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Office of
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Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites (40 CFR 192)

Volume I

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cleanup costs, and health benefits. For B3 and B4, which include a range over which remedial action is optional, the cost estimates were derived by assuming a value within the range which would typically be achieved and costing controls to reach this level. For B3, we assumed that at least 0.015 WL (including background) would be achieved. For B4, we assumed that at least 0.03 WL would be achieved.

The extent of contamination of buildings as well as the cleanup costs will not be known in detail until the cleanup program is well underway. Therefore, we used the Grand Junction remedial action program as the basis for our estimates. Appendix B contains a summary of the Grand Junction experience and the cost calculations which support the estimates in Table 7-1.

The cost estimates for each alternative standard are determined by the number of buildings requiring remedial work and the cost per building. As the remedial action criterion is lowered, more buildings will need to be cleaned up, increasing costs. A lower criterion also increases the cleanup costs per building since this requires more complete tailings removal. In many cases, successive actions are needed when the first remedial action does not meet the cleanup criterion. Using active measures to meet a cleanup criterion when the level is only slightly exceeded is much cheaper than tailings removal, roughly one-tenth as costly.

The benefit of cleaning up contaminated buildings is expresed by the number of lung cancer deaths avoided. This is estimated by assuming the risk factors discussed in Chapter 4 are appropriate, an initial distribution of decay product levels in contaminated buildings identical to that for the buildings monitored in Grand Junction, a 50-year average useful life remaining for the stock of contaminated buildings, and a 3-person household size. Also, benefits of cleanup are expressed by the maximum residual risks to people living in the buildings. This risk to an individual is calculated assuming lifetime exposure to radon decay products at the highest level each alternative standard allows.

7.2 Alternative Cleanup Standards for Near-site Contaminated Land

We have analyzed four alternative cleanup standards for near-site (on the site or adjacent to the site) contaminated lands. All have requirements that limit the amount of radium contamination because the presence of radium is a reasonable index of the health hazard, including that due to toxic chemicals as well as other radionuclides.

Alternative L1 approaches a high-cost nondegradation alternative; below this proposed radium limit it is usually not possible, using conventional survey equipment, to accurately distinguish between contaminated land and land with high naturally-occuring levels of radium. Alternatives L2 and L3 approximate optimized cost-benefit standards, but L2 demands a more rigorous cleanup of the soil

TABLE 7-1. COSTS AND BENEFITS OF ALTERNATIVE CLEANUP STANDARDS FOR BUILDINGS
(in 1981 dollars)

Alternative Standards	Radon Decay Product Limit (WL)[a]	Number of Buildings Requiring Cleanup[b]	Total Cost (millions of) dollars)	Deaths Avoided (in first 50y)[c]	Estimated Residual Risk of Lung Cancer[d]
B1	0.015	370	11.5	65	0.8 in 100
B2	0.02	330	8.5	60	1.3 in 100
B3	0.005 (above background) to 0.02	420	9.0	65	1.3 in 100
B4	0.01 (above background) to 0.05 (above background)	350	9.5	55	5 in 100

[a]The specified value includes background unless otherwise noted. Background in Grand Junction is approximately 0.007 WL.

[b]See Section 3.4. For Alternative B4, which is identical to the Grand Junction criteria for action, we assumed the geometric mean of our two extreme estimates for the number of buildings requiring remedial action. Assuming the distribution of radon decay product levels will be the same as in Grand Junction, the number of buildings in the United States requiring action was adjusted for the other options.

[c]Based upon the relative risk model. Estimates based upon the absolute risk model are a factor of two lower. Health benefits attributable to reductions in gamma radiation levels are much smaller and have not been quantified.

[d]Lifetime risk to the individual living in a house at the radon decay product concentration limit. This risk is calculated after subtracting background from the level permitted by the standard.

surface. Standard L4 is a least-cost alternative that allows high radiation levels that are close to Federal Guidance recommendations for exposure of individuals to all sources of radiation excepting natural background and medical uses.

The four alternative standards are:

Standard L1. (The standard proposed in April 1980). Land should be cleaned up to levels not exceeding an average 5 pCi/g of radium-226 in any 5-cm layer within 1 foot of the surface and in any 15-cm layer below 1 foot of the surface.

Standard L2. Land should be cleaned up to levels not exceeding an average of 5 pCi/g in the 15-cm surface layer of soil, and an average of 15 pCi/g over any 15-cm depth for buried contaminated materials.

Standard L3. Land should be cleaned up to levels not exceeding an average of 15 pCi/g in any 15-cm depth of soil.

Standard L4. Land should be cleaned up to levels not exceeding an average of 30 pCi/g in any 15-cm depth of soil.

In Table 7-2 we list the estimates of the costs and benefits of each alternative standard for near-site contamination around inactive tailing piles. In each standard, the only remedial method for which we estimated cost was the removal and disposal of contaminated soil, since this is generally less costly than placing earth cover and vegetation over contaminated areas and excluding access by fencing. The benefits are expressed by (1) the number of acres of land that are cleaned up and returned to productive use, and (2) the typical maximum residual risk to individuals living in houses that might then be built on this land.

The number of acres requiring cleanup under each option was based upon the results of the EPA gamma radiation survey of twenty inactive mill sites (Table 3-4). By assuming a typical depth profile of the radium contamination, it is possible to relate the gamma radiation levels measured by the survey to the areas of land contaminated above a specific concentration level of radium. If the top 15-cm layer of earth is uniformly contaminated with 30 pCi/g of radium, the gamma field at the surface would be 63 percent of the gamma flux from an infinitely thick layer, or 34 microroentgens/hr (He78). However, if the 30-pCi/g average in the top 15 cm of earth is due to a thin surface layer of nearly pure tailings of a few hundred pCi/g, the resulting gamma radiation at the surface would be about 54 microroentgens/hr. Since we expect windblown contamination profiles to be somewhere in between these extremes, we estimate that, on the average, 44 microroentgens/hr above background (385 mrem/y) implies 30 pCi/g radium contamination in the top 15 cm of soil (Standard L4). Similar analyses for Alternative Standards L1, L2, and L3 result in 3. 7 and

TABLE 7-2. COSTS AND BENEFITS OF ALTERNATIVE CLEANUP STANDARDS FOR LAND
(in 1981 dollars)

Alternative	Radium-226 Soil Concentration Limit (pCi/g)	Number of Acres Requiring Cleanup[a]	Total Cost (millions of dollars)	Estimated Residual risk of Lung Cancer[b]
L1	5	2700	21	2 in 100
L2	5 to 15	1900	14	2 in 100
L3	15	900	7	6 in 100
L4	30	250	2	10 in 100

[a] Areas of land near inactive tailings piles that have radium contamination in excess of the soil concentration limit.

[b] The lifetime risk of lung cancer to the individual living in a house built on land contaminated to the limits allowed by the alternative standards. This is based on the relative-risk model; use of the absolute-risk model gives risks which are about a factor of two lower.

22 microroentgens/hr, respectively (or 26, 61, and 193 mrem/y, respectively). Additional deeper contamination would yield only slightly higher gamma values because of shielding by the surface layer.

Using these correlations between radium contamination levels and gamma radiation levels, the areas requiring cleanup under each standard were estimated based on the EPA survey data. The total costs of cleanup were then calculated assuming a cleanup cost of $7650 (1981 dollars) per acre. This cost was estimated from EPA field experience (a cleanup program at the Shiprock mill site) and is in agreement with cost estimates of DOE contractors. Areas of heaviest contamination, such as the ore storage area and mill buildings, are excluded from this analysis since we have included them in the analysis of disposal costs for the piles.

The highest risk to people living in houses built upon contaminated land is due to the inhalation of radon decay products from radon that seeps into the house. In the worst case, Standards L1 and L2 would allow thick-surface earth layers with 5 pCi/g contamination, while Standards L3 and L4 would allow thick layers of contaminated soil at 15 pCi/g and 30 pCi/g, respectively. On the average, houses built on such 5 pCi/g earth would be expected to have indoor radon decay product levels of about 0.02 WL. Houses with poorer-than-average ventilation would have higher levels, while well-ventilated houses would have lower levels. Houses built on land more heavily contaminated than 5 pCi/g would have higher average indoor decay product levels in proportion to the contamination. The estimated risks due to lifetime exposure from these levels are listed in Table 7-2. These are maximum estimates since most contaminated land away from the immediate mill sites (where houses might be built) has only thin layers (a few tens of centimeters) of contaminated material.

The gamma radiation levels to individuals permitted under the four alternative standards are 80 mrem/yr for L1 and L2, 240 mrem/yr for L3, and 470 mrem/yr for L4. This assumes a thick layer of contaminated material over a large area at the maximum permitted levels of radium concentrations. These doses would lead to increased risk of many kinds of cancer, but this increase would be small compared to the lung cancer risks due to radon decay products.

7.3 Alternative Cleanup Standards for Offsite Properties

Tailings on offsite properties which are not associated with building construction are usually there because someone transported them from a tailings pile. Examples of this kind of misuse are tailings used as fill around fence posts and sewer lines, as the basis for sidewalks and driveways, and as conditioners for soil in gardens. Most tailings misused in this way are still concentrated; they are not diluted by large quantities of earth or spread thinly over large areas.

The major hazard stems from the chance that indoor radon levels will be high in new buildings constructed on contaminated offsite properties. There could also be a significant gamma radiation hazard if people spend a lot of time close to the tailings.

We expect that offsite properties where tailings were misused will typically exceed all the radium concentration limits specified for land contamination in Alternative Standards L1 through L4. Therefore, virtually all of the 6500 contaminated sites identified in Chapter 3 would require cleanup under any standard. Based on engineering assessments and similar cleanup work near a mill site in Edgemont, South Dakota, we estimate it would cost $6,000 to clean up each of these properties. This implies a total cleanup cost of $39 million. However, many of these sites are unlikely to cause a significant present or future hazard, either because of their location or because the quantity of tailings involved is so small. Cleaning up such sites implies high cost without significant benefits.

It is consistent and simple to use the same numerical cleanup criteria for offsite contamination of properties as for near-site land contamination. Since some offsite contaminated properties present a minimal hazard and would cost a great deal to clean up to any reasonable radium concentration criterion, additional criteria are considered in one of the following alternative standards for contaminated offsite properties:

Standard P1: Offsite properties should be cleaned up to the same levels as near-site land,(1) with no exceptions.

Standard P2: Offsite properties should be cleaned up to the same levels as near-site land, with the following exceptions:

a. When contamination levels averaged over 100 m^2 are less than the action levels required for near-site lands.
b. When the hazard from the tailings is judged to be insignificant because of location.

Small amounts of tailings will be eliminated from consideration if levels are averaged over an appropriate area. For Standard P2 we have selected 100 m^2 as a reasonable area for this purpose since this is the typical area of the foundation of a house. Thus, risk levels allowed under Standard P2 should be no higher than the risks allowed under the corresponding near-site land cleanup standard. Additional sites will be eliminated under Standard P2 because of their location.

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(1) Alternative Standards L1, L2, L3, or L4; whichever is selected as a land cleanup standard.

Based on an analysis of misused tailings that are not associated with buildings (Section 3.4), we estimate that, because of location or small quantity, Standard P2 would not require the cleanup of minor locations such as under sidewalks or around fence posts. Also, we estimate that half of the garden beds, yards, and detached buildings in which tailings were used and one-fourth of all driveways with tailings under them would not require cleanup. This would eliminate approximately 4,000 sites and save about $24 million, for a total cost of about $15 million.

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 January 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 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."

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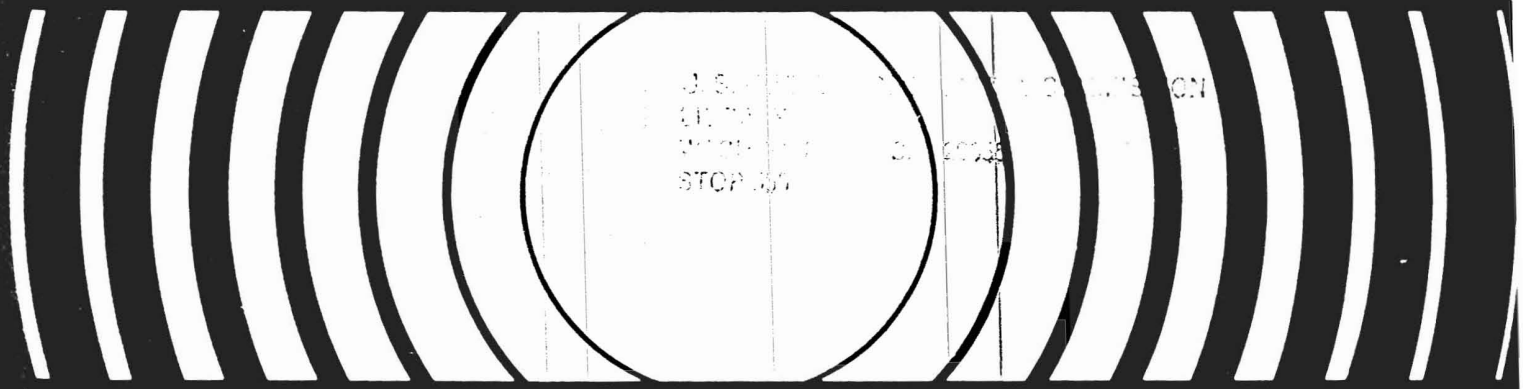

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reported to be between 9 and 25 centimeters per 1,000 years based on measurements of the amount of material carried by the river (Fo71, Haa75, Yo75). These erosion rates would not impair the effectiveness of a 3-meter earthen cover in a 1,000-year period. However, in 10,000 years, 2.5 meters of the cover would be eroded away if the high end of the range is attained. In contrast, if only the low end of the range is reached, 0.9 meters in 10,000 years, such a cover could remain reasonably effective. While these values lack refinement and do not reflect the particular site characteristics of any given tailings pile, they do serve to illustrate the range of uncertainties inherent in such long periods. Several similar considerations are discussed in Section 5.2 of the FEIS.

We believe that a 10,000 year standard for general application at all inactive sites would be too stringent for reasonable implementation. In view of the generally large uncertainties, remedial actions for many sites would be extreme, requiring relocation of many piles, very thick covers heavily reinforced with rock, and/or burial of tailings below grade in specially-dug pits. As shown in Chapter 6 and Appendix B of the FEIS, disposal by these methods is very costly, and also tends to be socially and environmentally disruptive. Moreover, we believe that a 10,000 year standard would present greater technical challenges and higher risks of substantial unplanned costs than is wise in a program to provide remedies for an undesirable existing situation.

D.5 Cleanup Standards

D.5.1 Radium-226 in Soil Standard

Comment 1: EPA should raise the proposed open lands cleanup standard for radium-226 to 10-15 pCi/g or increase the surface soil thickness specification to the top 15 cm of soil. This change will substantially reduce the amount of land that will need to be cleaned up without any significant loss of public health protection. (F-11, F-14, H-1, H-2)

Response: We have examined the costs and benefits of alternative standards ranging from 5 to 30 pCi/g and for different surface thicknesses. Costs for cleanup of land surfaces are sensitive to the selected limit; costs for removal of most buried tailings are not. In addition, we considered the difficulty of measuring various levels of surface contamination, and of identifying and measuring buried tailings. Detecting low concentrations of buried tailings could be difficult and nonproductive. As opposed to surface contamination, which is often windblown and mixed with surface soil, buried tailings are not expected to occur often in low concentrations, and are less hazardous when they do. Based on this analysis, we have revised the standard for surface contamination of soil from 5 pCi/g in the top 5 cm of soil to 5 pCi/g averaged over the top 15 cm of soil; and the

standard for subsurface contamination from 5 pCi/g to 15 pCi/g averaged over 15 cm layers of soil. We believe these standards will result in essentially the same health protection, but will be much simpler to implement.

Comment 2: EPA should raise the proposed open lands cleanup standard of 5 pCi/gm of radium-226 in any 5 cm thickness of soil within a foot of the surface or in any 15 cm thickness below 1 foot to a more readily detectable level, or reconsider the practicability of adopting a radium in soil standard. Measuring radium-226 at the levels (and in the layer specifications) of the proposed standard and distinguishing residual radioactive material at these levels from natural background will be difficult and costly. Many samples will have to be collected and analyzed to show compliance with the standards. (S-1, S-5, S-15, I-4, I-10, F-1, F-14, H-13, H-18)

Response: The standard for cleanup of land has been changed in a number of ways that will simplify determination of compliance (see the response to Comment 1, above). We were aware that detecting radium-226 in soil at the proposed level might present some measurement difficulties. However, we believed that the standard could be implemented reasonably by requiring only "reasonable assurance" that the numerical limit has been met within the accuracy of available field and laboratory instruments, when used with reasonable survey and sampling procedures. We have reevaluated this problem and conclude that the standard can be further relaxed to simplify the measurement problems without any sacrifice of health protection. The Final Standard also makes clearer our intent to avoid unnecessarily stringent verification of conformance to the standards (Subpart C, Section 192.20).

Comment 3: EPA should clarify the meaning of "any 5 or 15 cm" thickness of soil as used in the proposed open land cleanup standard. Interpreting the term "any" literally would lead to the conclusion that an infinite number of samples would need to be analyzed to demonstrate compliance with the standard. (P-3, F-10, F-14, H-1)

Response: The Proposed Standard would require only "reasonable assurance" that its numerical limits were satisfied. Such a literal interpretation of "any" would be unwarranted, because it would lead to impractical and, therefore, unreasonable implementation. The word "any" no longer appears in the standard, however, and we have provided additional implementation guidance. Nevertheless, the implementing agencies will still need to develop and apply detailed procedures that provide "reasonable assurance" that the numerical standards are satisfied.

Comment 4: EPA should clarify the fact that the proposed open lands cleanup standard of 5 pCi/g of radium-226 is a concentration above background. (F-10, H-1)

Response: The standard for cleanup of land applies to residual radioactive material from a uranium processing site. The Final Standard makes clear that its numerical requirements refer to an excess above the background level.

Comment 5: EPA should define the term "average" as used in the proposed open land cleanup standard of 5 pCi/g of radium-226 and also define the area over which the average applies. (P-4, P-5)

Response: The Final Standard for land cleanup (40 CFR 192.12(a)) is clear in applying to averages over specified thicknesses of soil. However, 40 CFR 192.20(b) (Guidance for Implementation) says, in effect, that compliance with the standard should be demonstrated by radiation surveys involving additional averaging over limited areas. Therefore, area averages may be taken in providing reasonable assurance that the standard for the average radium-226 concentration in specified thicknesses is satisfied. However, we believe the implementing agencies should determine the detailed procedures that provide reasonable assurance for the diverse conditions that occur in this remedial action program.

Comment 6: EPA should define how deep below the surface the open land cleanup standard of 5 pCi/gm of radium-226 applies (i.e., 5, 20, 100 ft.). (P-19)

Response: We do not believe it is necessary or wise to define the depth below the surface to which the land cleanup standard applies. The standard permits the implementing agencies to make decisions on a site-by-site basis. Most subsurface residual radioactive materials will usually be in the top few feet of soil. For exceptional cases where residual radioactive materials are present at greater depths, the need for removal of these materials can be determined on a case by case basis using the criteria for applying supplemental standards.

Comment 7: EPA should make the open land cleanup standard more flexible to allow for decisions based on site-specific considerations, including options for land reclamation rather than soil removal. (P-9, S-5, H-9, H-15, H-18)

Response: The standard for cleanup of land has been revised in a number of ways that provide additional flexibility in implementation. In particular, the land cleanup standard (40 CFR 192.12(a)) need not be applied when its application 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" (40 CFR 192.21(b), or when "the estimated cost (would be) unreasonably high relative to the long-term benefits, and the (tailings) do not pose a clear present or future hazard" (40 CFR 192.21(c)). Where either of these criteria is

satisfied, remedial actions need only come as close to meeting the standard for land cleanup as is reasonable under the specific circumstances (40 CFR 192.22). Reclamation may sometimes be justifiable under these criteria as an alternative to fully satisfying the land cleanup standards.

Comment 8: EPA should establish less stringent standards for cleanup of open lands for difficult-to-clean areas, such as steep hills, river banks, bluffs, etc. The proposed standards are not cost effective when the risk to workers attempting to cleanup these difficult areas are considered in relation to the reduction in future potential risks to the public. (F-10)

Response: See response to Comment 7, above. In addition, according to 40 CFR 192.21(a), supplemental standards (40 CFR 192.22) may be applied whenever public health or safety would be unavoidably endangered by attempting to satisfy any of the provisions of Subparts A and B of 40 CFR 192.

Comment 9: EPA should consider a gamma dose-rate standard as an alternative to the proposed open land cleanup standards of 5 pCi/g of radium-226. (H-18)

Response: We considered limiting the surface gamma radiation level, but concluded that this type of standard would be harder to apply to subsurface material (see Chapter 8 of the FEIS). However, the Agency expects gamma radiation survey instruments to be used in demonstrating compliance with the standards (see 40 CFR 192.20(b)).

Comment 10: EPA has not justified or demonstrated a need for the open land cleanup standard of 5 pCi/g of radium-226. EPA based this standard on the consideration that soil concentrations in excess of 5 pCi/g of radium-226 will result in radon decay product concentration in houses in excess of 0.01 WL. Because of the uncertainty between radium-226 in soil concentrations and indoor radon decay product concentrations, this is not an adequate basis on which to set a standard. Our calculations show that a radium-226 concentration of 30 pCi/g would result in an indoor radon decay product concentration of 0.02 WL. Therefore, the EPA standard of 5 pCi/g is too low and if a radium-226 in soil standard is to be used it should be no less than 30 pCi/g. (I-3, I-10, H-13, H-18)

Response: The purpose of the land cleanup standards 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 0.5 to 1%, for an assumed lifetime of

D.6 Implementation

Comment 1: EPA should establish requirements for or provide guidance on the methods, procedures and conditions to be used in monitoring compliance with the proposed standards. (P-3, P-11, P-17, S-5, S-18, F-2, F-8, F-9, F-10, H-7, H-23)

Response: The Agency considers the procedures and methods used in determining compliance to be an important part of making the standards effective. We considered including details on these procedures as part of our rulemaking. However, we chose to allow the implementing agencies to establish suitable procedures for the widely varying and incompletely known conditions of each processing site. The Agency is, however, providing general guidance on how the standards should be implemented (Subpart C of the Final Standards). The Agency is confident that DOE and NRC, in consultation with EPA and the States, will adopt implementation procedures consistent with the intent of the standards.

Comment 2: EPA should consider the need to specify confidence limits for the measurements to be used in determining compliance with the proposed standards. (P-4, I-1)

Response: The Agency does not believe it is appropriate or useful to specify confidence levels for the measurements to be used in determining compliance with the standard. Such limits are an integral part of a compliance monitoring program and we expect DOE to consider such limits in designing and implementing the remedial action program.

Comment 3: Gamma survey techniques should be used to determine compliance with the radium-226 open lands cleanup standard. These techniques are more practical than soil sampling procedures during actual cleanup operations. (S-18, F-10)

Response: We agree and expect that gamma survey techniques will be widely used as a surrogate measurement for radium-226 in determining compliance with the land cleanup standard (see Section 192.20(b) of the Final Standard).

D.7 Miscellaneous

Comment 1: The attenuation of tailings gamma radiation by soil overburden is not given correctly by Figure 5-2 in the DEIS. The attenuation of gamma radiation from tailings by overburden does not follow an exponential law, as would be the case for a point source. The concept of half-value-layer is not applicable to extended sources. Instead the attenuation can be shown to follow a second-degree exponential integral. (P-19)