of the survivors of the Hiroshima and Nagasaki atomic bombs. It is important to note that no one receives a zero dose of radiation. All doses received by people as a result of emissions from industrial sources are in addition to the natural background dose.

Studies are now underway to reassess radiation dose calculations for these survivors and to provide improved estimates of risk. These studies may reduce the uncertainty associated with extrapolation from high doses to low doses. These studies may also result in an increase of the estimated risk per unit dose. But they will not address the question of whether a threshold exists. EPA is monitoring the progress of this work and will initiate reviews of the risks of exposure to low levels of radiation upon its completion.

It could be argued that the approach taken understates the risk to an exposed individual. Two important and unquantifiable factors can lead to an underestimation of risk. The first is the possibility of greater susceptibility of some members of the population to radiation. The other factor that EPA cannot quantify is the synergistic effects of radiation with other pollutants. Radiation is only one of a number of carcinogens in the environment. While EPA's relative risk model takes into account the effect of chemicals that are widely distributed in the environment, there are hundreds of chemicals that are concentrated in local areas, and the effects of these chemicals are not and can not be taken into account.

C. Risk Assessment

EPA estimates numerical risk in several ways in this rulemaking. One is the maximum risk to which any individual would be exposed for his or her entire lifetimes, 70 years on the average. Another is to estimate the number of fatal cancers that will be caused by the annual radionuclide emissions from the studied facility. Another is to estimate how many persons within a certain distance of a source of pollutant emissions are at what level of individual risk. A risk distribution estimates how many persons within a certain distance of a source of pollutant emissions are at what level of individual risk. Typically, the distribution is given for 10-fold increments of individual risk. Such a distribution provides the decisionmaker with information on both the individual risk level for those exposed and the number of persons exposed at each level. For NESHAP and other decisions, the Agency has examined risk distributions both as measures of risk and to compare the effects of various strategies for risk reductions across a source category.

In attempting to make these estimates, EPA has tried at all times to give "best estimates" of the radionuclide concentrations in the environment and individual and population risks. Wherever possible, measured or reported data of emissions, meteorology and population were used. Where estimates were used, EPA has tried to use the most likely numbers in its assessments. When model facilities were used, they were designed to be representative of actual facilities. EPA's risk assessments are based on a current "snapshot" of each industrial source category as it now stands. EPA has not estimated the maximum conceivable risks that may result from the facilities analyzed at some point in the future. Future risk may be higher or lower depending on whether people move closer to, or further away from, the facilities studied and whether the emissions from those facilities increase or decrease. This is not to say that there is little or no uncertainly in the final results. As in all such assessments, the analysis have considerable uncertainly. EPA's analysis are not designed to consistently over- or underestimate risks.

The level of uncertainty is greater in the estimate of the maximum individual risk than in the estimate of population risk. Many possible errors in analysis cancel out in assessments of populations. For example, the results from pollutant dispersion models may be in error. For example, local meteorological conditions may cause more radionuclides to go in one direction than another. This effect may cause an over- or underestimate of the maximum individual risk, depending on where the most exposed individual is located. However, this source of error tends to be less important in population estimates, since the analysis integrates individual doses to a large number of people. If one person gets a larger risk due to local dispersion effects, it means that another person is getting less. Consequently, when the individual risks are summed, local conditions will not cause a serious error in the value for total population risk.

In estimating the radiation exposure to the meet exposed individual, EPA assumes that the person receiving the maximum individual risk lives for a lifetime, an average of 70 years, at the same site. EPA has assumed, *a priori*, that the person exposed to the maximum individual risk lives at the point of maximum exposure his whole life. EPA then makes its best estimate of the risks to the individual of living his entire lifetime under a set of certain conditions.

EPA makes this assumption as a matter of policy and does not believe that it undercuts the accuracy of risk assessments. It is not meant to be a "best guess" of how people live. EPA has made this assumption for several reasons. First, EPA is attempting to estimate the maximum individual risk and it is completely possible that someone could live in the same place for that person's entire life. Use of different assumptions could lead, in some cases, to understanding the maximum risk.

Second, a considerable fractions or risk can occur in less than 70 years. The effect of radiation and risk are not independent of age. Children appear to be a more susceptible to the effects of radiation than adults. In addition, due to their youth, they generally have a greater chance of developing the cancer the radiation would cause (and they are less likely to die of something else before they die of cancer). Due to these two factors, younger people are at a greater risk from the same dose than

older people. (See Table 1). If EPA were to reduce the number of years of assumed exposure to less than a lifetime, it would be unclear what number of years to use or where to place those years. For example, should EPA assume that the person lives in the same place from birth to age 19 or from age 35 to 50? Generally, in the first case the risk is 6 times greater than in the second case. Finally, the difference that would be caused by assuming a shorter period of exposure is not very significant. For an assumed constant rate of exposure, people receive over 60 percent of their total lifetime risk during their first nineteen years. To change the period of exposure from 70 years to the first 19 years of life would change the final result by less than a factor of 2.

TABLE 1.—AGE DEPENDENCE OF RISK DUE TO WHOLE BODY RADIATION

[Assumed Percentage of Total Lifetime Risk As A Function Of Ages At Which Radiation Exposure Occurs]

Period of exposure (ages)	Percentage of lifetime risk	Cumulative percentage of lifetime risk [1]
0 to 9	30	30
10 to 19	30	60
20 to 34	20	80
35 to 50	10	90
50+	10	100

[1] Exposure is at a constant rate for a lifetime.

D. Computer Models

1. Clean Air Act Assessment Package—1988 (CAP–88)

In this rulemaking, EPA uses the Clean Air Act Assessment Package—1988 (CAP–88) in risk analysis and to estimate the dose and risk resulting from radionuclide emissions to air. CAP–88 is a set of computer programs, data bases and associated programs that model the transport of radionuclides from the emission point through the environment to exposed human populations and estimates the resulting dose and health impact. For more information on the source of data used in CAP–88, see the BID.

a. Environmental transport of radionuclides. The computer program which models environmental transport in CAP–88 is AIRDOS–EPA. This program uses a modified Gaussian plume equation to estimate both horizontal and vertical dispersion of radionuclides released from up to six sources. The sources may be either elevated stacks, such as a smokestack, or reasonably uniform area sources, such as a pile of uranium mill tailings. Plume rises can be calculated assuming either a momentum-driven or buoyancy-driven plume. Assessments are done for a circular area within a radius of 80 kilometers (50 miles) around the facility.

AIRDOS–EPA computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food and intake rates to people from inhalation of air and ingestion of food produced in the assessment area. Estimates of the radionuclide concentrations in produce, milk and meat consumed by humans are made by coupling the output of the atmospheric transport models with the U.S. Nuclear Regulatory Commission Regulatory Guide 1.109 terrestrial food chain models. The computer program PREPAR is used to prepare the input data for use by AIRDOS–EPA. This is done to insure proper formatting of the large arrays required to do environmental transport calculations. These arrays include the agricultural productivity data, population distributions and meteorological data. PREPAR also passes on information on the fraction of food which is assumed to be home-grown, the fraction taken from production within the 80-km assessment area, and the fraction of uncontaminated food imported from outside the assessment area.

Population distributions are generated with the utility program SECPOP, which uses a data base of 1980 Census data. Since census enumeration districts vary widely in their size, the census data base is not very precise at estimating population groups close to the facility, and the arrays have to be modified with supplemental site specific data.

Meteorological data required to estimate the dispersion of radionuclides in air is either supplied from on-site weather stations or generated from stability arrays (STAR files) which are available from the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. These data are generated from weather data reported from airports across the nation and include the frequencies of wind direction, wind speed and stability category. Where on-site data are not available, and a reporting station is not close by, data are selected from the nearest reporting station judged to have similar weather conditions. The annual average rainfall rate is estimated for each facility from historical climatic data.

b. Estimation of dose and risk. The computer program RADRISK is used to estimate dose and risk conversion factors. Factors are provided for the pathways of ingestion and inhalation intake, ground level air immersion and ground surface irradiation. Factors are further broken down by particle size, solubility class and digestion transfer factors. These factors are generated once and stored in a data base for future use. The data base used for the 1988 rulemaking is RADRISK.V8401RBM. For more information concerning this data base, see the BID.

Estimation of dose and risk is made by the program DARTAB, which combines the inhalation and ingestion intake rates, and the air and ground surface concentrations output from AIRDOS–EPA with the dose and risk conversion factors from the RADRISK data base. DARTAB lists the dose and risk to the maximum individual, the average individual and the collective population. Doses and risks are further tabulated as a function of radionuclide, pathway, location and organ.

DARTAB also tabulates the number of people in each risk category, as well as the number of health effects from each risk category. Risk categories represent the lifetime risk and are computed by powers of ten from one in ten (1×10^{-1}) to one in a million (1×10^{-6}).

c. Limitations of the CAP–88 methodology. There are some limitations in the mathematical dispersion models that are available in CAP–88. The CAP–88 codes have been verified, and improvements will be made on a continuing basis as new techniques become available.

While up to six stack or area sources can be modeled, all the sources are modeled as if co-located at the same point; that is, stacks cannot be located in different areas of a facility. No correction for the diffusion introduced by building wakes or tip downwash can be made. Also, area sources are treated as uniform and co-located. Variation in radionuclide concentrations due to complex terrain cannot be modeled; all assessments assume a flat plain.

Errors arising from these assumptions will have a negligible effect for assessments where the distance to exposed individuals is large compared to the stack height, area or facility size.

d. Verification of the CAP–88 methodology. The Gaussian plume model used in CAP–88 to estimate dispersion of radionuclides in air is one of the most commonly used models. It produces results that agree with experimental data as well as other models, is fairly easy to work with, and is consistent with the random nature of turbulence.

The Office of Radiation Programs has made comparisons between the predictions of annual-average ground-level concentration to actual

environmental measurements and found very good agreement. In the recent paper "Comparison of AIRDOS–EPA Prediction of Ground-Level Airborne Radionuclide Concentrations to Measured Values", environmental monitoring data at five Department of Energy (DOE) sites were compared to AIRDOS–EPA predictions. EPA concluded that, as often as not, AIRDOS–EPA predictions are within a factor of 2 of actual concentrations.

2. COMPLY

This section deals with the compliance procedures that the Agency has developed to implement the NESHAPs for NRC-licensees. Most of the estimated 6,000 facilities subject to the rule possess very small quantities of radioactive materials, and under normal conditions they will not exceed the standard.

In cooperation with the National Council on Radiation Protection and Measurements (NCRP), a group chartered by Congress to develop basic concepts about radiation measurement and protection, EPA has developed a system for implementing the CAA that is easy to use and that reduces the burden of demonstrating compliance for small facilities. The NCRP assisted the Agency by developing a simplified screening model allowing the regulated community to calculate dose based on: emissions to the atmosphere, distance to the receptor, building dimensions, and other readily available information. The NCRP model employs a Gaussian plume air dispersion model which was modified to take into consideration building wake effects. It calculates dose through four exposure pathways: Inhalation, ingestion, immersion, and radionuclides deposits on the ground. It was developed by the NCRP to provide a simple method for calculating radiation dose from releases of radioactivity to the atmosphere.

The NCRP model is intentionally designed to overestimate the dose both to maintain simplicity for hand calculation, and because it was intended for screening purposes only. The model is presented in NCRP Commentary No. 3, "Screening Techniques for Determining Compliance with Environmental Standards." To augment these procedures, the EPA has developed a method allowing the regulated community to estimate a source term for the models in lieu of measured release rates. Simple compliance procedures for the regulated community have been devised based on these considerations.

The process consists of providing the regulated community with a series of ways to make increasingly more accurate estimates, depending on their potential to exceed the standard. First, a facility can be found in compliance if the quantity of radioactive material possessed during the year is less than that listed in a table of annual possession quantities (Appendix E, Table 1). The table of annual possession quantity has been derived using EPA's emission factors in collaboration with the NCRP screening model. The table assumes that the nearest resident is 10 meters from the point of release while food is produced at 100 meters.

A facility will also be in compliance if the average annual radionuclide emission concentration is less than that listed in a table of air concentration levels (Appendix E, Table 2). This table is based on the effective dose equivalent calculated by the NCRP screening model assuming that the resident and the source of food production are located at the point of release. If the facility is not demonstrated to be in compliance by using these tables, it can establish compliance by estimating a dose using the NCRP screening model with a radiological source term derived using EPA approved emission factors. These procedures are described in "Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Federal Facilities."

A user-friendly computer program called COMPLY has been developed to reduce the burden on the regulated community. The Agency has also prepared a "User's Guide for the COMPLY Code" to assist the regulated community in using the code, and in handling more complex situations such as multiple release points.

The compliance model, which is an extension of the NCRP screening model, is the last stage of the COMPLY computer code. The compliance model was developed by EPA to decrease overestimation of the dose estimates by allowing input of site-specific information by user. The differences between the compliance model and the screening models developed by NCRP are as follows:

1. The compliance model allows the use of more complete meteorological data—the frequency with which the wind blows in a given direction and the average wind speed in that direction (a wind rose).

2. It accounts for momentum or buoyant plume rise.

3. It allows for a more precise determination of the locations for the sources of food production.

4. It uses more realistic pathway parameters from AIRDOS-EPA as opposed to the conservative pathway parameters selected by NCRP for screening purposes.

These differences make the compliance model more realistic than the NCRP model, which was designed to be simple enough to be implemented using a hand calculator. Comparisons of the dose calculated using the compliance model to that calculated using the AIRDOS–EPA code at the same air concentration, show that the two codes produce essentially the same results for inhalation and immersion. The compliance model predicts dose rates that are somewhat greater than AIRDOS–EPA values for ingestion and radioactivity deposited on the ground.

More radionuclides are contained in the COMPLY computer code than are in NCRP Commentary No. 3 and the tables to calculate dose for Subpart I. The Agency intends to expand the list of nuclides for the hand calculational procedures and is interested in soliciting comments on which nuclides should be added.

E. Effective Dose Equivalent

Since 1985, when EPA proposed dose standards regulating NRC-licensees and DOE facilities, a different methodology for calculating dose has come into widespread use, the effective dose equivalent (EDE). In 1987, EPA, in recommending to the President new standards for all workers exposed to radiation, accepted this methodology for the regulation of doses from radiation. This method, which was originally developed by ICRP, will be used in all the dose standards proposed by EPA in this notice. In the past, EPA dose standards were specified in terms of limits for specific organ doses and the "whole body dose," a methodology which is no longer consistent with current practices of radiation protection.

The EDE is simple, is more closely related to risk and is recommended by the leading national and international advisory bodies. By changing to this new methodology, EPA will be converting to the common international method for calculating dose. This will make it easier for the regulated community to understand and meet our standards.

The EDE is the weighted sum of the doses to the individual organs of the body. The dose to each organ is weighted according to the risk that dose represents. These organ doses are then added together and that total is the effective dose equivalent. In this manner the risk from different sources of radiation can be controlled by a single

standard. The weighting factors for the individual organs are listed in Table 2:

TABLE 2.—WEIGHTING FACTORS FOR INDIVIDUAL ORGANS

Organ	Factor
Lung	.12
Breast	.15
Thyroid	.03
Gonads	.25
Bone surface	.03
Red bone marrow	.12
Remainder	.30

EPA risk models differ from those underlying the ICRP recommendations. The risks calculated by EPA are not strictly proportional to the EDE derived using ICRP quality factors and organ weighting factors. While the risk methodology underlying the ICRP EDE differs from that used by EPA, the widespread acceptance of the EDE approach, and the small likelihood that a regulation based on this concept would allow an unacceptable risk make it a reasonable basis for regulation under the CAA.

F. Science Advisory Board Review

Beginning in 1984, EPA's Science Advisory Board (SAB) has conducted reviews of the risk assessment methods used in this rulemaking. EPA has worked closely with the SAB with respect to their comments and findings and believes it has been responsive to them.

In 1984, the SAB recommended that available scientific information be integrated into an assessment document that would lead from identification of emission sources through calculation of radiation dose and health risk and the associated degrees of uncertainty; a full explanation of procedures to be provided. This has been done in the Environmental Impact Statement accompanying this rulemaking.

In 1988, the SAB reviewed the dose-risk conversion factors for low-LET radiation and for radon and the source terms and environmental pathway models used by EPA in the risk assessments which are considered in this rulemaking. Given below are specific SAB comments and the Agency's responses:

SAB comment: EPA should use the effective dose equivalent concept for regulations protecting people from exposure to radiation.

EPA response: This is done in the proposed rules.

SAB comment: EPA should use simple screening methods in implementation procedures such that only the largest users of radionuclides are required to report annually to EPA.

EPA response: A simple screening procedure is proposed.

SAB comment: SAB has given specific advice on risk factors for low-LET and for radon.

EPA response: The SAB approaches to these risk factors have been used in the risk assessments supporting this rulemaking.

SAB comment: EPA should improve presentation of risk by clearly stating assessment objectives, presenting the number of people exposed and health impacts in terms of individual risk ranges, defining input/output parameters clearly, and comparing risks with commonly encountered risks.

EPA response: Assessment objectives are carefully defined in the EIS in terms of the individuals and populations at risk. The number of people at risk and incidence is presented by range of risk. Summaries of inputs and outputs of the computer code models have been placed in the docket. Radiation risks are compared with other risks and other radiation control recommendations.

SAB comment: EPA should rigorously derive quantified uncertainty estimates for each risk assessment.

EPA response: This is a large task. For the short term, prior to the final rule, we will perform parameter sensitivity analysis of the most important parameters using simplifying assumptions. For the long term, an Agency task group has been formed to plan and conduct more complete studies of the uncertainty question. This longer term effort will take a number of years to complete.

EPA acknowledges the uncertainty in risk estimates, considers them when making risk management decisions and recognizes that a quantitative expression of uncertainty would be an improvement. However, it does not believe that the quantitative expression of uncertainties, which are themselves uncertain to a degree, would change the decisions made in this rulemaking. For a more complete discussion of uncertainty, see chapter 7, Volume 1 of the EIS.

SAB comment: Make environmental transport models state-of-the-art.

EPA response: The task group identified above will oversee the updating of risk assessment models for radionuclides. However, the SAB's recommendations to improve environmental transport models involve modifications of second order pathways, such as adding ingestion of contaminated soils by cattle to the existing ingestion pathways of cattle, correcting for the short range effect of the presence of a building on the air dispersion model predictions of radionuclide concentrations, and using seasonal parameters to describe agricultural practices instead of yearly averages.

While EPA acknowledges the desirability of making such improvements, we believe that the results of implementing these recommendations would make only minor changes in the estimated risks supporting this rulemaking.

V. Decision to List Under Section 112

Section 122(a) of the CAA required EPA to make a determination of whether or not "emissions of radioactive pollutants * * * will cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health." Once an affirmative determination is made, that section requires EPA to either list the substance under section 108(a)(1), governing National Ambient Air Quality Standards (NAAQS), 111(b)(1)(A), governing New Source Performance Standards, or 112(b)(1)(A), governing NESHAPs. EPA analyzed numerous studies which indicated that exposure to radionuclides can cause three major types of health effects: Cancer, genetic damage, and developmental effects. After considering these health effects, EPA made the determination that radionuclides cause or contribute to air pollution which "may reasonably be anticipated to endanger public health." Because EPA intended to regulate carcinogens under section 112, it listed radionuclides under section 112(b)(1)(A) [44 FR 76738 (Dec. 27, 1979)]. That decision was the first step in the regulatory process, and was challenged in the current litigation. As a result, EPA has reevaluated the decision and determined that the original listing under section 112 was correct. This discussion explains that decision to the public and provides an additional opportunity for comment on this issue.

The first part of the listing decision, the "hazardousness" of radionuclides, is unchallenged. The evidence that radionuclides can cause cancer has, if anything, increased since 1979, see Volume 1 of the BID. The evidence now points to the conclusion that radiation is even more dangerous than was believed at that time. While some people have expressed the view that, even though radiation can cause cancer, the amount of radionuclides that are released from a given source or industry is insignificant and to not present a risk. EPA believes that the results of the risk assessments demonstrate the risk to public health that results from radionuclide emissions

from industrial sources. These risk assessments support the listing decision.

Section 112(b)(1)(A) applies not merely to any "air pollutant" as do sections 108 and 111, but to a "hazardous air pollutant" that is defined as a pollutant that "causes or contributes to air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible or incapacitating reversible illness." Once a pollutant is determined to be a hazardous air pollutant, the only remaining step is for the Administrator to determine whether emissions of the pollutant present a risk warranting regulation under section 112—that is, whether it is a hazardous air pollutant "for which he intends to establish an emission standard" under that section. EPA has determined that radionuclides not only pose a risk of carcinogenicity and mutagenicity when emitted into the air (see, National Academy of Sciences, Commission on Biological Effects of Ionizing Radiation, Reports Number 3 and 4), but also are emitted in sufficient quantities as to create a risk warranting regulation under section 112. Therefore, EPA reaffirms its prior conclusion that radionuclides should be listed for regulation under section 112.

VI. EPA NESHAPs Policy

A. Legal Framework Under Vinyl Chloride

1. Introduction

Under the Congressional mandate of Section 112 of the Clean Air Act, EPA must promulgate NESHAPs that provide "an ample margin of safety" "to protect the public health." The recent *Vinyl Chloride* decision defines this language as having two stages of analysis. First, EPA must make an initial determination of what is safe, based exclusively on risk to health. Second, the level may be adjusted downward in order to provide a greater degree of safety. The second step provides the "ample margin" of safety.

2. "Safe" or "Acceptable" Level

The court in *Vinyl Chloride* explicitly declined to determine what risk level is safe or acceptable (the court used these terms interchangeably) or to set out the method for determining this level. The court recognized that scientific uncertainty concerning the effects of a particular carcinogenic pollutant is a matter for the Administrator's discretion under section 112. "EPA, not the court, has the technical expertise to decide what inferences may be drawn from the characteristics of * * * substances and to formulate policy with respect to what risks are acceptable." *Id.*, at 1163, *citing*, Environmental Defense Fund v. EPA, 598 F. 2d, 83–84 (DC Cir. 1978). But the Administrator may not consider other factors, such as cost or technological feasibility in making the "safe" determination.

The court did, however, provide some guidance on making the "safe" determination. The court stated that the Administrator must base the "safe" decision on "an expert judgment" concerning "the level of emissions that will result in an 'acceptable' risk to health." *Vinyl Chloride*, at 1164–65. To exercise this judgment, "the Administrator must determine what influences should be drawn from available scientific data and decide what risks are acceptable in the world in which we live." *Id.* at 1165. The court emphasized that "safe" does not require elimination of all risk. "There are many activities that we engage in every day—such as driving a care or even breathing city air—that entail some risk of accident or material health impairment; nevertheless, few people would consider those activities 'unsafe.'" *Id., citing, Industrial Union Dep't., AFL–CIO v. American Petroleum Inst.*, 448 U.S. 607,642 (1980) (OSHA Benzene Case)

3. Ample Margin of Safety

Because the determination in the first stage of analysis of what is "safe" is marked by scientific uncertainty, and safe does not mean risk free, the Administrator may set the level below that which is determined to be safe in order to achieve an "ample margin of safety." Once "safety" is assured with regard only to risk to health, the Administrator may consider cost and technological feasibility in lowering the level. "Because consideration of these factors at this stage is clearly intended to protect the public health, it is fully consistent with the Administrator's mandate under section 112." *Vinyl Chloride*, at 1165.

4. Uniqueness of Decision

The effect of *Vinyl Chloride* is to require a unique decisionmaking process for public health protection decisions, unlike any other regulatory decision faced by the Agency. This is the result of the court's prescription of two separate steps for decisionmaking, the first, in which only health factors can be considered in setting an acceptable risk level, and the second, in which additional factors including cost, technological feasibility, and other relevant factors may be considered in providing an ample margin of safety. This scheme is unlike any other in the Clean Air Act or any of the other statutes administered by EPA because the acceptable risk that EPA adopts in the first step cannot be exceeded by the standard EPA adopts in the second step.

In contrast, other EPA statutes have very different structures and legal requirements for decisionmaking on public health standards. For example, while the Safe Drinking Water Act provides for two separate decisions, the first is a health-based goal toward which to work, but not necessarily meet; the second is an enforceable standard that takes cost and feasibility into account. Under both the toxic Substances Control Act (TSCA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the balancing of health concerns and benefits of continued chemical use and control costs are explicitly provided for within a single decision. RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) both require statutory decisionmaking very different from the bifurcated process mandated by the Court for section 112.

Thus, the *Vinyl Chloride* decision requires EPA to consider whether a risk is acceptable without at the same time considering benefits of the activity causing risk, feasiblity of control, or other factors. This problem is particularly acute in the case of carcinogens, for which the Agency has stated that it is unable to identify a threshold no-effect level.

The very examples cited by the Court bring home the unusual nature of the Court's "acceptable risk" decision step. The court (quoting the Supreme Court's decision in the OSHA Benzene Case) cited "driving a car or even breathing city air" as activities that "few people would consider * * * 'unsafe.'" But driving a car entails risks that most people would consider high: the annual incidence approximates 50,000 fatal accidents, and the average individual risk (not the maximum, but the actuarial average risk) approximates a 1 in 100 chance of automobile-related death over a 70-year lifetime. Yet the Court was correct to say that our society accepts (or tolerates) the risk from driving cars. As a society, we continue to try to reduce the level of risk, but we accept it due to the value of the benefits in increased mobility that the automobile affords. The same is true of "breathing city air." Individuals live in cities to be close to the workplace, for the recreational and cultural advantages associated with cities, and for a variety of reasons extrinsic to the risk itself.

Commentors have often suggested that EPA consider a cost-benefit

analysis in assessing risk acceptability. The court has rejected this approach. How, then, is EPA to make those judgments? Later in this section, EPA sets out for public comment four approaches that deal with this issue. The approaches cover a range of possible risk levels, and they give prominence to different measures of risk, e.g., individual versus population risk.

B. Survey of Societal Risk

The question of what constitutes "safe" must be answered with reference to the "risks that are acceptable in the world in which we live." *Vinyl Chloride*, 824 F.2d at 1165.

In approaching the question of what level of risk is "acceptable" or "safe", EPA surveyed a range of health risks that our society faces. The objective of this survey was to develop information to place the radionuclide risk estimates in perspective. Thus, the risks examined included those encountered in everyday life, such as driving a car and breathing city air, which were cited in the *Vinyl Chloride* decision, as well as a range of regulatory judgments or risks. The EPA surveyed both the individual risk and the incidence in the population exposed to risk associated with the activities. Considering incidence comports with the purpose of section 112 to protect "public health" when incidence is viewed as a measure of health of the population as a whole.

The risks examined ranged from individual risks of 1 to 10 (10^{-1}) to less than 1 in 10,000,000 (10^{-7}). Everyday risks include risks from natural background radiation as well as risks from home accidents. Natural background radiation (excluding radon) at sea level creates individual lifetime cancer risks in the range of 3 in 1,000 (3×10^{-3}) and an estimated 10,000 cancer cases per year. Naturally occurring radon in homes poses an additional source of radiation risk, and these risks can be as high as 1 in 100 to 1 in 10 (10^{-2} to 10^{-1}) and cause an estimated 5,000 to 20,000 cancer cases per year. In the U.S., accidents, natural disasters, and rare diseases pose individual risks of death from 1 in 10,000 (10^{-4}) (e.g., tripping and falling which cause approximately 470 deaths per year) to 1 in 10,000,000 (10^{-7}) (e.g., rabies which causes an average of 1.5 deaths per year).

Judgments on risks have also spanned a broad range of risk levels. The NCRP, following recommendations of the International Commission on Radiological Protection, has recommended that maximum individual exposures from non-medical manmade radiation be limited to an amount corresponding to risks of 3 in 1,000 (3×10^{-3}). See Table 3 for a comparison of radiological risks and recommendations. It is important to note that the recommendations of national and international bodies shown in table 3 are coupled with recommendations that radiation doses should be "as low as reasonably achievable" (ALARA). The implementation of ALARA requires a site-specific consideration of the cost effectiveness of controls that could be added to reduce radiation doses. Therefore, these national and internationally recommended dose levels are acceptable only when the ALARA principle has also been satisfied.

The Food and Drug Administration (FDA) establishes tolerances for poisonous or deleterious substances, such as polychlorinated biphenyls (PCBs), at a level found necessary to protect the public health, taking into account the extent to which the substance is unavoidable in the food supply and the other ways the consumer may be affected by the same substance. For example, FDA has established a tolerance level for PCBs in fish at an individual risk of 7×10^{-5}, which could result in 34 cancer cases each year among heavy fish consumers alone (44 FR 38333, June 29, 1979).

The EPA regulates pesticide uses under FIFRA based on whether the pesticide creates unreasonable adverse effects, a statutory term defined as requiring the balancing of risks and benefits. The EPA has authorized some uses of the pesticide chlorobenzilate that would create individual risk of 1×10^{-6} to 7×10^{-6} and could result in 2 to 9 additional cancer cases per year (EPA banned other uses of this pesticide).

Regulatory judgments have also been made to require lower risks. For example, under the provisions of the Food, Drug, and Cosmetic Act, which povides that "no residue" from carcinogenic additives to animal feed may remain in any edible portion of the animal, FDA has established a policy of not allowing the use of additives that create a risk higher than 1 in 1,000,000 1×10^{-6}. A complete description of the risks EPA considered is presented in a document in the docket entitled "Survey of Risks."

No fixed risk level could be identified as acceptable in all cases and under all regulatory programs for two main reasons. First, as discussed above, in most cases the calculation or risks depends on different data, assumptions, and uncertainties. For example, the risk associated with motor vehicle and other common accidents can be calculated directly from accident records and therefore reflects actual risk, whereas environmental risks are based on estimating procedures and assumptions and therefore are more uncertain.

TABLE 3.—RADIOLOGICAL RISKS COMPARED

	Annual effective dose equivalent (mrem)	Lifetime risk
REGULATORY RISK		
Federal guidance [3] (1960) (individual, long-term)	500	1.5×10^{-3}
ICRP advisory [1,2] (1987) (all sources)	100	3×10^{-3}
NCRP advisory [2,3] (1985) (all sources)	100	3×10^{-3}
British advisory [3] (1987) (all sources)	50	1.5×10^{-3}
NCRP advisory [2,3] (1984) (air sources)	25	7×10^{-4}
NRC goal for nuclear power plants [3] (current)	5	1.5×10^{-4}
EPA drinking water standards (1976)	4	1.2×10^{-4}
BACKGROUND RISK		
Natural background (total)	300	1×10^{-3}
Natural background (total non-radon)	100	3×10^{-3}
Yearly round trip flight N.Y. to L.A. (70 years)	7	2×10^{-4}
Remaining fallout from atomic tests	4	1.2×10^{-4}

[1] International Commission on Radiological Protection.
[2] National Council on Radiation Protection and Measurement.
[3] Risks stated are the maximum allowed. These regulatory decisions presume that all exposures will be kept "as low as reasonably achievable".

Thus, actuarial and environmental risk estimates cannot be directly compared so as to draw precise judgments as to whether one risk is larger, or less acceptable, than another. Second, the acceptability of risk is a relative concept and involves consideration of different factors. Considerations in these judgments may include: The certainty and severity of the risk; the reversibility of the health effect; the knowledge or familiarity of the risk; whether the risk is voluntarily imposed or whether the individual receives a direct benefit for

accepting the risk voluntarily; the advantages of the activity; and the risk and advantages for any alternatives. Thus, different *judgments* on acceptability can be made for similar numerical estimates of risks.

In addition, the uses of individual risk and incidence as comparative factors face limitations since the relative size of the risks associated with an activity determine how the activity is defined. For example, incidence associated with a single leaking pipe at a plant within a particular industry could be quite small, but the cumulative risks associated with all plants within the industry could be significant. This limitation can be ameliorated by careful selection of the appropriate categories of sources.

In summary, EPA surveyed and considered this risk information to provide perspective on society's consideration and acceptance of risk. In its consideration, EPA is not judging whether each of the risks presented here is acceptable or unacceptable. They are presented, instead, to provide a context for evaluating the relative public health implications of a range of activities and the risk present in activities being considered for regulation under section 112.

C. General NESHAP Policy Considerations

The purpose of this section is to discuss and solicit comment on the appropriate criteria for determining an "acceptable risk" and an "ample margin of safety." In its determination, EPA will consider measures of health risk, and limitations and uncertainties of the risk estimation methods and basic data. A discussion of these factors follows, as well as a discussion of the four approaches to making the acceptable risk decision. Comments are solicited on all aspects of the discussion and the four approaches. The framework adopted in this proceeding has already been proposed in the Benzene NESHAP and may also become the policies for decisions on future NESHAPs but will not apply to other Agency programs or other sections of the Clean Air Act.

The main purpose of the discussion presented here is to provide a basis for comment on the major policy issues raised by the Court's opinion, in particular, on the requirement that in regulating air toxics under section 112 the Agency must decide what risk is acceptable in "the world in which we live." In the months since the Court's decision, issues about acceptability of risk from air toxics have been the subject of discussion both within the Agency and in public debate. The four alternative policy approaches outlined address the acceptable risk decision in different ways. The basic questions to be answered in each approach are: What measure or measures of risk should be given weight in the acceptable risk decision? Are there specific levels of individual or population risk that are acceptable? How should EPA balance individual, population risk and risk distribution? Should the same levels be set and the same measures applied for all NESHAPs? How should uncertainty in risk estimation be considered?

The approaches described include one in which all risk information and measures available as well as estimation limitations and uncertainties are considered in determining acceptable risk on a case-by-case basis. Other approaches simply apply one quantitative risk parameter, either risk to the maximally exposed individual or aggregate risk of increased fatal cancer in the population (population risk). The approaches also vary in the level of risk that would be acceptable. The details of the results of applying each of the approaches to radionuclide source categories are described later in this preamble.

Three of the approaches use either maximum individual risk or population risk as the sole criterion for acceptable risk. Some take the view that added cancer risk to the individual is the most, or only important measure. Two of the approaches use this as the only criterion for acceptable risk. The third approach uses incidence as the only criterion for acceptable risk. Arguments in favor of the individual risk measure are that no individual should be at high risk, that considering the number of people at risk leads to acceptance of higher individual risk when few people are exposed, and that it is inequitable for acceptable risk to an individual to depend upon the number of people similarly exposed. Arguments favoring use of added incidence are that it is an appropriate measure of total public health impact and this total risk to the population is a good indicator of acceptable risk.

On the other hand, fatal cancer is only one of a number of possible health effects and thus may not accurately measure the total health impact nor total population risk.

Uncertainty of risk estimates is also dealt with differently by the alternative approaches. Under Approach A, the case-by-case approach, all risk factors including estimation uncertainties are considered in the acceptable risk determination. Approaches B, C and D use a single risk measure as the criterion for the acceptable risk decision and thus would leave consideration of other risk measures and specific judgments concerning much of the overall uncertainty until the second step, the ample margin of safety decision. How to weigh these uncertainties is a problem under any approach because while the Agency often has quantitative estimates of uncertainty to use for specific elements of the risk assessment, it can often only make a qualitative judgment about whether the overall uncertainty in the methods and assumptions has resulted in a over- or underestimated risk. Comments are solicited on the consideration of uncertainty in acceptable risk decisions.

Each alternative deals similarly with the ample margin of safety decision. In each, all the health information as well as cost, technical feasibility, estimation uncertainties and other relevant factors would be considered. Comment is requested on five issues in particular. First, is the ample margin of safety step more suitable than the acceptable risk step to take into account (usually qualitatively) the direction and extent of estimation uncertainties? Second, should all technically feasible and affordable controls be required without regard to whether any significant risk reduction is associated with the control? Third, should the Agency adopt a policy of using the ample margin step to force the development of new technology to reduce risk? Fourth, how should EPA balance the various risk, technical, and economic considerations in ample margin of safety decisions? Fifth, what criteria should EPA use to define the "availability" and "feasibility" of technological controls?

The remainder of this section describes several risk measures, how they are derived, general questions regarding control technology, and the four alternative regulatory approaches. The approaches are considered from the perspective of application to the radionuclide source categories covered in today's notice and to the NESHAP program.

D. Risk Measures Considered in NESHAP Policy Approaches

In decisions on cancer risks from stationary sources of hazardous air pollutants, the Agency has estimated three measures of health risk. These are termed "maximum individual risk," "risk distribution," and "incidence". Each of these combines an estimate of the dose/response for a pollutant with estimates of exposure to the pollutant. The response estimated is the pollutant-related increase in the probability that an individual will contract fatal cancer in his or her lifetime. The exposure

estimated is the average daily exposure assuming exposure for 70 years.

1. Maximum Individual Risk

Individual risk is expressed as an estimated probability, e.g., 1 in 100 (10^{-2}), 1 in 1,000 (10^{-3}), 1 in 10,000 (10^{-4}). Thus a 1×10^{-3} individual risk is an added "chance" of 1 in 1,000 of contracting fatal cancer sometime in the individual's lifetime.

In this discussion, the maximum individual lifetime risk is the additional cancer risk of a person due to exposure for 70-year lifetime at a point of maximum concentration of an emitted pollutant. The maximum individual risk is sometimes called the maximum exposed individual risk. This estimate is based on the fact that the concentration of an emission, and the consequent risk, diminishes with distance from its source. For NESHAP decisions, the practice has been to estimate this figure for the largest annual average pollutant concentration to which any member of the public may be subject according to census data on residence locations. It has also been estimated in some other Agency decisions as the maximum at the source perimeter.

The maximum individual lifetime risk is different from average individual risk which is sometimes estimated for sources like public drinking water systems or food in which the concentration of a pollutant and other factors are assumed to be equal at all distribution locations. This distinction is particularly relevant when considering the maximum risk one might find acceptable from different sources. In using the maximum individual risk in acceptable risk decisions for hazardous air pollutants, its limitations should be considered. Used alone, the measure does not tell how many people may be so affected; it relates only to the risk to the most exposed individual(s).

2. Risk Distribution

A risk distribution estimates how many persons within a certain distance (e.g. 80 km) of a source of pollutant emissions are at what level of individual risk. Typically, the distribution is given for 10-fold increments of individual risk. Such a distribution provides the decisionmaker with information on both the individual risk level for those exposed and the number of persons exposed at each level. For NESHAP and other decisions, the Agency has examined risk distributions both as measures of risk and to compare the effects of various strategies for risk reductions across a source category.

In making an acceptable risk decision, one relevant consideration is how many people are exposed at each risk level, e.g. a (10^{-2}) risk might be acceptable if only one person were at that level, but not if 1,000 people were subject to it. Similarly, the number of persons exposed at various individual risk levels could be an important element in deciding on acceptable risk. The risk distribution could be used in similar ways to consider whether an ample margin of safety exists.

3. Incidence

Incidence is an estimate of population, rather than individual, risk. It is derived by multiplying individual risk by the estimate of the number of persons at that level of risk and summing the results over all risk levels. This number, which provides a lifetime population risk figure, is then divided by 70 (years) to give an annual fatal cancer incidence estimate. The incidence parameter can be used as an estimate of impact on the entire exposed population within a given area by totalling the incidence associated with each increment of individual risk. Incidence can also be portrayed along with individual risk and population numbers in a risk distribution. Typically, the Agency weighs incidence estimates in conjunction with maximum individual risk or average individual risk estimates. Estimated incidence generally is a particularly informative parameter when looking at aggregate risk from a category of like sources. One feature to take into account whenever it is used is its dependence on the size of the source category.

E. Uncertainties in Risk Measures.

Each of the three risk parameters defined above has three elements. These are the estimated response per unit of pollutant concentration (e.g. pCi/1 in air), the estimated exposure concentration, and the estimation of the number and location of the population residing in the area of the sources (usually taken from census data).

Uncertainties exist in estimating each of these elements for a variety of reasons including the fact that the relevant data and our understanding of the biological events involved are not complete. Where data gaps exist, qualitative and quantitative assumptions are made based on our present understanding of the biological mechanisms of cancer causation, estimates of air dispersion, engineering estimates, and other factors. Selection of certain assumptions to be used is a policy decision. The Agency has published guidelines covering many of these for both cancer risk assessment and exposure assessment. ["Final Guidelines for Carcinogen Risk Assessment," 51 FR 33992 (September 24, 1986) and "Final Guidelines for Estimating Exposures," 51 FR 33042 (September 24, 1986)].

The following is a discussion of methods used to calculate the three parameters, together with a few examples of the uncertainties.

Risk assessment, under EPA guidelines, takes into account the nature and amount of evidence that the agent will cause the effect of concern in humans as well as the uncertainties of interpretation of data and its quantification. When the toxicity data from human studies are available, as in the case of radionuclides (which is a known carcinogen), there is less uncertainty about the hazard of dose/response than when the data is solely from animal studies. Nevertheless, important uncertainties enter into the analysis even when human data is available. Examples include the fact that human epidemiological studies are often retrospective and measure effects of exposure that occurred many years in the past. The level of exposure to the agent at that time usually must be estimated and cannot be verified. Also, in certain categories of human studies, the studies are often of workers exposed to the pollutant. Worker populations are not representative of the general population with respect to age or sex. Workers are also generally the healthier segment of the population. These factors can lead to over- or underestimation of risk.

When data from animal studies are used, uncertainties about exposure can be experimentally controlled, but other uncertainties arise. Many of these concern the extrapolation from data collected in animal tests to estimate effects on humans. The extrapolation has to try to account for many factors, such as the equivalent dose for humans and laboratory animals given the size differences and the potential differences in metabolism and excretion of a chemical pollutant.

In addition, uncertainties arise in extrapolating the observed dose/response relationship from either workplace or animal test exposures to the usually lower dose levels of the general population.

In estimating exposure, the dispersion of a pollutant from a source is usually quantified by a predictive mathematical model using a known or model source emission rate, temperature and velocity characteristics, and weather patterns at nearby stability array (STAR) stations, typically the nearest recording weather station. The model predicts the

concentration of the dispersed pollutant at various distances from the source. Standard assumptions are that the population around the source resides there for a 70-year lifetime and is continuously exposed to the modeled concentrations. The amount of emissions can be derived from sampling and analysis of emissions at the source or from engineering estimates, with more or less uncertainty associated with each method according to the type of emission. There are varying degrees of accuracy and precision in sampling, analysis, or estimates of emissions. Therefore the uncertainties involved in the method of estimating individual exposure and the number of individuals exposed are numerous. Thus, it is evident that uncertainty is difficult to quantify. Questions relevant to two-step decisionmaking under the *Vinyl Chloride* opinion are: At which step or steps should uncertainty be accounted for? How should uncertainty be considered if it cannot be quantified?

F. Technology Availability and Plant Closure Considerations

In the proposed benzene NESHAP, as well as in this NESHAP for radionuclides, EPA has considered only factors relating to risks to public health in deriving alternative "acceptable" levels of risk. However, in evaluating whether to further reduce the risk to provide for an ample margin of safety, EPA has also considered the extent to which plants would be forced to: (a) Install control technologies which are not cost effective or fully demonstrated and/or (b) curtail or stop production. These considerations are reflected in today's proposal to the extent that they apply to affected radionuclide sources.

With regard to the availability of technology to control air pollutants, EPA has in this case considered a technology available if it has been installed on a commercial scale in the United States and adequate data have been collected on plant and control equipment characteristics and performance. However, at various times in the past, EPA has considered emission standards which force plants to install technologies which do not meet these current "availability" criteria or cause facilities to curtail production or shut down. For example, EPA has in the past considered a technology "available" if it has been commercially demonstrated in other countries, even if no units have been installed in the United States. Also, EPA has considered bench- or pilot-scale demonstrations in order to judge reasonableness of expenditures for commercial demonstration of a given technology. Others have argued that EPA should not be concerned about the extent to which technologies are "available" since the standards should be solely based on public health considerations. Proponents of this latter view argue that the health-based standards will themselves provide adequate incentive for currently high risk industries to develop new control technologies. Still others argue that the compliance schedules in section 112 will cause sources to close rather than undertake the risk of installing costly technology that is unproven.

The EPA solicits public comment on the relative merits of alternative criteria for determining the availability of technology and on the question of appropriate alternative methods for encouraging development of alternative technologies, processes, product substitutes, and/or lifestyle changes.

G. Description of Alternative Policy Approaches

Each of the four approaches described here for comment treat the "acceptable risk" decision differently. The first approach considers all risk factors in the "acceptable" decision and then considers all risk factors plus cost and feasibility of emission controls in the "ample margin of safety" decision. The other three approaches differ from the first in that they use a single parameter, maximum individual lifetime risk or incidence, as the sole deciding factor for acceptable risk, while considering other factors in the "ample margin" decision.

The case-by-case and single parameter approaches differ in the degree to which they possess each of two desirable features. One feature is the ability of the Agency to consider the weight of evidence, or confidence, in the hazard data from which risk numbers are derived and the confidence in the emission and exposure estimates. The second feature is the degree to which decisions are clear and understandable, and thus can be perceived by the public as consistent.

The case-by-case approach is designed to bring all of the evidence to bear in association with risk numbers at both decision steps. The Agency has adopted the policy of risk assessment contained in the 1983 study by the National Academy of Sciences entitled "Risk Assessment in the Federal Government Managing the Process" (National Academy Press). This study covers the various elements of cancer risk assessment and the assumptions and uncertainties it involves.

One of the policies emphasized in the report and adopted by EPA is to give the risk manager a risk characterization which contains the information needed for a decision on how much confidence to place on numbers. For example, numbers for risk estimates for two different pollutants might look the same, but be based on data sets of quite different quality. A very large set of data from human and animal studies could be the foundation for a high degree of certainty in deriving a quantitative dose/response relationship. On the other hand, a quantitative dose/response estimate based on less evidence could be more uncertain. Moreover, emission estimates and exposure modeling may be based on site-specific information, assumptions, or combinations of the two. Depending on the data and assumptions, there can be large differences in the confidence of the exposure estimates. EPA has used a variety of data in this rulemaking and has confidence in the data used for the purposes of this rulemaking. However, a risk manager would be justified in using two kinds of estimates differently in decisionmaking, in spite of the fact that the numbers might be very similar.

An advantage of the case-by-case approach is that it uses the full range of evidence behind the risk numbers in determining acceptable risk and in deciding on an ample margin of safety. A disadvantage of this approach is that it relies on case-by-case interpretation and judgment of data, which can make the basis for the decision more difficult for the public to understand. In addition, decisions may appear inconsistent when different numerical risks are judged to be acceptable in different cases.

The single measure approaches takes risk numbers at face value for the acceptable risk decision, with a fuller consideration of the weight of all evidence at the margin of safety step. The advantages of these approaches are their clarity and ease of administration, which are good bases for adoption of such an approach. Their disadvantage is that they do not consider all of the risk factors, risk characterization, and uncertainties in the initial step.

Approach A. Case-by-Case Approach

Under this approach, the Administrator makes decisions on what is an acceptable risk on a case-by-case basis. The Administrator considers individual risk, risk distribution and incidence, their estimation limitations and uncertainties in judging which levels of emissions present acceptable risks to public health for each of the sources considered. This approach recognizes that the risk to public health is a combination of these factors, and, therefore, the level of acceptable risk to

the public health varies among the different sources.

In applying Approach A, the approach is to examine the risk distribution and to consider maximum individual risks around 10^{-4} or less to be the preferred range. The 10^{-4} level was selected for reasons analogous to its use in Approach C (see discussion of Approach C for further explanation). Under all Approach A decisions, however, the Agency will closely examine the aggravating and mitigating factors associated with the risk estimates. Included in this examination is recognition that there are considerable uncertainties in the risk characterization, emission, estimates, and exposure assumptions; these uncertainties may very widely among assessment. Acceptability of higher risks includes consideration of the number of people at that risk and the total incidence. Greater weight is given to the incidence associated with individual risks greater than 10^{-5}, this is because risks lower than this are generally considered small. In addition, both the dose/response and exposure estimates increase in uncertainty at these lower levels, which generally represent large extrapolations from high to low doses and dispersion of the pollutant at greater distance from the source, respectively. Risks greater than the 10^{-4} or less preferred range may be judged acceptable in this approach when all factors are considered. Examples of circumstances that EPA believes appropriate to consider include: (1) The uncertainties of the analysis; (2) the degree of over or under estimation in the risk characterization; (3) the weight of evidence of the health effects and non-quantified health effects, (4) modeled versus measured exposures, and; (5) the estimated population predicted at lifetime risk of around 1 in 10,000 or greater.

It should be recognized that zero risk is unattainable. This approach provides a mechanism to reasonably consider various health risks or other health related factors that are appropriate to each source category.

EPA has also considered the health risk due to the level of natural background radiation. In the case of radionuclides, the background levels cause higher individual and population risks than any of the source categories being considered for regulation in this rulemaking.

The highest level of emissions that is considered in the acceptable risk step is the baseline level of emissions. Alternatives other than baseline emissions are developed to give the Administrator reasonable alternatives with specific quantitative benefits to choose from. In reality, the concepts of acceptable risk and ample margin of safety exist on a continuum and are not easily quantified.

Decisions on acceptable risk are premised on the highest associated risk that was judged acceptable after weighing the many different considerations appropriate for that source category. Clearly all the alternatives for that source category that present smaller risks are also acceptable. Any alternative that is higher than the chosen alternative for that case allows risks that are unacceptable. However, that does not mean that any risk that is even slightly higher than the chosen alternative is inherently unacceptable. In order to develop standards, discrete alternatives are selected and discrete lines are drawn.

Approach B. Incidence-Based Approach

In this approach, incidence is the only parameter used to decide acceptability of risk. At the "ample margin of safety" step, all of the risk parameters as well as estimation uncertainties, cost, and feasibility are considered. The annual incidence proposed as acceptable is no more than 1 death/yr per source category. The EPA is proposing an incidence number of 1 per category because it is felt that one was small compared to the total number of cancer deaths each year and in relation to incidence associated with risks from numerous everyday activities. Comment is requested on the appropriateness of this selection.

Approach B relies on incidence. An advantage of an incidence-based approach is that while incidence and maximum individual lifetime risk are uncertain figures, in general, incidence figures are likely to be more accurate than maximum individual lifetime risk figures. A maximum individual lifetime risk estimate is much more sensitive to errors in modeling assumptions in the exposure estimate. When those uncertainties are spread throughout the exposed population in an incidence estimate, they tend to average out and thus to yield results that are less uncertain.

One feature to note is that since no other criterion besides incidence plays a role in the acceptable risk decision, high maximum individual risk levels would be acceptable so long as the exposed population is sufficiently small that the incidence level is met.

Approach C. $1x10^{-4}$ or less Maximum Individual Risk Approach

This approach would use maximum individual risk as the sole criterion for deciding acceptable risk. At the ample margin of safety step, the risk distribution and incidence would be added to the factors considered as well as uncertainty, cost and feasibility.

The acceptable risk level for maximum individual risk under this approach is $1x10^{-4}$ or less. This approach focuses on the estimation of the maximum concentration to which anyone could be exposed, which is used to calculate the maximum individual risk. Approach C's acceptable risk is defined as $1x10^{-4}$ maximum individual risk. This level is analogous to the top of the target individual risk range used in some other EPA programs. A risk of 10^{-4} falls roughly in the middle of the range of risks considered in the survey of societal risks, discussed earlier in this section. An advantage of using the single parameter of individual risk is that it is simple and clear cut. The level chosen is low enough to assure that the risk to the public health is acceptable. One disadvantage of Option C is that without the additional perspective of the risk distribution and incidence estimates and all other risk information, many decisions would ride exclusively on the uncertain prediction of the concentration and location of the area of maximum exposure. The accuracy of emission factors, meteorological data, and census data for specific source locations are among the more uncertain estimates, but would be the most critical elements under this decision. However, at the ample margin of safety step, the other risk measure could be examined to bring the needed perspective to the overall decision.

Approach D. $1x10^{-6}$ or Less Maximum Individual Risk Approach

This approach is identical to Approach C except that it uses a more stringent criterion for individual risk. The acceptable risk is defined as $1x10^{-6}$ maximum individual risk. This level is proposed on the theory that risks below this level have been generally regarded as small additions to an individual lifetime risk or cancer considering the risks faced by background radiation. Additionally, the 10^{-6} level falls near the lower end of the risk range in the survey of risks, discussed earlier in this section.

Based on current information, EPA is unable to accurately quantify the effects resulting from the implementation of Approach D. We are interested in

receiving comments concerning the effects of such action.

H. Format of Standards

The format of the standards proposed for the various source categories vary because of the differing technical features of the sources. For example, area sources emitting radon are best monitored by flux measurements. Thus, flux standards are most appropriate. Similarly, mixtures of radionuclides are best related to public health through the use of the concept of dose. We have proposed dose standards to limit emissions in those cases where it is appropriate. Where a single radionuclide is emitted or a single radionuclide emission limit would serve to limit all others, we have proposed an emission limit for that radionuclide. Where no form of emission limit is possible, we resort to work practice standards.

VII. Discussion of Source Categories

The regulatory decisions proposed today are based on the risk assessments and other factors available in the current rulemaking record. This proposal may provide EPA with additional risk analyses or other information relevant to these decisions. Consequently, based on such information the Administrator may choose to reach a different regulatory decision in the final rule for some or all the source categories addressed in the rulemaking.

A. Department of Energy Facilities

1. Introduction

The DOE administers many facilities, including government-owned, contractor-operated facilities across the country. Some facilities conduct nuclear energy and weapons research and development, some enrich uranium and produce plutonium for nuclear weapons and reactors, and some process, store and dispose of radioactive wastes. These facilities contain significant amounts of radioactive material and emit radionuclides into the air. Other facilities contain large stockpiles of byproduct material which emit large quantities of radon. A discussion of DOE facilities in this category appears as a separate section later in this Preamble. EPA is considering the two categories separately in this rulemaking because of the imprecision of converting radon measurements into dose standards. In addition, the two categories employ different control methods.

Some of the DOE facilities emitting radionuclides are on large sites covering hundreds of square miles in remote locations. Some of the smaller sites resemble typical industrial facilities and are located in suburban areas.

In total, DOE has almost 100 sites that emit radionuclides. These facilities emit a wide variety of radionuclides in various physical and chemical states. Emissions from various DOE facilities represent many types of radionuclides and both internal and external dose pathways (although specific facilities may emit only one or two radionuclides affecting only one pathway).

DOE facilities are presently covered by a radionuclide NESHAP which limits emissions such that no individual receives a whole body dose of 25 mrem/y or receives a dose of 75 mrem/y to any organ. DOE also controls releases from these facilities under DOE orders which limit calculated doses to the general public to be less than 100 mrem/y from all sources and pathways. By incorporating the ALARA concept into its Orders, DOE has kept the dose to the public well below 100 mrem/y. The NESHAP also mandates that DOE send annual reports of emissions to EPA. The information gathered from these reports contributed to EPA's risk assessment of DOE facilities.

2. Estimates of Exposure and Risk

EPA's risk assessment of DOE facilities is a site-by-site assessment. Emissions are based on DOE's 1986 report of emissions, meteorological data is taken from nearby weather stations, and population distributions within 80 km are based on U.S. census tract data. EPA has a high degree of confidence in the results of this risk assessment.

According to EPA's analysis, all DOE facilities are in compliance with the current NESHAP. The risk to the most exposed individual is approximately 1.2×10^{-4}. DOE facilities are estimated to cause 0.17 fatal cancers per year to the exposed populations within 80 km of all DOE facilities. Most of the exposed population has a lifetime fatal cancer risk of less than 1×10^{-6}.

Table 4 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2 and 3.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI, to the DOE source category are described below.

Approach A: Case-by-Case Approach—Decision on Acceptable Risk. As stated earlier the maximum individual risk to any individual is 1.2×10^{-4}, which is virtually the same as the level generally preferred under the case-by-case approach. Only a few people are at risks greater than 1×10^{-4}, and the vast majority of people within 80 km of DOE facilities receive risks of less than 1×10^{-6}. The estimated annual incidence is 0.17 fatal cancers per year. Most DOE facilities have much smaller emissions than that causing the highest individual risk and do not contribute significantly to the total risk from the entire category. In addition, DOE has reduced the emissions from its facilities over the last few years and is continuing to do so.

EPA examined several alternatives before determining the acceptable level. Those alternatives and the risks they present are illustrated in Table 4. After examining these different options, the Administrator proposes to determine that 10 mrem/y ede, which represents the baseline, is acceptable under the case-by-case approach.

TABLE 4.— ALTERNATIVES FOR ACCEPTABLE RISK FROM DOE FACILITIES

	Alternative 1 (baseline)	Alternative 2	Alternative 3
Maximum individual risk (lifetime)	1.2×10^{-4}	3.6×10^{-6}	2.4×10^{-5}
Incidence within 80 km (death/y)	0.17	0.13	0.094
Risk individual:			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	(1)	0	0

TABLE 4.— ALTERNATIVES FOR ACCEPTABLE RISK FROM DOE FACILITIES—Continued

	Alternative 1 (baseline)	Alternative 2	Alternative 3
E-5 to E-4	600,000	540,000	250,000
E-6 to E-5	1M	140,000	410,000
Less E-6	65M	66M	66M
Risk incidence:			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	([1])	0	0
E-5 to E-4	0.12	0.11	0.042
E-6 to E-5	0.035	0.0067	0.040
Less E-6	0.011	0.014	0.012

Other Health Impacts: Total cancers no more than twice fatal cancers.
[1] EPA believes there are people at this risk at two facilities. However, we cannot quantify the number because site visits have not been made.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from DOE facilities. To reduce the complexity of studying the costs and benefits of all different control options, EPA has concentrated on the facilities with the largest emissions. The costs and benefits of controlling emissions to various levels can be seen in Table 5.

Based on the costs of achieving alternative 2 and the very small reductions of incidence and the small decreases in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current level, represented by a level of 10 mrem/y ede, will protect public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go significantly higher, that the protection of public health requires that a NESHAP be promulgated to insure that the current levels of emissions which are safe with an ample margin of safety are not increased. Therefore, EPA is proposing a NESHAP manadating that radionuclide emissions from DOE facilities shall not cause any individual to receive a dose of greater than 10 mrem/y ede.

TABLE 5.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR DOE FACILITIES

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	1.2×10^{-4}	0.17					
1-A	1.2×10^{-4}	0.17					
2	3.6×10^{-5}	0.13	0.04	0.04	$7.4M	$0.7M	$0.7M
3	2.4×10^{-5}	0.094	0.036	0.076	111M	16M	17M

Regulatory Status: Currently we have a NESHAP limiting air emissions to 25 mrem/y whole body and 75 mrem/y any organ (equivalent to a MIR of 7×10^{-4}).
Comments:
Alternative 1: Baseline, no rule—Self regulated by DOE. They use ALARA procedures and their own overall whole body limit of 100 mrem/y. The current NESHAP would be vacated.
Based on a low-LET risk factor of 400 fatal cancers per million person-rad, ranging from 120 to 1200 fatal cancers per million person-rad, the Alternative 1 risk may range from 3.6×10^{-5} to 3.6×10^{-4}.
Alternative 1-A: Baseline rule, emission limit of 10 mrem/y ede (equivalent to a MIR of 3×10^{-4})—highest emissions are from Reactive Metals, Los Alamos and Hanford sites.
Alternative 2: Emission limit of 3 mrem/y ede (equivalent to a MIR of 1×10^{-4})—the following controls are needed: RMI—HEPA filters on 3 stacks; Los Alamos—beam stops and delay lines; Hanford—N-reactor remains closed; Oak Ridge-HEPA filters, particulate scrubbers, and tritiated water capture.
Alternative 3: Emission limit of 1 mrem/y ede (equivalent to a MIR of 3×10^{-5})—the following additional controls are needed: Savannah River—HEPA filters for particulate control; FMPC-HEPA filters and scrubbers to control uranium emissions.
Alternative 4: Table does not contain alternative to bring the MIR to 1×10^{-6} because it is not yet possible to predict results accurately. Many additional controls would be needed. DOE roughly estimates cost to exceed $250 million.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. EPA has determined that emissions from DOE facilities cause less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from DOE facilities. To reduce the complexity of studying the costs and benefits of all different control options, EPA has concentrated on the facilities with the largest emissions. The costs and benefits of controlling emissions to various levels can be seen in Table 5.

Based on the costs of achieving alternative 2 and the very small reductions of incidence and the small decreases in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current level, represented by a level of 10 mrem/y ede, will protect public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go significantly higher, that the protection of public health requires that a NESHAP be promulgated to insure that the current levels of emissions are not increased. Therefore, EPA is proposing a NESHAP mandating that radionuclide emissions from DOE facilities shall not cause any individual to receive a does of greater than 10 mrem/y EDE.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. The use of dose-based standards makes it simple to determine the correct standard under this approach. When the dose is evenly distributed to all organs, an effective dose equivalent of 3 mrem/y for 70 years equals a risk of 1×10^{-4}. Therefore, under this approach, an

acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 3 mrem/y.

Decision on Ample Margin of Safety. After comparing the benefits and costs of reducing risks below the safe level, EPA has determined that no further reductions below the level of 3 mrem/y EDE are needed. Therefore, EPA is proposing a NESHAP of 3 mrem/y which protects public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. The use of dose based standards makes it simple to determine the correct standard under this approach. When the dose is evenly distributed to all organs, an effective dose equivalent of 0.03 mrem/y for 70 years equals a risk of 1×10^{-6}. Therefore, under this approach an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 0.03 mrem/y.

Decision on Ample Margin of Safety. After comparing the benefits and cost of reducing risks below the safe level, EPA has determined that no further reductions below the level of 0.03 mrem/y EDE are needed to protect public health with an ample margin of safety. Therefore, EPA is proposing a NESHAP of 0.03 mrem/y protects public health with an ample margin of safety.

4. Implementation

a. Introduction. ORP's experience in implementing the existing radionuclide NESHAP covering DOE facilities has shown that implementation of the current standard has several problems. EPA is proposing a new system for implementing the proposed NESHAP designed to overcome some of the limitations in the present standard. This system will be used regardless of the specific level of standard that is chosen.

b. Yearly reports. The implementation system for the NESHAP is designed to provide EPA with yearly reports on the levels of emissions from regulated facilities and resulting doses. Presently, DOE facilities monitor their emissions and make annual reports to EPA. These reports should continue under the new NESHAP. Although the report is based on a calendar year the dose standard applies to any year, i.e. any period of 12 consecutive months. Since these reports provide EPA with the information it needs, DOE facilities are exempted from the requirements of 61.10.

c. Definition of a facility. A problem in implementing the current standard is the ambiguity associated with the present definition of a facility. All the buildings, structures and operations within one contiguous site shall be considered a single facility. For example, the entire DOE facility at Oak Ridge, Tennessee must meet the current standard of 25 mrem/y, instead of each individual building getting its own 25 mrem/y standard.

d. Distinction between construction and modification. Since EPA takes the position that a facility is all the buildings within a given plant site, there can be confusion over whether the construction of a new building constitutes an existing facility, is new construction, or is a modification of an existing facility. It is proposed that the new NESHAP will specify that the construction of a new building is new construction at the facility and not a modification of the facility. This distinction is important because all new construction needs to be checked to see whether or not it needs prior approval but modifications which do not cause a net increase in the rate of emissions from the facility do not need prior approval.

e. Prior approval of new construction or modification. EPA will not change the basic definition of modification that exists at 40 CFR 61.15. A change that causes any increase in the rate of emissions is a modification, no matter how small that increase is. To reduce unnecessary paperwork, it is appropriate to avoid applications in cases of small changes.

EPA proposes a system under which DOE facilities will use AIRDOS to determine the dose to the most exposed individual due to the modification or new construction. If the estimated maximum individual dose added by the new construction or modification is less than 1% of the standard, then the modification or new construction does not need prior approval.

In making the determination of dose, for this purpose DOE must use the emission factors and source term determination from "BID: Procedures Approved for Demonstrating Compliance with the Dose Limits Established by 40 CFR Part 61, subpart I." (BID: Compliance).

B. Nuclear Regulatory Commission Licensed and Non-DOE Federal Facilities

1. Introduction

NRC-licensed, Agreement state-licensed, and non-DOE federal facilities include over 6,000 different facilities. These facilities include research and test reactors, hospitals, clinics, the radiopharmaceutical industry, low level nuclear waste facilities, and other research and industrial facilities. These facilities are located in all fifty states. EPA estimates that virtually every American lives within 80 km of an NRC licensee.

The facilities in this category emit a large number of radionuclides. These radionuclides affect individuals by inhalation, ingestion, ground deposition and immersion pathways. Individual facilities may emit only one or two radionuclides affecting only one or two pathways.

Emissions from this source category are presently covered by a radionuclide NESHAP which mandates that emissions do not cause any individual to receive a whole body dose of more than 25 mrem/y or receive a dose of 75 mrem/y to any organ. Two categories of NRC-licensees have been exempted from coverage by the existing NESHAP: High-level nuclear waste (HLW) facilities and uranium fuel cycle (UFC) facilities. There are two types of HLW facilities, management and disposal facilities. The disposal of HLW, which occurs at a few unique facilities, is considered as a separate source category. The management, processing and storage of HLW that occurs at a NRC-licensee is included in the estimate of emissions of the licensee used in the analysis that underlies today's proposal for this category. Most of the NRC-licensees that manage, process or store HLW do so because it is related to their other operations. For radionuclide NESHAPs, EPA has determined that it is impractical to separately analyze and regulate two different emissions from the same facility. UFC facilities, which are distinctly different facilities, are being analyzed as a separate source category.

2. Estimates of Exposure and Risk.

EPA's risk assessment of this category combined an analysis of the nine sub-categories that make up this category. Due to the wide scope of this category, EPA's risk assessment of this source category is based on large emitters and model facilities with model populations. The assessment included both analysis of those facilities believed to be the largest emitters and model facilities within each sub-category. The estimates of maximum individual risk are based on the site-by-site assessment of the largest known emitters.

The analysis of the largest sources was based on information compiled from previously existing data bases and information received from some of the sources themselves. The model facilities were developed after reviewing data from surveys conducted by the NRC and

the Conference of Radiation Control Program Directors. The use of model facilities increases the uncertainty of the risk assessment. Especially uncertain are estimates of the population within given risk ranges. EPA requests that commentors provide any additional information concerning emissions from this source category that might change EPA's estimate of maximum individual risk or population incidence.

The estimates of population risks are based on extrapolations from model facilities using census tract data. Frequency distributions do not take into account overlapping sources.

The results of this analysis are a maximum individual risk of 1.6×10^{-4}. EPA estimates that this category results in 0.13 fatal cancers per year. EPA's analysis shows that less than 0.5% of the U.S. population receives a lifetime fatal cancer risk greater than 1×10^{-6}. Some of the larger NRC-licensees do release small amounts of iodine-125 and iodine-131; these radionuclides can cause thyroid cancer.

Table 6 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2 and 3.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI to the NRC-licensees source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. The maximum individual risk to any individual is approximately 1.6×10^{-4} which is higher than the level preferred under the case-by-case approach. The estimated annual incidence is 0.13 fatal cancers per year; virtually all of that risk is borne by people whose risk is less than 1×10^{-5}, and over 80% of the risk is borne by individuals whose risk is less than 10^{-6}. Most NRC-licensees have much smaller emissions and do not contribute significantly to the total risk.

EPA examined several alternatives before determining the acceptable level. Those alternatives and the risks they present are illustrated in Table 6. After examining these different options, the Administrator proposes to determine that 10 mrem/y ede, which represents the baseline, is acceptable under the case-by-case approach. A maximum individual risk higher than the preferred level is acceptable in this case because only a few individuals incur this level of risk and because the risk distribution is such that incidence is only 0.13 per year.

TABLE 6.—ALTERNATIVES FOR ACCEPTABLE RISK FROM NRC LICENSEES

	Alternative 1 (baseline)	Alternative 2	Alternative 3
Maximum individual risk (lifetime)	1.6×10^{-4}	1.0×10^{-4}	3.0×10^{-5}
Incidence within 80 km (death/y)	0.13	0.13	0.12
Risk individual:			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	[1]	[1]	0
E-5 to E-4	2,600	2,600	800
E-6 to E-5	720,000	720,000	400,000
Less E-6	240M	240M	240M
Risk incidence:			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	[1]	[1]	0
E-5 to E-4	0.00054	0.00054	0.00025
E-6 to E-5	0.024	0.024	0.011
Less E-6	0.11	0.11	0.11

Other Health Impacts: Total cancers may be as much as 9 times higher than the number of fatal cancers because risks from some of the largest facilities in this source category are caused predominately by iodine which causes thyroid cancer.

[1] We believe there are some individuals at this risk level but all 6,000 facilities in this category have not been characterized.

Decision on Ample Margin of Safety. EPA has examined the control technology necessasry to lower emissions from NRC-licensees. To reduce the complexity of studying the costs and benefits of all different control options, EPA has concentrated on the facilities with the largest emissions. The costs and benefits of controlling emissions can be seen in Table 7.

Based on the costs of achieving alternative 2 and the very small reductions of incidence and the small decreases in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current level, represented by a level of 10 mrem/y ede, will protect public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go higher, that the protection of public health requires that a NESHAP be promulgated to insure that the current levels of emissions which are safe with an ample margin of safety are not increased. Therefore, EPA is proposing a NESHAP mandating that radionuclide emissions from NRC-licensees shall not cause any individual to receive a dose of greater than 10 mrem/y ede.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. EPA has determined that emissions from NRC-licensees cause less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from NRC-licensees. To reduce the complexity of studying the costs and benefits of all different control options, EPA has concentrated on the facilities with the largest emissions. The costs and benefits of controlling emissions to various levels can be seen in Table 7.

TABLE 7.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR NRC FACILITIES

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	1.6×10^{-4}	0.13					
1-A	1.6×10^{-4}	0.13					
2	1.0×10^{-4}	0.13	<0.01	<0.01	$5M	$2.4M	$2.4M
3	3.0×10^{-5}	0.12	0.1	0.1	$20M	$9.6M	$12M
4	1.0×10^{-5}	0.07	0.05	0.06	$35M	$23M	$35M

Regulatory Status: Currently we have a NESHAP limiting air emissions to 25 mrem/y whole body and 75 mrem/y any organ (equivalent to a MIR of 7×10^{-5}).
Comments: For this category, non-fatal cancer risk is appreciably higher than the fatal cancer risk because most of the risk is due to I-131 and I-125 exposure (thyroid).
Alternative 1: Baseline, no rule—Some facilities may cause higher risks. All 6000 facilities have not been characterized. The current NESHAP would be vacated. Based on a low-LET risk factor of 400 fatal cancers per million person-rad, ranging from 120 to 1200 fatal cancers per million person-rad, the Alternative 1 risk may range from 4.8×10^{-5} to 4.8×10^{-4}.
Alternative 1-A: Baseline rule, 10 mrem/y ede (equivalent to a MIR of 3×10^{-5})—As a practical matter, this alternative is the same as the current NESHAP.
Alternative 2: Emission limit of 3 mrem/y ede (equivalent to a MIR of 1×10^{-5})—cost estimates are very uncertain. Several hundred facilities would install controls or measure emissions to demonstrate compliance.
Alternative 3: Emission limit of 1 mrem/y ede (equivalent to a MIR of 3×10^{-5})—cost estimates are very uncertain; estimates are not site specific.
Alternative 4: Emission limit of 0.3 mrem/y ede (equivalent to a MIR of 1×10^{-5})—compliance procedures have been developed to reduce the burdens to the regulated community. At this level many facilities will have difficulty demonstrating compliance.
Alternative 5: Table does not contain alternative to bring the MIR to 1×10^{-5} because it is not possible to predict the impact. Many additional controls would be needed. Implementation would be burdensome as most facilities would now have to demonstrate compliance with an emission limit in rigorous fashion.

Based on the costs of achieving alternative 2 and the very small reductions of incidence and the small decreases in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current level, represented by a level of 10 mrem/y EDE, will protect public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go higher, that the protection of public health requires that a NESHAP be promulgated to insure that the current levels of emissions are not increased. Therefore, EPA is proposing a NESHAP mandating that radionuclide emissions from NRC-licensees shall not cause any individual to receive a dose of greater than 10 mrem/y EDE.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. The use of dose-based standards makes it simple to determine the correct standard under this approach. When the dose is evenly distributed to all organs, an effective dose equivalent of 3 mrem/y for 70 years equals a risk of 1×10^{-4}. Therefore, under this approach, an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective does equivalent of more than 3 mrem/y.

Decision on Ample Margin of Safety. After comparing the benefits and costs of reducing risks below the safe level, EPA has determined that no further reductions below the level of 3 mrem/y EDE are needed. Therefore, EPA will propose a NESHAP of 3 mrem/y which protects public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. When the dose is evenly distributed to all organs, an effective dose equivalent of 0.03 mrem/yr for 70 years equals a risk of 1×10^{-6}. Therefore, under this approach, an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 0.03 mrem/y.

Decision on Ample Margin of Safety. After comparing the benefits and costs of reducing risks below the safe level, EPA has determined that no further reductions below the level of 0.03 mrem/y EDE are needed to protect public health with an ample margin of safety. Therefore, EPA will propose a NESHAP of 0.03 mrem/y which protects public health with an ample margin of safety.

4. Implementation

a. Introduction. The system for implementing this NESHAP is described in "A Guide for Determining Compliance with Clean Air Act Standards for Radionuclide Emissions From NRC-Licensed and Non-DOE Federal Facilities." The Agency has also developed the COMPLY Computer Code (described earlier), for IBM and IBM-compatible computers, to assist the regulated community in determining compliance with the standard.

b. Yearly reports. The implementation system for the NESHAP is designed to provide EPA with yearly reports on the levels of emissions and the dose caused by those emissions from regulated facilities. There are over 6,000 NRC-licensees, many of whom have very small amounts of radionuclides. EPA considers that the emissions from most sources in this category are so low that reporting should not be necessary. EPA has developed a system to determine whether or not reporting is required by estimating the dose caused by a facility's emissions. As long as the dose to the maximum individual is 10% of the standard or less, then the facility does not have to report. EPA currently estimates that if the cutoff is 1 mrem/yr, then less than 300 facilities would have to report to EPA.

The Agency has developed a system for dose determination that is based on screening models originally developed by the NCRP. This system is a series of screening tests each more complicated and more realistic than the next. Using this system, each affected facility will, annually, have to check to see whether or not it needs to report to EPA. Even in it does not have to report, it must keep records of the results for 5 years to demonstrate that it has checked to see whether or not it needs to report. Although the report is based on a calendar year the dose standard applies to any year, i.e. any period of 12 consecutive months.

In order to simplify calculation of the source term, the Agency will allow the use of generic emission factors. The derivation of these emission factors is explained in BID: Compliance. These factors are applied to the quantity of radionuclides used annually at the facility. Radionuclides in sealed containers are excluded. The results of these calculations are used as the input of emissions for the screening model mentioned above.

Since these reports will provide EPA with the information it needs, NRC-licensees are exempted from the requirements of 61.10.

c. Prior approval for modification or new construction. EPA proposes that the system discussed for DOE facilities also be used for this source category except that the sources will not use AIRDOS to

calculate the doses. Instead they will use the screening models and measured emissions or emission factors described above.

C. Uranium Fuel Cycle Facilities

1. Introduction

Uranium Fuel Cycle (UFC) facilities are the facilities used in the conversion of uranium ore to electric power. They include uranium mills and tailings (non-radon emissions), hexafloride conversion plants, fuel fabrication plants and commercial nuclear power plants. These facilities are licensed by the NRC. (Uranium fuel enrichment facilities are not included in this category because they are covered as DOE facilities.) These facilities are large sophisticated operations with the potential for large releases of radionuclides.

These facilities are not covered by a NESHAP. However, all releases from these facilities (air, water and direct gamma radiation) are covered under the Uranium Fuel Cycle Standard, 40 CFR 190. This standard was promulgated by EPA under the authority of the AEA and is enforced by NRC. Under the standard, the combined releases of all UFC facilities must not cause any individual to receive a dose of more than 25 mrem/y to the whole body or to any organ except the thyroid (which can receive 75 mrem/y). This standard has been implemented and enforced by the NRC. In the past, the Administrator has decided not to regulate this category under section 112, because he determined that the AEA standard protected public health with an ample margin of safety. EPA's decision not to regulate this category is one of the issues in the current litigation. After reconsidering this issue, EPA has decided to analyze UFC facilities using the same four regulatory options used for other categories.

2. Estimates of Exposure and Risk

EPA's risk assessment for this category is the combination of the results of the assessments of the different types of facilities included in this category. The source term for emissions from uranium mill tailing piles is estimated from a model mill using NRC methodology. The estimate does not include radon releases which are covered by a separate NESHAP. Meteorological and population data are based on typical mill sites. The assessment of the two uranium hexafluoride conversion plants is based on reported emissions and census population distributions using nearby meteorological data.

The assessment for fuel fabrication plants is based on reported emissions and census population distributions from large facilities. The emission estimate for nuclear power plants is based on actual releases from operating plants. Population data is taken from NRC reference populations for coastal, river and lake sites. Assessments consider effects of multiple reactors at a site, but not the overlap of multiple sites. Virtually the entire U.S. population lives within 80 km of at least one UFC facility.

The results of the analysis show that the most exposed individual receives a dose associated with an increased risk of fatal cancer of 2.2×10^{-4}. There is less than 0.1 fatal cancer per year in the population, and virtually all the population risk is received by people with a lifetime risk of less than 1×10^{-6}.

Table 8 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2 and 3.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI, to the UFC facilities source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is approximately 2.2×10^{-4} which is higher than the level preferred under the case-by-case approach. The estimated annual incidence is 0.1 fatal cancers per year, and almost all of that risk is borne by people whose risk is less than 1×10^{-6}.

EPA examined several alternatives before determining the acceptable level. Those alternatives and the risks they present are illustrated in Table 8. After examining these different options, the Administrator proposes to determine that Alternative 1 (baseline emissions) is acceptable under the case-by-case approach. A maximum individual risk higher than the preferred level is acceptable in this case because the risk distribution is such that incidence is only 0.1 per year.

TABLE 8.—ALTERNATIVES FOR ACCEPTABLE RISK FROM URANIUM FUEL CYCLE FACILITIES

	Alternative 1 (baseline)	Alternative 2	Alternative 3
Maximum individual risk (lifetime)	2.2×10^{-4}	1.4×10^{-4}	3.0×10^{-5}
Incidence within 80 km (death/y)	0.10	0.10	0.10
Risk individual			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	95	[1]	0
E-5 to E-4	13,000	13,000	4,000
E-6 to E-5	190,000	190,000	190,000
Less E-6	240M	240M	240M
Risk incidence			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	0.00024	[1]	0
E-5 to E-4	0.0024	0.0024	0.001
E-6 to E-5	0.0093	0.0093	0.0093
Less E-6	0.091	0.091	0.091

Other Health Impacts: Total cancers no more than twice fatal cancers.

[1] At least one person may be at this risk level, total number of people unknown because site visit has not been made.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from UFC facilities. To reduce the complexity of studying the costs and benefits of all different control options, EPA has concentrated on the facilities with the largest emissions. The costs and benefits of controlling emissions can be seen in Table 9.

Based on the costs of achieving alternative 2 and the fact that it would reduce the incidence of fatal cancer by less than one case every 100 years, and considerating the small decreases in individual risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current level, represented by a level of 10 mrem/y ede, will protest public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go significantly higher, that the protection of public health requires that a NESHAP be promulgated to insure that the current levels of emissions which are safe with an ample margin of safety are not increased. Therefore, EPA is proposing a NESHAP mandating that radionuclide emissions from UFC facilities shall not cause any individual to receive a dose of greater than 10 mrem/y ede.

Approach B: Incidence Based Approach. Decision on Acceptable Risk.

EPA has determined that emissions from UFC facilities cause less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

TABLE 9.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR URANIUM FUEL CYCLE FACILITIES

Alternative	MIR	Incidence	Incremental Incidence Reduction	Total Incidence Reduction	Incremental Capital Cost	Incremental Annualized Cost	Total Annualized Cost
1	2.2×10^{-4}	0.10					
1-A	2.2×10^{-4}	0.10					
2	1.4×10^{-4}	0.10	<0.01	<0.01	$5M	$5.4M	$5.4M
3	3.0×10^{-5}	0.10	<0.01	<0.01	$75M	$31M	$36M

Regulatory Status: Current AEA standard limits total emissions to 25 mrem/y whole body; 25 mrem/y any organ. Previously, we deferred to this AEA standard and did not propose a NESHAP for this source category.

Comments:

Alternative 1: Baseline, no rule—AEA rule limits risk to a maximum value of 7×10^{-4}.

Based on a low-LET risk factor of 400 fatal cancers per million person-rad, ranging from 120 to 1200 fatal cancers per million person-rad, the Alternative 1 risk may range from 6.6×10^{-5} to 6.6×10^{-4}.

Alternative 1-A: Baseline rule—10 mrem/y ede. The dose from one uranium mill is of this magnitude. CAA rule allows citizen suits not allowed under the AEA.

Alternative 2: Emission limit of 5 mrem/y ede (equivalent to a MIR of 1.4×10^{-4})—Particulate controls added to uranium mills. 5 mrem/y is the NRC design goal for nuclear power reactors.

Alternative 3: Emission limit of 1 mrem/y ede (equivalent to a MIR of 3×10^{-5})—Most of the incidence is due to power reactors and only a few are affected by this alternative, so there is little reduction in incidence. Additional controls are required for uranium mills and uranium conversion plants.

Alternative 4: Table does not contain alternative to bring the MIR to 1×10^{-6} because of the difficulty in estimating impacts. About half of the operating nuclear plants would add additional controls. Most supporting facilities would add additional controls. Cost would be large.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from UFC facilities. To reduce the complexity of studying the costs and benefits of all different control options, EPA has concentrated on the facilities with the largest emissions. The costs and benefits of controlling emissions to various levels can be seen in Table 9.

Based on the costs of achieving alternative 2 and the small associated decreases in individual risk, and the fact that virtually no reduction in incidence would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current levels, represented by a level of 10 mrem/y ede, will protect public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go significantly higher, that the protection of public health requires regulation under section 112 to insure that the current levels of emissions which are safe with an ample margin of safety are not increased. Therefore, EPA is proposing a NESHAP mandating that radionuclide emissions from UFC facilities shall not cause any individual to receive a dose of greater than 10 mrem/y ede.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. When the dose is equally distributed to all organs, an effective dose equivalent of 3 mrem/y for 70 years equals a risk of 1×10^{-4}. Therefore, under this approach, an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 3 mrem/y.

Decision on Ample Margin of Safety. After comparing the benefits and costs of reducing risks below the safe level, EPA has determined that no further reductions below the level of 3 mrem/y EDE are needed. Therefore, EPA is proposing a NESHAP of 3 mrem/y which protects public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. When the dose is equally distributed to all organs, an effective dose equivalent of 0.03 mrem/y for 70 years equals a risk of 1×10^{-6}. Therefore, under this approach, an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 0.03 mrem/y.

Decision on Ample Margin of Safety. After comparing the benefits and cost of reducing risks below the safe level, EPA has determined that no further reductions below the level of 0.03 mrem/y EDE are necessary to protect public health with an ample margin of safety. Therefore, EPA is proposing a NESHAP of 0.03 mrem/y which protects public health with an ample margin of safety.

4. Implementation

For each approach proposed today, EPA has independently decided that the same level of regulation is appropriate for both UFC facilities and NRC-licensees. Therefore, EPA proposes to remove the exemption for UFC facilities in the NRC-licensee NESHAP and regulate them exactly the same as other licensees, including reporting and recordkeeping requirements.

D. Elemental Phosphorus Plants

1. Introduction

Elemental phosphorus plants extract pure phosphorus from ore for use in the chemical industry. These facilities emit radionuclides into the air because phosphate ore is high in uranium and its decay products. These decay products, especially polonium-210 and lead-210, become volatilized during the extraction process and are released into the atmosphere. There are eight (5 operational, 3 standby) elemental phosphorus plants located in four different states. However, most of the emissions come from two plants in Idaho.

Due to the types of radionuclides emitted by these plants, virtually all the dose is received by the lung through the inhalation pathway causing an increased risk of lung cancer. This risk can be controlled through the use of a standard which directly limits emissions of polonium-210 (control measures which limit polonium-210 also limit emissions of lead-210). There is no need to write dose standards.

Elemental phosphorus plants are currently regulated by a NESHAP that limits their emissions to no more than 21 curies of polonium-210 annually.

2. Estimates of Exposure and Risk

EPA's risk assessment of elemental phosphorus plants is a site-by-site assessment of operating and standby plants, based on monitored data and throughput. Meteorological data was taken from nearby stations. Maximum

individual risks were assessed at actual residences or at a location 1500 m in the predominant wind direction. The location of nearby populations was taken from census tract data.

According to the assessment, EPA estimates that the most exposed individual receives a lifetime fatal cancer risk of 5.6×10^{-4}. There is an increased incidence of 0.072 fatal cancer per year in the nearby (within 80 km) population. Over 75 percent of the exposed population receives risks of less than 1×10^{-6}.

Table 10 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2, 3 and 4.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI to the elemental phosphorus plants source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is approximately 5.6×10^{-4} which is higher than the level generally preferred under the case-by-case approach. The estimated annual incidence is less than 0.072 fatal cancers per year.

EPA examined several alternatives before determining the acceptable level. Those alternatives and the risks they present are illustrated in Table 10. After examining these different options, the Administrator proposes to determine that alternative 1 (10 Ci/y of polonium-210) is acceptable under the case-by-case approach. A maximum individual risk higher than the preferred level is acceptable in this case because the risk distribution is such that incidence is only 0.072 per year.

TABLE 10.—ALTERNATIVES FOR ACCEPTABLE RISK FROM ELEMENTAL PHOSPHORUS PLANTS

	alternative 1 (baseline)	alt. 2	alt. 3	alt. 4
Maximum individual risk (lifetime)	5.6×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	1.1×10^{-5}
Incidence within 80 km (death/y)	0.072	0.024	0.011	0.0022
Risk individual				
E-2 to E-1	0	0	0	0
E-3 to E-2	0	0	0	0
E-4 to E-3	6,000	800	[1]800	0
E-5 to E-4	100,000	15,000	8,000	600
E-6 to E-5	310,000	330,000	190,000	12,000
Less E-6	1.4M	1.5M	1.8M	1.8M
Risk incidence				
E-2 to E-1	0	0	0	0
E-3 to E-2	0	0	0	0
E-4 to E-3	0.012	0.0019	0.0019	0
E-5 to E-4	0.038	0.0037	0.0021	0.00009
E-6 to E-5	0.016	0.012	0.0053	0.00030
Less E-6	0.0056	0.0065	0.0021	0.0016

Other Health Impacts: Non-fatal cancers no more than 5% of deaths.
[1] Alternative 3 has no additional impact on the plant causing the highest risk.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from elemental phosphorus plants. The costs and benefits of controlling emissions can be seen in Table 11. Based on the costs of achieving alternative 2 and the very small reductions of incidence and the small decrease in maximum individual risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that current emissions, represented by a level of 10 Ci/y polonium-210, will protect public health with an ample margin of safety. No further reduction below the safe level is required. However, EPA believes that the risks are high enough, and have the potential to go significantly higher, that the protection of public health requires regulation under section 112 to insure that the current levels of emissions which are safe with an ample margin of safety are not increased. Therefore, EPA is proposing a standard of 10 Ci/y of polonium-210, which will protect public health with an ample margin of safety.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the emissions from elemental phosphorus plants cause less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from elemental phosphorus plants.

TABLE 11.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR ELEMENTAL PHOSPHORUS PLANTS

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	5.6×10^{-4}	0.072					
1-A	5.6×10^{-4}	0.072					
2	2.4×10^{-4}	0.024	0.048	0.048	$9M	$2M	$2M
3	2.4×10^{-4}	0.011	0.013	0.061	7M	3M	5M
4	1.1×10^{-5}	0.0022	0.009	0.070	19M	12M	17M

Regulatory Status: Current NESHAP of 21 curies per year of Po-210.

Comments:

Alternative 1: Baseline, no rule—Existing NESHAP would be withdrawn.

Based on a low-LET risk factor of 400 fatal cancers per million person-rad, ranging from 120 to 1200 fatal cancers per million person-rad, the Alternative 1 risk may range from 1.7×10^{-4} to 1.7×10^{-3}.

Alternative 1-A: Baseline rule, emission limit of 10 Ci/y Po-210—highest current emission rate is 10 curies/y Po-210.

Alternative 2: High energy scrubbers on the two largest plants.

Alternative 3: High energy scrubbers on all plants.

Alternative 4: Fabric filters on two largest plants, high energy scrubbers on all other plants.

Alternative 5: Table does not contain alternative to bring the MIR to 1×10^{-6} because of the difficulties in accurately estimating the impacts. Probably 3 plants including the 2 largest ones processing western phosphate rock high in uranium would close. Two smaller plants processing low uranium eastern phosphate rock could continue after additional controls are installed at an annualized cost of about $8 million.

The costs and benefits of controlling emissions can be seen in Table 11. Based on the costs of achieving alternative 2 and the very small reduction of incidence and the small decrease in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. Therefore, EPA believes that limiting emissions to their current level, represented by a level of 10 Ci/y polonium-210, will protect public health with an ample margin of safety. No further reduction below the safe level is required.

However, as in Approach A, EPA believes that the risks are high enough, and have the potential to go significantly higher, that the protection of public health requires that a NESHAP be promulgated to insure that the current levels of emissions are not increased. Therefore, EPA is proposing a standard of 10 Ci/y of polonium-210 which will protect public health with an ample margin of safety.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. An emissions limit of 0.6 Ci/y of polonium-210 for 70 years corresponds to a risk of 1×10^{-4}. Therefore, under this approach, an acceptable level of emissions is 0.6 Ci/y.

Decisions on Ample Margins of Safety. After comparing the benefits and costs of reducing risks below the safe level, EPA has determined that no further reductions below the level of 0.6 Ci/y are needed. Therefore, EPA is proposing a NESHAP of 0.6 Ci/y of polonium-210 which protects public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach Decision on Acceptable Risk. An emissions limit of 0.006 Ci/y of polonium-210 for 70 years corresponds to a risk of 1×10^{-6}. Therefore, under this approach, an acceptable level of emissions is 0.006 Ci/y.

Decision on Ample Margin of Safety. After comparing the benefits and cost of reducing risks below the safe level, EPA has determined that no further reductions below the level of 0.006 Ci/y are needed to protect public health with an ample margin of safety. Therefore, EPA is proposing a NESHAP of 0.006 Ci/y of polonium-210 which protects public health with an ample margin of safety.

4. Implementation

The current NESHAP for elemental phosphorus plants required each plant to either conduct an initial test on its emissions or get a waiver from testing. After this original report no further testing was required, unless plant operations were changed significantly. EPA plans to continue this system, without the waiver provisions. Tests conducted under the current NESHAP are still valid if conditions have not changed.

Plants will be required to monitor their operations continuously and keep records of the results of their monitoring onsite for five years. Plant owners will have to certify on a semiannual basis that no changes in operations that would require new testing have occurred. Although the report is based on a calendar year the emission limit applies to any year, i.e. any period of 12 consecutive months.

Since the reports from provide EPA with the information it needs, elemental phosphorous plants are exempted from the requirements of 61.10.

E. Coal-Fired Utility and Industrial Boilers

1. Introduction

This category covers electrical utility and industrial boilers which emit the radionuclides naturally present in coal. Coal contains only minute amounts of radionuclides. This category is being considered because large boilers burn large quantities of coal and are so widely dispersed throughout the nation that the radionuclide emissions are estimated to cause 0.8 fatal cancer a year among the U.S. population.

Emissions from coal-fired boilers are presently regulated under National Ambient Air Quality Standards for particulate matter. In addition, the larger new coal-fired boilers have to meet New Source Performance Standards (NSPS). Coal-fired boilers are regulated for the other pollutants they emit including SO_2, particulates, and other hazardous air pollutants such as arsenic and benzene.

2. Estimates of Exposure and Risk

EPA's risk assessment of coal-fired boilers is based on extrapolations of real emissions with model populations. Estimates of emissions are from the reference facilities with the largest emissions. These emissions were analyzed on four sites: Urban, suburban, rural and remote. Further information was received from a recent study of emissions from coal-fired boilers done by the Office of Air Quality, Planning and Standards. EPA assumed that the entire U.S. population lives within 80 km of at least one coal fired boiler.

EPA estimates that the maximum individual risk is 3×10^{-5} and that there are 0.8 fatal cancers a year caused by radionuclide emissions from coal fired boilers. Virtually all the fatal cancer risk is borne by individuals whose lifetime fatal cancer risk is less than 1×10^{-4}.

Table 12 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels [i.e., risk distribution], and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternative 2.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI. to the coal-fired boilers source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is approximately 3×10^{-4} which achieves a lower level of risk than the upper bound that is described in the case-by-case approach. The estimated annual incidence is estimated at 0.8 fatal cancer per year.

EPA examined several alternatives before determining the acceptable level; those alternatives and the risks they

present are illustrated in Table 12. After examining these different options, the Administrator has determined that baseline emissions are acceptable under the case-by-case approach.

TABLE 12.—ALTERNATIVES FOR ACCEPTABLE RISK FROM COAL FIRED BOILERS—NUMBERS UNCERTAIN

	Alternative 1 (baseline)	Alternative 2
Maximum individual risk (lifetime)	2.5×10^{-5}	1.0×10^{-6}
Incidence within 80 km (death/y)	0.8	0.4
Risk individual		
E-2 to E-1	0	0
E-3 to E-2	0	0
E-4 to E-3	0	0
E-5 to E-4	(a)	0
E-6 to E-5	130,000	0
Less E-6	240M	240M
Risk incidence		
E-2 to E-1	0	0
E-3 to E-2	0	0
E-4 to E-3	0	0
E-5 to E-4	(a)	0
E-6 to E-5	0.001	0
Less E-6	0.8	0.4

Other Health Impacts: Total cancers no more than twice fatal cancers.

[a] At least one person may be at this risk level, total number of people unknown because site visit has not been made.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from coal-fired boilers. The costs and benefits of controlling emissions can be seen in Table 13. Based on the huge costs of achieving alternative 2 and the small reduction of incidence and the small decreases in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. The fact that no individual receives a high risk is a significant factor in this decision.

Therefore, EPA has determined that limiting radionuclide emissions from coal-fired boilers to current levels will protect public health with an ample margin of safety. No further reduction below the safe level is required. Due to the small level of radionuclides in coal and the fact that all new facilities will have to meet NSPS, a NESHAP does not need to be promulgated for coal fired boilers. EPA proposes not to regulate this source category.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the emissions from coal-fired boilers cause 0.8 fatal cancer per year, which is less than the 1 fatal cancer per year. Therefore, by this approach, current emissions are acceptable.

Decision on Ample Margin of Safety. EPA has examined the control technology necessary to lower emissions from coal-fired boilers. The cost and benefits of controlling emissions can be seen in Table 13. Based on the huge costs of achieving alternative 2 and the small reduction of incidence and the small decreases in risk that would result, EPA has determined that it is not necessary to further reduce risks below their current level. The fact that no individual receives a high risk is a significant factor in this decision.

Therefore, EPA has determined that limiting radionuclide emissions from coal-fired boilers to current levels will protct public health with an ample margin of safety. No further reduction below the safe level is required. Due to the small level of radionuclides in coal and the fact that all new facilities will have to meet NSPS, a NESHAP does not need to be promulgated for coal fired boilers. EPA proposes not to regulate this source category.

TABLE 13.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR COAL-FIRED BOILERS

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1(util)	2.5×10^{-5}	0.4					
1(inds)	7×10^{-6}	.4					
2(util)	1×10^{-7}	.2	0.2	0.2	$13B	$4.4B	$4.4B
2(inds)	1×10^{-6}	.2	.2	.2		1.7B	1.7B

Regulatory Status: Particulate emission controls also control radionuclides. Particulates are controlled by NSPS, PSD, and SIP. Previously, we did not propose a rule on the grounds that risks are small on a facility basis and other pollutants from these boilers cause far more risk. Controlling these other pollutant risks also controls radionuclide risks.

Comments:

Alternative 1: Baseline, no rule—utility boilers: current emissions as controlled by NSPS, PSD, and SIP; industrial boilers: current emissions as controlled by SIP. Based on a low-LET risk factor of 400 fatal cancers per million person-rad, ranging from 120 to 1200 fatal cancers per million person-rad, the Alternative 1 risk may range from 7.5×10^{-6} to 7.5×10^{-5}.

Alternative 2: Emission limit of 0.03 mrem/y ede. Utility boilers: retrofit of all sources to meet NSPS (particulate standard). Assumes ESPs are used to retrofit to an emission limit of 13 ng/joule (NEPS revised). Industrial boilers: retrofit all units >2MM Btu/h with ESPs.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. Under this approach, an acceptable risk is one which causes a maximum individual risk of 1×10^{-4} or less. EPA estimates that the maximum individual risk from coal-fired boilers is 3×10^{-5}, which exposes the public to a lower degree of risk than that allowed under this approach. Therefore, this level constitutes an acceptable risk to health.

Decision on Ample Margin of Safety. EPA believes that limiting radionuclide emissions to current levels from coal-fired boilers protects public health with an ample margin of safety. In addition, there is good reason to believe that emissions would decrease in the future. Therefore, EPA finds under this approach that the risks from radionuclide emissions from coal-fired boilers do not require regulation under section 112 of the CAA.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. Under this approach, an acceptable risk is one that causes a maximum individual risk of 1×10^{-6} or lower, which corresponds to a NESHAP standard level of 0.03 mrem/y ede. Current emissions from both industrial boilers and utility boilers are above the acceptable range of 1×10^{-6}. Therefore, retrofitting of many sources so that they meet the NSPS for particulates will be necessary to reduce the risk below 1×10^{-6}.

Decision on Ample Margin of Safety. EPA has determined that a NESHAP standard of 0.03 mrem/y EDE provides an ample margin of safety. As stated above, under this approach, retrofitting of all coal-fired boilers would be necessary to reduce the current emissions to below a level of 0.03 mrem/y EDE. Therefore, EPA proposes that all coal-fired boilers be retrofitted to met NSPS for particulates.

4. Implementation

The standard proposed for this category applies the NSPS 40 CFR 60.41a and 60.41b for particulates to all coal fired boilers whose output is greater than 2 million BTU's an hour. This NESHAP will be implemented in the same way as the NSPS is currently implemented.

F. High-Level Nuclear Waste Disposal Facilities

1. Introduction

Management and storage operations for high-level nuclear waste, spent fuel and transuranic waste are addressed in the categories for DOE facilities and NRC-licensed and non-DOE Federal facilities described above. This category addresses facilities constructed and dedicated to long term disposal of such materials pursuant to regulations to be promulgated at 40 CFR 191 Supbart B. Site characterization studies for the first such repository are being conducted by DOE and currently center on Yucca Mountain Nevada. In addition, DOE is constructing a test Waste Isolation Pilot Plant (WIPP) which may be dedicated as a disposal facility.

2. Estimates of Exposure and Risk

EPA's risk assessment of HLW disposal facilities is based upon DOE engineering estimates for conceptual designs for the WIPP in New Mexico, an MRS facility and a permanent repository at Yucca Mountain. They were analyzed by EPA and are believed to be reasonable. Although the decision on Yucca Mountain's acceptability has not yet been made, for purposes of improving the accuracy of the analysis, using a real site, EPA has analyzed the Yucca Mountain site. Population data was taken from U.S. census data at these sites.

EPA estimates that the maximum individual risk is 3×10^{-7} and that there would be 0.0001 fatal cancers a year caused by radionuclide emissions from HLW disposal facilities to less than 1 million people within 80 km of these facilities. All the fatal cancer risk is borne by individuals whose total fatal cancer risk is less than 1×10^{-6}.

The reason why the emissions and risks are so low is the nature of the disposal operations. Sealed sources will be brought to the site and buried below ground. Normal operations preclude any significant air emissions.

Table 14 presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI, to the HLW disposal facilities source category are described below.

Approach A: Case-by-Case Approach. Decision on Safe With an Ample Margin of Safety. As stated above, the individual risks from HLW disposal facilities are very small, less than 1×10^{-6}. In addition, there would be 0.0001 fatal cancers a year from radionuclide emissions from disposal of HLW, see Table 14. The emissions are so low that it was not necessary to evalaute any alternatives. The Administrator determines that the estimate of emissions from disposal of HLW represents a level that will protect public health with an ample margin of safety. EPA believes that since the emissions are so low, and there is no reason to expect that emissions to air would significantly increase, no NESHAP is needed.

TABLE 14.—ALTERNATIVES FOR ACCEPTABLE RISK FROM HIGH LEVEL NUCLEAR WASTE DISPOSAL FACILITIES

	Alternative 1 (baseline)
Maximum individual risk (lifetime)	2.8×10^{-7}
Incidence within 80 km (death/y)	0.00011
Risk individual:	
E-2 to E-1	0
E-3 to E-2	0
E-4 to E-3	0
E-5 to E-4	0
E-6 to E-5	0
Less E-6	780,000
Risk incidence:	
E-2 to E-1	0
E-3 to E-2	0
E-4 to E-3	0
E-5 to E-4	0
E-6 to E-5	0
Less E-6	0.0001

Other Health Impacts: Total cancers no more than twice fatal cancers.

No currently operating facilities. Baseline emissions are estimates of expected emissions. No alternative given due to expected risks well below 1×10^{-6}.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the emissions from disposal of HLW will cause much less than one fatal cancer per year. Therefore, under this approach, expected radionuclide emissions are acceptable.

Decision on Ample Margin of Safety. As stated above, the individual risks from disposal of HLW are very small, less than 1×10^{-6}. In addition, there is 0.0001 fatal cancer a year from radionuclide emissions from disposal of HLW, see Table 14. The emissions are so low that no alternatives were evaluated. The Administrator proposes to determine that emissions from disposal of high-level waste will protect public health with an ample margin of safety. EPA believes that since the emissions are so low and there is no reason to expect that they would increase, no NESHAP is needed.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. An effective dose equivalent of 3 mrem/yr for 70 years equals a risk of 1×10^{-4}. Therefore, under this approach an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 3 mrem/y.

Decision on Ample Margin of Safety. EPA believes that risks from emissions from HLW disposal will be so small that current emissions protect public health with an ample margin of safety. In addition, there is no reason to believe that they would increase above expected levels. Therefore, EPA proposes to find that since the risks from radionuclide emissions from HLW disposal are so low and there is no reason to expect they would increase, no NESHAP is needed.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. An effective dose equivalent of 0.03 mrem/yr for 70 years equals a risk of 1×10^{-6}. Therefore, under this approach, an acceptable level of emissions is the amount that shall not cause any member of the public to receive an effective dose equivalent of more than 0.03 mrem/y.

Decision on Ample Margin of Safety. EPA believes the risks from air emissions from HLW disposal are so small that estimated emissions protect public health with an ample margin of safety. In addition, there is no reason to believe they will be higher than expected. Therefore, EPA finds that since the risks from radionuclide emissions from HLW disposal are so low and there is no reason to expect them to increase, no NESHAP is needed.

G. Radon Releases from Department of Energy Facilities

1. Introduction.

The DOE administers many facilities, including government-owned,

contractor-operated facilities across the country. Some of these facilities have large stockpiles of radium-containing material. Because this ore was originally high in uranium content, the tailings material that is left has a high radium content and, therefore, emits large quantities of radon. This material is stored in at least five different sites owned or controlled by DOE in Missouri, New Jersey, New York, Ohio and Utah. DOE is presently in the process of taking remedial action at these sites to dispose of the material on a long-term basis.

The current NESHAP covering DOE facilities does not regulate radon emissions. Environmental groups challenged EPA in court to address the problem of radon emissions from DOE facilities. EPA is responding with this proposed NESHAP.

2. Estimates of Exposure and Risk

EPA's risk assessment of DOE facilities is a site-by-site assessment of current emissions. Radon emission estimates were mostly measured values provided by DOE or estimated from measured radium-226 concentrations in the wastes. The meteorological data were taken from nearby stations and populations are based on U.S. census tract data.

According to EPA's analysis, lifetime fatal cancer risk to the most exposed individual is 2.4×10^{-3}. DOE facilities cause an estimated 0.16 fatal cancer per year to the 25.7 million persons within 80 km of the DOE facilities. Approximately 40 percent of the risk to that population comes from individuals whose risk is over 1×10^{-6}. It is noted that this analysis does not consider the planned remedial actions which will be implemented under CERCLA, as amended, in conjunction with either Interagency Agreements or Federal Facilities Agreements with EPA. Remedial action is scheduled at the Monticello Mill Tailings Pile near Monticello, Utah, per a signed Federal Facility Agreement.

Table 15 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2, 3 and 4.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI to the radon emissions from the DOE source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum lifetime individual risk to any individual is 2.4×10^{-3} which is higher than the level generally preferred under the case-by-case approach. The estimated annual incidence is approximately 0.16 fatal cancer per year, and approximately 40 percent of that risk is borne by people whose risk is over 1×10^{-6}. EPA has examined several alternatives before determining the acceptable level; those alternatives and the risks they present are illustrated in Table 15. After examining these different options, the Agency would propose that the risk associated with alternative 2 represents a level that is acceptable under the case-by-case approach. A maximum individual risk higher than the preferred level is acceptable in this case because the risk distribution is such that incidence is only 0.042 per year.

Decision on Ample Margin of Safety. EPA has examined several alternative levels of control of radon emissions from DOE facilities. The costs and benefits of controlling emissions can be seen in Table 16. Based on the costs of further controls to reduce radon emissions, and the small decreases in risk and very small incidence reductions they represent, EPA has determined that it is not necessary to further reduce risks below the acceptable level, alternative 2. Therefore, EPA is proposing a NESHAP limiting radon emissions from DOE facilities to 20 pCi/m^2-s, which will protect public health with an ample margin of safety.

TABLE 15.—ALTERNATIVES FOR ACCEPTABLE RISK FROM RADON FROM DOE FACILITIES

	Alternative 1 (baseline)	Alt. 2	Alt. 3	Alt. 4
Maximum individual risk (lifetime)	2.4×10^{-3}	2.9×10^{-4}	1.8×10^{-4}	1.3×10^{-4}
Incidence within 80 km (death/y)	0.16	0.042	0.021	0.012
Risk individual:				
E-2 to E-1	0	0	0	0
E-3 to E-2	90	0	0	0
E-4 to E-3	3,500	180	70	45
E-5 to E-4	26,000	4,800	2,000	500
E-6 to E-5	1.4M	96,000	44,000	15,000
Less E-6	27M	28M	28M	28M
Risk incidence:				
E-2 to E-1	0	0	0	0
E-3 to E-2	0.002	0	0	0
E-4 to E-3	0.011	0.0004	0.0001	0.00007
E-5 to E-4	0.007	0.0020	0.00057	0.0002
E-6 to E-5	0.040	0.0027	0.0012	0.0005
Less E-6	0.10	0.037	0.020	0.01

Other Health Impacts: Non-fatal cancers no more than 5 percent of deaths.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the radon emissions from DOE facilities cause less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

TABLE 16.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR RADON FROM DOE FACILITIES

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	2.4×10^{-3}	0.16					
2	2.9×10^{-4}	0.042	0.12	0.12	$29M	$1.5M	$1.5M
3	1.8×10^{-4}	0.021	0.021	0.14	14M	0.7M	2.2M
4	1.3×10^{-4}	0.012	0.009	0.15	13M	0.7M	2.8M

Regulatory Status: Self regulated by DOE. AEA rules for uranium mill tailings are appropriate for this source category.

Comments:

Alternative 1: Baseline, no rule—Self-regulated by DOE.

Based on radon risk factor of 360 fatal cancers per million-WLM, ranging from 160 to 720 fatal cancers per million person-WLM, the Alternative 1 risk may range from 1.1×10^{-3} to 5.8×10^{-3}.

Alternative 2: Cover source to limit emissions to 20 pCi/m²s—This is the same level as the current AEA rule set by EPA for uranium mill tailings.

Alternative 3: Cover source to limit emissions to 6 pCi/m²s—Most of the cost is to control emissions from the Monticello tailings pile.

Alternative 4: Cover source to limit emissions to 2 pCi/m²s—Most of the cost is to control emissions from the Monticello tailings pile.

Alternative 5: Table does not contain alternative to bring the MIR to 1.1×10^{-4} because of the difficulties of estimating the impact. Additional radon controls would be required, amounting to about 8 meters of additional dirt cover. Costs could be in excess of $5 million.

MIR value does not decrease directly in proportion to emission flux because of the differing assumptions associated with each facility. Facilities are not alike.

Decision on Ample Margin of Safety. Based on an analysis of the costs of various control alternatives and decreases in risk and incidence they represent, see Table 16, EPA has determined that it is necessary to reduce risks to the level of alternative 2, but that further reductions are unnecessary. Therefore, EPA is proposing a NESHAP limiting radon emissions from DOE facilities to 20 pCi/m^2-s, which will protect public health with an ample margin of safety.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach.

Decision on Acceptable Risk. Since the dose/risk relationship for radon is reasonably well established, an acceptable level of emissions can be estimated under this approach. A radon emission limit of 2 pCi/m^2-s yields a lifetime risk of 1×10^{-4} to the maximum exposed individual. Therefore, under this approach an acceptable level of emission is 2 pCi/m^2-s.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-4} are needed. Therefore, EPA is proposing a NESHAP limiting emissions of radon to 2 pCi/m^2-s which would protect public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach.

Decision on Acceptable Risk. A radon emission limit of 0.02 pCi/m^2-s yields a lifetime risk of 1×10^{-6} to the maximum exposed individual. Therefore, under this approach, an acceptable level of emissions is 0.02 pCi/m^2-s.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-6} are needed. Therefore, EPA is proposing a NESHAP limiting emissions to 0.02 pCi/m^2-s which would protect public health with an ample margin of safety.

4. Implementation

This NESHAP is a flux standard that limits the emission of radon from DOE facilities. The standard limits the amount of radon that can be emitted per unit area (m^2) per unit of time (s). This standard is not an average per facility but is an average per radon source. This will require that all radon sources must be disposed of in a manner that will reduce the radon flux to meet the standard.

The proposed standard will be effective immediately upon promulgation. While EPA believes that DOE will be able to meet this standard, EPA recognizes that in some cases DOE may need some time to perform all the actions necessary to reduce radon emissions to the required levels. In such a case, DOE may request a waiver of the compliance deadline of up to two years, under section 112(c)(1)(b)(ii) of the CAA. If two years are not sufficient time EPA is prepared to discuss schedules for compliance. EPA recognizes that the requirements of CERCLA and other environmental laws will have to be considered in these discussions.

Since the reports of the testing provide EPA with the information it needs, DOE-facilities are exempted from the requirements of 61.10.

H. Phosphogypsum Stacks

1. Introduction

Phosphogypsum stacks are large piles of waste from wet acid phosphorus fertilizer production. Phosphogypsum stacks are found at 41 different sites in 12 states. Because phosphate ore is relatively high in uranium and radium, phosphogypsum stacks are also high in these elements. The presence of radium in the stacks causes them to release radon into the atmosphere. In connection with the litigation, EPA has agreed to propose a standard for this source category.

2. Estimates of Exposure and Risk

EPA has performed a pile-by-pile assessment of radon releases at 58 phosphogypsum stacks at 41 sites. Radon emissions are based on measured radon fluxes at stacks in Florida and Idaho, the radium content of the phosphate rock and the estimated area of the stacks. Maximum individual risks are based on the locations of nearby residents obtained from industry or topographical maps. Where information was unavailable, people were assumed to be 800 meters from the site boundary. Populations within 80 km were taken from census tract data.

The estimated maximum individual risk of fatal cancer from radon emissions from phosphogypsum stacks is 2.0×10^{-4}. The radon emissions cause 0.97 fatal cancers per year to the population within 80 km. Approximately 90% of the risk to the population is borne by people whose risk is less than 1×10^{-5}, and 40% of the risk is borne by people whose risk is less than 1×10^{-6}.

Table 17 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2 and 3.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI, to the phosphogypsum stacks source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is 2.0×10^{-4} which is slightly higher than the level generally preferred under the case-by-case approach. Of the 58 stacks, only 4 had risks greater than 1×10^{-4}. The estimated annual incidence of fatal cancer is less than 1 per year, and almost all of that risk is borne by people whose risk is less than 1×10^{-5}. EPA has examined several alternatives before determining the acceptable level. Those alternatives and the risks they present are illustrated in Table 17. After examining these different alternatives, the Administrator has determined that baseline emissions, alternative 1, represents a level that is acceptable under the case-by-case approach. A maximum individual risk higher than the preferred level is acceptable in this case because only a few individuals are exposed to this level and because the risk distribution is such that incidence is only 0.97 per year.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, and the decreases in risk and small incidence reductions they represent, see Table 18, EPA has determined that it is not necessary to further reduce risks below the safe baseline level, alternative 1. EPA proposes a NESHAP limiting radon emissions from phosphogypsum stacks to 20 pCi/m^2–s, which represents current emissions, which will protect public health with an ample margin of safety.

TABLE 17.—ALTERNATIVE FOR ACCEPTABLE RISK FOR DISPOSAL OF PHOSPHOGYPSUM STACKS

	Alternative 1 (baseline)	Alternative 2	Alternative 3
Maximum individual risk (lifetime)	2.0×10^{-4}	1.6×10^{-4}	5.6×10^{-5}
Incidence within 80 km (death/y)	0.97	0.83	0.29
Risk individual			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	[1]	[1]	0
E-5 to E-4	400,000	290,000	17,000
E-6 to E-5	16M	14M	2.6M
Less E-6	78M	81M	92M
Risk incidence			
E-2 to E-1	0	0	0
E-3 to E-2	0	0	0
E-4 to E-3	[1]	[1]	0
E-5 to E-4	0.094	0.064	0.0033
E-6 to E-5	0.52	0.41	0.068
Less E-6	0.34	0.34	0.21

Other Health Impacts: Non-fatal cancers no more than 5% deaths.

[1] At least one person may be at this risk level, total number of people unknown because site visit has not been made.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the radon emission from phosphogypsum stacks cause less than one fatal cancer per year. Therefore, by this approach, current emissions provide an acceptable level of risk. However, the current incidence estimate is 0.97 fatal cancer a year, which is very close to the acceptable level. Future analysis could demonstrate that current emissions are not acceptable and need to be reduced.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, and the decreases in risk and small incidence reductions they represent, see Table 18, EPA has determined that it is not necessary to further reduce risk below the safe baseline level, alternative 1.

TABLE 18.–ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR DISPOSAL OF PHOSPHOGYPSUM STACKS

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	2.0×10^{-4}	0.97					
2	1.6×10^{-4}	0.83	0.14	0.14	$500M	$ 43M	$ 43M
3	5.6×10^{-5}	0.29	0.54	0.68	$500M	$ 25M	$ 68M

Regulatory Status: Presently unregulated. This source category is analogous to uranium mill tailings, but has much less radon emission per unit area. EPA is required under court order to propose a standard for this category.

Comments:

Alternative 1: Baseline rule, cover source to limit emissions to 20 pCi/m^2s—Stacks have emissions of 4 to 15 pCi/m^2s; no cover would be needed. This rule would be equivalent to the current AEA rule set by EPA for uranium mill tailings.

Based on radon risk factor of 360 fatal cancers per million person–WLM, ranging from 160 to 720 fatal cancers per million person–WLM, the Alternative 1 risk may range from 8.9×10^{-5} to 4.0×10^{-4}.

Alternative 2: Cover source to limit emissions to 6 pCi/m^2s—Stacks are covered with 0.5 meters of dirt. Usually dirt is not locally available and must be hauled to the site.

Alternative 3: Cover source to limit emissions to 2 pCi/m^2s—Stacks are covered with 1 meter of dirt.

Alternative 4: Table does not contain alternative to bring the MIR to 1×10^{-6} because the impacts cannot be accurately estimated. If all stacks would need a dirt cover of average depth of 4 meters, the total annualized cost would seem to approach $300 million.

However, to prevent emissions from increasing, EPA is proposing a NESHAP for this source category limiting radon emissions from phosphogypsum stacks to 20 pCi/m^2–s. This represents current emissions and will protect public health with an ample margin of safety.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A radon emission limit of 2 pCi/m^2–s corresponds approximately to a lifetime risk of 1×10^{-4} to the maximum exposed individual. Under this approach, an acceptable level of emissions is an average radon flux of 2 pCi/m^2–s from phosphogypsum stacks.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-4} are needed. Therefore, EPA is proposing limiting emissions to 2 pCi/m^2–s, which would protect public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A radon emission limit of 0.02 pCi/m^2–s corresponds approximately to a lifetime risk of 1×10^{-6} to the maximally exposed individual. Under this approach, an acceptable level of emissions is an average radon flux of .02 pCi/m^2–s.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-6} are needed. Therefore, EPA is proposing limiting radon emissions levels to 0.02 pCi/m^2–s, which would protect public health with an ample margin of safety.

4. Implementation

This NESHAP is a flux standard that limits the emission of radon from phosphogypsum stacks. The standard limits the amount of radon that can be emitted per unit area (m^2) per unit of time (s). This standard is not an average per facility but is an average per phosphogypsum stack. This will require that all stacks be disposed of in a manner that will reduce the radon flux to meet the standard.

Sixty days after the effective date of this rule or sixty days after the operator ceases using a phosphogypsum stack the operator must test the stack to determine whether or not the stack is in compliance with the flux standard. If Approach A or B is selected it is expected that all stacks will be in compliance with the standard. If Approach C or D are selected the stacks will most likely not be in compliance unless they cover the stack with dirt, or something else, to reduce the radon flux off the stack. If an operator knows that the stack cannot meet the standard, the operator can admit noncompliance instead of testing the stack.

Stacks must be retested every two years unless EPA requires more frequent testing or EPA determines that less frequent testing is sufficient to assure compliance with the standard. EPA will also reduce the need for testing if EPA determines that testing will interfere with ongoing operations designed to cover the stack.

Since the reports of the testing provide EPA with the information it needs, phosphogypsum stacks are exempted from the requirements of 61.10.

I. Underground Uranium Mines

1. Introduction

When these mines are operating, their ventilation systems emit large amounts of radon into the atmosphere. The levels of radon in an unventilated mine are a hazard to the miners. Ventilating to reduce radon exposure to the miners increases exposure to the general population.

Underground uranium mines are regulated by an existing NESHAP. This NESHAP requires bulkheading of unused portions of the mines in an effort to reduce the internal wall surface area of the mine and thereby reduce radon emissions into the mine air. EPA has found that this system is unworkable for existing mines, and it is unproven for new mines. The interiors of these mines are so extensively interconnected that any attempt at bulkheading either produces no results or prevents fresh air from getting to the miners.

2. Estimates of Exposure and Risk

EPA's risk assessment of underground uranium mines is a site-by-site assessment of all operating or operable mines. Emission estimates were based on radon concentration or working level measurements and ventilation rates provided by mine operators.

The meteorological data was taken from nearby stations and populations from 5 to 80 km are based on U.S. census tract data. Population distributions within 5 km were taken from site visits or obtained from mine owners.

The maximum individual risk of fatal cancer from radon emissions from underground uranium mines is 1.2×10^{-3}. The radon emissions cause 0.77 fatal cancer per year to the population within 80 km.

Table 19 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2 and 3.

TABLE 19.—ALTERNATIVES FOR ACCEPTABLE RISK FPR UNDERGRAOUN URANIUM MINES

	alternative 1 (baseline)	alternative 2	alternative 3
Maximum individual risk (lifetime)	1.2×10^{-3}	2.7×10^{-4}	1.9×10^{-4}
Incidence within 80 km (death/y)	0.77	0.43	0.20
Risk individual			
E–2 to E–1	0	0	0
E–3 to E–2	6	0	0
E–4 to E–3	90,000	15,000	1500
E–5 to E–4	1.6M	880,000	280,000
E–6 to E–5	250,000	1.0M	1.6M
Less E–6	7,000	20,000	22,000
Risk incidence			
E–2 to E–1	0	0	0
E–3 to E–2	0.00008	0	0
E–4 to E–3	0.21	0.028	0.0024
E–5 to E–4	0.54	0.30	0.099
E–6 to E–5	0.021	0.096	0.099
Less E–6	0.00005	0.00025	0.00035

Other Health Impacts: Non-fatal cancers no more than 5% of deaths.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI. to the surface uranium mines source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is 1.2×10^{-3} which is higher than the level preferred under the case-by-case approach. The estimated annual incidence is 0.77 fatal cancer per year. EPA has examined several alternatives before determining the acceptable level; those alternatives and the risks they present are illustrated in Table 19. After examining these

different alternatives, the Agency would propose that the risks associated with alternative 2 represents the level that is acceptable under the case-by-case approach. Alternative 2 limits the emissions to 1500 Ci/y of radon. An emissions limit of 1500 Ci/y provides an acceptable level of risk.

However, EPA recognizes that, among the source categories analyzed, uranium mines present a unique situation in determining an acceptable level of risk. This occurs because Mine Safety and Health Administration (MSHA) standards require owners to protect mine workers by operating mine ventilation equipment to reduce the radon levels within the mines. This results in emissions of whatever amount of radon is necessary to reduce the radon levels in the mines to the required levels.

After considering the conflict in the goals of the MSHA regulations and the goals of the CAA, EPA has concluded that emissions higher than 1500 Ci/y can be allowed without increasing the risk to the nearby individuals. If a mine releases its exhaust fan emissions from a 30-meter stack, then radon emissions of 5,000 Ci/y would result in the same level of risk to the most exposed individuals as a ground level releases of 1500 Ci/y. This alternative provides an effective means to ventilate the mine, reducing radon levels in the mine, while protecting those persons exposed to the emissions from a mine. Therefore, the Agency would propose that the risks associated with exhaust vent emissions of radon from underground uranium mines emitted either at ground level with an emission limit of 1500 Ci/y or from a stack that is at least 30 meters high with an emission limit of 5000 Ci/y provides an acceptable level of risk.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, including the likelihood of closures and the decreases in risk and very small incidence reductions they represent, see Table 20, EPA has determined that it is not necessary to further reduce risks below the acceptable level, alternative 2. EPA recognizes that closures are not in themselves a reason not to further reduce risks.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier the radon emissions from underground uranium mines cause less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

TABLE 20.—Alternatives for Ample Margin for Safety for Underground Uranium Mines

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	1.2×10^{-3}	0.77					
1-A	1.2×10^{-4}	0.77					
2	2.7×10^{-4}	0.43	0.34	0.34	$15M	$8M	$8M
3	1.9×10^{-4}	0.20	0.23	0.57	$ *	$ *	$ *

Regulatory Status: Currently there is a NESHAP in place requiring work practices to limit radon emissions (bulkheads).

Comments:

Alternative 1: Baseline, no rule—existing NESHAPS would be vacated. Bulkheading is no longer believed effective.

Based on radon risk factor of 360 fatal cancers per million person-WLM, ranging from 160 to 720 fatal cancers per million person-WLM, the Alternative 1 risk may range from 5.3×10^{-4} to 2.4×10^{-3}.

Alternative 1-A: Baseline rule—10,000 Ci/y radon emissions limit. The largest mine emits 8900 Ci/y radon.

Alternative 2: Emission limit of 1,500 Ci/y radon for ground level release or 5,000 Ci/y radon if there is a 30 meter stack. Three mines exceed 5,000 Ci/y radon and would have to reduce operating time by 2-5 months. Several mines would in addition need to cut new vent shafts.

Alternative 3: Emission limit of 1,000 Ci/y radon. This alternative is more stringent than Alternative 2. (* Additional costs are in terms of mines shut down which cannot be quantified at this time.)

Alternative 4: Table does not contain alternative to bring the MIR to 1×10^{-6} because it is difficult to estimate the impact of such action. Most likely, mines could not operate at this level. Six mines would close; new mines could not be opened.

Decision on Ample Margin of Safety. EPA has examined several alternatives before determining the alternative that results in emissions that are safe with an ample margin of safety; those alternatives are presented in Table 20. After examining these different alternatives, the Administrator has determined that alternative 2 represents the level that is safe with an ample margin of safety. Alternative 2 limits the emissions to 1500 Ci/y of radon. An emissions limit of 1500 Ci/y provides a level of emissions that is safe with an ample margin of safety.

However, EPA recognizes that, among the source categories analyzed, uranium mines present a unique situation in determining an acceptable level of risk. This occurs because Mine Safety and Health Administration (MSHA) standards require owners to protect mine workers by operating mine ventilation equipment to reduce the radon levels within the mines. This results in emissions of whatever amount of radon is necessary to reduce the radon levels in the mines to the required levels.

After considering the conflict in the goals of the MSHA regulations and the goals of the CAA, EPA has concluded that emissions higher than 1500 Ci/y can be allowed without increasing the risk to the nearby individuals. If a mine releases its exhaust fan emissions from a 30-meter stack, then radon emissions of 5,000 Ci/y would result in the same level of risk to the most exposed individuals as a ground level release of 1500 Ci/y. This alternative provides an effective means to ventilate the mine, reducing radon levels in the mine, while protecting those persons exposed to the emissions from a mine. Therefore, the Administrator has determined that exhaust vent emissions of radon from underground uranium mines emitted either at ground level with an emission limit of 1500 Ci/y or from a stack that is at least 30 meters high with an emission limit of 5000 Ci/y protects public health with an ample margin of safety.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. Since the dose/risk relationship for radon is well established, it is straightforward to determine the correct standard under this approach. A radon emission limit of 500 Ci/y of radon under current release conditions equals a lifetime risk of 1×10^{-4} to the most exposed individual. Therefore, under this approach, an acceptable level of emissions is 500 Ci/y of radon from any single mine.

Decision on Ample Margin of Safety. Based on the considerations expressed earlier, EPA believes that no further reductions below emissions of 500 Ci/y of radon would be needed. Therefore, EPA is proposing a NESHAP of 500 Ci/y of radon from any single mine, which would protect public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A radon emissions limit of 5 Ci/y of radon would expose an individual to a lifetime risk of 1×10^{-6}. Therefore, under this approach, an acceptable level of emissions is 5 Ci/y of radon from any single underground uranium mine.

Decision on Ample Margin of Safety. A standard of 5 Ci/y radon would be impossible for most underground uranium mines to meet. Since this standard would shut down the industry, there is no need to look at lowering it further. EPA is proposing that underground uranium mines not emit more than 5 Ci/y radon-222 into the atmosphere in any year.

4. Implementation

This standard is an emission standard. Mines are limited in the amount of radon they emit from their exhaust vents. Due to Mine Safety and Health Administration (MSHA) regulations, which are designed to protect the miners from high levels of radon in the mine, the exhaust fans must be operating whenever there are miners working in the mine. This limits EPA flexibility in developing other types of standards to control radon emissions.

Under Approach A and B the limit is 1500 curies of radon a year. If mines emit radon from a stack 30 meters in height or higher, the risks to nearby individuals is reduced such that larger radon emissions will still result in risk levels that are safe with an ample margin of safety. In an effort to provide flexibility for the mine owners in meeting their obligations under MSHA regulations, EPA will allow mines that have 30 meter stacks to emit up to 5,000 curies a year.

Under Approach C, mines can emit up to 500 curies of radon a year, and under Approach D, they can emit up to 5 curies of radon a year. Under all the Approaches, mines will be required to measure and report their annual emissions. Although the report is based on a calendar year the emission limit applies to any year, i.e. any period of 12 consecutive months. Since these reports provide EPA with the information it needs, underground uranium mines are exempted from the requirements of 61.10.

J. Surface Uranium Mines

1. Introduction

Surface mining is accomplished by the excavation of one or more pits to expose uranium ore for removal. While this technique has accounted for about 50–70% of the uranium ore tonnage produced in this country between 1956 and 1985, much of today's uranium production is from underground mines and other sources. In the past, annual production from surface mines ranged from a few hundred tons of ore to 100,000 tons or more. In recent years, surface mining operations have been very large, typically 100,000 tons or more. Due to the dramatic decline in the uranium industry since 1981, the number of surface mines in operation in the U.S. has dropped from 50 in 1981 to just 2 in 1987. While only 2 mines are currently active, there remain about 1,200 mines in the U.S. in various stages of reclamation.

During surface mining, topsoil may be segregated and saved for reclamation; overburden is piled on land beside the pit. The pit and overburden represents a large surface area from which radon can escape into the atmosphere. Radon emissions are higher than usual because radium concentrations are larger than average near bodies of uranium ore.

Health, safety and environmental hazards associated with uranium mining are regulated by a variety of Federal and State laws. As a result of the laws and regulations, uranium mines, especially surface operations, are vastly different operations today than during the 1950s and 1960s. Many of the inactive mines are presently being reclaimed under state law. Reclamation of the mines significantly reduces radon emissions. In the past, EPA decided not to promulgate a NESHAP for this category. That decision was challenged in litigation and is being reexamined in this rulemaking.

2. Estimates of Exposure and Risk

EPA conducted a field study during the summer of 1988 to obtain information with which to model the surface mining industry so that estimates of risk from surface mining could be made. Radiometric surveys were conducted of the two active mines, located in Texas and Wyoming, and 25 inactive mines located in Arizona, New Mexico, Colorado, South Dakota, Texas and Wyoming. In addition, the demographic and meteorologic data were gathered in and around each mining site.

The maximum individual risk of fatal cancer from radon emissions from surface uranium mines is 1.0×10^{-4}. The radon emissions cause 0.016 fatal cancer per year to the population within 80 km. Over 80% of the risk to the population is borne by people whose risk is less than 1×10^{-5}, and 50% of the risk is borne by people whose risk is less than 1×10^{-6}.

Table 21 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels, (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternative 2.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI, to the surface uranium mines source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is 1.0×10^{-4} which is the level generally preferred under the case-by-case approach. The estimated annual incidence is less than 0.0067 fatal cancer per year, and most of that risk is borne by people whose risk is less than 1×10^{-5}. EPA has examined several alternatives before determining the acceptable level, those alternatives and the risks they present are illustrated in Table 21. After examining these different alternatives, the Agency has determined that baseline emissions, alternative 1, represents the level that is acceptable under the case-by-case approach.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, and the decreases in risk and very small incidence reductions they represent, see Table 22, EPA has determined that it is not necessary to further reduce risks below the safe baseline level, alternative 1. Current emissions have an associated risk which is safe with an ample margin of safety. Especially important in this determination is the extremely low population risk and the current state reclamation system which is working to reduce its already low risks.

Due to the depressed state of the uranium mining industry, there is no reason to believe that any new surface mines will be constructed. Therefore, the baseline risks are not expected to increase in the future, and EPA proposes not to regulate this source category.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the radon emissions from surface uranium mines

cause much less than one fatal cancer per year. Therefore, under this approach, current emissions are acceptable.

TABLE 21.—ALTERNATIVE FOR ACCEPTABLE RISK FOR SURFACE URANIUM MINES

	Alternative 1 (baseline)	Alternative 2
Maximum individual risk (lifetime).	1.0×10^{-4}	6.6×10^{-5}
Incidence within 80 km (death/y).	0.016	0.0029
Risk individual:		
E-2 to E-1	0	0
E-3 to E-2	0	0
E-4 to E-3	240	0
E-5 to E-4	1,400	750
E-6 to E-5	62,000	28,000
Less E-6	5.8M	5.8M
Risk incidence:		
E-2 to E-1	0	0
E-3 to E-2	0	0
E-4 to E-3	0.0004	0
E-5 to E-4	0.0006	0.0005
E-6 to E-5	0.0020	0.0007
Less E-6	0.0035	0.0017

Other Health Impacts: Non-fatal cancers no more than 5 percent of deaths.

Approach C: 1×10^{-4} or less Maximum Individual Risk Approch. Decision on Acceptable Risk. Current emissions from surface uranium mines present risks of 1.0×10^{-4} to the maximum exposed individual. Therefore, under this approach current emissions provide an acceptable level of risk.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, and the decreases in risk and very small incidence reductions they represent, see Table 22, EPA has determined that it is not necessary to further reduce risks below the safe baseline level, alternative 1, to protect health with an ample margin of safety. Therefore, EPA is proposing not to regulate under this approach.

Approach D: 1×10^{-5} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A radon emission limit of 0.02 pCi/m²— yields to the most exposed individual. Therefore, under this approach, an acceptable level of emissions is 0.02 pCi/m²—s.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-5} are needed. EPA is proposing a NESHAP limiting emissions of radon to 0.02 pCi/m²—s which would protect public health with an ample margin of safety.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, and the decreases in risk and very small incidence reductions they represent, see Table 22, EPA has determined that it is not necessary to further reduce risks below the safe baseline levels, alternative 1, to protect health with an ample margin of safety. Therefore, EPA is proposing not to regulate under this approach.

TABLE 22.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR SURFACE URANIUM MINES

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	1.0×10^{-4}	0.016					
2	6.6×10^{-5}	0.0029	0.013	0.013	$15M	$0.8M	$0.8M
3	2.2×10^{-5}	0.0015	0.0014	0.014	$51M	$2.6M	$3.3M
4	1.3×10^{-5}	0.0007	0.0008	0.014	$110M	$5.6M	$8.9M

Regulatory Status: Presently unregulated by EPA. State reclamation rules apply to most of these mines. These requirements reduce radon emissions when the mine is closed and reclaimed. Some mines are located on Federal (23%) and Indian (7%) lands; reclamation rules established by Interior, Agriculture, or DOE then apply.

Comments:

Alternative 1: Baseline, no rule—State reclamation rules apply. Analysis assumes larger production mines characterize the risk associated with surface uranium mining. Analysis is based on 25 mines. States with reclamation requirements include Colorado, Texas, Utah, Wyoming and South Dakota.

Based on radon risk factor of 360 fatal cancers per million person-WLM, ranging from 160 to 720 fatal cancers per million person-WLM, the Alternative 1 risk may range from 4.4×10^{-5} to 2.0×10^{-4}.

Alternative 2: Cover source to limit emissions to 40 pCi/m²s—This alternative represents Federalization of State laws covering reclamation. Assumes 0.2 meters of dirt cover.

Alternative 3: Cover source to limit emissions to 20 pCi/m²s—Assumes 0.9 meters of dirt cover.

Alternative 4: Cover source to limit emissions to 6 pCi/m²s—Assumes 2.4 meters of dirt cover.

Alternative 5: Table does not contain alternative to bring the MIR to 1×10^{-6} because of the difficulty in accurately estimating the impacts. Most likely, in addition to State laws covering reclamation, EPA would add additional dirt cover requirements amounting to about 3 meters of dirt to further reduce radon emissions. The total annualized costs would approach $20 million for the 25 largest mines. There are over 1000 of these mines, although most are small operations.

4. Implementation

This NESHAP is a flux standard that limits the emission of radon from uranium mines. The standard limits the amount of radon that can be emitted per unit area (m²) per unit of time (s). This standard is an average per mine including the overburden. This will require that all mimes must be disposed of in a manner that will reduce the radon flux to meet the standard.

Sixty days after the effective date of this rule or sixty days after the operator ceases using a surface uranium mine the operator must test the mine to determine whether or not the mine is in compliance with the flux standard. If an operator knows that the mine cannot meet the standard, the operator can admit noncompliance instead of testing.

Mines must be retested every two years unless EPA requires more frequent testing or EPA determines that less frequent testing is sufficient to assure compliance with the standard. EPA will also reduce the need for testing if EPA determines that testing will interfere with ongoing operations designed to reduce the flux from the mine.

Since the reports of the testing provide EPA with the information it needs, surface uranium mines are exempted from the requirements of 61.10.

K. Radon Releases from Operating Uranium Mill Tailings Piles

1. Introduction

The process of separating uranium from its ore creates waste material that is called uranium mill tailings. Since uranium ore generally contains less than 1 percent uranium, uranium milling produces large quantities of tailings. These tailings are collected in impoundments that vary in size from 20 to 400 acres. The tailings contain large amounts of radium, and, therefore, they emit large quantities of radon. There are 26 licensed uranium mills in the western United States. Due to the depressed state of the uranium industry, most of these mills are not currently operating.

The Uranium Fuel Cycle standard, 40 CFR 190, does not regulate radon emissions from the tailings piles. Radon emmissions during operating are currently regulated by a NESHAP which is a work practice standard which specifies two methods, one of which must be used in the construction of any new tailings impoundment. Existing tailing piles cannot be used after December 31, 1992. Extensions and exceptions can be granted that would allow an existing pile to continue to operate beyond the 1992 deadline. The piles must be disposed of in accordance with EPA's AEA standard, 40 CFR 192.

For the current radionuclides NESHAP rulemaking, EPA is proposing rules for three different subcategories that deal with mill tailings: Operating mill tailings—existing piles, operating mill tailings—new technology, and disposal of uranium mill tailings (as a separate source category; see section VII.L of this notice).

This source category, operating mill tailings, has two subcategories because existing and future mill tailings piles present different problems. Existing mill tailings piles are large piles of wastes that emit radon. There is nothing that can be done to reduce the amount of radon they emit except cover them. New piles can be designed to utilize disposal systems that reduce the problem before very large (hundreds of acres) piles that require disposal accumulate. The new technology cannot readily be used on old piles. It is easier and cheaper to simply cover up the existing piles than to break them up into a series of smaller piles and dispose of them separately.

EPA has determined that it is not feasible to prescribe an emission standard for radon emissons from uranium mill tailing piles. Radon is emitted from the surfaces of tailings piles in a manner analogous to fugitive dust emissions and cannot be emitted through a conveyance designed and constructed to capture such radom emissions. Instead, EPA is requiring on improved work practice for the disposal of newly generated tailings and is specifying a date of which all newly generated tailings must be managed by this work practice.

A crucial issue with all uranium mill tailing piles is that of timing. The ony way to permanently reduce radon emissions from a pile is to cover it up and dispose of it. The piles continue to emit radon at significant levels which they remain uncovered. EPA has not dealt with this timing issue before. We are dealing with it at this time because there has been little, if any, action taken to dispose of the piles. If EPA promulgates a disposal NESHAP, it can require that disposal be started within a set period of time after operations cease or after the rule is promulgated. If this issue is not addressed with a disposal NESHAP, then a NESHAP covering operational piles could require termination of operations and start of final disposal within a set time.

Timing is also a significant issue for the owners of operating mill tailings piles. Operators want to be able to continue to use their existing piles for as long as possible. This allows them to avoid spending money on disposal or new impoundments. In the current NESHAP, EPA dealt with this issue by allowing the continued use of all existing piles until December, 1992, and creating a system of exceptions and extensions that would allow continued use for low risk piles until 2001. This system has been challenged as violating the section 112 requirement that NESHAP compliance be attained within 2 years.

2. Estimates of Exposure and Risk

EPA's risk assessment of operating uranium mill tailings is a site-by-site assessment of all 26 currently licensed mills. Emissions were estimated from the radium-226 concentrations in the tailings, the amount of tailings, and the assumption that 1 pCi/g of radium-226 in the tailings produces 1 pCi/m ^{2}-s of radon. The meteorological data was taken from nearby stations and populations from 5 to 80 km are based on U.S. census tract data. Populations within 5 km were counted at each of the sites. EPA analyzed current emissions and the emissions that would be expected when new tailings impoundments are created in the future.

There are twelve licensed piles that are either operating or on standby. According to EPA's analysis, the lifetime fatal cancer risk to the most exposed individual is 3.3×10^{-3} from these twelve piles. Uranium mill tailings are estimated to cause 1.6 fatal cancer per year to the 4.5 million persons within 80 km of the tailings piles.

Tables 23 and 24 present example scenarios to show how different emission levels would result in different health risk profiles. The tables present the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The tables also present available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2, 3 and 4.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI, to the radon emissions from the uranium mill tailings source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum individual risk to any individual is 3.3×10^{-3} which is higher than the level generally preferred under the case-by-case approach. The estimated annual incidence within 80 km is 1.6 fatal cancers per year, and most of that risk is borne by people whose risk is less than 1×10^{-4}. Many of the piles are closing which will increase emissions from the tailings as they dry out. EPA has examined several alternatives before determining the acceptable level; those alternatives and the risks they present are illustrated in Tables 23 and 24.

After examining these different alternatives, the Agency would propose that the risks associated with alternative 3 for these twelve existing piles which limits the length of time that mills can continue to place new tailings on existing impoundments to 2 years, and limits the emissions to 6 pCi/m^2—s radon after disposal is completed, and alternative 2 for new technology for future piles, which requires a single large impoundment, represents the level that is acceptable under the case-by-case approach.

Decision on Ample Margin of Safety. Mills cannot create new impoundments to replace the existing impoundments in less than two years. EPA has determined that no alternatives more restrictive than alternative 3 need to be analyzed. The costs of this alternative are described in Table 25. Therefore, EPA is proposing to allow existing

impoundments to operate for no more than two years unless they meet the work practice requirements for new impoundments. There is no reason to require closure of an existing impoundment which meets the requirements for new impoundments so that a new impoundment which is similar would need to be constructed.

For new impoundments, EPA has analyzed the costs of further controls to reduce radon emissions, and the decreases in risk and very small incidence reductions they represent, see Table 26.

TABLE 23.—ALTERNATIVES FOR ACCEPTABLE RISK FOR OPERATING URANIUM MILL TAILINGS PILES—EXISTING PILES [1]

	Alternative 1 (baseline)	Alternative 2	Alternative 3
Maximum individual risk (< lifetime exposure)	3.3×10^{-3}	1.4×10^{-3}	4.6×10^{-4}
Incidence within 80 km	1.6 for 15y (24)	1.6 for 6y (9.6)	1.6 for 2y (3.2)
Risk individual			
E-2 to E-1	0	0	0
E-3 to E-2	600	300	0
E-4 to E-3	40,000	20,000	6,000
E-5 to E-4	400,000	200,000	60,000
E-6 to E-5	400,000	200,000	60,000
Less E-6	3.4M	3.8M	4.1M
Risk incidence			
E-2 to E-1	0	0	0
E-3 to E-2	1.2	0.5	0.16
E-4 to E-3	12.0	4.8	1.6
E-5 to E-4	9.0	3.6	1.2
E-6 to E-5	1.5	0.6	0.2
Less E-6	0.0015	0.0006	0.0002

Other Health Impacts: Non-fatal cancers no more than 5 percent deaths. Incidence at greater than 80 km is comparable to that within 80 km.

[1] This assessment assumes that a disposal NESHAP has been promulgated, which would force closure of the piles as soon as they are filled.

TABLE 24.—ALTERNATIVES FOR ACCEPTABLE RISK FOR OPERATING URANIUM MILL TAILINGS PILES—NEW TECHNOLOGIES

	Alternative 1 (baseline)	Alt. 2	Alt. 3	Alt. 4
Maximum individual risk (lifetime)	3.3×10^{-3}	1.8×10^{-4}	6.0×10^{-4}	2.0×10^{-5}
Incidence within 80 km (death/y)	0.78	0.11	0.053	0.018
Risk individual:				
E-2 to E-1	0	0	0	0
E-3 to E-2	550	0	0	0
E-4 to E-3	96,000	23,000	0	0
E-5 to E-4	450,000	120,000	72,000	24,000
E-6 to E-5	1.8M	1.1M	300,000	130,000
Less E-6	110	1.2M	2.0M	2.2M
Risk incidence:				
E-2 to E-1	0	0	0	0
E-3 to E-2	0.018	0	0	0
E-4 to E-3	0.47	0.027	0	0
E-5 to E-4	0.17	0.051	0.028	0.0043
E-6 to E-5	0.12	0.023	0.016	0.0081
Less E-6	0.0000	0.01	0.02	0.007

Other Health Impacts: Non-fatal cancers no more than 5% of deaths incidence at greater than 80 km is comparable to that within 80 km.

EPA has determined that no further reductions to alternative 3 or 4 are called for to provide an ample margin of safety. EPA believes that a NESHAP requiring the work practices of either phased disposal in 40-acre impoundments (alternative 3) or continuous disposal (alternative 4) will protect public health with an ample margin of safety.

TABLE 25.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR 12 OPERATING URANIUM MILL TAILINGS—EXISTING PILES

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	3.3×10^{-3}	1.6/15 yr (total 24)					
2	1.4×10^{-3}	1.6/6 yr (total 10)	(14 Total)	(14 Total)	$230M	$33M	$33M
3	4.6×10^{-4}	1.6/2 yr (total 3)	(7 Total)	(21 Total)	$160M	$46M	$42M

Regulatory Status: Currently there is a NESHAP in place requiring work practices to limit radon emissions. Analysis assumes existing NESHAPS for new licensed mills is not vacated and there is a disposal NESHAP that requires disposal within 2 years of being closed.

(If a disposal rule is not promulgated then a uniform but unknown amount of risk, up to a maximum risk of 1.6 deaths/y and MIR of 2×10^{-3}, would be added to each alternative. Or, this increase could be prevented by promulgating a rule for this category that requires immediate closure.)

Comments: Alternative 1: Baseline, no rule—allows use of existing piles until full (15 years). Existing NESHAP would be vacated for operations of licensed mills. Existing NESHAP for operations at new licensed mills is not vacated.

Based on radon risk factor of 360 fatal cancers per million person-WLM, ranging from 160 to 720 fatal cancers per million person-WLM, the Alternative 1 risk may range from 1.5×10^{-3} to 6.6×10^{-3}.

Alternative 2: Current NESHAP—allows use of existing piles for a maximum of 6 years. Costs include early disposal and capacity replacement.

Alternative 3: Same as current NESHAP—except allows use of existing piles for 2 years. After NESHAP is implemented the annual incidence rate is 0.07 due to radon from all existing piles after they are covered. Costs include early disposal and capacity replacement. Total annualized cost is not the sum of incremental annualized cost because alternative 2 and 3 represent changes in time of performing procedures instead of changes in the stringency of controls.

Alternative 4: Table does not contain alternative to bring the MIR to 1×10^{-5} because there are no further alternatives beyond Alternative 3 other than immediate stop use of the tailings piles.

TABLE 26.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR OPERATING URANIUM MILL TAILINGS—NEW TECHNOLOGIES

Alternative	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
1	3.3×10^{-3}	0.78					
2	1.8×10^{-4}	0.11	0.67	0.69	$30M	$2.4M	$2.4M
3	6.0×10^{-5}	0.053	0.06	0.73	7M	0.56M	3.0M
4	2.0×10^{-5}	0.018	0.04	0.77	<$8M>	<$0.64M>	<$2.3M>

Regulatory Status: Currently there is a NESHAP in place requiring work practices to limit radon emissions.

(If a disposal rule is not promulgated then a uniform but unknown amount of risk, up to a maximum risk of 1.6 deaths/y and MIR of 2×10^{-2}, would be added to each alternative. Or, this increase could be prevented by promulgating a rule for this category that requires immediate closure.)

Comments:

Alternative 1: Baseline, no rule—current technology is used. Assumes 12 existing mills.

Based on radon risk factor of 360 fatal cancers per million person-WLM, ranging from 160 to 720 fatal cancers per million person-WLM, the Alternative 1 risk may range from 1.5×10^{-3} to 6.6×10^{-3}.

Alternative 2: Single large lined impoundment. Assumes 8 mills.

Alternative 3: Current NESHAP—several small lined impoundments with 40 acre limit (phased disposal). Assumes 8 mills.

Alternative 4: Current NESHAP—tailings are dried and disposed of immediately. Total capital cost is less than other two alternatives. Assumes 8 mills.

Alternative 5: To bring MIR to 1×10^{-4}, uranium tailings piles should not operate.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the radon emissions from uranium mill tailings impoundments cause more than one fatal cancer per year. Therefore, under this approach, current emissions must be reduced to provide an acceptable level of risk. However if current NESHAP work practices are continued for new impoundments, radon emissions will cause less than one fatal cancer per year and therefore present acceptable risks. For new technologies, Alternative 1 represents an acceptable level of risk for a relatively small industry (i.e., 12 mills), provided the industry remains at the current level.

Decision on Ample Margin of Safety. Mills cannot create new impoundments to replace the existing impoundments in less than two years, even if they ceased operations in the interim. EPA has determined that no alternatives more restrictive than alternative 3 need to be analyzed. Therefore EPA will allow existing impoundments that do not use new technology to operate for no more than two years. There is no reason to require closing an existing impoundment which meets the requirements for new impoundments so that a new impoundment which is similar would need to be constructed.

For new impoundments, EPA has analyzed the costs of further controls to reduce radon emissions, and the decreases in risk and very small incidence reductions they represent, see Table 26. EPA has determined that no further reductions to alternative 3 or 4 are called for to provide an ample margin of safety. EPA believes that a NESHAP requiring the work practices of either phased disposal in 40 acre impoundments or continuous disposal will protect public health with an ample margin of safety.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A work practice standard of either phased or continuous disposal results in a lifetime risk of less than 1×10^{-4} to the most exposed individual. There is no reason to require closing an existing impoundment which meets the requirements for new impoundments so that a new impoundment which is similar would need to be constructed. The risks that result from allowing the continued use of existing disposal methods that do not meet these work practices bring the risks above the level of 1×10^{-4}. Therefore, under this approach, a work practice standard of phased or continuous disposal starting on the effective date of the rule provides an acceptable level of emissions.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, see Table 26, and the low risks resulting from the use of the new work practice standards, alternatives 3 and 4, EPA believes that no further measures are needed. Existing impoundments that meet the work practice standard will be allowed to continue to operate. Therefore, EPA is proposing a work practice NESHAP requiring either phased or continuous disposal of tailings starting on the effective date of the rule would protect public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A radon emission limit of 0.02 pCi/m^2-s results in a lifetime risk of 1×10^{-6} to the most exposed individual. Therefore, under this approach, an acceptable level of emissions is 0.02 pCi/m^2-s.

Decision on Ample Margin of Safety. A NESHAP limiting any increase of ambient radon levels to 0.02 pCi/m^2-s would protect public health with an ample margin of safety. EPA believes there is no method to manage mill tailings which will result in this low an ambient radon level. Therefore, under this approach, EPA is proposing to prohibit the production of new tailings.

4. Implementation

This NESHAP is a work practice standard designed to reduce radon emissions by forcing mill operators to manage their tailings in a way that will reduce radon emissions. Under Approach A or B, mill operators would not be allowed to put any tailings on a mill tailings impoundment which does not meet the new work practices, phased or continuous disposal, two years after the effective date of this NESHAP. EPA is making a generic finding that at least two years is required for the construction of new impoundments using the new control technology and that during that two year period all persons will be protected from imminent endangerment from uranium mill tailings piles.

Under Approach C, mill operators would have to go to the new work practices after the effective date of the rule. Under Approach D, no new mill tailings may be produced starting after the effective date of the rule. EPA is forced to go to this extreme solution because it knows of no way to manage new tailings that will result in risks of less than 1×10^{-6}.

Since EPA already has the information it needs, uranium mill tailings are exempted from the requirements of 61.10.

L. Radon Releases From the Disposal of Uranium Mill Tailings Piles

1. Introduction

After uranium mill tailings impoundments can no longer be used, they must be disposed of. In addition to

the fourteen licensed piles that commercial licensees are decommissioning. DOE controls 24 abandoned uranium mill tailings piles. The 1978 Uranium Mill Tailings Radiation Control Act (UMTRCA) gave DOE responsibility for remedial actions at these sites. This Act also requires EPA to set environmental standards which control the releases from all disposed uranium mill tailings impoundments.

In the past, EPA decided not to regulate under the CAA the disposal of uranium mill tailing impoundments regulated under UMTRCA. That decision has been challenged in court, so EPA is reexamining this category. The UMTRCA regulation limits postclosure radon releases to 20 pCi/m^2—s from the tailings piles.

2. Estimates of Exposure and Risk

EPA's risk assessment of uranium mill tailings is a site-by-site assessment of all 24 inactive piles and 14 licensed piles that are being decommissioned. An additional uncertainty to this risk assessment occurs because DOE currently has plans to relocate eleven of the inactive mill tailings piles to unpopulated areas; in addition, DOE plans to stabilize the remaining 13 piles pursuant to regulations in 40 CFR Part 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings. EPA has information in the rulemaking record concerning DOE's plans which will be considered for use in the development of the final rule.

Emissions were estimated from the estimated area of the tailings pile combined with the assumed radon flux of 20 pCi/m^2—s for reclaimed piles and 1 pCi/m^2—s per pCi/g of radium for unreclaimed piles. The meteorological data was taken from nearby stations, and populations from 5 to 80 km are based on U.S. census tract data. Populations within 5 km were measured at the sites.

According to EPA's analysis, lifetime fatal cancer risk to the most exposed individual is 2.1×10^{-2}. The tailings piles cause 2.5 fatal cancers per year to the 9.7 million persons within 80 km.

Table 27 presents example scenarios to show how different emission levels would result in different health risk profiles. The table presents the risk estimates at baseline in terms of estimated annual fatal cancer incidence, maximum individual lifetime risk, total population exposed at or above particular risk levels (i.e., risk distribution), and annual incidence attributable to the population exposed at each risk level. The table also presents available estimates of annual incidence and maximum individual lifetime risk for a lower emission level identified as alternatives 2, 3 and 4.

3. Application of Alternative Policy Approaches

The decisions that would result from the application of the four policy approaches described in Section VI to the radon emissions from the uranium mill tailings source category are described below.

Approach A: Case-by-Case Approach. Decision on Acceptable Risk. As stated earlier, the maximum risk to any individual is 2.1×10^{-2} which is much higher than the level generally preferred under the case-by-case approach. The estimated annual incidence within 80 km is 2.5 fatal cancers per year. Most of that risk is borne by people whose risk is less than 1×10^{-4}. EPA examined several alternatives before determining the acceptable level; those alternatives and the risks they present are illustrated in Table 27. After examining these different alternatives, the Agency would propose that the risks associated with alternative 3 is acceptable under the case-by-case approach.

Decision on Ample Margin of Safety. Based on the costs of further controls to reduce radon emissions, and the small decreases in risk, see Table 28, EPA has determined that it is not necessary to further reduce risks below the safe level, alternative 3. EPA is proposing a NESHAP limiting radon emissions from the disposal of uranium mill tailings to 6 pCi/m^2—s, which will protect public health with an ample margin of safety.

Approach B: Incidence Based Approach. Decision on Acceptable Risk. As explained earlier, the radon emissions from the disposal of uranium mill tailings cause 2.5 fatal cancers per year. Therefore, under this approach, current emissions provide a level of risk which is not acceptable. In order to reach an acceptable risk, current emissions must be reduced by a factor of 2.5.

TABLE 27.—ALTERNATIVES FOR ACCEPTABLE RISK FOR DISPOSAL OF URANIUM MILL TAILINGS

[Inactive and licensed]

	Alternative 1 (baseline)	Alt. 2	Alt. 3	Alt. 4
Maximum individual risk (lifetime)	2.1×10^{-2}	1.0×10^{-4}	3.0×10^{-4}	1.0×10^{-4}
Incidence within 80 km (death/y)	2.7	0.12	0.040	0.013
Risk individual:				
E-2 to E-1	350	0	0	0
E-3 to E-2	12,000	(1)	0	0
E-4 to E-3	300,000	1,000	300	100
E-5 to E-4	3.4M	100,000	20,000	10,000
E-6 to E-5	2.5M	1.6M	300,000	200,000
Less E-6	3.6M	8.0M	9.4M	9.5M
Risk incidence:				
E-2 to E-1	0.08	0	0	0
E-3 to E-2	0.3	(1)	0	0
E-4 to E-3	1.2	0.004	0.0005	0.0002
E-5 to E-4	0.9	0.04	0.005	0.002
E-6 to E-5	0.2	0.045	0.014	0.005
Less E-6	0.004	0.03	0.02	0.007

[1] We believe there could be a few people at this risk, but DOE may move the piles in question.

Note.—*Other Health Impacts:* Non-fatal cancers no more than 5% of deaths.

Decision on Ample Margin of Safety. Based on an analysis of the costs of various control alternatives and decreases in risk and incidence they represent, see Table 28, EPA has determined that it is necessary to reduce risks to the level of alternative 3, but that further reductions are unnecessary. EPA is proposing a NESHAP limiting

radon emissions from disposal of uranium mill tailings to 6 pCi/m²s, which will protect public health with an ample margin of safety.

TABLE 28.—ALTERNATIVES FOR AMPLE MARGIN OF SAFETY FOR DISPOSAL OF URANIUM MILL TAILINGS

	MIR	Incidence	Incremental incidence reduction	Total incidence reduction	Incremental capital cost	Incremental annualized cost	Total annualized cost
Alternative:							
1	2.1×10^{-3}	2.7					
2	1.0×10^{-3}	0.12	2.6	2.6	$210M	$22M	$22M
3	3.0×10^{-4}	0.040	0.08	2.7	63M	7M	29M
4	1.0×10^{-4}	0.013	0.03	2.7	53M	6M	34M

Regulatory Status: Current AEA rule limits radon emission after disposal to 20 pCi/m²s. Previously, we deferred to this rule and did not propose a CAA rule.
Comments:
Alternative 1: Baseline, no rule—AEA rule remains in force, but no deadline for disposal. MIR reflects piles that are currently uncovered.
Based on radon risk factor of 360 fatal cancers per million person-WLM, ranging from 160 to 720 fatal cancers per million person-WLM, the Alternative 1 risk may range from 9.3×10^{-3} to 4.2×10^{-3}.
Alternative 2: Cover source to limit emissions to 20 pCi/m²s—the same level as the current AEA rule set by EPA.
Alternative 3: Cover source to limit emissions to 6 pCi/m²s.
Alternative 4: Cover source to limit emissions to 2 pCi/m²s. Emission rate is close to background emission rate of the cover. Implementation becomes difficult.
Alternative 5: Table does not contain alternative to bring MIR to 1×10^{-4} because it is not possible to accurately predict the impacts. Compared to Alternative 3, an additional 8 meters of dirt cover would probably be needed to provide the necessary reduction by a factor of 300. The additional annualized cost would be approximately $70 million.

Approach C: 1×10^{-4} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. Since the dose/risk relationship for radon is well established it is easy to determine the correct standard under this approach. A radon emission limit of 2 pCi/m²—s results in a lifetime risk of 1×10^{-4} to the most exposed individual. Therefore, under this approach, an acceptable level of emissions is 2 pCi/m²—s.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-4} are needed. Therefore, EPA is proposing a NESHAP limiting any emissions of radon to 2 pCi/m²—s, which will protect public health with an ample margin of safety.

Approach D: 1×10^{-6} or Less Maximum Individual Risk Approach. Decision on Acceptable Risk. A radon emission limit of 0.02 pCi/m²—s results in a lifetime risk of 1×10^{-6} to the most exposed individual. Therefore, under this approach, an acceptable level of emissions is 0.02 pCi/m²—s.

Decision on Ample Margin of Safety. Due to the costs and difficulty of further reducing emissions, EPA believes that no further reductions below a risk level of 1×10^{-6} are needed. Therefore, EPA is proposing a NESHAP limiting any release of radon to 0.02 pCi/m²—s, which would protect public health with an ample margin of safety.

4. Implementation

Under this NESHAP, all uranium mill tailings will have to be covered to reduce the amount of radon they release. Under approaches A, B, C, and D, the standard limits the emission of radon from the mill tailings impoundments. The standard limits the amount of radon that can be emitted per unit area (m²) per unit of time (s). This standard is an average per mill tailings pile.

Sixty days after the effective date of this rule or sixty days after the pile ceases to be operational, the owner will test the pile to determine whether or not the pile is in compliance with the flux standard. If owner knows that the pile cannot meet the standard, the owner can admit noncompliance instead of testing the pile.

Piles must be retested every two years unless EPA requires more frequent testing or EPA determines that less frequent testing is sufficient to assure compliance with the standard. EPA will also reduce the need for testing if EPA determines that testing will interfere with ongoing operations designed to cover the pile.

Since the reports of the testing provide EPA with the information it needs, uranium mill tailings are exempted from the requirements of 61.10.

This standard like all NESHAPS requires compliance by existing sources within 90 days after the effective date in accordance with the CAA, 42 U.S.C. 7412(c)(1)(B)(i). EPA, however, is aware that many sources covered by this subpart will not be able to come into compliance that quickly. EPA is prepared to develop expeditious compliance schedules in consultation with affected parties within the framework of the waiver provision of 42 U.S.C. 7412(c)(1)(B)(ii) following the procedures described in 40 CFR 61.10 and 61.11 or through the enforcement mechanisms of 42 U.S.C. 7413, as appropriate. EPA recognizes that the requirements of CERCLA and other environmental laws will have to be considered in these consultations.

VIII. Legal Issues Raised by Parties in the Radionuclides Litigation

The following is a discussion of the legal issues which have been raised in the current litigation. We have omitted reference to issues where they are resolved in the detailed discussion of the source categories earlier in the Preamble.

1. Can EPA Not Issue Standards Under Section 112 in Situations Where People Will Be Killed by a Source of Pollution? Can EPA Disregard Projected Deaths as Insignificant?

Response: EPA is presenting four different approaches for defining acceptable risk. Under all of these approaches, it is possible that a situation may present an acceptable risk even though some fatal cancers are estimated to be caused by the pollution. Any emissions of a pollutant assumed to be nonthreshold is assumed to entail some risk, however small, of fatal cancer. Section 112 does not require EPA to define a safe level as that level that entails no risk of fatal cancer. The DC Circuit Court, in the *vinyl chloride* decision, clearly stated that safe does not mean risk free. EPA agrees with the Court that section 112 requires a finding of acceptable risks, acceptable for the world in which we live. This means that some risk of fatal cancer may be acceptable.

2. Must NESHAPS Provide "Equal Protection" for All Individuals, Including Those in Small Population Groups?

Response: EPA believes that everyone is entitled to be protected by a standard that, overall, protects health with an ample margin of safety. Such a standard need not assure that every individual faces the same precise MIR. As with any regulation of a point source of pollution, the sources considered for regulation in this Preamble give higher risks to the people who are closer to the facility than to people who are farther away. It is impossible to protect all people equally unless the emission limit and, therefore, the risk is zero. Under the CAA, EPA is only required to protect public health (which includes the health of individuals) with an ample margin of safety; equal protection of all individuals is not required.

3. Can EPA Set a Standard That EPA Does Not Find Protects Public Health With an Ample Margin of Safety?

Response: EPA recognizes its duty to set NESHAPS that protect public health with an ample margin of safety. EPA will not establish a NESHAP that it does not find protects public health with an ample margin of safety.

4. Can EPA Set a Dose Standard?

Response: Section 112 requires that EPA set standards which protect public health with an ample margin of safety. The section allows EPA to set emission standards or work practice standards. Dose standards are, in effect, emission standards, since the standards require the source to have emissions that are low enough to meet the dose standard. There is a direct correlation between dose and risk. Sources would use the computer compliance models to track the doses caused by their emissions.

For categories involving very large numbers of different radionuclides, EPA has chosen not to set specific radionuclide emission standards because they would be completely impractical. All radionuclides are different—they have different half-lives, emit different levels of different kinds of energy and affect different parts of the body. Health physicists for years have used the concept of radiological dose to account for these many effects.

If EPA were not allowed to take advantage of this extensive body of knowledge, EPA would be forced to set separate emission standards for hundreds of distinct radionuclides. Since different sources use different radionuclides in different combinations, and many individual radionuclides are present in small amounts in only a few places; judged individually, it would generally be difficult to justify standards that would require any decrease in emissions. Yet the combination of the individual radionuclide with the scores of others that may be released from a facility can cause a significant risk that should be regulated.

5. Is the Use of 1970 Census Data Instead of 1980 Census Data Acceptable?

Response: 1980 census data has been used in the present rulemaking.

6. Can EPA Allow Non-Regulation and Rely on Industry Practices?

Response: EPA is obligated in this litigation to reexamine each source category and assure that public health is protected with an ample margin of safety. EPA may find that standards are unnecessary so long as public health is protected with an ample margin of safety. For example, if the risks caused by a source category's current emissions are low enough to protect public health with an ample margin of safety, then the decision whether or not to set a baseline standard will be based on whether EPA has any reason to believe that there is a need to insure that future emissions will not increase.

7. Does EPA's Use of a Non-Threshold Hypothesis Require a Finding of Significant Risk?

Response: EPA thoroughly considered the results of risk assessments before making a finding of significant risk regarding radionuclides. This assessment was based, in part, on the scientific consensus of the non-threshold carcinogenicity of radionuclides. EPA does not believe a finding of carcinogenicity need automatically result in a finding of significant risk. However, for radionuclides, the risk assessment supports EPA's finding of significant risk. See, Section 112 discussion earlier in preamble and discussion of individual source categories.

8. Must Radon Emissions From Underground Uranium Mines Contribute a Significant Increment to the Total Human Exposure Burden in Order for Those Emissions To Be Regulated Under the Clean Air Act?

Response: A level of emissions is not considered to be acceptable merely because it is below background. The relevant question under section 112 is whether, in the judgment of the Administrator, radionuclides cause, or contribute to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness. The Agency believes, based on substantial scientific evidence, that radionuclide emissions from underground uranium mines meet that test. See, preamble discussion of underground uranium mines.

9. Are the Risks From Underground Uranium Mines Radon Emissions Real or Hypothetical? Does It Matter?

Response: EPA utilizes scientifically accurate procedures in evaluating the risks posed by each source category. While EPA is ultimately forced to estimate these risks, the Agency has confidence in its methodology and considers the results to be a proper foundation for decisionmaking.

10. Can Calculations Based on a Hypothetical "Maximally Exposed Individual" Be Used To Support a Finding of Significant Risk?

Response: As a matter of expert judgment, EPA used a reasonable mix of data sources, using measured and estimated data inputs.

IX. Request for Comments

Throughout this notice, comments and information are requested on specific areas. In addition, partly in response to *Vinyl Chloride*, EPA is reexamining assumptions and decision methods it has relied upon in making section 112 hazardous air pollutant regulatory determinations. As part of that process, EPA is seeking to engage the public and all interested parties in discussion concerning both specific elements of alternative proposals for radionuclide standards and a broader reexamination of assumptions and decision methods.

In an effort to structure that discussion, EPA has formulated the four alternative approaches noted earlier for the control of hazardous air pollutant emissions under section 112 of the CAA. Today's **Federal Register** notice proposes these four approaches for the control of air emissions of radon and other radionuclides and thereby provides the opportunity for EPA to solicit comments from the public on a variety of issues associated with this reexamination of the Federal program for hazardous air pollutants. Determinations on many of these specific issues within the proposed radionuclides and benzene regulations for proposal benzene regulations, see 53 FR 28496–28592, July 28, 1988) may be expected to set precedents for the approach to be used for the substantial number of forthcoming NESHAP decisions. Major areas on which the

Administrator requests public comment include, among others:

(1) Should EPA consider all risk information in decision on risk acceptability or rely on a single numerical risk criterion? If multiple risk measures are to be used as the basis for decisions on risk acceptability, how should EPA balance individual versus population risk reductions?

(2) What health risk is acceptable not considering the cost and technical feasibility of achieving it? Moreover, what constitutes an ample margin of safety in cases where all exposures pose some risk?

(3) Should EPA require standards pursuant to the ample margin of safety decisions under section 112 that are "technology forcing"? What criteria should EPA use to define the "availability" and "feasibility" of technological controls?

(4) In the ample margin of safety determination, how should EPA balance the residual health risks versus the possibility of plant closures?

(5) How should uncertainty in risk estimates be considered in these decisions?

(6) How should EPA balance the various risk, technical, and economic considerations in ample margin of safety decisions? How should EPA consider the ramifications of potential errors and uncertainty of judgments on technology capability and costs?

(7) Should EPA set a risk limit rather than a dose limit or an emission limit?

(8) Should EPA establish a system for certifying that phosphogypsum piles and/or surface uranium mines are not going to be used anymore and, therefore, are ready for disposal? If so, what should that system be?

(9) Should EPA keep the current underground uranium mine NESHAP to control radon emissions for new mines?

(10) Is the proposed regulatory approach for underground uranium mines appropriate? Should EPA consider other combinations of stack height and radon emission limits?

(11) Is EPA's decision to list radionuclides under section 112 of the CAA appropriate?

(12) Should EPA determine compliance with a dose standard on the basis of the point of maximum concentration where there is a residence, school, business or office or should some other point or criteria be used?

(13) If EPA uses schools, businesses or offices as potential compliance points should EPA's implementation system adjust the exposure received at those points with occupancy factors? If so, what should they be?

(14) Considering that accidental releases are included in the emissions subject to the standard, should EPA include some additional provision in its compliance procedures dealing with accidents?

X. Miscellaneous

A. Docket

The docket is an organized and complete file of all information considered by EPA in the development of the standards. The docket allows interested persons to identify and locate documents so they can effectively participate in the rulemaking process. It also serves as the record for judicial review.

Transcripts of the hearings, all written statements, the Agency's response to comments, and other relevant documents have been placed in the docket and are available for inspection and copying during normal working hours.

B. General Provisions

Except where otherwise specifically stated, the general provisions of 40 CFR Part 61, Subpart A apply to all sources regulated by this rule.

C. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (OMB) under the *Paperwork Reduction Act*, 44 U.S.C 3501 *et seq.* An Information Collection Request document has been prepared by EPA (ICR NO. 1100), and a copy may be obtained from Carla Levesque, Information Policy Branch; EPA; 401 M St., SW. (PM-223); Washington, DC 20460 or by calling (202) 382-2468.

Public reporting burden for this collection of information is estimated to vary from 16 to 40 hours per response, with an average of 22 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden may be sent to the above address, but should be sent to the Office of Information and Regulatory Affairs, Paperwork Reduction Project (2060-0115), Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA." In developing the final rule EPA will respond to any OMB or public comments on the information collection requirements contained in this proposal.

D. Executive Order 12291

Under Executive Order 12291, EPA is required to judge whether this regulation is a "major rule" and therefore subject to certain requirements of the Order. The EPA has determined that regulations proposed for Approaches A, B and C for all categories and for D for all non-radon radionuclide categories will result in none of the adverse economic effects set forth in section I of the Order as grounds for finding a regulation to be a "major rule." These regulations are not major because: (1) Nationwide annual compliance costs do not meet the $100 million threshold; (2) the regulations do not significantly increase prices or production costs; and (3) the regulations do not cause significant adverse effects on domestic competition, employment, investment, productivity, innovation, or competition in foreign markets.

The regulations proposed under Approach D for radon categories, especially for the disposal of mill tailings for radon, may cause industries to incur costs exceeding $100 million and therefore may be determined to be a major rule under Executive Order 12291. The regulations could cause significant adverse effects on domestic competition, employment, investment, productivity, innovation, or competition in foreign markets. However, as provided by section 8 of the Order, the Agency has not conducted a Regulatory Impact Analysis (RIA) of these proposed regulations because of the time constraint of the judicially-ordered schedule.

All of the proposed regulations presented in this notice were submitted to OMB for review as required by Executive Order 12291. Any written comments from OMB to EPA and any written EPA response to those comments will be included in the docket.

E. Regulatory Flexibility Analysis

Section 603 of the Regulatory Flexibility Act, 5 U.S.C. 603, requires EPA to prepare and make available for comment an "initial regulatory flexibility analysis" in connection with any rulemaking for which there is a statutory requirement that a general notice of proposed rulemaking be published. The "initial regulatory flexibility analysis" describes the effect of the proposed rule on small business entities.

However, section 604(b) of the Regulatory Flexibility Act provides that

section 603 "shall not apply to any proposed * * * rule if the head of the Agency certifies that the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."

EPA believes that virtually all small businesses covered by this final rule already comply. In addition, EPA has placed reporting exemptions in the rule for NRC-licensees to limit the amount of paperwork that would be required by the smaller operators. Therefore, this rule will have little or no impact on small businesses. A small business is one that has 750 employees or fewer.

For the preceding reasons, I certify that this rule will not have significant economic impact on a substantial number of small entities.

List of Subjects in 40 CFR Part 61

Air pollution control, Hazardous materials, Asbestos, Beryllium, Mercury, Vinyl chloride, Benzene, Arsenic, and Radionuclides.

Dated: February 28, 1989.

William K. Reilly,

Administrator.

PART 61—[AMENDED]

It is proposed to amend Part 61 of chapter I of title 40 of the Code of Federal Regulations as follows:

1. The authority citation for Part 61 continues to read as follows:

Authority: 42 U.S.C. 7401–7642.

2. By revising Subpart H to read as follows:

Subpart H—National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities

Sec.

Subpart H—National Emission Standards for Emissions of Radionuclides Other Than Radar From Department of Energy Facilities

§ 61.90 Designation of facilities.

The provisions of this subpart apply to operations at any facility owned or operated by the Department of Energy that emits any radionuclide other than radon-222 into the air, except that this subpart does not apply to disposal at facilities subject to 40 CFR Part 191 subpart B or 40 CFR Part 192.

§ 61.91 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Effective dose equivalent" means the sum of the products of absorbed dose and appropriate factors to account for differences in biological effectiveness due to the quality of radiation and its distribution in the body. The unit of the effective dose equivalent is the rem. For purposes of this subpart, doses caused by radon-220, radon-222 and their respective decay products are not included. The method for calculating effective dose equivalent is outlined in the International Commission on Radiological Protection's Publication No. 26.

(b) "Facility" means all buildings, structures and operations on one contiguous site.

(c) "Radionuclide" means a type of atom which spontaneously undergoes radioactive decay.

(d) "Residence" means any home, house, apartment building, or other place of dwelling which is occupied during any portion of the relevant year.

§ 61.92 Standard.

Approach A and Approach B

Emissions of radionuclides to the air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr.

Approach C

Emissions of radionuclides to the air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 3 mrem/yr.

Approach D

Emissions of radionuclides to the air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 0.03 mrem/yr.

§ 61.93 Emission monitoring and test procedures.

(a) To determine compliance with the standard, radionuclide emissions shall be determined and effective dose equivalent values to members of the public calculated using EPA approved sampling procedures, computer models AIRDOS–EPA and RADRISK (CAP–88 version), or other procedures which EPA has determined to be suitable.

(b) Radionuclide emission rates from point sources (stacks or vents) shall be measured in accordance with the following requirements:

(1) Effluent flow rate measurements shall be made using the following methods:

(i) Reference Method 2 of Appendix A to Part 60 shall be used to determine velocity and volumetric flow rates for stacks and large vents.

(ii) Reference Method 2A of Appendix A to Part 60 shall be used to measure flow rates through pipes and small vents.

(2) Radionuclides shall be extracted, collected and measured using the following methods:

(i) Reference Method 1 of Appendix A Part 60 shall be used to select sampling sites.

(ii) Representative samples of an effluent stream shall be withdrawn continuously for the sampling site following the guidance presented in ANSI–N13.1 "Guide to Sampling Airborne Materials in Nuclear Facilities" (including the guidance presented in Appendix A of ANSI–N13.1), as specified in paragraph 61.18. Samples shall be collected continuously whenever there is potential for radionuclides to be emitted. The requirements for continuous sampling are applicable to batch processes when the unit is in operation. Periodic sampling (grab samples) may be used only with EPA's prior approval. Such approval may be granted in cases where continuous sampling is not practical and radionuclide emission rates are relatively constant.

(iii) Radionuclides shall be collected and measured using procedures based on the principles of measurement described in Appendix B, Method 114. Use of methods based on principles of measurement different from those described in Appendix B, Method 114 must have prior approval from the Administrator. EPA reserves the right to approve of measurement procedures.

(iv) A quality assurance program shall be conducted that meets the performance requirements described in Appendix B, Method 114.

(3) When it is impractical to sample an effluent stream at an existing source in accordance with the site selection and sample extraction requirements of paragraphs § 61.93(b), the facility operator may use alternative site selection and sample extraction procedures provided that:

(i) It can be shown that the requirements of paragraph § 61.93(b) are impractical for the effluent stream.

(ii) The alternative procedure will not significantly underestimate the emissions.

(iii) The alternative procedure is fully documented.

(iv) The operator has received prior approval from EPA.

§ 61.94 Compliance and reporting.

(a) Compliance with this standard shall be determined by calculating the effective dose equivalent to any member of the public at the offsite point of maximum annual air concentration, where there is a residence, school, business or office. The operators of each facility shall submit an annual report to EPA by June 30 which includes the results of the monitoring and the dose calculations required by § 61.93 for the previous calendar year.

(b) In addition to the requirements of paragraph (a) of the section, an annual report shall include the following information:

(1) The name of the facility.

(2) A list of the radioactive materials used at the facility.

(3) A description of the handling and processing that the radioactive materials undergo at the facility.

(4) A list of the stacks or vents or other points where radioactive materials are released to the atmosphere.

(5) A description of the effluent controls that are used on each stack, vent, or other release point and an estimate of the efficiency of each control device.

(6) Distances from the points of release to the nearest residence, school, business or office and the nearest farms producing vegetables, milk, and meat.

(7) The values used for all other user-supplied input parameters for the computer models (e.g., meteorological data) and the source of these data.

(8) All information required in an application to construct or modify a facility under 61 subpart A, for all construction and modifications which are completed in the calendar year for which the report is prepared, but for which the requirement to apply for approval to construct or modify was waived under § 61.96.

(9) Each report shall be signed and dated by the principal executive officer or public official in charge of the facility and contain the following declaration immediately above the signature line: "I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001."

(c) If the facility is not in compliance with the emission limits of § 61.92 in the calendar year covered by the report then the facility must report to the Administrator on a monthly basis the information listed in paragraph (b) of this section, for the preceding month. These reports will be due 30 days following the end of each month. This increased level of reporting will continue until the Administrator has determined that the monthly reports are no longer necessary. In addition to all the information required in paragraph (b) of this section, monthly reports shall also include the following information:

(1) All controls or other changes in operation of the facility that will be or are being installed to bring the facility into compliance.

(2) If the facility is under a judicial or administrative enforcement decree the report will describe the facilities performance under the terms of the decree.

§ 61.95 Recordkeeping requirements.

All facilities must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine dose. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard. These records must be kept at the site of the facility for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.96 Applications to construct or modify.

(a) In addition to any activity that is defined as construction under 61 subpart A, any fabrication, erection or installation of a new building or structure within a facility is also defined as new construction for purposes of 40 CFR Part 61, subpart A.

(b) An application for approval under § 61.07 does not need to be filed for any new construction of or modification within an existing facility if the effective dose equivalent, caused by all emissions from the new construction or modification, is less than 1% of the limit prescribed in § 61.92. The effective dose equivalent shall be calculated using the source term derived using Appendix D as input to the dispersion and other computer models described in § 61.93. In addition, based on its last annual report the facility is in compliance with this subpart.

§ 61.97 Exemption from the reporting and testing requirements of 40 CFR 61.10

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

3. By revising Subpart I to read as follows:

Subpart I—National Emission Standards for Radionuclide Emissions From Facilities Licensed by the Nuclear Regulatory Commission and Federal Facilities Not Covered by Subpart H

Sec.

Subpart I—National Emission Standards for Radionuclide Emissions From Facilities Licensed by the Nuclear Regulatory Commission and Federal Facilities Not Covered by Subpart H

§ 61.100 Applicability.

The provisions of this subpart apply to NRC-licensed facilities and to facilities owned or operated by any Federal agency other than the Department of Energy, except that this subpart does not apply to disposal at facilities under 40 CFR Part 191 subpart B, or to low energy accelerators or to any NRC-licensee that possesses and uses radionuclides only in the form of sealed sources.

§ 61.101 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Agreement State" means a State with which the Atomic Energy Commission or the Nuclear Regulatory Commission has entered into an effective agreement under subsection 274(b) of the Atomic Energy Act of 1954, as amended.

(b) "Effective dose equivalent" means the sum of the products of absorbed dose and appropriate factors to account

for differences in biological effectiveness due to the quality of radiation and its distribution in the body. The unit of the effective dose equivalent is the rem. For purposes of this subpart doses caused by radon-220, radon-222 and their decay products formed after their release from the facility are not included. The method for calculating effective dose equivalent is outlined in the International Commission on Radiological Protection's Publication No. 26.

(c) "Facility" means all buildings, structures and operations on one contiguous site.

(d) "Federal facility" means any facility owned or operated by any department, commission, agency, office, bureau or other unit of the government of the United States of America except for facilities owned or operated by the Department of Energy.

(e) "NRC-licensed facility" means any facility licensed by the Nuclear Regulatory Commission or any Agreement State to receive title to, receive, possess, use, transfer, or deliver any source, by-product, or special nuclear material.

(f) "Radionuclide" means a type of atom which spontaneously undergoes radioactive decay.

§ 61.102 Standard.

Approach A and Approach B

Emissions of radionuclides to the air from a NRC-licensed or federal facility shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr.

Approach C

Emissions of radionuclides to the air from a NRC-licensed or federal facility shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 3 mrem/yr.

Approach D

Emissions of radionuclides to the air from a NRC-licensed or federal facility shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 0.03 mrem/yr.

§ 61.103 Determining compliance.

The only criteria by which compliance with the emission standard in this subpart shall be determined is the doses calculated by either the EPA computer code COMPLY or the alternative requirements of Appendix E. The source terms to be used for input into COMPLY shall be determined through the use of the measurement procedures listed in § 61.107 or the emission factors in Appendix D.

§ 61.104 Reporting requirements.

(a) The owner or operator of a facility must submit an annual report to the EPA by March 30 of the following year.

(1) The report or application must provide the following information:

(i) The name of the facility.

(ii) The name of the person responsible for the operation of the facility and the name of the person preparing the report (if different).

(iii) The location of the facility, including suite and/or building number, street, city, county, state, and zip code.

(iv) The mailing address of the facility, if different from item (iii).

(v) A list of the radioactive materials used at the facility.

(vi) A description of the handling and processing that the radioactive materials undergo at the facility.

(vii) A list of the stacks or vents or other points where radioactive materials are released to the atmosphere.

(viii) A description of the effluent controls that are used on each stack, vent, or other release point and an estimate of the efficiency of each device.

(ix) Distances from the point of release to the nearest residence, school, business or office and the nearest farms producing vegetables, milk, and meat.

(x) The effective dose equivalent calculated using the compliance procedures in § 61.103.

(xi) The physical form and quantity of each radionuclide emitted from each stack, vent or other release point, and the method(s) by which these quantities were determined.

(xii) The volumetric flow, diameter, effluent temperature, and release height for each stack, vent or other release point where radioactive materials are emitted, the method(s) by which these were determined.

(xiii) The height and width of each building from which radionuclides are emitted.

(xiv) The values used for all other user-supplied input parameters (e.g., meteorological data) and the source of these data.

(xv) All information required in an application to construct or modify a facility under 61 subpart A, for all construction and modifications which were completed in the relevant calendar year but for which the requirement to apply for approval to construct or modify was waived under § 61.106.

(xvi) Each report shall be signed and dated by the principal executive officer or public official in charge of the facility and contain the following declaration immediately above the signature line:

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

(b) Facilities emitting radionuclides in an amount that would cause less than 10% of the dose listed in § 61.102, as determined by the compliance procedures from § 61.103, are exempt from the reporting requirements of § 61.104. Facilities shall annually make a new determination whether they are exempt from reporting.

(c) If the facility is not in compliance with the emission limits of § 61.102 in the calendar year covered by the report then the facility must report to the Administrator on a monthly basis the information listed in paragraph (a) of this section, for the preceding month. These reports will be due 30 days following the end of each month. This increased level of reporting will continue until the Administrator has determined that the monthly reports are no longer necessary. In addition to all the information required in paragraph (a) of this section, monthly reports shall also include the following information:

(1) All controls or other changes in operation of the facility that will be or are being installed to bring the facility into compliance.

(2) If the facility is under a judicial or administrative enforcement decree the report will describe the facilities performance under the terms of the decree.

§ 61.105 Recordkeeping requirements.

The owner or operator of any facility must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard, and, if claimed, qualification for exemption from reporting. These records must be kept at the site of the facility for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.106 Applications to construct or modify.

(a) In addition to any activity that is defined as construction under 61 subpart A, any fabrication, erection or installation of a new building or structure within a facility is also defined as new construction for purposes of 40 CFR Part 61, subpart A.

(b) An application for approval under § 61.07 does not need to be filed for any new construction of or modification within an existing facility if one of the following conditions is met:

(1) The effective dose equivalent calculated by using methods described in § 61.103, that is caused by all emissions from the facility including the proposed new construction or modification, is less than 10% of the limit prescribed in § 61.102.

(2) The effective dose equivalent calculated by using methods described in § 61.103, that is caused by all emissions from the new construction or modification, is less than 1% of the limit prescribed in § 61.102.

§ 61.107 Emission determination.

(a) Facility owners or operators may, in lieu of monitoring, estimate radionuclide emissions in accordance with Appendix D.

(b) Radionuclide emission rates from point sources (stacks or vents) shall be measured in accordance with the following requirements:

(1) Effluent flow rate measurements shall be made using the following methods:

(i) Reference Method 2 of Appendix A to Part 60 shall be used to determine velocity and volumetric flow rates for stacks and large vents.

(ii) Reference Method 2A of Appendix A to Part 60 shall be used to measure flow rates through pipes and small vents.

(2) Radionuclides shall be extracted, collected and measured using the following methods:

(i) Reference Method 1 of Appendix A to Part 60 shall be used to select sampling sites.

(ii) Representative samples of an effluent stream shall be withdrawn continuously for the sampling site following the guidance presented in ANSI–N13.1 "Guide to Sampling Airborne Materials in Nuclear Facilities" (including the guidance presented in Appendix A of ANSI–N13.1), as specified in paragraph § 61.18. Samples shall be collected continuously whenever there is potential for radionuclides to be emitted. The requirements for continuous sampling are applicable to batch processes when the unit is in operation. Periodic sampling (grab samples) may be used only with EPA's prior approval. Such approval may be granted in cases where continuous sampling is not practical and radionuclide emission rates are relatively constant.

(iii) Radionuclides shall be collected and measured using procedures based on the principles of measurement described in Appendix B, Method 114. Use of methods based on principles of measurement different from those described in Appendix B, Method 114 must have prior approval from the Administrator. EPA reserves the right to approve of measurement procedures.

(iv) A quality assurance program shall be conducted that meets the performance requirements described in Appendix B, Method 114.

(3) When it is impractical to sample an effluent stream at an existing source in accordance with the site selection and sample extraction requirements of paragraphs § 61.107(b)(2), the facility operator may use alternative site selection and sample extraction procedures provided that:

(i) It can be shown that the requirements of paragraphs § 61.107(b)(2) are impractical for the effluent stream.

(ii) The alternative procedure will not significantly underestimate the emissions.

(iii) The alternative procedure is fully documented.

(iv) The operator has received prior approval from EPA.

§ 61.108 Exemption from the Reporting and Testing Requirements of 40 CFR 61.10

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

4. By revising subpart K to read as follows:

Subpart K—National Emission Standards for Radionuclide Emissions From Elemental Phosphorus Plants

Sec.

Subpart K—National Emission Standards for Radionuclide Emissions From Elemental Phosphorus Plants

§ 61.120 Applicability.

The provisions of this subpart are applicable to owners and operators of calciners and nodulizing kilns at elemental phosphorus plants.

§ 61.121 Definitions.

(a) "Elemental phosphorus plant" or "plant" means any facility that processes phosphate rock to produce elemental phosphorus. A plant includes all buildings, structures, operations, calciners and nodulizing kilns on one contiguous site.

(b) "Calciner" or "Nodulizing kiln" means a unit in which phosphate rock is heated to high temperatures to remove organic material and/or to convert it to a modular form. For the purpose of this subpart, calciners and nodulizing kilns are considered to be similar units.

(c) "Operator" means any person who owns, operates or controls elemental phosphorous plant.

§ 61.122 Emission standard.

Approach A and B

Emissions of polonium-210 to air from all calciners and nodulizing kilns at an elemental phosphorus plant shall not exceed a total of 10 curies a year.

Approach C

Emissions of polonium-210 to air from all calciners and nodulizing kilns at an elemental phosphorus plant shall not exceed a total of 0.6 curies a year.

Approach D

Emissions of polonium-210 to air from all calciners and nodulizing kilns at an elemental phosphorus plant shall not exceed a total of 0.006 curies a year.

§ 61.123 Emission testing.

(a) Each owner or operator of an elemental phosphorus plant shall test emissions from the plant according to the following requirements:

(1) Within 90 days of the effective date of this standard for a plant that has an initial start-up date preceding the effective date of this standard; or

(2) Within 90 days of start-up for a plant, that has an initial startup after the effective date of the standard.

(b) The Administrator shall be notified at least 30 days prior to an emission test so that EPA may, at its option, observe the test.

(c) An emission test shall be conducted at each operational calciner or nodulizing kiln. If emissions from a calciner or nodulizing kiln are discharged through more than one stack, then an emission test shall be conducted at each stack and the total emission rate from the calciner or kiln shall be the sum of the emission rates from each of the stacks.

(d) Each emission test shall consist of three sampling runs that meet the requirements of § 61.125. The phosphate rock processing rate during each run shall be recorded. An emission rate in curies per metric ton of phosphate rock processed shall be calculated for each run. The average of all three runs shall apply in computing the emission rate for the test. The annual polonium-210 emission rate from a calciner or nodulizing kiln shall be determined by multiplying the measured polonium-210 emission rate in curies per metric ton of phosphate rock processed by the annual phosphate rock processing rate in metric tons. In determining the annual phosphate rock processing rate, the values used for operating hours and operating capacity shall be values that will maximize the expected processing rate. For determining compliance with the emission standard of § 61.122, the total annual emission rate is the sum of the annual emission rates for all operating calciners and nodulizing kilns.

(e) If the owner or operator changes his operation in such a way as to increase his emissions of polonium-210, such as changing the type of rock processed, the temperature of the calciners or kilns, or increasing the annual phosphate rock processing rate, then a new emission test shall be conducted under these conditions.

(f) Each owner of an elemental phosphorus plant shall furnish the Administrator a written report of the results of the emission test within 60 days of conducting the test. The report must provide the following information:

(1) The name of the facility.

(2) The name of the person responsible for the operation of the facility and the name of the person preparing the report (if different).

(3) A description of the effluent controls that are used on each stack, vent, or other release point and an estimate of the efficiency of each device.

(4) The results of the testing, including the results of each sampling run completed.

(5) The values used for all other user-supplied input parameters (e.g., meteorological data) and the source of these data.

(6) Each report shall be signed and dated by the principal executive officer in charge of the facility and contain the following declaration immediately above the signature line:

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

§ 61.124 Recordkeeping requirements.

The owner of any plant must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used in emission testing. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the results of the emission testing. These records must be kept at the site of the plant for at least five years and, upon request, be made available for inspection by the Administrator, or his authorized representative.

§ 61.125 Test methods and procedures.

(a) Each owner or operator of a source required to test emissions under § 61.123, unless an equivalent or alternate method has been approved by the Administrator, shall use the following test methods:

(1) Test Method 1 of Appendix A to Part 60 shall be used to determine sample and velocity traverses;

(2) Test Method 2 of Appendix A to Part 60 shall be used to determine velocity and volumetric flow rate;

(3) Test Method 3 of Appendix A to Part 60 shall be used for gas analysis.

(4) Test Method 5 of Appendix A to Part 60 shall be used to collect particulate matter containing the polonium-210; and

(5) Test Method 111 of Appendix B to this part shall be used to determine the polonium-210 emissions.

§ 61.126 Monitoring of operations.

(a) The owner or operator of any source subject to this subpart using a wet-scrubbing emission control device shall install, calibrate, maintain, and operate a monitoring device for the continuous measurement of the pressure loss of the gas stream through the scrubber. The monitoring device must be certified by the manufacturer to be accurate within ±250 pascals (±1 inch of water). Records of these measurements shall be maintained at the source and made available for inspection by the Administrator for a minimum of 5 years.

(b) The owner or operator of any source subject to this subpart using an electrostatic precipitator control device shall install, calibrate, maintain, and operate a monitoring device for the continuous measurement of the primary and secondary current and the voltage in each electric field. Baseline operating values for these parameters shall be maintained within ±30 percent of their baseline operating values. Records of these measurements shall be maintained at the source and made available for inspection by the Administrator for a minimum of 5 years.

(c) For the purpose of conducting an emission test under § 61.123, the owner or operator of any source subject to the provisions of this subpart shall install, calibrate, maintain, and operate a device for measuring the phosphate rock feed to any affected calciner or nodulizing kiln. The measuring device used must be accurate to within 6±5 percent of the mass rate over its operating range. Records of these measurements shall be maintained at the source and made available for inspection by the Administrator for a minimum of 5 years.

§ 61.127 Certification of stable operation.

Every 6 months the owner of a plant shall certify to the Administrator that no changes in operation that would require new testing under § 61.123(e) have occurred or inform the Administrator of the date on which new testing will occur.

§ 61.128 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

5. By adding the following Subpart Q:

Subpart Q—National Emission Standards for Radon Emissions From Department of Energy Facilities

Sec.

Subpart Q—National Emission Standards for Radon Emissions From Department of Energy Facilities

§ 61.190 Designation of facilities.

The provisions of this subpart apply to the design and operation of all storage and disposal facilities for radium-containing material (i.e., byproduct material as defined under section 11.e(2) of the Atomic Energy Act of 1954 (as amended)) that are owned or operated by the Department of Energy that emit radon-222 into air, including these facilities: 1) The Feed Materials Production Center, Fernald, Ohio; 2) the Niagara Falls Storage Site, Lewiston, NY; 3) the Weldon Spring Site, Weldon

Spring, Mo.; 4) the Middlesex Sampling Plant, Middlesex, NJ; 5) the Monticello Uranium Mill Tailings Pile, Monticello, Utah. This subpart does not apply to facilities listed in, or designated by the Secretary of Energy under Title I of the Uranium Mill Tailings Control Act of 1978.

§ 61.191 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Facility" means all buildings, structures and operations on one contiguous site.

(b) "Source" means any building, structure, pile, impoundment or area that is or contains waste material containing radium in sufficient concentration to emit radon-222 in excess of this standard prior to remedial action.

§ 61.192 Standard.

Approach A and Approach B

No source at Department of Energy facilities shall emit more than 20 pCi/m^2s of radon-222 into the air.

Approach C

No source at Department of Energy facilities shall emit more than 2 pCi/m^2s of radon-222 into the air.

Approach D

No source at Department of Energy facilities shall emit more than 0.02 pCi/m^2s of radon-222 into the air.

§ 61.193 Radon monitoring and compliance procedures.

(a) Sixty days after the effective date of this subpart each DOE facility shall conduct testing for all sources within the facility, in accordance with the procedures described in Appendix B, Method 115 and provide EPA with a report detailing the actions taken and the results of the radon-222 flux testing. In lieu of testing the facility may make an admission that the source is in noncompliance.

(b) Each facility shall retest each source in accordance with the procedures described in Appendix B, Method 115 every two years and report to EPA. The Administrator may temporarily or permanently waive the retesting requirement or change the time between tests, if the Administrator determines that more frequent testing is required, the actions being conducted at the facility to reduce radon emissions preclude testing, or the facility demonstrates that the actions taken to reduce the radon flux from the source are of such a nature that a reduction in the frequency of the tests is appropriate.

(c) Ninety days after the testing is required, each facility shall report the results of the testing or an admission of noncompliance. Each report shall include the following information:

(1) The name of the facility.

(2) A list of the sources at the facility

(3) A description of the control measures taken to decrease the radon flux from the source and any actions taken to insure the long term effectiveness of the control measures.

(4) The results of the testing conducted, including the results of each measurement.

(5) Each report shall be signed and dated by the principal executive officer or public official in charge of the facility and contain the following declaration immediately above the signature line:

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

§ 61.194 Recordkeeping requirements.

The facility must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard, and, if claimed, qualification for exemption from reporting. These records must be kept at the facility for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.195 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

6. By adding the following Subpart R:

Subpart R—National Emission Standards for Radon Emissions From Phosphogypsum Stacks

Sec.

Subpart R—National Emission Standards for Radon Emissions From Phosphogypsum Stacks

§ 61.200 Designation of facilities.

The provisions of this subpart apply to the phosphogypsum that is produced as a result of phosphorus fertilizer production and all existing phosphogypsum stacks.

§ 61.201 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Operator" means any person who owns, operates or controls a phosphogypsum stack.

(b) "Phosphogypsum stacks" or "stacks" are piles of waste from phosphorus fertilizer production containing phosphogypsum.

§ 61.202 Standard.

Approach A and Approach B

All phosphogypsum shall be disposed of in stacks or in phosphate mines which shall not emit more than 20 pCi/m^2s of radon-222 into the air.

Approach C

All phosphogypsum shall be disposed of in stacks or in phosphate mines which shall not emit, more than 2 pCi/m^2s of radon-222 into the air.

Approach D

All phosphogypsum shall be disposed of in stacks or in phosphate mines which shall not emit, more than 0.02 pCi/m^2s of radon-222 into the air.

§ 61.203 Radon monitoring and compliance procedures.

(a) Sixty days after the effective date of the rule or sixty days after the operator ceases use of a phosphogypsum stack, whichever is later, the operator shall conduct testing for the stack in accordance with the procedures described in Appendix B, Method 115 and provide EPA with a report detailing the actions taken and the results of the radon-222 flux testing. In lieu of testing the facility may make an admission that the source is in noncompliance.

(b) Each operator shall retest each source in accordance with the procedures described in Appendix B,

Method 115 every two years and report to EPA. The Administrator may temporarily or permanently waive the retesting requirement or change the time between tests, if the Administrator determines that more frequent testing is required, the actions being conducted on the stack to reduce radon emissions preclude testing, the stack is in compliance without the use of any control measures, or the operator demonstrates that the actions taken to reduce the radon flux from the stack are of such a nature that a reduction in the frequency of the tests is appropriate.

(c) Ninety days after the testing is required, each operator shall report the results of the testing or an admission of noncompliance. Each report shall include the following information:

(1) The name of the facility.

(2) A list of the stacks controlled by the operator.

(3) The name of the person responsible for the operation of the facility and the name of the person preparing the report (if different).

(4) A description of the control measures taken to decrease the radon flux from the source and any actions taken to insure the long term effectiveness of the control measures.

(5) The results of the testing conducted, including the results of each measurement.

(6) Each report shall be signed and dated by the principal executive officer in charge of the facility and contain the following declaration immediately above the signature line:

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See 18 U.S.C. 1001.

(d) Sixty days after the effective date of the rule and annually thereafter, the operator shall file a report with the Administrator. This report will inform the Administrator which stacks are still being used for the disposal of additional phosphogypsum and which stacks are no longer being used for the disposal of additional phosphogypsum and, therefore, are ready for disposal.

§ 61.204 Recordkeeping requirements.

An operator must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard. These records must be kept at the facility for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.205 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

7. By adding the following Subpart S:

Subpart S—National Emission Standards for Radon Emissions From Surface Uranium Mines

Sec.

Subpart S—National Emission Standards for Radon Emissions From Surface Uranium Mines

§ 61.210 Designation of facilities.

The provisions of this subpart are applicable to any surface uranium mine which:

(a) Has mined or will mine over 100,000 tons of ore during the life of the mine; or

(b) Has had or will have an annual ore production rate greater than 10,000 tons, unless it can be demonstrated that the mine will not exceed total ore production of 100,000 tons during the life of the mine.

§ 61.211 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Owner" means any person who owns, operates or controls a surface uranium mine.

(b) "Surface uranium mine" means a man-made excavation made for the purpose of removing material containing uranium for the principle purpose of recovering uranium.

§ 61.212 Standard.

Approach A, B and C

[No Rule]

Approach D

Surface uranium mines shall not emit more than 0.02 pCi/m^2s of radon-222 into the air.

61.213 Radon monitoring and compliance procedures.

(a) Sixty days after the effective date of the rule or sixty days after the mine owner ceases use of a mine, whichever is later, the operator shall conduct testing of the mine in accordance with the procedures described in Appendix B, Method 115 and provide EPA with a report detailing the actions taken and the results of the radon-222 flux testing.

(b) Each mine owner shall retest each source in accordance with the procedures described in Appendix B, Method 115 every two years and report to EPA. The Administrator may temporarily or permanently waive the retesting requirement or change the time between tests, if the Administrator determines that more frequent testing is required, the actions being conducted on the stack to reduce radon emissions preclude testing, or the operator demonstrates that the actions taken to reduce the radon flux from the mine are of such a nature that a reduction in the frequency of the tests is appropriate.

(c) Ninety days after the testing is required, each mine owner shall report the results of the testing or admit being in noncompliance. Each report shall include the following information:

(1) The name of the facility.

(2) The name of the person responsible for the operation of the facility and the name of the person preparing the report (if different).

(3) A description of the control measures taken to decrease the radon flux from the source and any actions taken to insure the long term effectiveness of the control measures.

(4) The results of the testing conducted, including the results of each measurement.

(5) Each report shall be signed and dated by the principal executive officer in charge of the facility and contain the following declaration immediately above the signature line:

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

§ 61.214 Recordkeeping requirements.

The facility must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard. These records must be kept at the site of the facility for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.215 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

8. By revising Subpart B to read as follows:

Subpart B—National Emission Standards for Radon Emissions From Underground Uranium Mines

Sec.
61.20 Designation of facilities.
61.21 Definitions.
61.22 Standard.
61.23 Radon monitoring and compliance procedures.
61.24 Recordkeeping requirements.
61.25 Exemption from the reporting and testing requirements of 40 CFR 61.10.

Subpart B—National Emission Standards for Radon Emissions From Underground Uranium Mines

§ 61.20 Designation of facilities.

The provisions of this subpart are applicable to an active underground uranium mine which:

(a) Has mined or will mine over 100,000 tons of ore during the life of the mine; or

(b) Has had or will have an annual ore production rate greater than 10,000 tons, unless it can be demonstrated that the mine will not exceed total ore production of 100,000 tons during the life of the mine.

§ 61.21 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Active mine" means an underground uranium mine which is being ventilated to allow workers to enter the mine for any purpose.

(b) "Owner" means any person who owns, operates or controls an underground uranium mine.

(c) "Underground uranium mine" means a man-made underground excavation made for the purpose of removing material containing uranium for the principle purpose of recovering uranium.

§ 61.22 Standard.

Approach A and Approach B

(a) The exhaust vents of an active underground uranium mine shall not emit more than 1500 curies of radon-222 into the atmosphere in any year.

(b) The requirements of paragraph (a) of this section notwithstanding, if all the exhaust vent emissions of radon-222 from underground uranium mines are emitted from stacks that are at least 30 meters high then all the exhaust vents of an active underground uranium mine may emit up to 5,000 curies of radon-222 into the atmosphere in any year.

Approach C

The exhaust vents of an active underground uranium mine shall not emit more than 500 curies of radon-222 into the atmosphere in any year.

Approach D

The exhaust vents of an active underground uranium mine shall not emit more than 5 curies of radon-222 into the atmosphere in any year.

§ 61.23 Radon monitoring and compliance procedures.

(a) An underground uranium mine owner shall conduct testing to determine the radon-222 emissions from their mines in accordance with the procedures described in Appendix B, Method 115 and provide EPA with a report of the results of the testing.

(b) The report of the results for each year shall be sent to EPA by March 31 of the following year. Each report shall include the following information:

(1) The name of the mine.

(2) The name of the person responsible for the operation of the facility and the name of the person preparing the report (if different).

(3) A list of the exhaust vents at the mine, including their location and size.

(4) The results of the testing conducted.

(5) Each report shall be signed and dated by the principal executive officer in charge of the facility and contain the following declaration immediately above the signature line:

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

(c) If the facility is not in compliance with the emission limits of § 61.22 in the calendar year covered by the report then the facility must report to the Administrator on a monthly basis the information listed in paragraph (b) of this section, for the preceding month. These reports will be due 30 days following the end of each month. This increased level of reporting will continue until the Administrator has determined that the monthly reports are no longer necessary. In addition to all the information required in paragraph (b) of this section, monthly reports shall also include the following information:

(1) All controls or other changes in operation of the facility that will be or are being installed to bring the facility into compliance.

(2) If the facility is under a judicial or administrative enforcement decree the report will describe the facility's performance under the terms of the decree.

§ 61.24 Recordkeeping requirements.

The mine must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard. These records must be kept at the mine for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.25 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

9. By revising Subpart W to read as follows:

Subpart W—National Emission Standards for Radon Emissions From Operating Mill Tailings

Sec.
61.250 Designation of facilities.
61.251 Definitions.
61.252 Standard.

Sec.
61.253 Exemption from the reporting and testing requirements of 40 CFR 61.10.

Subpart W—National Emission Standards for Radon Emissions From Operating Mill Tailings

§ 61.250 Designation of Facilities.

The provisions of this subpart apply to owners or operators licensed to manage uranium byproduct materials during and following the processing of uranium ores, commonly referred to as uranium mills and their associated tailings. This subpart does not apply to the disposal of tailings.

§ 61.251 Definitions

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Area" means the vertical projection of the pile upon the earth's surface.

(b) "Continuous disposal" means a method of tailings management and disposal in which tailings are dewatered by mechanical methods immediately after generation. The dried tailings are then placed in trenches or other disposal areas and immediately covered to all applicable Federal standards.

(c) "Dewatered" means to remove the water from recently produced tailings by mechanical or evaporative methods such that the water content of the tailings does not exceed 30 percent by weight.

(d) "Operation" means that an impoundment is being used for the continued placement of new tailings or is in standby. An impoundment is in operation from the day that tailings are first placed in the impoundment until the day that final closure beings.

(e) "Owner" means any person who owns or operates a uranium mill or an existing tailings pile or a new impoundment.

(f) "Phased disposal" means a method of tailings management and disposal which uses lined impoundments which are filled and then immediately dried and covered to meet all applicable Federal standards.

(g) "Uranium byproduct material" or "tailings" means the waste produced by the extraction or concentration of uranium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction and which remain underground do not constitute byproduct material for the purposes of this subpart.

§ 61.252 Standard.

Approach A and Approach B

Two years following the effective date of this rule no tailings may be placed in any impoundment which was not designed and constructed to meet one of the two following work practices and in the following manner:

(a) Phased disposal in lined tailings impoundments that are no more than 40 acres in area and meet the requirements of § 192.32(a). The owner shall have no more than two impoundments in operation at any one time.

(b) Continuous disposal of tailings such that tailings are dewatered and immediately disposed with no more than 10 acres uncovered at any time and operated in accordance with § 192.32(a).

Approach C

After the effective date of this rule, no tailings may be placed in any impoundment which was not designed and constructed to meet one of the two following work practices and in the following manner:

(a) Phased disposal in lined tailings impoundments that are no more than 40 acres in area and meet the requirements of § 192.32(a). The owner shall have no more than two impoundments in operation at any one time.

(b) Continuous disposal of tailings such that tailings are dewatered and immediately disposed with no more than 10 acres uncovered at any time and operated in accordance with § 192.32(a).

Approach D

After the effective date of this rule no tailings may be produced.

§ 61.253 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

10. By adding the following Subpart T:

Subpart T—National Emission Standards for Radon Emissions From the Disposal of Uranium Mill Tailings

Sec.
61.220 Designation of facilities.
61.221 Definitions.
61.222 Standard.
61.223 Compliance procedures.
61.224 Recordkeeping requirements.
61.225 Exemption from the reporting and testing requirements of 40 CFR 61.10.

Subpart T—National Emission Standards for Radon Emissions From the Disposal of Uranium Mill Tailings

§ 61.220 Designation of facilities.

The provisions of this subpart apply to the disposal of tailings at all sites that managed residual radioactive material or uranium byproduct materials during and following the processing of uranium ores, commonly referred to as uranium mills and their associated tailings, that are listed in, or designated by the Secretary of Energy under Title I of the Uranium Mill Tailings Control Act of 1978 or regulated Title II of the Uranium Mill Tailings Control Act of 1978.

§ 61.221 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act or subpart A of Part 61. The following terms shall have the following specific meanings:

(a) "Operational" means a uranium mill tailings pile that is licensed to accept additional tailings, and those tailings can be added without violating subpart W or any other Federal, state or local rule or law.

(b) "Owner" means any person who owns, operates, controls or is responsible for the disposal of a uranium mill tailings pile or impoundment, including the Department of Energy.

(c) "Uranium byproduct material" or "tailings" means the waste produced by the extraction or concentration of uranium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction and which remain underground do not constitute byproduct material for the purposes of this subpart.

§ 61.222 Standard.

Approach A and Approach B

Radon-222 emissions to the air from nonoperational uranium mill tailings piles shall not exceed 6 pCi/m^2s of radon-222.

Approach C

Radon-222 emissions to the air from nonoperational uranium mill tailings piles shall not exceed 2 pCi/m^2s of radon-222.

Approach D

Radon-222 emissions to the air from nonoperational uranium mill tailings piles shall not exceed 0.02 pCi/m^2s of radon-222.

§ 61.223 Compliance procedures.

(a) Sixty days after the effective date of this subpart or 60 days after the pile ceases to be operational, whichever is later, owners of uranium mill tailings shall conduct testing for all piles within the facility in accordance with the procedures described in Appendix B, Method 115 and provide EPA with a report detailing the actions taken and

the results of the radon-222 flux testing. In lieu of testing the owner may make an admission that the source is in noncompliance.

(b) Each owner shall retest each pile in accordance with the procedures described in Appendix B, Method 115 every two years and report to EPA. The Administrator may temporarily or permanently waive the retesting requirements or change the time between tests, if the Administrator determines that more frequent testing is required, the actions being conducted on the pile to reduce radon emissions preclude testing, or the owner demonstrates that the actions taken to reduce the radon flux from the pile are of such a nature that a reduction in the frequency of the tests is appropriate.

(c) Ninety days after the testing is required, each facility shall report the results of the testing or an admission of noncompliance. Each report shall include the following information:

(1) The name of the facility.

(2) A list of the piles at the facility.

(3) A description of the control measures taken to decrease the radon flux from the source and any actions taken to insure the long term effectiveness of the control measures.

(4) The results of the testing conducted, including the results of each measurement.

(5) Each report shall be signed and dated by the principal executive officer or public official in charge of the facility and contain the following declaration immediately above the signature line:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalities for submitting false information including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

§ 61.224 Recordkeeping requirements.

The facility must maintain records documenting the source of input parameters including the results of all measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. In addition, the documentation should be sufficient to allow an independent auditor to verify the correctness of the determination made concerning the facility's compliance with the standard. These records must be kept at the site of the facility for at least five years and upon request be made available for inspection by the Administrator, or his authorized representative.

§ 61.225 Exemption from the reporting and testing requirements of 40 CFR 61.10.

All facilities designated under this subpart are exempt from the reporting requirements of 40 CFR 61.10.

11. By adding the following Subpart U:

Subpart U—National Emission Standards for Coal-Fired Boilers

Sec.
61.230 Designation of facilities.
61.231 Definitions.
61.232 Standard.

Subpart U—National Emission Standards for Coal-Fired Boilers

§ 61.230 Designation of facilities.

The provisions of this subpart apply to all coal-fired boilers operated by electric utility companies for the generation of electrical power and all industrial boilers whose output is greater than 2 million BTUs an hour.

§ 61.231 Definitions.

As used in this subpart, all terms not defined here have the meaning given them in the Clean Air Act of subpart A of Part 61 or 40 CFR 60.41a or 40 CFR 60.41b.

(a) "Coal-fired boiler" means a boiler that burns coal as an energy source in order to heat water.

§ 61.232 Standard.

Approach D

(a) All coal-fired boilers that are owned by electric utility companies shall meet all the requirements of 40 CFR Part 60 subpart Da that relate to the control of particulate matter.

(b) All industrial coal-fired boilers not regulated under paragraph (a) of this section shall meet all the requirements of 40 CFR Part 60 subpart Db that relate to the control of particulate matter.

12. By adding the following to the list of System International units of measure in § 61.03(a):

m^2 = square meter

13. By adding the following to the list of other units of measure in 61.03(b):

Ci = curie
pCi = picocurie = 10^{-12} curie
mrem = millirem = 10^{-3} rem

14. By adding the following to the methods in Appendix B:

Method 114—Test Methods for Monitoring Radionuclide Emissions from Stationary Sources

1. Purpose and Background

This appendix contains guidance on: (1) Continuous stack sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for both sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of collection and analysis methods which are applicable to the effluent stream to be measured.

2. Continuous Stack Sample Collection Methods

Continuous sample collection methods are based on "principles of sample collection" which are applicable to the continuous collection of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of a flow through counter to directly measure the radionuclide, or suitable sorters or bubblers to collect the radionuclides.

2.1 *Radionuclides as Particulates.* The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI–N13.1(1) shall be followed in using filter media to collect particulates.

2.2 *Radionuclides as Gases.*

2.2.1 *The Radionuclide Tritium (H–3).* Tritium in the form of water vapor is continuously collected from the

extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B–1 or may be oxidized using a metal catalyst to tritiated water and collected as described above.

2.2.2 *Radionuclides of Iodine.* Iodine is collected from the continuously extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolites and caustic solutions.

2.2.3 *Radionuclides of Argon, Krypton and Xenon.* Radionuclides of these elements are measured directly in the continuously extracted sample stream using a flow through counter or are collected from the extracted sample by low temperature sorption techniques. Appropriate sorters may include charcoal or metal zeolites.

2.2.4 *Radionuclides of Oxygen, Carbon, Nitrogen and Radon.* Radionuclides of these elements are measured directly in the continuously extracted sample using a flow through counter. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

3. Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public.

Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in this section, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 *Methods for Alpha Emitting Radionuclides.*

3.1.1 *Method A–1 Radiochemistry-Alpha Spectrometry.*

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA–605(2), ASTM–D–3972(13).

3.1.2 Method A–2, *Radiochemistry-Alpha Counting.*

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with an alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO–12096(18).

3.1.3 Method A–3, *Direct Alpha Spectrometry.*

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 eV (HWFM) or better, ASTM–D–3084(16).

3.1.4 Method A–4, *Direct Alpha Counting* (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determinations may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well-known, (2) measurements using either Method A–1 or A–2 have shown that this method provides a reasonably accurate measurement of the emission rate, and (3) the effective dose equivalent from the emission does not exceed 10 percent of the applicable emission standard. Gross alpha measurements are applicable to mixtures of radionuclides only for the purposes described in section 3.7. APHA–601(3), ASTM–D–1943(10).

3.1.5 Method A–5, *Chemical Determination of Uranium.*

Principle: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into hexone. Impurities are removed from the hexone layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM–E–318(15), ASTM–D–2907(14).

3.1.6 Method A–6, *Radon–222—Continuous Gas Monitor.*

Principle: Radon–222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is passed through a filter and if needed a desiccant to remove particulates and excess moisture. The alpha particles from radon–222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/1 of radon–222.

Applicability: This method is applicable to the measurement of radon–222 in effluent streams which do not contain significant quantities of radon–222. Users of this method should calibrate the monitor in a radon calibration chamber at lesat twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1–86–04(24)

3.2 *Methods of Gaseous Beta Emitting Radionuclides.*

3.2.1 Method B–1, *Direct Counting in Flow-Through Ionization Chambers.*

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for measuring the activity of a gaseous beta-emitting radionuclide that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP–0096(17), NCRP–58(23).

3.2.2 Method B–2, *Direct Counting in Flow-Through Chamber with Beta Detectors.*

A chamber of known volume which contains a Geiger-Muller tube or other beta detector is used. The effluent gas stream passes through the chamber at a given flow rate. The activity of the radionuclide is determined from the beta count rate.

Applicability: This method is appropriate for measuring the activity of a gaseous beta-emitting radionuclide with a maximum energy greater than 0.2MeV (beta-max) when no other beta-emitting nuclides are present.

3.3 *Methods for Non-Gaseous Beta Emitting Radionuclides.*

3.3.1 Method B–3, *Radiochemistry-Beta Counting.*

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield, and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA–608(5).

3.3.2. Method B–4, *Direct Beta Counting* (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only: (1) When it is known that the sample contains only a single nuclide, (2) measurements made using Method B–3 show reasonable agreement with the gross beta measurement and (3) the effective dose equivalent from the emissions does not exceed 10% of the limits of the applicable standard. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes described in section 3.7. APHA–602(4), ASTM–D–1890(10).

3.3.3 Method B–5, *Liquid Scintillation Spectrometry.*

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon–14. APHA–609(6), EML–LV–0539–17(19).

3.4 *Gamma Emitting Radionuclides.*

3.4.1 Method G–1, *High Resolution Gamma Spectrometry.*

Principle: The sample is counted with a high resolution gamma detector, either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured for the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 kev. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM–3649(9), IDO–12096(18).

3.4.2 Method G–2, *Low Resolution Gamma Spectrometry.*

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest.

Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 KeV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM–D–2459(12), EMSL–LV–0539–17(19).

3.4.3 Method G–3. *Single Channel Gamma Spectrometry.*

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

3.5 *Counting methods.* All of the above methods with the exception of Method A–5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM–3648(8).

3.5.1 *Alpha Counting*:

• *Gas flow proportional counters.* The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

• *Scintillation counters.* The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

• *Solid-state counters.* Semiconductor materials, such as silicon surface-barrier p–n junctions, act as solid ionization chambers. The alpha particles interact with the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

• *Alpha spectrometers.* Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

3.5.2 *Beta Counting*:

• *Ionization chambers.* These chambers contain the beta-emitting nuclide in gaseous form. Either the ionization current or the rate of charge may be measured.

• *Geiger-Muller (GM) counters- or gas flow proportional counters.* The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

• *Scintillation counters.* The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

• *Liquid scintillation spectrometers.* Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

3.5.3 *Gamma Counting*:

• *Low-resolution gamma spectrometers.* The gamma rays interact with a thallium-activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

• *High-resolution gamma spectrometers.* Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detector resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

• *Single channel analyzers.* Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

3.5.4 *Calibration of counters.* Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted.

For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium–137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

3.6 *Radiochemical methods for selected radionuclides.* Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which have the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in section 3.1 through 3.4 may be used.

3.7 *Applicability of gross alpha and beta measurements to unidentified mixtures of radionuclides.* Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A–4) or gross beta (Method B–4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

TABLE 1.—LIST OF APPROVED METHODS FOR SPECIFIC RADIONUCLIDES

Radionuclide	Approved methods of analysis
Am-241	A-1, A-2, A-3, A-4
Ar-41	B-1, B-2, G-1, G-2, G-3
Ba-140	G-1, G-2, G-3
Br-82	G-1, G-2, G-3
C-11	B-1, B-2, G-1, G-2, G-3
C-14	B-5
Ca-45	B-3, B-4, B-5
Ce-144	G-1, G-2, G-3
Cm-244	A-1, A-2, A-3, A-4
Co-60	G-1, G-2, G-3
Cr-51	G-1, G-2, G-3
Cs-134	G-1, G-2, G-3
Cs-137	G-1, G-2, G-3
Fe-55	B-5, G-1
Fe-59	G-1, G-2, G-3
Ga-67	G-1, G-2, G-3
H-3 (H_2O)	B-5
H-3 (gas)	B-1
I-123	G-1, G-2, G-3
I-125	G-1
I-131	G-1, G-2, G-3
In-113m	G-1, G-2, G-3
Ir-192	G-1, G-2, G-3
Kr-85	B-1, B-2, G-1, G-2, G-3
Kr-87	B-1, B-2, G-1, G-2, G-3
Kr-88	B-1, B-2, G-1, G-2, G-3
Mn-54	G-1, G-2, G-3
Mo-99	G-1, G-2, G-3
N-13	B-1, B-2, G-1, G-2, G-3
O-15	B-1, B-2, G-1, G-2, G-3
P-32	B-3, B-4, B-5
Pm-147	B-3, B-4, B-5
Po-210	A-1, A-2, A-3, A-4
Pu-238	A-1, A-2, A-3, A-4
Pu-239	A-1, A-2, A-3, A-4
Pu-240	A-1, A-2, A-3, A-4
S-35	B-5
Se-75	G-1, G-2, G-3
Sr-90	B-3, B-4, B-5
Tc-99	B-3, B-4, B-5
Te-201	G-1, G-2, G-3
Uranium (total alpha)	A-1, A-4
Uranium (Isotopic)	A-1, A-3
Xe-133	G-1
Yb-169	G-1, G-2, G-3
Zn-65	G-1, G-2, G-3

4. Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of know precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure, functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

4.3 The samples collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

4.3.2 A description of sampling probes and representativeness of the samples.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures and frequency of calibration.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of valid data obtained compared to the amount expected under normal conditions.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective actions will be taken and who is responsible for taking the corrective action.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

5. References

(1) American National Standards Institute, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities", ANSI–N13.1–1969, American National Standards Institute, New York, New York (1969).

(2) American Public Health Association, "Methods of Air Sampling", 2nd Edition, Method 605, "Tentative Method of Analysis for Plutonium content of Atmospheric Particulate Matter, American Public Health Association, New York, NY (1977).

(3) Ibid, Method 601, "Tentative Method of Analysis for Gross Alpha Radioactivity Content of the Atmosphere."

(4) Ibid, Method 602 "Tentative Method of the Analysis for Gross Beta Radioactivity Content of the Atmosphere."

(5) Ibid, Method 608, "Tentative Method of Analysis for Strontium-90 Content of Atmospheric Particulate Matter."

(6) Ibid, Method 609, "Tentative Method of Analysis for Tritium Content of the Atmosphere."

(7) Ibid, Method 603, "Tentative Method of Analysis for Iodine-131 Content of the Atmosphere."

(8) American Society for Testing and Materials, 1986 Annual Book ASTM Standards, Designation D–3648–78, "Standard Practices for the Measurement of Radioactivity." American Society for Testing and Materials, Philadelphia, PA (1986).

(9) Ibid, Designation D-3649-85, "Standard Practice for High Resolution Gamma Spectrometry."
(10) Ibid, Designation D-1943-81 "Standard Test Method for Alpha Particle Radioactivity of Water."
(11) Ibid, Designation D-1890-81 "Standard Test Method for Beta Particle Radioactivity of Water."
(12) Ibid, Designation D-2459-72, "Standard Test Method for Gamma Spectrometry of Water."
(13) Ibid, Designation D-3972-82, "Standard Test Method for Isotopic Uranium in Water by Radiochemistry."
(14) Ibid, Designation D-2907-83, "Standard Test Methods for Microquantities of Uranium in Water by Fluorometry."
(15) Ibid, Designation E-318, "Standard Test Method for Uranium in Aqueous Solutions by Colorimetry."
(16) Ibid, Designation D-3084-75, "Standard Practice for Alpha Spectrometry of Water."
(17) Corley, J.P. and C.D Corbit, "A Guide for Effluent Radiological Measurements at DOE Installations" DOE/EP-0096, Pacific Northwest Laboratories, Richland, Washington (1983).
(18) Department of Energy "RESL Analytical Chemistry Branch Procedures Manual" IDO-12096, U.S. Department of Energy, Idaho Falls, Idaho (1982).
(19) Environmental Protection Agency "Radiochemical Analytical Procedures for Analysis of Environmental Samples", EMSL-LV-0539-17, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada (1979).
(20) Environmental Protection Agency, "Radiochemistry Procedures Manual" EPA 520/5-84-006, Eastern Environmental Radiation Facility Montgomery, Alabama (1984).
(21) National Council on Radiation Protection and Measurements, NCRP Report No. 50, Environmental Radiation Measurements", National Council on Radiation Protection and Measurement, Bethesda, Maryland (1976).
(22) Ibid, Report No. 47, "Tritium Measurement Techniques." (1976)
(23) Ibid, Report No. 58 "A Handbook of Radioactivity Measurement Procedures" (1985).
(24) Environmental Protection Agency, "Interim Indoor Radon and Radon Decay Product Measurement Protocols", EPA 520/1-86-04, U.S. Environmental Protection Agency, Washington, DC (1986).

Appendix B—[Amended]

15. By adding the following Method to the list of method in Appendix B:

Method 115—Monitoring for radon-222 emissions

This Appendix describes the monitoring methods which must be used in determining the radon-222 emissions from underground uranium mines, uranium mill tailings piles, phosphogypsum stacks, and other piles of waste material emitting radon.

1. Radon-222 Emissions from Underground Uranium Mine Vents

1.1 Sampling Frequency and Calculation of Emissions. Radon-222 emissions from underground uranium mine vents shall be determined using one of the following methods:

1.1.1 Continuous Measurement. These measurements shall be made and the emissions calculated as follows:

(a) The radon-222 concentration shall be continuously measured at each mine vent whenever the mine ventilation system is operational.

(b) Each mine vent exhaust flow rate shall be measured at least 4 times per year.

(c) A weekly radon-222 emission rate for the mine shall be calculated and recorded weekly as follows:

$$A_w = C_1Q_1T_1 + C_2Q_2T_2 + \ldots C_iQ_iT_i$$

Where:

A_w = Total radon-222 emitted from the mine during week(Ci)
C_i = Average radon-222 concentration in mine vent i(Ci/m^3)
Q_i = Volumetric flow rate from mine vent i(m^3/hr)
T_i = Hours of mine ventilation system operation during week for mine vent i(hr)

(d) The annual radon-222 emission rate is the sum of the weekly emission rates during a calendar year.

1.1.2 Periodic Measurement. This method is applicable only to mines that continuously operate their ventilation system except for extended shutdowns. Mines which start up and shut down their ventilation system frequently must use the continuous measurement method described in Section 1.1.1 above. Emission rates determined using periodic measurements shall be measured and calculated as follows:

(a) The radon-222 shall be continuously measured at each mine vent for at least one week every three months.

(b) Each mine vent exhaust flow rate shall be measured at least once during each of the radon-222 measurement periods.

(c) A weekly radon-222 emission rate shall be calculated for each weekly period according to the method described in Section 1.1.1 In this calculation T = 168 hr.

(d) The annual radon-222 emission rate from the mine should be calculated as follows:

$$A_y = \frac{52 - W_s}{n} (A_{w1} + A_{w2} + \ldots A_{wi}$$

Where:

A_y = Annual radon-222 emission rate from the mine (Ci)
A_{wi} = Weekly radon-222 emission rate during the measurement period i(Ci)
n = Number of weekly measurement periods per year
W_s = Number of weeks during the year that the mine ventilation system is shut down in excess of 7 consecutive days, i.e. the sum of the number of weeks each shutdown exceeds 7 days.

1.2 *Test Methods and Procedures.* Each underground mine required to test its emission, unless an equivalent or alternative method has been approved by the Administrator, shall use the following test methods:

1.2.1 Test Method 1 of Appendix A to Part 60 shall be used to determine velocity traverses. The sampling point in the duct shall be either the centroid of the cross section or the point of average velocity.

1.2.2 Test Method 2 of Appendix A to Part 60 shall be used to determine velocity and volumetric flow rates.

1.2.3 Test Method 6A of Appendix B, Method 114 to Part 61 shall be used for the analysis of radon-222.

2. Radon-222 Emissions From Uranium Mill Tailings Piles

2.1 Measurement and Calculation of the Mean Radon Flux.

2.1.1 *Frequency of Flux Measurements.* Radon flux measurements shall be performed on uranium mill tailings piles after disposal as described below. Additional measurements shall be performed at any time if the cover on the pile is disturbed or erodes in a manner that could cause a significant increase of the mean radon flux of the pile.

2.1.2 *Distribution and Number of Flux Measurements.* Radon flux measurements shall be made at approximately regularly spaced locations over the surface of the tailings pile. The minimum number of radon flux measurements required to determine the mean flux is 100 or two per acre whichever is smaller.

2.1.3 *Restrictions to Radon Flux Measurements.* The following restrictions are placed on making radon flux measurements:

(a) Measurements shall not be initiated within 24 hours of a rainfall.

(b) If a rainfall occurs during the 24-hour measurement period, the measurement is invalid if the seal has washed away or if the collector is surrounded by water.

(c) Measurements shall not be performed if the ambient temperature is below 35°F or if the ground is frozen.

2.1.4 *Radon Flux Measurements.* Measuring radon flux involves the adsorption of radon on activated

charcoal in a large-area collector. The radon collector is placed on the surface of the tailings pile area to be measured and allowed to collect radon for a time period of 24 hours. The radon collected on the charcoal is measured by gamma-ray spectroscopy. The detailed measurement procedure provided in Appendix A of EPA 520/5-85-029(1) shall be used to measure the radon flux on the tailings piles, except the surface of the tailings pile cover shall not be penetrated by the lip of the collector as directed in the procedure, rather the collector shall be carefully positioned on a flat surface with soil or fine sand, containing no more than background quantities of radium-226, used to seal the edge.

2.1.5 *Calculations.* The radon flux calculations shall be made as provided in Appendix A of reference EPA86(1). The mean radon flux for the uranium mill tailings pile shall be calculated by summing all individual flux measurements and dividing by the total number of flux measurements.

2.1.6 *Reporting.* The results of individual flux measurements, the approximate measurement locations on the tailings pile, and the mean radon flux shall be included in the emission test report. Any condition or unusual event that occurred during the measurements that could significantly affect the results shall also be reported.

3.0 Radon-222 Emissions From Phosphogypsum Stacks

3.1 Measurement and Calculation of the Mean Radon Flux. Radon flux measurements shall be made on phosphogypsum stacks as described below:

3.1.1 *Distribution and number of flux measurements.* The distribution and number of radon flux measurements required on a stack will depend on clearly defined areas of the stack (called regions) that can have significantly different radon fluxes due to surface conditions. The mean radon flux shall be determined for each individual region of the stack. Regions that shall be considered are:

(a) Water covered areas,
(b) Water saturated areas (beaches),
(c) Loose and dry top surface areas,
(d) Hard-packed roadways, and
(e) Sides.

3.1.2 *Number of flux measurements.* Radon flux measurements shall be made within each region on the phosphogypsum stack, except for those areas covered with water. Measurements shall be made at regularly spaced locations across the surface of the region, realizing that surface roughness will prohibit measurements in some areas of a region. The minimum number of flux measurements considered necessary to determine a representative mean radon flux value for each type of region is:

(a) Water covered area—no measurements required as radon flux is assumed to be zero,
(b) Water saturated beaches—50 radon flux measurements,
(c) Loose and dry top surface—100 radon flux measurements,
(d) Hard-packed roadways—50 radon flux measurements, and
(e) Sides—100 radon flux measurements.

A minimum of 300 measurements are required. A stack that has no water cover can be considered to consist of two regions, top and sides, and will require a minimum of only 200 measurements.

3.1.3 *Restrictions to radon flux measurements.* The following restrictions are placed on making radon flux measurements:

(a) Measurements shall not be initiated within 24 hours of a rainfall.
(b) If a rainfall occurs during the 24 hour measurement period, the measurement is invalid if the seal around the lip of the collector has washed away or if the collector is surrounded by water.
(c) Measurements shall not be performed if the ambient temperature is below 35°F if the ground is frozen.

3.1.4 *Areas of stack regions.* The approximate area of each region of the stack shall be determined in units of square meters.

3.1.5 *Radon flux measurements.* Measuring radon flux involves the adsorption of radon on activated charcoal in a large-area collector. The radon collector is placed on the surface of the stack area to be measured and allowed to collect radon for a time period of 24 hours. The radon collected on the charcoal is measured by gamma-ray spectroscopy. The detailed measurement procedure provided in Appendix A of EPA 520/5-85-0029(1) shall be used to measure the radon flux on phosphogypsum stacks, except the surface of the phosphogypsum shall not be penetrated by the lip of the radon collector as directed in the procedure, rather the collector shall be carefully positioned on a flat surface with soil or phosphogypsum used to seal the edge.

3.1.6 *Calculations.* The mean radon flux for each region of the phosphogypsum stack and for the total stack shall be calculated and reported as follows:

(a) The individual radon flux calculations shall be made as provided in Appendix A EPA 86 (1). The mean radon flux for each region of the stack shall be calculated by summing all individual flux measurements for the region and dividing by the total number of flux measurements for the region.

(b) The mean radon flux for the total phosphogypsum stack shall be calculated as follows:

$$J_s = \frac{J_1A_1 + J_2A_2 + J_iA_i}{A_t}$$

Where:

J_s = Mean flux for the total stack (pCi/m^2-s)
J_i = Mean flux measured in region i(pCi/m^2-s)
A_i = Area of region i(m^2)
A_t = Total area of the stacks

3.1.7 *Reporting.* The results of individual flux measurements, the approximate locations on the stack, and the mean radon flux for each region and the mean radon flux for the total stack shall be included in the emission test report. Any condition or unusual event that occurred during the measurements that could significantly affect the results should be reported.

4.0 References.

(1) Hartley, J.N. and Freeman, H.D., "Radon Flux Measurements on Gardinier and Royster Phosphogypsum Piles Near Tampa and Mulberry, Florida," U.S. Environmental Protection Agency Report, EPA 520/5-85-029, January 1986.

16. By adding the following Appendix D to Part 61:

Appendix D—Estimated Emissions Methods for Estimating Radionuclide Emissions

1. Purpose and Background

Facility owners or operators may estimate radionuclide emissions to the atmosphere for dose calculations instead of measuring emissions. Particulate emissions from mill tailing piles should be estimated using the procedures listed in reference #2. All other emissions may be estimated by using the "Procedures" listed below, or using the method described in reference #1.

2. Procedure

To estimate emissions to the atmosphere:

(a) Determine the amount (in curies) used at facilities for the period under consideration. Radioactive materials in sealed packages that remain unopened, and have not leaked during the assessment period should not be included in the calculation.

(b) Multiply the amount used by the following factors which depend on the

physical state of the radionuclide. They are:

(i) 1 for gases;

(ii) 10^{-3} for liquids or particulate solids; and

(iii) 10^{-6} for solids.

If any nuclide is heated to a temperature of 100 degrees Celsius or more, boils at a temperature of 100 degrees Celsius or less, or is intentionally dispersed into the environment, it must be considered to be a gas.

(c) If a control device is installed between the place of use and the point of release, multiply emissions from (b) by an adjustment factor. These are presented in Table 1.

TABLE 1.—ADJUSTMENT TO EMISSION FACTORS FOR EFFLUENT CONTROLS

Controls	Types of radionuclides controlled	Adjustment factor to emissions	Comments and conditions
HEPA Filters	Particulates	0.01	Not applicable to gaseous radionuclides; periodic testing is prudent to ensure high removal efficiency.
Fabric Filter	Particulates	0.1	Monitoring would be prudent to guard against tears in filter.
Sintered Metal	Particulates	1	Insufficient data to make recommendation.
Activated Carbon Filters	Iodine Gas	0.1	Efficiency is time dependent; monitoring is necessary to ensure effectiveness.
Douglas Bags: Held 1 week or longer for decay	Xenon	(1) 0.5	Based on xenon half-life of 5.3 days;
Released within 1 week	Xenon	1	Provides no reduction of exposure to general public.
Venturi Scrubbers	Particulates	0.05	Although venturis may remove gases, variability in gaseous removal efficiency dictates adjustment factor for particulates only.
	Gases	1	
Packed Bed Scrubbers	Gases	0.1	Not applicable to particulates.
Electrostatic Precipitators	Particulates	0.05	Not applicable for gaseous radionuclides.
Xenon Traps	Xenon	0.1	Efficiency is time dependent; monitoring is necessary to ensure effectiveness.
Fume Hoods	All	1	Provides no reduction to general public exposures.
Vent Stacks	All	1	Generally provides no reduction of exposure to general public.

[1] Per week.

References

(1) Environmental Protection Agency, "A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclides Emissions from NRC-Licensed and Non-DOE Federal Facilities", EPA 5201/1-89-002, January 1989.

(2) Nuclear Regulatory Commission, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations", U.S. Nuclear Regulatory Commission Regulatory Guide 3.59, March 1987.

17. By adding the following Appendix E to Part 61:

Appendix E—Compliance Procedures Methods for Determining Compliance With Subpart I

1. Purpose and Background

This Appendix provides simplified procedures to reduce the burden on Nuclear Regulatory Commission (NRC) licensees, and non-Department of Energy Federal facilities in determining compliance with 40 CFR Part 61, Subpart I. The procedures consist of a series of increasingly more stringent steps, depending on the facility's potential to exceed the standard.

First, a facility can be found in compliance if the quantity of radioactive material possessed during the year is less than that listed in a table of annual possession quantities. A facility will also be in compliance if the average annual radionuclide emission concentration is less than that listed in a table of air concentration levels. If the facility is not in compliance by these tables, it can establish compliance by estimating a dose using screening procedure developed by the National Council on Radiation Protection and Measurements with a radiological source term derived using EPA approved emission factors. These procedures are described in a "Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions From NRC-Licensed and Non-DOE Federal Facilities."

A user-friendly computer program called COMPLY has been developed to reduce the burden on the regulated community. The Agency has also prepared a "User's Guide for the COMPLY Code" to assist the regulated community in using the code, and in handling more complex situations such as multiple release points. The basis for these compliance procedures are provided in "Background Information Document: Procedures Approved for Demonstrating Compliance with 40 CFR Part 61, Subpart I". The compliance model is the highest level in the COMPLY computer code and provides for the most realistic assessment of dose by allowing the use of site-specific information.

2. Table of Annual Possession Quantity.

(a) Table 1 may be used for determining if facilities are in compliance with the standard. The possession table can only be used if the following conditions are met:

(i) No person lives within 10 meters of any release point; and

(ii) No milk, meat, or vegetables are produced within 100 meters of any release point.

(b) All restrictions on selecting the physical state of the radionuclide from section 61.103 apply to section 61.104. (c) If the quantity of any radionuclide possessed annually is less than the value listed in Table 1, the facility is in a compliance. If a facility uses multiple radionuclides, and the sum of the amount of each used annually divided by the limit from Table 1 is less than unity, then the facility is in compliance.

TABLE 1.—ANNUAL POSSESSION QUANTITIES FOR ENVIRONMENTAL COMPLIANCE

Radionuclide	Annual possession quantities (Ci/yr)		
	Gaseous [1] form	Liquid/ powder form	Solid form
Ag-110m	8E-05	8E-02	8E+01
Am-241	2E-07	2E-04	2E-01
Ar-41	1E+00	E	
Au-198	4E-02	4E+01	4E-04
Ba-140	2E-03	2E+00	2E+03
C-14	3E-01	3E+02	3E+05
Ce-144	1E-03	1E+00	1E+03
Cm-244	3E-06	3E-03	3E+00
Co-60	1E-05	1E-02	1E+01
Cr-51	5E-02	5E+01	5E+04
Cs-134	4E-05	4E-02	4E+01
Cs-137	2E-05	2E-02	2E+01
Eu-154	1E-05	1E-02	1E+01
Fe-59	1E-03	1E+00	1E+03
Ga-67	1E-01	1E+02	1E+05
Gd-152	1E-06	1E-03	1E+00
H-3	8E+00	8E+03	8E+06
Hf-181	2E-03	2E+00	2E+03
Hg-197	2E-01	2E+02	2E+05
Hg-203	4E-03	4E+00	4E+03
I-123	4E-01	4E+02	4E+05
I-125	5E-03	5E+00	5E+03
I-131	6E-03	6E+00	6E+03
In-113m	2E+00	2E+03	2E+06
Ir-192	8E-04	8E-01	8E+02
K-40	6E-05	6E-02	6E+01
Kr-83m	7E+03		
Kr-85	5E+02		
Kr-85m	9E+00		
Kr-87	2E+00		
Mn-54	2E-04	2E-01	2E+02
Mo-99 [2]	7E-02	7E+01	7E-04
Na-24	2E-02	2E+01	2E+04
Nb-95	2E-03	2E+00	2E+03
Ni-63	3E-01	3E+02	3E+05

[1] Radionuclides boiling at 100 °C or less, or exposed to a temperature of 100 °C or more, must be considered to be a gas.
[2] Mo-99 contained in a generator to produce technetium-99 can be assumed to be a solid.

TABLE 1.—ANNUAL POSSESSION QUANTITIES FOR ENVIRONMENTAL COMPLIANCE (CONTINUED)

Radionuclide	Annual possession quantities (Cr/yr)		
	Gaseous form [1]	Liquid powder form	Solid form
P-32	5E-03	5E+00	5E+03
Pb-210	5E-05	5E-02	5E+01
Po-210	9E-05	9E-02	9E+01
Ru-103	3E-03	3E+00	3E+03
S-35	3E-02	3E+00	3E+04
Sb-124	5E-04	5E-01	5E+02
Sc-46	3E-04	3E-01	3E+02
Se-75	1E-03	1E+00	1E+03
Sn-113	2E-03	2E+00	2E+03

TABLE 1.—ANNUAL POSSESSION QUANTITIES FOR ENVIRONMENTAL COMPLIANCE (CONTINUED)—Continued

Radionuclide	Annual possession quantities (Cr/yr)		
	Gaseous form [1]	Liquid powder form	Solid form
Sr-85	2E-03	2E+00	2E+03
Sr-90	8E-04	8E-01	8E+02
Tc-95m	1E-03	1E+00	1E+03
Tc-99m	1E+00	1E+03	1E+06
W-187	9E-02	9E+01	9E+04
Xe-133	4E+01		
Xe-133m	5E+01		
Xe-135	6E-00		
Zn-65	3E-04-	3E-01	3E+02

[1] Radionuclides boiling at 100 °C or less, or exposed to a temperature of 100 °C or more, must be considered to be a gas.

3. Table of Concentration Levels

(a) Table 2 may be used for determining if facilities are in compliance with the standard.

1. The concentration table can only be used if all releases are from point sources and concentrations have been measured using EPA-approved methods, and the distance between each stack or vent and the nearest resident is greater than 3 times the diameter of the stack or vent.

2. If the concentration of any radionuclide released from the facility is less than the value listed in Table 2, the facility is in compliance. If a facility releases multiple radionuclides, and the sum of the concentration of each radionuclide divided by its limiting concentration from Table 2 is less than unity, then the facility is in compliance.

4. NCRP Screening Model

The procedures described in National Council on Radiation Protection and Measurement Commentary No. 3 "Screening Techniques for Determining Compliance with Environmental Standards" may be used to determine the dose to members of the general public from emissions of radionuclides to the atmosphere.

5. The COMPLY Computer Code

The COMPLY computer code may be used to determine compliance with Subpart I. The compliance model in the COMPLY computer code may be used to determine the dose to members of the general public from emissions of radionuclides to the atmosphere. The compliance model contains more radionuclides than the current version of NCRP Commentary No. 3.

TABLE 2.—CONCENTRATION LEVELS FOR ENVIRONMENTAL COMPLIANCE

Radionuclide	Concentration (Ci/m³)	Radionuclide	Concentration (Ci/m³)
Ag-110m	7E-14	Kr-85	7E-07
Am-241	2E-15	Kr-85m	1E-08
Ar-41	1E-09	Kr-87	3E-09
Au-198	1E-11	Mn-54	2E-13
Ba-140	1E-12	Mo-99	8E-12
C-14	4E-12	Na-24	2E-11
Ce-144	7E-13	Nb-95	2E-12
Cm-244	4E-15	Ni-63	1E-11
Co-60	2E-14	P-32	7E-14
Cr-51	5E-11	Pb-210	3E-15
Cs-134	2E-14	Po-210	8E-15
Cs-137	2E-14	Ru-103	2E-12
Eu-154	2E-14	S-35	5E-13
Fe-59	8E-13	Sb-124	4E-13
Ga-67	8E-11	Sc-46	4E-13
Gd-152	2E-14	Se-75	4E-13
H-3	4E-09	Sn-113	5E-13
Hf-181	2E-12	Sr-85	8E-13
Hg-197	2E-11	Sr-90	2E-14
Hg-203	9E-14	Tc-95m	1E-13
I-123	5E-10	Tc-99	2E-13
I-125	9E-14	Tc-99m	2E-9
I-131	3E-9	W-187	2E-11
In-113m	3E-09	Xe-133	5E-8
Ir-192	8E-13	Xe-133m	7E-9
K-40	3E-14	Xe-135	1E-8
Kr-83m	9E-06	Zn-65	7E-14

6. References

(1) Environmental Protection Agency, "A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclides Emissions from NRC-Licensed and Non-DOE Federal Facilities", EPA 5201/1-89-002, January 1989.

(2) Environmental Protection Agency, "User's Guide for the COMPLY code", EPA 520/1-89-003, January 1989.

(3) Environmental Protection Agency, "Background Information Document: Procedures Approved for Demonstrating Compliance with 40 CFR Part 61, Subpart I", EPA 520/1-89-001, January 1989.

(4) National Council on Radiation Protection and Measurement, "Screening Techniques for Determining Compliance with Environmental Standards", NCRP Commentary No. 3, Revision of January 1989.

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