ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 192

[A-FRL 2211-8a]

Standards for Remedial Actions at Inactive Uranium Processing Sites

AGENCY: U.S. Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: We are issuing final health and environmental standards to govern stabilization, control, and cleanup of residual radioactive materials (primarily mill tailings) at inactive uranium processing sites. These standards were developed pursuant to Section 275 of the Atomic Energy Act (42 U.S.C. 2022), as added by Section 206 of the Uranium Mill Tailings Radiation Control Act of 1978 (Pub. L. 95-604), and were proposed in April 1980 and January 1981.

The standards apply to tailings at locations that qualify for remedial action under Title I of Pub. L. 95-604. The standards for control provide that the tailings be stabilized in a way that gives reasonable assurance that the health hazards associated with the tailings will be controlled and limited for a long period of time. They also establish a requirement to control releases of radon from tailings piles. The standards for cleanup set limits on the radon decay-product concentration and gamma radiation levels in buildings affected by tailings and on the radium-226 concentration in contaminated land.

In response to comments on the proposed standards for disposal and for cleanup, we have evaluated a number of alternatives in terms of their costs and the reductions achievable in potential health effects. A number of changes have been made, including raising some of the numerical limits and eliminating some requirements. The purpose of most of these changes is to make implementation easier and less costly. The changes should not result in any substantial loss of health or environmental protection over that which would have been provided by the proposed standards.

EFFECTIVE DATE: The final standards take effect on March 7, 1983.

ADDRESSES: *Final Environmental Impact Statement.* Background information is given in the *Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites.* (FEIS), EPA Report 520/4-82-013-1. Single copies of the FEIS, as available, may be obtained from the Program Management Office (ANR-458), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-9351.

Docket. Docket Number A-79-25 contains the rulemaking record. The docket is available for public inspection between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section (A-130), West Tower Lobby, 401 M Street, S.W., Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Dr. Stanley Lichtman, Guides and Criteria Branch (ANR-460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-8927.

SUPPLEMENTARY INFORMATION:

I. Introduction

On November 8, 1978, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604 (henceforth designated "the Act"). In the Act, Congress stated its finding that uranium mill tailings ". . . may pose a potential and significant radiation health hazard to the public, . . . and . . . that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." The Administrator of the Environmental Protection Agency (EPA) was directed to set ". . . standards of general application for the protection of the public health, safety, and the environment . . ." to govern this process of stabilization, disposal, and control.

The Act directs the Department of Energy (DOE) to conduct necessary remedial actions at designated inactive uranium processing sites to achieve compliance with the standards established by EPA. Standards are required for two types of remedial actions: control and cleanup. Control is the operation which places the tailings piles in a condition that will minimize the risk to man for a long time. Cleanup is the operation which reduces the potential health consequences of tailings that have been dispersed from tailings piles by natural forces or removed by man and used elsewhere in buildings or land.

In April 1980, we proposed standards for cleanup of tailings (45 FR 27370, April 22, 1980) and made them effective immediately as interim standards (45 FR 27366, April 22, 1980). We took this action to allow DOE to begin remedial work immediately at some contaminated buildings which posed a high level of risk. In January 1981, we proposed standards for control of tailings piles (46 FR 2556, January 9, 1981) and issued a Draft Environmental Impact Statement (DEIS) covering both the control and cleanup standards. Public hearings on the standards were held in Salt Lake City, Utah, on April 24-25, 1981; in Durango, Colorado, on April 27-28, 1981; and in Washington, D.C., on May 14-15, 1981.

We received a wide range of responses to the proposed standards and the DEIS. Sixty-eight substantive comment letters were received and twenty-three individuals testified or submitted comments at the public hearings. Comments were received from a broad spectrum of participants, including private citizens, public interest groups, members of the scientific community, representatives of industry, and State and Federal agencies. We have carefully reviewed and considered these comments in preparing the FEIS and in promulgating these final standards. The written comments are reproduced in the FEIS, which also contains our detailed responses. The major issues raised in public comments, our response to them, and the detailed changes in the standards are given in Sections III and IV. Below we simply summarize the major conclusions reached as a result of our review.

These standards are established to satisfy the purposes of the Act to ". . . stabilize and control . . . tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public." The Act does not provide specific criteria to be used in determining that these purposes have been satisfied. We have therefore made it our objective to establish standards that take account of the tradeoffs between costs and benefits in a way that assures adequate protection of the public health, safety, and the environment; that can be implemented using presently available techniques and measuring instruments; and that are reasonable in terms of overall costs and benefits. We have been especially cognizant of the need to differentiate what would be desirable from what we believe to be necessary to achieve the purposes of the Act.

Substantial dissatisfaction with the proposed standards was expressed in written comments and at the public hearings. In response to these views, we carefully evaluated a number of alternatives with respect to the above factors. Details of each of the alternative control and cleanup standards we considered are given in the FEIS. Selected results of our analysis that are pertinent to our choices for each part of the final standard are given in Section III of this Notice. The following table contains a summary of the alternative standards we considered for control of tailings piles.

ALTERNATIVE STANDARDS FOR CONTROL OF URANIUM MILL TAILINGS PILES

Alternative	Principal requirements		
	Minimum time that controls should prevent erosion and misuse (years)	For radon emission from top of pile (pCi/m^2s)	For water quality protection
No standards	None (radioactivity decays to 10 percent in 265,000 yr).	No limit (The average emission is 500 pCi/m^2s).	None (Toxic chemicals in tailings at concentrations 100 times background).
EPA proposed standard	1,000	2 above background	No increased concentration of toxic chemicals.
Alternative A	1,000 to 10,000	2 above background	No degradation that would prevent present uses.
Alternative B	200 to 1,000	20	Guidance, based on water quality criteria.
Alternative C	Indefinite, long-term	100	Guidance, based on water quality criteria.
Alternative D	Durable cover; 100-yr institutional control; discourage moving of piles.	No requirement	Prevent significant erosion of tailings to surface water or ground water, or treat water before use.
Alternative E	Minimal cover to prevent wind-blown erosion only; 100- to 200-yr institutional control; move only piles in immediate danger due to floods.	No requirement	No protection required.

The alternative cleanup and control standards can be generally categorized as:

(1) *Least-cost* alternatives which provide minimum acceptable health protection, and depend upon the use of institutional methods of control;

(2) *Optimized cost-benefit* alternatives which provide longer term health protection, without reliance on institutional controls, but at somewhat higher costs; and

(3) *Nondegradation* alternatives which attempt to achieve close to the same environmental consequences as might occur if the ore had not been mined; these entail much higher costs, and could result in some undesirable environmental consequences.

Our analysis was based on assuming that remedial actions to satisfy "least cost" tailings pile control standards would entail applying a thin earthen cover and little or no reinforcement of relatively steep side slopes. Integrity of the cover would be assured through active maintenance for 100 years. Only minimal flood protection measures would be applied, and as few as one pile would be moved to a more stable location. Covers would be progressively thicker and less dependent upon care under the more stringent alternatives, with more gradual slopes and greater use of rock for reinforcement. Under the "nondegradation" alternatives, up to half of the piles would be moved to satisfy either water protection or longevity requirements.

The alternative cleanup standards would require progressively more complete removal of tailings from more buildings. Remedial methods that do not involve tailings removal may be used on a limited basis under all but "nondegradation" alternatives.

The more stringent land cleanup alternatives require more complete removal of contaminated material, implying that larger areas may be cleaned up at each contaminated location and somewhat greater numbers of sites qualify for cleanup.

We concluded that the standards we originally proposed approach a "nondegradation" alternative that would, in at least some cases, be difficult to implement, since they specify cleanup and control limits close to background levels. More importantly, the small incremental health benefits, when compared to the benefits for less stringent alternatives, do not appear to justify the large additional costs.

We selected an "optimized cost-benefit" rather than a "least cost" alternative for the final standards, in part because it provides much greater protection of health at only a small increase above the least cost alternatives, and in part because it does not place primary reliance on institutional methods of control. The final standards provide for:

(1) *Control systems for tailings piles*—Control and stabilization which will ensure, to the extent reasonably achievable, an effective life of 1000 years, and in any case, for at least 200 years. This control and stabilization will be designed to provide a barrier which will effectively minimize the potential for misuse and spread of the tailings, limit the average radon emission from the surface of tailings piles to no more than 20 pCi/m^2s,[1] protect against flooding, and protect from wind and water erosion. We have also provided an alternative equivalent to the radon emission limit that is stated in terms of the maximum radon concentration in air at locations off the pile.

(2) *Flood control*—Diking or other flood protection controls given first consideration, rather than moving piles, when there is a risk from floods.

(3) *Control of waterborne pollutants*—DOE should assess each site and establish any corrective or preventive programs found necessary to meet relevant State and Federal Water Quality Standards and to be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act, as amended.

(4) *Cleanup of buildings*—An objective for reduction of radon decay products of 0.02 WL,[2] with a maximum limit of 0.03 WL.

(5) *Cleanup of dispersed tailings*—Limitations of soil radium content to 5 pCi/g (above background) averaged over the top 15 centimeters of soil, and to 15 pCi/g averaged over any 15 centimeters of soil below this.

(6) *Cleanup of off-site land*—Remedial actions applied only to situations that constitute a hazard; in those cases, cleanup equivalent to the above standard for dispersed tailings.

The Table below provides a summary comparison of the proposed and final standards. The following sections provide a more detailed discussion of the basis for the final standards.

[1] A curie is the amount of radioactive material that produces 37 billion nuclear transformations (e.g., decays of radium into radon) per second. A picocurie (pCi) is a trillionth of a curie. One picocurie of material produces just over two transformations per minute. pCi/m^2s is a unit for the release rate of radioactivity from a surface (m=meter, s=second). pCi/g is a unit for the radioactivity concentration in a mass of material (g=gram).

[2] A "working level" (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts. Working level is a measure of the concentration of radioactivity in the air, not of how much radiation a person actually receives.

SUMMARY COMPARISON OF PROPOSED AND FINAL STANDARDS

	Proposed	Final
Control of Tailings Piles:		
1. Longevity	At least 1000 years	Up to 1000 years, to the extent reasonably achievable, but at least 200 years.
2. Radon emissions from disposal site.	2 pCi/m^2s; equivalent to about 99.6% reduction.	20 pCi/m^2s, *or* 0.5 pCi/1 in air outside the disposal site; equivalent to about 96% reduction.
3. Water protection	Specific limits for a number of toxic and radioactive contaminants in groundwater; nondegradation of surface water.	Use existing State and Federal standards; apply site-specific measures where needed.
Cleanup of Buildings:		
1. Indoor radon decay products	Shall not exceed 0.015 WL	Shall not exceed 0.03 WL; to the extent practicable, achieve 0.02 WL.
2. Indoor gamma radiation	20 microR/hr	Unchanged.
Cleanup of Land:		
1. Surface	5 pCi/g in any 5 cm layer within one foot of surface.	5 pCi/g in the 15 cm surface layer.
2. Buried	5 pCi/g in any 15 cm layer below one foot.	15 pCi/g in any 15 cm layer below the surface layer.
Exceptions:		
1. Procedure	Site-specific exception procedures	Supplemental standards (may be applied on generic or site-specific basis).
2. Applicability	Where health and safety would be endangered, or where costs clearly outweigh benefits.	Same as proposed; criteria also provided to avoid cleanup of small amounts of tailings and inaccessible tailings posing minimal hazards.

It should be noted that these standards in no way are intended to establish precedents for other situations or regulations involving similar environmental objectives, but with different economic and/or technological circumstances. For example, our forthcoming proposed standards for active uranium mills will be based on an independent analysis of operating and future mills, which may result in different standards. Similarly, our remedial action standard for contaminated buildings should not be taken as an appropriate design goal for indoor radon decay product concentration in new housing, or as a remedial action goal appropriate for all circumstances.

II. Summary of Background Information

Beginning in the 1940's, the U.S. Government purchased uranium for defense purposes. As a result, large quantities of tailings were created by the uranium milling industry. These tailings are a sand-like material, and are attractive for use in construction and soil conditioning. Most of these mills are now inactive, and the ultimate disposal of their tailings has not yet taken place. In addition, tailings have been dispersed from the piles at most of the sites by natural forces, or have been removed by man for use in or around buildings, or on land. The Act provides for the cleanup of these offsite tailings as well as for the long-term control of the tailings piles.

Congress designated twenty-two inactive sites, and the Department of Energy has added two more. The sites are located in the West, predominantly in arid areas, except for a single site at Canonsburg, Pa. Tailings piles at these sites range in area from 5 to 150 acres and in height from a few feet to as much as 230 feet. The amount of tailings at each site ranges from only residual contamination to 2.7 million tons. The twenty-four designated sites combined contain about 26 million tons of tailings covering a total of about 1,000 acres.

The most important hazardous constituent of uranium mill tailings is radium, which is radioactive. We estimate that these tailings contain a total of about 15,000 curies of radium. Radium, in addition to being hazardous itself, produces radon, a radioactive gas whose decay products can cause lung cancer. The amount of radium in tailings, and, therefore, the rate at which radon is produced, will decay to about 10% of the current amount in several hundred thousand years. Other potentially hazardous constituents of tailings include arsenic, molybdenum, selenium, uranium, and, usually in lesser amounts, a variety of other toxic substances. The concentrations of these materials vary from pile to pile.

Radiation and toxic materials may cause a variety of cancers, and other diseases, as well as genetic damage and teratogenic effects. Tailings are hazardous to man because: (1) decay products of radon may be inhaled and increase the risk of lung cancer; (2) individuals may be exposed to gamma radiation from the radioactivity in tailings; and (3) radioactive and toxic materials from tailings may be ingested with food or water. We believe the first of these hazards is clearly the most important.

The radiation hazard from tailings lasts for many hundreds of thousands of years, and some nonradioactive toxic chemicals persist indefinitely. The hazard from uranium tailings therefore must be viewed in two ways. In themselves, the tailings pose a present hazard to human health. Beyond this immediate, but generally limited, health threat, the tailings are vulnerable to human misuse and to dispersal by natural forces for an essentially indefinite period. In the long run, this threat of expanded, indefinite contamination overshadows the present dangers to public health. The Congressional report accompanying the Act expressed the view that the methods used for remedial actions should not be effective for only a short period of time. It stated: "The committee believes that uranium mill tailings should be treated . . . in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms," and, that "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. I, p. 17, and Pt. II, p. 40 (1978).)

For the purpose of establishing standards for the protection of health, we assume a linear, nonthreshold dose-effect relationship as a reasonable basis for estimating risks to the general public from radiation. This means we assume that any radiation dose poses some risk and that the risk of low doses is directly proportional to the risk that has been demonstrated at higher doses. We recognize that the data available preclude neither a threshold for some types of damage below which there are no harmful effects, nor the possibility that low doses of gamma radiation may be less harmful to people than the linear model implies. However, the major radiation hazard from tailings arises from alpha radiation, and the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (the BEIR Committee) stated in their 1980 report that for ". . . radiation, such as from internally deposited alpha-emitting radionuclides, the application of the linear hypothesis is less likely to lead to overestimates of risk, and may, in fact, lead to underestimates."

Our quantitative estimates of radiation risk are based on our review of epidemiological studies, conducted in the United States and in other countries, of underground miners of uranium and other metals who have been exposed to radon decay products, and on three reports: *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (1972) and *Health Effects of Alpha Emitting Particles in the Respiratory Tract* (1976) by the BEIR Committee, and the report of the United Nations Scientific Committee on the Effects of Atomic Radiation entitled *Sources and Effects of Ionizing Radiation* (1977). Details of our risk estimates are provided in *Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands* (EPA 520/4-78-013) and in the FEIS.

Although the studies of underground miners show that there is a significant risk of lung cancer from exposure to radon decay products, there is some uncertainty about its magnitude. Exposures of miners are estimated from the time spent in each location in a mine and the measured radon decay product levels at those locations. However, radon decay product measurements were infrequent and often nonexistent for exposures of miners prior to the 1960's. The uncertainty increases when data for miners are used to estimate risk to the general population because there are differences in age, physiology, exposure conditions, and other factors between the two populations. Nevertheless, we believe the information available provides an estimate of risk which is probably reliable within a factor of two or three, and that this constitutes an adequate basis for these standards.

It is not possible to reduce the risk to zero for people exposed to radiation or, for that matter, to many other hazardous materials. In order to decide on an appropriate level of a small residual risk, we evaluated the costs and benefits of different levels of control. We also considered technical difficulties associated with implementing different levels of control.

The legislative record shows that Congress intended that EPA set general standards and not specify any particular method of control. Therefore, our analyses of control methods, costs, risks, and other pertinent factors emphasize the general characteristics of uranium mill tailings and the designated sites. The Act gives other agencies of the Federal Government the responsibility to decide how to satisfy these standards at specific sites. They will issue site-specific Environmental Impact Statements or Environmental Assessments, as appropriate, covering such matters.

The information upon which we based these health and environmental standards for control and cleanup of tailings from inactive uranium processing sites is summarized below. Additional background information and more complete presentations are given in our notices of proposed rulemaking (45 FR 27370, April 22, 1980, and 46 FR 2556, January 9, 1981) and in the FEIS.

A. The Risks from Tailings

Uranium mill tailings can affect man through four principal environmental pathways:

- *Diffusion of radon-222, the decay product of radium-226, from tailings into indoor air.* Breathing radon-222, an inert gas, and its short half-life decay products, which attach to tiny dust particles, exposes the lungs to alpha radiation (principally from polonium-218 and polonium-214). The exposures involved may be large for persons who have tailings in or around their houses, or who live very close to tailings piles. Additional, but smaller, exposures to alpha radiation may result from long-lived radon-222 decay products (principally lead-210 and polonium-210). Exposure due to radon from tailings in or around buildings is best estimated from direct measurements of its decay products in indoor air.
- *Direct exposure to gamma radiation.* Many of the radioactive decay products in tailings produce gamma radiation. The most important are lead-214, bismuth-214, and thallium-210. Hazards from gamma radiation are limited to persons in the immediate vicinity of piles or removed tailings. Exposure due to gamma radiation from tailings is readily estimated from direct measurements.
- *Dispersal of small particles of tailings material in the air.* Wind erosion of unstabilized tailings piles creates airborne tailings material. The predominant dose is to the bones from eating foods contaminated by thorium-230, radium-226, and lead-210, and is small. Exposure due to airborne transport of radon and particulates from a pile usually cannot be directly measured, but may be estimated using meteorological transport models.
- *Waterborne transport of radioactive and toxic material.* Dispersal of unstabilized tailings by wind or water, or leaching, can carry radioactive and other toxic materials to surface or ground water. Current levels of contamination appear to be low or nonexistent. However, some long-term future contamination of surface and ground water and consequent intake by man and animals is possible. Potential exposures due to the transport of waterborne contaminants are highly site-specific and can generally only be determined by a careful survey program.

The following discussion of risks focuses largely on current biological effects; however, these current effects could be expanded by future misuse of tailings by man and by uncontrolled effects of natural forces. Our standards reflect consideration of both current and future impacts of tailings.

1. Air Pathways. We estimated the hazards posed by radon emissions to air from uranium mill tailings piles and from tailings used in and around houses. For the first case we used meteorological models and considered people in the neighborhood of the pile, the population in the local region, and the remainder of the national population. For the second, we drew largely upon experience from contaminated houses in Grand Junction, Colorado. Four sources of exposure were considered; inhaled short-lived radon decay products, gamma radiation, the long-lived radon decay products, and airborne tailings.

From our analysis we conclude:

(a) Lung cancer caused by the short-lived decay products of radon is the dominant radiation hazard from tailings. Effects of gamma radiation, of long-lived radon decay products, and of airborne tailings from the piles are generally much less significant, although high gamma radiation doses may sometimes occur.

(b) Individuals who have tailings in or around their houses often have large exposures to indoor radon and hence high risks of lung cancer. For example, in 50% of a sample of 190 houses with tailings in Grand Junction, Colorado, we estimate that the lifetime excess risk due to exposure to short-lived radon decay products prior to remediation may have been greater than 4 chances in 100.

(c) Individuals living near an uncontrolled tailings pile are also subjected to high risks from short-lived radon decay products. For example, we estimate that people living continuously next to some of the piles may have lifetime excess lung cancer risks as high as 4 chances in 100.

(d) Based on models for the cumulative risk to all exposed populations, we estimate that, without remedial action, the radon from all the inactive sites considered together could cause about 170 to 240 potential excess lung cancer deaths per century. Of these, 55% to 80% are projected to occur among persons living less than 50 miles from a pile.

There is a substantial uncertainty in these estimates because of uncertainties in the rate of release of radon from tailings piles, the exposure people will receive from its decay products, and from our incomplete knowledge of the effects on people of these exposures. In addition, our estimates are based upon current sizes and geographical distributions of populations. If populations increase in the future, the estimated impact would be larger.

We concluded that a primary objective of standards for *cleanup* of tailings should be to remove or reduce existing and potential risks due to radon decay products indoors. Such risks from indoor radon decay products arise in two ways—in existing buildings where tailings were used in construction and cause elevated levels, and from land contaminated sufficiently to cause elevated levels in new construction. A secondary objective should be to reduce high exposures to gamma radiation due to tailings in buildings or on land away from the tailings piles.

We concluded that a primary objective of standards for *control* of tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces, such as wind; rain, and flood waters. A second objective should be to reduce radon emissions from tailings piles. A third objective should be the elimination of significant exposure to gamma radiation from tailings piles.

2. Water Pathways. Although water contamination does not now appear to be a significant source of immediate radiation exposure at the piles, both radionuclides and nonradioactive toxic substances, such as arsenic, molybdenum, and selenium, could be leached or otherwise removed from tailings and contaminate water resources. If this occurred, it could then affect crops, animals, and people. Such contamination could, in principle, be caused by either past or future releases from the tailings. Tailings piles at inactive sites have already lost most of the water deposited in them during mill operations through evaporation and seepage. However, elevated concentrations of radioactive or toxic substances in ground water have been observed at only a few of the designated sites (four are identified in the FEIS), and in some standing water ponds (but not in running water). Any future water contamination would arise from the effects of rain or through flooding of a pile, from penetration of a pile from below by ground water, or from leaching of tailings transported off a pile.

A theoretical analysis performed for the Nuclear Regulatory Commission (NRC) of a larger model pile showed that contamination of ground water by selenium, sulfate, manganese, and iron might exceed current drinking water standards over an area 2 kilometers wide and 8 to 30 kilometers long. However, more than 95% of this projected contamination was attributable to initial seepage of process water discharged to the pile during mill operations. The movement of contaminants through a pile and subsoil to ground water depends on a combination of complex chemical and physical properties, as well as on local precipitation and evaporation rates. Chemical and physical processes can effectively remove or retard the flow of many toxic substances passing through subsoil. However, some contaminants such as arsenic, molybdenum, and selenium, can occur in forms that are not removed. Typically, ground water can move as slowly as a few feet per year, and only in coarse or cracked materials does the speed exceed one mile per year. For these reasons, contaminants from tailings may not affect the quality of nearby water supply wells for decades or longer after they are released. However, once contaminated, the quality of water supplies cannot usually be easily restored simply by eliminating the source (although, in some cases removing or isolating the tailings may contribute to improving water quality).

Based on results from the NRC generic model for mill tailings piles, it is likely that the few observed cases of ground water contamination resulted from seepage of the original liquid waste discharges from the mill. Additional future contamination of ground water should be much smaller, and in most cases would be expected to be minimized by measures required to control misuse of tailings by man and dispersal by wind, rain, and flood waters. These measures should also effectively eliminate the threat of contamination of surface water by runoff or from leaching of tailings transported off piles, and provide reasonable protection of surface and ground water from contamination by flooding. However, at a few specific sites, especially in areas of high rainfall or where ground water tables intersect the piles, special consideration of possible future contamination of ground water may be needed.

Though a few sites appear to have some existing contamination due to the presence of tailings, we believe it will usually not be feasible or practical to remove the contaminants from subsoil or ground water. Whether or not it is feasible or practical to restore an aquifer and to what degree will depend on site-specific factors, such as the ability to restore the aquifer in its hydrogeologic setting, the cost, the present and future value of the aquifer as a water resource, the availability of alternative supplies, and the degree to which human exposure is likely to occur.

We concluded that potential contamination of surface and ground water at the inactive sites must be considered on a site-specific basis. The remedial program should provide for adequate hydrological and geochemical surveys of each site as a basis for determining whether specific water protection or cleanup measures should be applied. In many cases, the control measures needed for other purposes should reduce any potential for contamination.

In addition to the available information upon which we based our conclusion, hydrological and geochemical studies are presently being conducted or planned at a number of sites. The purpose of these studies is to gather additional information so as to more fully assess any actual or potential ground water contamination and to better understand the mechanism of contaminant movement. The studies will identify the extent and character of contaminants remaining in the piles, as well as the direction, rate of movement and degree of attenuation of any contaminants already released. In particular, attention is being given to identifying the likelihood of contaminants reaching an actual or potential water supply source. We are currently reviewing current studies and will review future studies assessing the site-specific factors related to potential ground water contamination.

As stated previously in this Section II, site-specific Environmental Assessments (EAs) or Environmental Impact Analyses (EIAs) will be prepared for each site. We will review the information generated as part of those. The EAs or EIAs would gather data on a site-specific basis which would either characterize the site completely or confirm the use of general models in determining potential mechanisms for impact or lack of impact on ground water.

We believe that it is important to conclude these studies as quickly as possible. These studies will provide a more complete data and analytical base to allow us to reevaluate the decision not to set ground water protection standards. Information to be obtained as a part of the studies will include the response of the tailings and interstitial fluids to water table and precipitation stimuli; distribution of radionuclides and other contaminants within the tailings pile; identification of mobile constituents within the tailings and ground water system; and analyses of the mechanisms for the release and transport of the contaminants both to the surface and downward to ground water.

To date, the results of more recent studies than those we described in our FEIS strongly support our decision not to issue general numerical water protection standards. We intend to continue to review additional information as it becomes available, and will reconsider our decision if the need to do so becomes apparent.

B. Cleanup and Control of Tailings

1. Control of Tailings Piles. The objectives of tailings control and stabilization efforts are to prevent their misuse by man, to reduce radon emissions (and gamma radiation exposure), and to avoid the contamination of land and water by preventing erosion by natural processes. The longevity (i.e., long-term integrity) of control is particularly important. This is affected by the potential for disruption by man; by the probability of occurrence of such natural phenomena as earthquakes, floods, windstorms, and glaciers; and by chemical and mechanical processes in the piles. Prediction of the long-term integrity of control methods becomes less certain as the period of concern increases. Beyond several thousand years, long-term geological processes and climatic change become the dominant factors.

Methods to prevent misuse by man and disruption by natural phenomena may be divided into those whose integrity depends upon man and his institutions ("active" controls) and those that do not ("passive" controls). Examples of active controls are fences, warning signs, restrictions on land use, and inspection and repair of semi-permanent tailings covers, temporary dikes, and drainage courses. Examples of passive controls are thick earthen covers, rock covers, massive earth and rock dikes, burial below grade, and moving piles out of locations highly subject to erosion, such as unstable river banks.

Erosion of tailings by wind, rain, and flooding can be inhibited by contouring the pile and its cover, by stabilizing the surface (with rock, for example) to make it resistant to erosion, and by constructing dikes. If necessary, erosion can be inhibited by burying tailings in a shallow pit or moving them away from a particularly flood-prone or otherwise geologically unstable site.

Methods to control release of radon range from applying a simple barrier (such as an earthen cover) to such ambitious treatments as embedding tailings in cement or processing them to remove radium, the precursor of radon. Covering tailings with a permeable (porous) barrier, such as earth, delays radon diffusion so that most of it decays and is effectively retained in the cover. In addition to simple earthen covers, other less permeable materials such as asphalt, clay, or soil cement, usually in combination with earthen covers, may be used. The more permeable the covering material, the thicker it must be to achieve a given reduction in radon release. However, maintaining the integrity of very thin impermeable covers, such as plastic sheets, even over a period as short as several decades is unlikely given the chemical and physical stresses present at piles.

The most likely constituents of covers for use to control tailings are locally available earthen materials. The effectiveness of an earthen cover as a barrier to radon depends most strongly on its moisture content. Typical clay soils in the uranium milling regions of the west exhibit ambient moisture contents of 9% to 12%. For nonclay soils ambient moisture contents range from 6% to 10%. The following table provides, as an example, the cover thicknesses that would be required to reduce the radon emission to 20 pCi/m²s for the above ranges of soil moisture. Three examples of tailings are shown that cover the probable extreme values of radon emission from bare tailings at the designated sites (100 to 1000 pCi/m²s); the most common value is probably somewhat less than 500 pCi/m²s.

ESTIMATED COVER THICKNESS (METERS) TO ACHIEVE 20 PCi/M²S

Radon emission from tailings (pCi/m²s)	Percent moisture content of cover			
	6	8	10	12
100	1.7	1.3	1.0	0.7
500	3.4	2.6	2.0	1.5
1,000	4.1	3.2	2.4	1.8

These values are for simple homogeneous covers. In practice, multi-layer covers using clay next to the tailings can be used to significantly reduce the total thickness required.

Methods that control radon emissions will also prevent transport of particulates from the tailings pile to air or to surface water.[3] Similarly, permeable covers sufficiently thick for effective radon control will also absorb gamma radiation effectively (although thin impermeable covers will not).

[3] However, recent studies suggest the possibility that some chemical processes in tailings piles could carry dissolved contaminants upward, perhaps even through earthen coverings. Control system designers must carefully consider this possibility.

Control of possible contamination of ground water is difficult. In the few cases where this is a potentially significant problem, clay liners and/or clay caps may provide a good degree of protection for at least many decades. However, more permanent protection may require removal to a site with more favorable hydrological, geochemical, or meteorological characteristics.

Very effective long-term inhibition of misuse by man, as well as of releases to air and surface water, could be achieved by burying tailings in deep mined cavities. In this case, however, direct contact with ground water would be difficult to avoid. The potential hazards of tailings could also be reduced by chemically processing them to remove contaminants. Such processes have limited efficiencies, however, so the residual tailings would still require control. Furthermore, the extracted substances (e.g., radium and thorium) would be concentrated, and would require further control.

We analyzed the costs of a number of possible control methods. The total cost is affected most strongly by the type of material used to stabilize the surface against erosion and inhibit misuse by man, by the water protection features required, and by the number of piles that must be moved to new sites. In general, costs of covers using man-made materials (e.g., asphalt) are somewhat higher than costs for earthern covers. Active control measures are usually less costly in the short term than are passive measures. The costs for burial of tailings piles or for using chemical processing to extract radium (and perhaps other substances) are much higher than those for disposal using covers. We find that, given a decision to carry out any significant stabilization, the total cost of control using earthen covers does not depend strongly on the degree of reduction of radon emissions, for reductions by up to about a factor of 50 (the maximum that would probably be required at any site under these standards).

2. Cleanup of Tailings. The objective of cleanup of tailings from buildings is to reduce elevated indoor levels of radon decay products and gamma radiation. The objective of cleanup of tailings from land is to remove the potential for elevated levels of radon decay products in future buildings, and exposure of people to gamma radiation.

A variety of methods for cleanup of buildings are available. The most commonly used, and the most reliable and permanent measure, is to dig out the tailings and return them to the pile. This is sometimes relatively easy, such as removing tailings from outside footings, but may be very difficult, as in removing tailings from under a concrete slab floor in a finished room. Other methods include air filtration, improved ventilation, and the use of sealants to keep out radon.

Windblown tailings on lands around a tailings pile are usually removed by scraping off the top few inches of earth with earth-moving equipment and adding it to the pile. Land cleaned up in this way is relatively easily restored to close to background levels of radioactivity because windblown tailings are usually on the surface and easy to remove. Generally the cost is determined by the amount of land scraped, and not by the depth of scraping required. Alternatively, the land could be removed from productive use, access restricted, and the tailings fixed on the site by deep plowing.

When tailings have been removed from piles and misused in other ways, such as for soil conditioners in gardens and yards or as fill under detached buildings, the usual cleanup measure is to dig up the tailings and return them to the pile.

III. Resolution of Major Issues Raised in Public Comments

A. The Basis for the Standards

1. Health Risk Models. Some commenters considered that the models we used to estimate risks from breathing radon decay products underestimate the risk. More, however, argued that the models overestimate the risk. Some of these comments argued that the use of data on exposure of underground miners was not valid for estimating risks to the general public and suggested that we should use a lower risk estimate recently published as a contributed article in *Nature* (*290*:98, 1981).

We have reviewed the evidence presented and conclude that it does not support changing the risk models we have used. We agree that some evidence exists that risks may be either higher or lower than those we use, but, when all the available information is carefully considered, this evidence is not compelling. It is also true that the use of data on underground miners to predict risks to the general public is less than ideal; however, we have corrected for the most obvious difference (breathing rate) and do not believe this substantial body of evidence can be ignored. Finally, the estimates published in the article in *Nature* are not convincing. The upper limit of lung cancer risk given by these authors is apparently based on assuming that the total period of risk following exposure is only 15 years. However, the evidence from the Japanese A-bomb survivor data, the only large body of data for a general population, leads to use of a lifetime period of risk following exposure. Our detailed responses to these comments are presented in the FEIS.

2. Cost Estimates. Commenters suggested that our estimates of the costs to implement the standards were low (by a factor of two or more) and that we had not included costs for engineering, field supervision, contingencies, or for reclamation of borrow pits from which cover material was obtained.

Many of these comments are correct. Our estimates in the DEIS were expressed in 1978 dollars. Costs of some construction activities have increased substantially between 1978 and 1982. We have revised our cost estimates to reflect these changes, and have also included previously omitted costs for engineering, field supervision, contingencies, and reclamation of borrow pits. We have analyzed specific estimates of the cost of meeting the proposed standards and find that our revised estimates are lower than those of the DOE, but in substantial agreement with those provided by industry and NRC. Our cost estimates are reported in detail in the FEIS.

3. Cost-Benefit Analysis. Commenters expressed the view that the cost of implementing the proposed standards will be high compared to the benefits, that we failed to carry out a cost-benefit analysis for these standards, or that we did not adequately consider alternatives to the standards proposed.

It is not possible to carry out a formal quantitative cost-benefit analysis for these standards. Many of the hazards reduced (or avoided) through their application (or through application of alternative standards) can neither be evaluated quantitatively nor restated in terms of a common index of value. The major hazard, the extent of possible future misuse of tailings by man, is almost impossible to quantify. A further complication is that the benefits of successful control accrue over a very long period of time, whereas the costs occur now. We can only roughly estimate how long control will last and how many cases of lung cancer might be avoided over the full term of effective control.

Instead of a quantitative cost-benefit anlaysis, we have cited examples of the impact of misuse and dispersal by wind and water in the FEIS, and have estimated the impact of radon emissions from unstabilized piles. We have then estimated the extent to which these impacts might be avoided over the long term under realistic alternative standards, and made judgments about which alternatives offer the most cost-effective reduction of these impacts. The final standards are based on the results of such an analysis of alternatives, including a detailed consideration of their costs. This information is presented in Chapters 6 and 7 of the FEIS. Based on these analyses, we have made a number of changes (described in Sections B and C, below) to make the standards more cost-effective and easier to implement.

One notable conclusion from our analysis is that providing tailings piles with thick, durable covers costs surprisingly little more than applying minimal covers that will require maintenance and last a much shorter time. This conclusion follows from the large start-up expenditures related to managing the remedial program and undertaking any significant level of remedial work at mill sites. Thick covers offer greatly increased benefits from inhibiting misuse, controlling radon emissions, and increased longevity of the covers' effectiveness. For example, we estimate that the final control standard provides about ten times greater overall benefits than the lowest cost alternative standard, for only about 25 percent greater cost. Therefore, given that tailings piles will be stabilized under any of the alternatives we considered, we find it cost-effective to stabilize them well. This observation strongly influenced our choice of a radon release standard, as discussed in Section III.B.2, below.

Cost and benefit estimates for the alternative standards we considered are reported in detail in the FEIS; we briefly summarize here only our estimates for the final standards we selected.

Costs: We estimate the remedial action costs for mill sites and for off-site cleanup will be 158 and 38 million (1981) dollars, respectively. DOE has estimated its program development and management ("overhead") costs as 118 million (1981) dollars. These estimated total expenditures of 314 million (1981) dollars will occur over a period of seven years or more.

Benefits: We estimate benefits under the assumption, when appropriate, that tailings pile control systems will be partially effective longer than the standard requires. Control systems are required to be effective for as long as reasonably achievable up to 1000 years, but for not less than 200 years. Under this standard most of the 24 tailings pile will be stable against erosion and casual intrusion for misuse for much longer than 1000 years. Those few piles that are susceptible to flood damage will be protected for at least 200 years, and might not suffer real damage for much longer. During the period of full control, the maximum risk for individuals living very near a tailings pile from exposure to its radon emissions will be reduced by about 97%, from about 3 chances in 100 to about 1 chance in 1000. An estimated 200 potential premature deaths per century will be avoided initially, for a total of many thousands over the life of the cover. The potential for or existence of water contamination from tailings piles will be evaluated and any protective or remedial actions that the implementing agencies determine are warranted will be taken. We further estimate that about 60 premature deaths will be avoided by cleaning up contaminated buildings. An undeterminable additional number of deaths and the institutional burden of applying land-use controls may be avoided by cleaning up 1900 acres of land containing windblown tailings and about 3200–6500 additional locations where tailings have been brought for inappropriate uses.

4. Scope of the Standards and the EIS. Commenters expressed the view that some important impacts of mill tailings were not adequately considered in the DEIS and that we had not considered all of the available pertinent data. They cited inadequate consideration of (a) the health impacts of toxic elements, (b) radiation doses to man from the food pathway, and (c) the effects of radionuclides and toxic elements on plants and animals.

We have reviewed the available data on toxic elements in tailings and improved the FEIS in this respect (Appendix C). We have concluded that it is reasonable to expect that hazards from toxic elements will be adequately limited if control and cleanup are carried out according to these final standards. We have also reviewed the radiation doses from ingestion of food and confirmed our earlier conclusion that the risks from this pathway are small. We have not specifically required measures to protect animals and plants from the hazards of radioactivity, since we have concluded that the impacts are small.

Some comments expressed the view that the proposed standards were too narrow in scope to adequately protect public health. For example, it was proposed that the standards should include: Limits for radionuclide concentrations in air particulates and in vegetation; limits for toxic elements in soil; guidance for the interim period prior to remedial actions; and radiation protection criteria for workers who perform remedial actions.

We have considered these comments and believe that no changes are needed. If control and cleanup are carried out according to these final standards, the health impact from radionuclides in air and from food pathways, and from toxic elements in soil, which are already low, would be further mitigated. Workers are already protected under existing Federal Guidance for occupational radiation exposures. Finally, the impacts that will occur prior to completion of remedial actions are sufficiently small that we do not believe special interim standards are justified.

B. The Standards for Control of Tailings Piles

1. Longevity of the Control. Some commenters expressed the view that the proposed requirement that stabilization and control last for at least 1000 years is unreasonable because events cannot be predicted over this period of time with sufficient certainty. They recommended a period of no more than 100 to 200 years, and that active institutional care, such as access control and periodic maintenance, be permitted. Other commenters recommended that the longevity required should be greater than 1000 years, and expressed the view that a requirement for longevity of up to 10,000 years is practical.

We consider the single most important goal of control to be effective isolation and stabilization of tailings for as long a period of time as is reasonably feasible, because tailings will remain hazardous for hundreds of thousands of years. The longevity of tailings control is governed chiefly by the possibilty of intrusion by man and erosion by natural forces. Reasonable assurance of avoiding casual intrusion by man can be provided through the use of relatively thick and/or difficult-to-penetrate covers (such as soil, rock, or soil-cement). No standard can guarantee absolute protection against the purposeful works of man, and these standards do not require such protection. Protection against natural forces requires consideration of wind and surface water erosion, and of the possibility of flood damage. Wind and surface water erosion are relatively well-understood and predictable, and are easily inhibited through the use of rock or, in some cases, vegetative surface stabilization. Similarly, a body of scientific and engineering knowledge exists to predict the frequency and magnitude of floods for periods of many hundreds of years, and to provide the engineering controls to protect against such floods (including the possibility of moving a pile if this is more economical). We considered longevity requirements ranging from 100 to 10,000 years and have concluded that existing knowledge permits the design of control systems for these tailings that have a good expectation of lasting at least for periods of 1000 years. We recognize that it may not always be practical, however, to project such performance with a high degree of certainty, because of limited engineering experience with such long time periods.

We know no historical examples of societies successfully maintaining active care of decentralized materials through public institutions for periods extending to many hundreds or thousands of years. We have concluded that primary reliance on passive measures is preferable, since their long-term performance can be projected with more assurance than that of measures which rely on institutions and continued expenditures for active maintenance.

Section 104 of the Act requires the Federal Government to acquire and retain control of these tailings disposal sites under licenses issued by the Nuclear Regulatory Commission (NRC). The NRC is authorized to require performance of any maintenance, monitoring, and emergency measures that are needed to protect public health and safety. As long as the Federal Government exercises its ownership rights and other authorities regarding these sites, they should not be systematically exploited by people or severely degraded by natural forces.

We believe that these institutional provisions are essential to support any project whose objectives is as long term as are these disposal operations, and for which we have as little experience. This does not mean that we believe primary reliance should be placed on institutional controls; rather, that institutional oversight is an essential backup to passive control. We note, in this regard, that the remedial actions required by these standards would not make it safe to build habitable structures on the disposal sites. Federal ownership of the sites is assumed to preclude such inappropriate uses.

In the final standards we have modified the requirement for longevity of control so as to assure that it is practical for agencies to certify that the standards are implemented in all cases. We recognize that this is a remedial action program, that these sites were not chosen with long-term disposal in mind, and that our ability to predict the longevity of engineered designs is not always adequate to the task at hand. The proposed standard required a longevity of control of at least 1000 years. The final standard requires that control measures be carried out in a manner that provides reasonable assurance that they will last, to the extent reasonably achievable, up to 1000 years and, in any case, for a minimum of 200 years. The widely varying characteristics of the inactive sites, the uncertainties involved in projecting performance of control measures over long periods of time, and the large costs involved in moving some tailings piles to provide a very high degree of assurance of longevity make this change appropriate. (We estimate up to 50 million dollars might be unnecessarily spent to move piles under the proposed requirement for a longevity of at least 1000 years.) The change does not signify that there are circumstances under which the term of protection contemplated by the proposed standards is not appropriate. The change merely acknowledges that implementing agencies may in some cases have difficulty certifying that control measures that are appropriate can reasonably be expected to endure without degradation for 1000 years. Man's ability to predict the future is notoriously limited. That fact, which on the one hand warrants our making responsible societal efforts to limit risk to future generations, also warrants our refraining from actions undertaken merely in the name of necessarily artificial levels of statistical certainty.

We selected this period of period of performance because we believe there is a reasonable expectation that readily achievable controls will remain effective for at least this period. However, we recognize that uncertainties increase significantly beyond a thousand years, and we conclude it would be unreasonable to require that assurance be provided that the controls will be effective for periods of up to 10,000 years.

2. The Radon Release Limit. Some commenters expressed the view that the proposed radon emission standard of 2 pCi/m²s from the surface of a tailings pile was either unreasonably low or unnecessary. Others suggested that proper consideration of costs and benefits would lead to a higher standard, in the range of 40–100 pCi/m²s. Some urged that the standards for radon be expressed as a limit on ambient air concentration at the site boundary, rather than as an emission limit. Others were concerned that the proposed level could not be reliably implemented, since it is close to background levels. Finally, many argued that radon emitted from tailings piles does not constitute a significant health hazard because it cannot be distinguished from background radon levels a short distance from a tailings pile (i.e., ¼–½ mile), and that, therefore, there is no need for a radon emission standard.

We believe that limiting radon emissions from tailings piles serves several necessary functions: reducing the risk to nearby individuals and individuals at greater distances; and furthering the goals of reliable long-term deterrence of misuse of tailings by man and control of erosion of piles by natural processes. The degree of reduction of radon emissions achieved by a disposal system is more or less directly related to the degree of abatement of each of these hazards.

Our analysis predicts significant risk to people living next to tailings piles, and field measurements confirm elevated levels of radon in air close to the piles. If radon emissions are not reduced, we estimate that individuals residing permanently near some of the piles could incur as much as three to four chances in a hundred of a fatal lung cancer in addition to normal expectations. The fact that increases in radon levels due to the piles cannot be distinguished relative to background levels further away from a pile does not mean that radon is not present or that there is no increased risk from this radon—it merely means that measurements are not capable of unambiguously detecting such levels. Limiting radon release, therefore, not only benefits the nearby individual, but also reduces the adverse effects of radon well beyond the immediate vicinity of the site.

Radon emission was selected as the preferred quantity to be specified by the standard because, unlike ambient air concentration at the site boundary, it is directly related to the degree of radon control achieved. A site boundary standard would not necessarily require any control of radon emissions (since the boundary might be moved arbitrarily far from the pile), and, in any case, compliance would depend on indefinitely excluding public access across the boundary.

We have concluded that a limit on a radon emission is the most direct and appropriate means for furthering the Congressional objective of adequate and reliable long-term control of tailings. Such a limit assures a sufficient earthen cover (or its equivalent) to provide an acceptable degree of stabilization and isolation of the tailings over a long period of time. Congress did not intend that EPA set standards for one generation only, or that it set standards without consideration of the long-term reliability of whatever means are available for implementing them. (Similarly, Congress anticipated that short-term institutional controls would not provide the primary basis for protection.) Although the implementing agencies will decide which specific controls to employ, this does not preclude our considering, in accordance with Congress' directive, the effect of a particular choice of a numerical limit on the maintenance of future control. Therefore, in selecting the value for radon emissions, an important consideration was that the standard promote the objectives of adequate isolation and stabilization to control both intrusion by man and erosion by natural forces.

We have reevaluated the costs and benefits of alternative standards and have revised the radon emission standard to 20 pCi/m²s, in part because we concluded that the incremental benefits of the proposed standards are not justified by the increased costs, and in part because recent results of tests of covers indicate that a 2 pCi/m²s standard may be more difficult to achieve than we originally believed. The specific alternatives we analyzed are described in detail in the FEIS. They ranged from controlling emissions to 2 pCi/m²s to providing only a minimal cover that we estimate would, on the average, reduce total radon emissions by half (to final values ranging from 40 pCi/m²s to 500 pCi/m²s, depending upon the site.) Estimated disposal costs for these options (excluding DOE overhead and the cost of moving piles) range from 50 to 195 million dollars. The costs for the revised standard of 20 pCi/m²s were estimated as 95 million dollars; this is approximately 45 million dollars less than for the proposed standard.

We have concluded that this revised standard will provide excellent protection of public health, safety, and the environment. Control measures designed to meet this standard will prevent misuse and protect piles from erosion by providing adequate isolation of tailings. The standard provides more than 96% of the reduction of the potential for lung cancer from radon emissions provided by the proposed standard. Under the revised emission limit, the excess risk to the most exposed individual would be reduced to a few chances in a thousand. In addition, it provides this protection at a substantial cost reduction compared to the originally proposed standard (including the modification of the longevity requirement, the combined saving is approximately 95 million dollars). The revised emission limit should also be high enough to remove any concern associated with confusing radon from tailings with radon emitted from normal soils (typically up to 1 pCi/m²s), and can be readily achieved through the use of a wider variety of earthen materials than the proposed standards.

We conclude from our analysis that a higher emission standard, such as 100 pCi/m²s, would not achieve the above objectives to an acceptable degree. It would result in a five times greater risk to individuals living near a tailings pile and a similar increase in the impact from radon emissions on local, regional, and national populations (to 20% of the total risk from uncontrolled piles). The control measures required to meet such a less restrictive standard would provide significantly less isolation against intrusion and protection against erosion. The further cost reduction compared to the final standard would be relatively small (approximately 20 million dollars).

The Department of Energy, in the course of the consultations that Section 206 of the Act requires before we promulgate final standards, expressed its strong preference for an ambient air concentration standard rather than an emission standard. Therefore, through calculations described in the FEIS, we determined an alternative standard expressed as a radon concentration at the *edge of the tailings* that we believe would require basically the same level of control as the 20 pCi/m²s emission standard. Applying a concentration standard at the edge of the tailings resolves our concerns about applying it at a site boundary. A limit applied at a site boundary would permit varying effectiveness of cover, depending on the choice of location of the boundary, and compliance would depend on indefinite maintenance of the boundary. However, a radon concentration standard at any position that is defined in terms of its relation to the tailings has a fixed relationship to radon releases and compliance does not depend on institutional maintenance of a fence.

Calculations can be used to estimate the values of the annual average radon concentrations at various distances from tailings piles with a given emission rate. Considering the uncertainties in such calculations, we are confident that designing control systems to keep the maximum annual average radon concentration at the edges of the tailings below 0.5 pCi/1 will provide approximately the same overall health protection as designing them for an average emission rate of 20 pCi/m²s.

Under either form of the radon limit the radon concentration due to a pile will be well below the background level at any residence near the disposal site. The final standard contains both forms of radon limit, as approximately equivalent alternatives.

3. Avoiding Contamination of Water. Commenters expressed concern that the proposed requirements for protection of water are unnecessarily restrictive, are impractical or too costly to implement, or incorporate numerical values that had not been adequately justified. Some argued that water protection should be handled on a site-specific basis, that general standards were not necessary, and that water quality standards were not an appropriate basis for these regulations. Other comments expressed the opposite view that the proposed standards did not provide sufficient protection, that already degraded ground water should be cleaned up, or that numerical values should be included for additional toxic elements.

We have carefully reviewed available data on contamination of ground water at the designated sites. Studies of these sites are not yet conclusive, but they provide little evidence of recent movement of contaminants into ground water, and there is some evidence that the geochemical setting may inhibit contaminants from entering usable ground water at two sites where there might otherwise be a problem (Salt Lake City and Canonsburg). The proposed standards might be difficult to implement at certain sites because our ability to perform definitive hydrological assessments is limited. That is, they could lead to decisions to use very expensive control methods, such as moving piles to new sites and installing liners, even though no substantial threat to ground water is demonstrated. We also believe that minor degradation of ground water may be acceptable, such as for water of already inadequate quality for existing or probable uses, or for very small aquifers.

Finally, we agree that there is uncertainty associated with the appropriateness of both the toxic elements selected and the numerical values specified in the proposed standards, which were drawn mainly from existing national water quality standards for surface water and public drinking water supplies.

In summary, although a few sites appear to have some existing ground water contamination, probably due to dewatering of process liquids from the tailings, we believe there is a low probability of additional contamination at most of the sites. The remedial program should provide for adequate hydrological and geochemical surveys of each site as a basis for determining whether specific water protection or cleanup measures should be applied. Whether or not it is feasible or practical to restore an aquifer and to what degree will depend on site-specific factors, including the aquifer's hydrogeologic setting, the cost, the present and future value of the aquifer as a water resource, the availability of alternative supplies, and the degree to which human exposure is likely to occur.

We do not believe that the existing evidence indicates that ground water contamination from inactive mill tailings is or will be a matter of regulatory concern. We have decided, therefore, not to establish general substantive standards on this subject. Should evidence be found that shows that this judgment is in error, we will consider the need for further rulemaking procedures.

A possible alternative to the above course of action is for us to establish a general regulatory mechanism for others to use in deciding, on a site-specific basis, whether a ground water problem exists and, if so, what remedial action is appropriate. Such a nonsubstantive, or procedural, mechanism would resemble that established by our regulations implementing the Solid Waste Disposal Act, as amended (47 FR 32274, July 26, 1982). In this connection, the Uranium Mill Tailings Radiation Control Act reflects the desire of Congress (in Section 206) that EPA's standards be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act. It also requires NRC to concur in DOE's remedial actions at each site (in Section 108) and to issue licenses for these sites (in Section 104) that may encompass any ". . . monitoring, maintenance, or emergency measures necessary to protect public health and safety." These functions are consistent with those embodied in EPA's above-referenced regulations. We have decided not to adopt this alternative, because we believe that the devising of any necessary such mechanisms for application under this Act can more appropriately be left to the NRC and DOE.

If any existing contamination or potential for future ground water contamination is present we have provided, therefore, in the implementation section of these standards, that judgments on the possible need for monitoring or remedial actions should be guided by relevant considerations described in EPA's hazardous waste management system, and by relevant State and Federal Water Quality Criteria for existing and anticipated uses of the aquifer. Decisions to undertake remediation should consider the costs and benefits of possible remedial and control measures, including the extent and usefulness of the aquifer. We have also concluded that the same approach is appropriate to surface water, which should be adequately protected in any case by any control measures meeting the standards for longevity and radon emission.

C. The Standards for Cleanup of Tailings

1. Radium-226 in Soil. Comments about the cleanup standard for radium-226 in soil dealt primarily with the proposed numerical value of the standard and perceived difficulty of measurement to show conformance. Many comments expressed the view that there was no justification for a standard as low as 5 pCi/g and that a higher value would be most cost-effective. Recommended values ranged from 10–30 pCi/g.

The purpose of this standard is to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure of people using contaminated land. We estimate that each increase of 0.01 WL inside a house increases the risk of lung cancer to each of its inhabitants by something like one-half to one in a hundred, for an assumed lifetime of residency. The infiltration of radon in soil gas directly into a house is by far the largest contributor to indoor radon, and we estimate that soil extensively contaminated at a level of 5 pCi/g radium can readily lead to indoor levels of radon decay products of 0.02 WL. Because the risks from soils contaminated with radium-226 are potentially so great, the proposed standard was set at a level as close to background as we believed reasonable, taking into consideration the difficulties in measuring this level and distinguishing it from natural backgound.

We have examined the costs and benefits of alternative standards ranging from 5 to 30 pCi/g. These are described in detail in the FEIS. Total cleanup costs are less than 10% to 20% of the total costs of disposal of tailings piles for all the alternatives considered. Costs for cleanup of windblown tailings from land surfaces are sensitive to the standard, because the area to be cleaned up varies approximately inversely with the limit selected. Costs for removal of buried tailings are not sensitive to the standard, since the amount to be removed varies only slightly with the limit selected. That is, we concluded most buried tailings would be removed under any of the alternatives considered. We also considered the difficulty of measuring various thicknesses of surface contamination, and in identifying and measuring contamination due to buried tailings. Detection of buried tailings could be difficult. However, buried tailings, as opposed to surface contaimination (usually windblown and diluted with soil), can be effectively located using a higher detection limit than the proposed standard of 5 pCi/g. Based on these analyses, we have modified the standard for surface contamination of soil (5 pCi/g) from an average over the top 5 cm of soil to an average over the top 15 cm of soil; and revised the standard for subsurface contamination from 5 pCi/g to 15 pCi/g (still averaged over any 15 cm layer of soil). We believe these standards will result in essentially the same degree of cleanup, and will be simpler to implement.

For tailings transported by man to off-site properties, the hazard varies with the amount of tailings involved and their location. The proposed standard did not provide for exemption of locations posing a low hazard. The final standard requires cleanup of contamination only when the amount and location of tailings poses a clear present or future hazard, and provides criteria to assist this determination. We estimate that perhaps more than half of the identified locations of such contamination do not present a hazard sufficient to warrant cleanup, at an estimated saving of 24 million dollars.

Some comments expressed the view that measuring radium-226 and distinguishing residual radioactive materials from natural background at the levels proposed would be difficult and costly, and that many samples would have to be collected and analyzed to show compliance with the standards. The changes we have made make determination of compliance with the standard easier and less costly. In addition, we have provided guidance in this Notice and the FEIS on implementation of the standards, to clarify our intent that unnecessarily stringent (and costly) verification that the standards have been achieved should be avoided.

2. Radon Decay Products in Buildings. Some comments expressed the view that the proposed indoor radon decay product standard of 0.015 WL would be difficult and costly to implement, because it is within the upper range of levels that commonly occur in houses due to natural causes. For example, it might be necessary to distinguish whether the standard is exceeded because of the presence of tailings or because of anomalies in the natural background. This could result in costly and unnecessary remedial actions, or in the frequent use of an exceptions procedure. These comments recommended that we raise this standard to a more cost-effective value that can be more easily distinguished from naturally-occurring levels.

We have considered these arguments and re-examined the costs and benefits of alternative standards. We used the data from the Grand Junction, Colorado, remedial program for contaminated buildings to assist this evaluation. Reduction of radon decay products in existing buildings is probably the most cost-effective of all types of remedial actions for tailings, because the high risk associated with indoor radon decay products. Based on these evaluations, the standard has been revised upward only slightly so as to facilitate implementation and to more closely conform to other related standards. Under the final standard the objective of remedial actions is to achieve an indoor radon decay product concentration of 0.02 WL. For circumstances where remedial action has been performed and it would be unreasonably difficult and costly to reduce the level below 0.03 WL, the remedial action may be terminated at this level without a specific finding of the need for an exception. However, we have also sought to avoid excessive costs by encouraging the use of active measures (such as heat exchangers, air cleaners, and sealants) to meet the objective of 0.02 WL when further removal of tailings to achieve levels below 0.03 WL is impractical. We believe the final standard deals adequately with complications introduced by the presence of any high concentration of naturally-occurring radionuclides, and avoids unnecessary and costly remedial actions that produce only marginal improvements.

D. Reducing Regulatory Burdens. Some commenters suggested that the proposed standards should be flexible to take account of unusual circumstances, site-specific factors, and any complications due to high natural background levels. These commenters recommended that this be accomplished by raising the numerical limits, establishing different standards for unusual circumstances, or by expressing the standards as a range of values.

We agree that it is appropriate and desirable to take into account, as far as practical, different circumstances. In addition, we believe that regulations should be easy to carry out and not contain unnecessary procedural requirements. We have encouraged the implementing agencies to do this in our "Guidance for Implementation" as described below. We have also changed the procedures for situations in which it would be unreasonable to satisfy the standards from an "exceptions" process to one in which the implementing agencies apply "Supplemental Standards." This is also described below. Finally, the numerical limits of some of the standards have been raised; this will assure that they are more readily distinguishable from background levels.

IV. Implementation.

The Act requires the Secretary of Energy to select and perform the remedial actions needed to implement these standards, with the full participation of any State that shares the cost, with the concurrence of the Nuclear Regulatory Commission, and in consultation, when appropriate, with affected Indian tribes and the Secretary of the Interior.

The cost of remedial action will be borne by the Federal Government and the States as prescribed by the Act. Control and stabilization remedial activities are large scale undertakings for which there is relatively little experience. Although preliminary engineering assessments have been performed, specific engineering requirements and costs to meet the standards at each site have yet to be determined. We believe control and stabilization costs (including DOE overhead) averaging about 10–12 million (1981) dollars per tailings pile are most likely. For some sites, this cost may be partly offset by recovered land values or through provisions of the Act for recovery of uranium or other minerals through reprocessing the tailings prior to performing remedial actions.

A. Guidance for Implementation

Conditions at the inactive processing sites vary greatly, and engineering experience with some of the required remedial actions is limited. It is our objective that implementation of these standards be consistent with the assumptions we have made in deriving them. We are therefore providing "Guidance for Implementation" to avoid needless expense which may result from uncertainty or confusion as to what level of protection the standards are intended to achieve.

The standard for control and stabilization of tailings piles is primarily intended as a design standard. Implementation will require a judgment that the method chosen provides a reasonable expectation that the provisions of the standard will be met, to the extent reasonably achievable, for up to 1000 years, and, in any case, for at least 200 years. This judgment will necessarily be based on site-specific analyses of the properties of the sites, candidate control systems, and the potential effects of natural processes over time, and, therefore, the measures required to satisfy the standard will vary from site to site. We expect that computational models, theories, and expert judgment will be the major tools in deciding that a proposed control system will adequately satisfy the standard. Post-remediation monitoring will not be required to show compliance, but may serve a useful role in determining whether the anticipated performance of the control system is achieved.

The purpose of our cleanup standards is to provide the maximum reasonable protection of public health and the environment. Costs incurred by remedial actions should be directed toward this purpose. We intend the standards to be implemented using search and verification procedures whose cost and technical requirements are reasonable. For example, since we intend the cleanup standards for buildings to protect people, measurements in such locations as small crawl spaces and furnace rooms may often be inappropriate. Remedial action decisions should be based on radiation levels in the parts of buildings where people spend substantial amounts of time. The standards for cleanup of land are designed to limit the exposure of people to gamma radiation, and to limit the level of radon decay products in buildings that might later be built on the land. In most circumstances, no significant harm would be caused by not cleaning up small areas of land contaminated by tailings. Similarly, it would be unreasonable to require expensive detailed proof that all the tailings below the surface of open lands had been removed. Procedures that provide a reasonable assurance of compliance with the standards will be adequate. Where measurements are necessary to determine compliance with the cleanup standards, they should be performed within the accuracy of presently available field and laboratory measurement capabilities and in conjunction with reasonable survey and sampling procedures designed to minimize the cost of verification. We are confident that DOE and NRC, in consultation with EPA and the States, will adopt implementation procedures consistent with our intent in establishing these standards.

B. Supplemental Standards

The varied conditions at the designated sites and limited experience with remedial actions make it appropriate that EPA allow adjustment of the standards where circumstances require. We believe that, in most cases, our final standards are adequately protective and can be implemented at reasonable cost. However, the standards could be too strict in some applications. We anticipate that such circumstances might occur. We originally proposed to deal with this through an "exceptions" procedure which would relax standards when certain criteria were satisfied. We agree with the comments, however, that the proposed procedure was unnecessarily burdensome to apply.

In the final regulations we have eliminated this procedure and replaced it with a simplified procedure for applying "supplemental standards." This is a more effective means of accomplishing our original purpose. An additional significant change in the proposed criteria for exceptions is the addition of criterion 192.21(c), which relaxes the requirement for cleanup of land at off-site locations when residual radioactive materials are not clearly hazardous and cleanup costs are unreasonably high. This category of contamination was not adequately addressed in the proposals.

Regulatory Impact Analysis

Under Executive Order 12291, EPA must judge whether a regulation is "Major" and therefore subject to the requirement of a Regulatory Impact Analysis. That order requires such an analysis if the regulations would result in (1) an annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers, individual industries, Federal, State, or local government agencies or geographic regions; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

This regulation is not Major, because we expect the costs of the remedial action program in any calendar year to be less than $100 million; States bear only 10% of these costs and there are no anticipated major effects on costs or prices for others; and we anticipate no significant adverse effects on domestic or foreign competition, employment, investment, productivity, or innovation. The costs of these standards are discussed in the FEIS.

This regulation was submitted to the Office of Management and Budget for review as required by Executive Order 12291.

This regulation will not have a significant effect on a substantial number of small entities, as specified under Section 605 of the Regulatory Flexibility Act, because there are no small entities subject to this regulation.

Dated: December 15, 1982.

Anne M. Gorsuch,
Administrator.

List of Subjects in 40 CFR Part 192

Environmental protection; Radiation protection; Uranium.

In 40 CFR Chapter I, Part 192 is revised to read as follows:

PART 192—HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

Sec.
192.00 Applicability.
192.01 Definitions.
192.02 Standards.

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

192.10 Applicability.
192.11 Definitions.
192.12 Standards.

Subpart C—Implementation

192.20 Guidance for implementation.
192.21 Criteria for applying supplemental standards.
192.22 Supplemental standards.
192.23 Effective date.

Authority: Section 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604.

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.00 Applicability

This subpart applies to the control of residual radioactive material at designated processing or depository sites under Section 108 of the Uranium Mill Tailings Radiation Control Act of 1978 (henceforth designated "the Act"), and to restoration of such sites following any use of subsurface minerals under Section 104(h) of the Act.

§ 192.01 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title I of the Act.

(b) *Remedial* action means any action performed under Section 108 of the Act.

(c) *Control* means any remedial action intended to stabilize, inhibit future misuse of, or reduce emissions or effluents from residual radioactive materials.

(d) *Disposal site* means the region within the smallest perimeter of residual radioactive material (excluding cover materials) following completion of control activities.

(e) *Depository site* means a disposal site (other than a processing site) selected under Section 104(b) or 105(b) of the Act.

(f) *Curie* (Ci) means the amount of radioactive material that produces 37 billion nuclear transformation per second. One picocurie (pCi) = 10^{-12}Ci.

§ 192.02 Standards

Control shall be designed[4] to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average [5] release rate of 20 picocuries per square meter per second, *or*

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.10 Applicability

This subpart applies to land and buildings that are part of any processing site designated by the Secretary of Energy under Section 102 of the Act. Section 101 of the Act, states, in part, that "processing site" means—

(a) Any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless—

(1) Such site was owned or controlled as of Janurary 1, 1978, or is thereafter owned or controlled, by any Federal agency, or

(2) A license (issued by the (Nuclear Regulatory) Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under Section 274 of such Act) for the production at site of any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date; and

(b) Any other real property or improvement thereon which—

(1) Is in the vicinity of such site, and

(2) Is determined by the Secretary, in consultation with the Commission, to be contaminated with residual radioactive materials derived from such site.

§ 192.11 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as defined in Title I of the Act or in Subpart A.

(b) "Land" means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building.

(c) "Working Level" (WL) means any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

(d) "Soil" means all unconsolidated materials normally found on or near the surface of the earth including, but not limited to, silts, clays, sands, gravel, and small rocks.

§ 192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site:*

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building—

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or

[4] Because the standard applies to design, monitoring after disposal is not required to demonstrate compliance.

[5] This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere.

equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

Subpart C—Implementation

§ 192.20 Guidance for implementation

Section 108 of the Act requires the Secretary of Energy to select and perform remedial actions with the concurrence of the Nuclear Regulatory Commission and the full participation of any State that pays part of the cost, and in consultation, as appropriate, with affected Indian Tribes and the Secretary of the Interior. These parties, in their respective roles under Section 108, are referred to hereafter as "the implementing agencies." The implementing agencies shall establish methods and procedures to provide "reasonable assurance" that the provisions of Subparts A and B are satisfied. This should be done as appropriate through use of analytic models and site-specific analyses, in the case of Subpart A, and for Subpart B through measurements performed within the accuracy of currently available types of field and laboratory instruments in conjunction with reasonable survey and sampling procedures. These methods and procedures may be varied to suit conditions at specific sites. In particular:

(a)(1) The purpose of Subpart A is to provide for long-term stabilization and isolation in order to inhibit misuse and spreading of residual radioactive materials, control releases of radon to air, and protect water. Subpart A may be implemented through analysis of the physical properties of the site and the control system and projection of the effects of natural processes over time. Events and processes that could significantly affect the average radon release rate from the entire disposal site should be considered. Phenomena that are localized or temporary, such as local cracking or burrowing of rodents, need to be taken into account only if their cumulative effect would be significant in determining compliance with the standard. Computational models, theories, and prevalent expert judgment may be used to decide that a control system design will satisfy the standard. The numerical range provided in the standard for the longevity of the effectiveness of the control of residual radioactive materials allows for consideration of the various factors affecting the longevity of control and stabilization methods and their costs. These factors have different levels of predictability and may vary for the different sites.

(2) Protection of water should be considered in the analysis for reasonable assurance of compliance with the provisions of § 192.02. Protection of water should be considered on a case-specific basis, drawing on hydrological and geochemical surveys and all other relevant data. The hydrologic and geologic assessment to be conducted at each site should include a monitoring program sufficient to establish background ground water quality through one or more upgradient wells, and identify the presence and movement of plumes associated with the tailings piles.

(3) If contaminants have been released from a tailings pile, an assessment of the location of the contaminants and the rate and direction of movement of contaminated ground water, as well as its relative contamination, should be made. In addition, the assessment should identify the attenuative capacity of the unsaturated and saturated zone to determine the extent of plume movement. Judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization. The decision on whether to institute remedial action, what specific action to take, and to what levels an aquifer should be protected or restored should be made on a case-by-case basis taking into account such factors as technical feasibility of improving the aquifer in its hydrogeologic setting, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water resource, the availability of alternative water supplies, and the degree to which human exposure is likely to occur.

(b)(1) Compliance with Subpart B, to the extent practical, should be demonstrated through radiation surveys. Such surveys may, if appropriate, be restricted to locations likely to contain residual radioactive materials. These surveys should be designed to provide for compliance averaged over limited areas rather than point-by-point compliance with the standards. In most cases, measurement of gamma radiation exposure rates above and below the land surface can be used to show compliance with § 192.12(a). Protocols for making such measurements should be based on realistic radium distributions near the surface rather than extremes rarely encountered.

(2) In § 192.12(a), "background level" refers to the native radium concentration in soil. Since this may not be determinable in the presence of contamination by residual radioactive materials, a surrogate "background level" may be established by simple direct or indirect (e.g., gamma radiation) measurements performed nearby but outside of the contaminated location.

(3) Compliance with § 192.12(b) may be demonstrated by methods that the Department of Energy has approved for use under Pub. L. 92–314 (10 CFR 712), or by other methods that the implementing agencies determine are adequate. Residual radioactive materials should be removed from buildings exceeding 0.03 WL so that future replacement buildings will not pose a hazard [unless removal is not practical—see § 192.21(c)]. However, sealants, filtration, and ventilation devices may provide reasonable assurance of reductions from 0.03 WL to below 0.02 WL. In unusual cases, indoor radiation may exceed the levels specified in § 192.12(b) due to sources other than residual radioactive materials. Remedial actions are not required in order to comply with the standard when there is reasonable assurance that residual radioactive materials are not the cause of such an excess.

§ 192.21 Criteria for applying supplemental standards

The implementing agencies may (and in the case of Subsection (f) shall) apply standards under § 192.22 in lieu of the standards of Subparts A or B if they determine that any of the following circumstances exists:

(a) Remedial actions required to satisfy Subparts A or B would pose a clear and present risk of injury to workers or to members of the public, notwithstanding reasonable measures to avoid or reduce risk.

(b) Remedial actions to satisfy the cleanup standards for land, § 192.12(a), or the acquisition of minimum materials required for control to satisfy § 192.02(b), would, notwithstanding reasonable measures to limit damage, directly produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near the site, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

(c) The estimated cost of remedial action to satisfy § 192.12(a) at a "vicinity" site (described under Sec. 101(6)(B) of the Act) is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations. Supplemental standards should not be applied at such sites, however, if individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail under § 192.12(a).

(d) The cost of a remedial action for cleanup of a building under § 192.12(b) is clearly unreasonably high relative to the benefits. Factors that should be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be affected by the remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

(e) There is no known remedial action.

(f) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials.

§ 192.22 Supplemental standards

Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of § 192.21.

(a) When one or more of the criteria of § 192.21(a) through (e) applies, the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standard as is reasonable under the circumstances.

(b) When § 192.21(f) applies, remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable.

(c) The implementing agencies may make general determinations concerning remedial actions under this Section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this Section for a specfic location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies. The Department of Energy shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section.

§ 192.23 Effective date.

Subparts A, B, and C shall be effective March 7, 1983.

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