DOE/DP-0011
Volume 1 of 2

Commingled Uranium Tailings Study

Volume I

Plan for Stabilization and Management of Commingled Uranium Mill Tailings

June 30, 1982

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U.S. Department of Energy
Assistant Secretary for Defense Programs
Office of Defense Waste and Byproducts Management

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Washington, D.C. 20545

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TABLE OF CONTENTS

		Page
Section I.	SUMMARY	5
Section II	BACKGROUND	7
Section III.	AMOUNT AND CONDITION OF THE TAILINGS	10
Section IV.	REGULATORY REQUIREMENTS	12
Section V.	STABILIZATION COST ESTIMATES	14
Section VI.	COST-SHARING ALTERNATIVES	15
	Items for Cost-Sharing	15
	Cost-Sharing Approaches	15
	Tonnage Ratio	15
	Acreage Ratio	16
	Flat Fee	16
	Engineered Assessment	16
	Recommendations for Cost-Sharing	17
Section VII.	ADMINISTRATIVE OPTIONS AND PLAN IMPLEMENTATION	19
	Administrative Options	19
	Administration by Mill Owners	19
	Administration by the Federal Government	19
	Administration by the State Government	19
	Recommendation for Administrative Option	19
	Plan Implementation	20
	Assumptions	20
	Implementation and Follow-Up Activities	20
	Long-Term Ownership	21
Section VIII.	STANDARDS AND REGULATIONS	22
	Introduction	22
	Radon Sources	22
	Health Impacts	23
	Proposed Standards	25
	Implementation of Standards and Regulations	27
	Recommendations	27

Section I

SUMMARY

This report, prepared in accordance with Section 213 of Public Law 96-540, presents a plan for a cooperative program to provide assistance in the stabilization and management of commingled uranium mill tailings. The report is organized in two volumes, a summary report (Volume I) and a companion technical report (Volume II).

Commingled tailings are those which resulted from milling contracts with the United States Government to produce uranium for use primarily in defense programs and which are mixed with similar tailings from other milling activities. These Government contracts were in force between 1943 and 1970 with the Manhattan Engineering District (MED) and the Atomic Energy Commission (AEC). Commingled tailings are located at 13 sites in six western states. There are approximately 138 million tons of tailings at these sites, about 56 million tons of which are defense related. Commingled piles contain 129 million tons of tailings; "AEC-only" and "commercial-only" piles contain 4.8 and 4.3 million tons, respectively (see Table 1 in Section III). These tailings cover an area of about 3296 acres, most in solid tailings piles, the rest in solution or evaporation ponds.

Regulatory responsibility for uranium mill tailings rests primarily with the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). The NRC's authority may be further shared with Agreement States. The EPA has proposed stabilization standards for inactive tailings piles, while the NRC has issued regulations for the stabilization of active tailings piles. New Mexico, an Agreement State, has also issued regulations for managing uranium mill tailings. The standards and regulations are not consistent, as shown in Table 2 (Section IV). Congress suspended the enforcement of NRC's regulations, and is considering requiring the EPA to issue their standards on a specific schedule and to consider all relevant factors in their development.

The U.S. Department of Energy (DOE) cost estimates for reclamation of the commingled tailings sites vary from $130 to $640 million depending on the standards applied. Detailed engineering studies based on more cost-effective regulations will be needed to develop a precise cost estimate. Several cost-sharing approaches have been considered and a combination of them is recommended (see Table 3 in Section VI) to take into account the conditions existing at each site. The Government share of the cost would range from $50 to $270 million, depending on the standards applied and the cost-sharing assumptions used. A cost summary for reclamation of the commingled tailings site and the defense-related portion of them, based on different regulatory and cost-sharing assumptions, is shown in Table 4 (Section VI). Various options were investigated for administering an assistance program. The DOE recommends that the states be given the option to administer the program if they share the cost with the Federal Government.

The DOE believes that the cost to implement EPA and NRC proposed standards and regulations does not appear to be commensurate with the health benefits

achievable. In addition, the difficulty in measuring radon concentrations at levels close to natural background does not appear to have been considered. A discussion of the sources, health impacts, and implementation of the proposed standards and regulations is included in this report. The following specific revisions would result in a more cost-effective program and should be considered: deletion of the radon flux standard; raising the radium limit for decontaminated surface soil to at least 15 pCi/g; shortening the longevity requirement to 100 years; and eliminating the tailings cover thickness requirement. The DOE cost estimate for implementing a program using these revised regulations would be about $260 million, of which the Government's share would be approximately $110 million.

The DOE recommends that the standards and regulations for tailings stabilization be relaxed and that any program of stabilization be limited to prevention of migration and erosion of the tailings and inadvertent exposure to them. The plan presented here shows the effort and costs that would be incurred if the Government were to implement such a plan. The Department makes no recommendation as to the advisability of actually implementing legislation authorizing an assistance program, and stands ready to respond to comments on the plan by Congress, other Government agencies, or interested parties.

Section II

BACKGROUND

This report has been prepared by the Department of Energy (DOE) based on the requirements of Public Law (P.L.) 96-540, Section 213, which states:

> The Secretary of Energy shall develop a plan for a cooperative program to provide assistance in the stabilization and management of uranium mill tailings which have resulted from ore processing to extract uranium under contract with the United States for use primarily in defense programs and which are now commingled with other tailings. In developing the plan, the Secretary shall establish the amount and condition of the tailings resulting from such Federal contracts at each currently operating or currently licensed extraction site in order to permit calculation of the Federally contracted share of the total tailings which must be stabilized and managed over time. The plan shall include a methodology for establishing the extent of Federal assistance appropriate to meet the costs for stabilizing and managing such tailings at each such site in order to comply with a requirement of Federal law or regulation imposed after termination of such Federal contracts. The Secretary shall consult with the owners and operators of each such site and shall submit the plan and his recommendations to the Armed Services Committees of the Congress not later than October 1, 1981.*

Federal contracts for the purchase of uranium concentrate to support defense programs were made by the MED from 1943 to 1946 and by the AEC from 1947 until 1970. A total of 34 commercially operated mills produced uranium concentrate for sale to the AEC. Of these, 13 are now under NRC or state license and have defense-related tailings commingled with other tailings (Figure 1).

The AEC's uranium concentrate procurement contracts did not include provisions for stabilization or management of the uranium mill tailings. In 1972, Congress (P.L. 92-314) authorized a program to perform remedial actions on structures in Grand Junction, Colorado, where mill tailings had been used for construction. The Uranium Mill Tailings Radiation Control Act of 1978 (P.L. 95-604) authorized the cleanup of 24 inactive uranium millsites where uranium concentrate had been produced for the AEC. The cost of the cleanup is being shared by the Federal and state governments on a 75 percent versus 25 percent and 90 percent versus 10 percent basis, respectively, for these programs. The latter Act also required that the EPA and NRC develop standards for managing tailings at all active (licensed) millsites, including the commingled sites.

During the hearings that preceded the passage of P.L. 95-604, representatives of the uranium milling industry raised questions regarding Federal assistance for stabilization of tailings at the active commingled sites. Two reports to Congress treat this matter:

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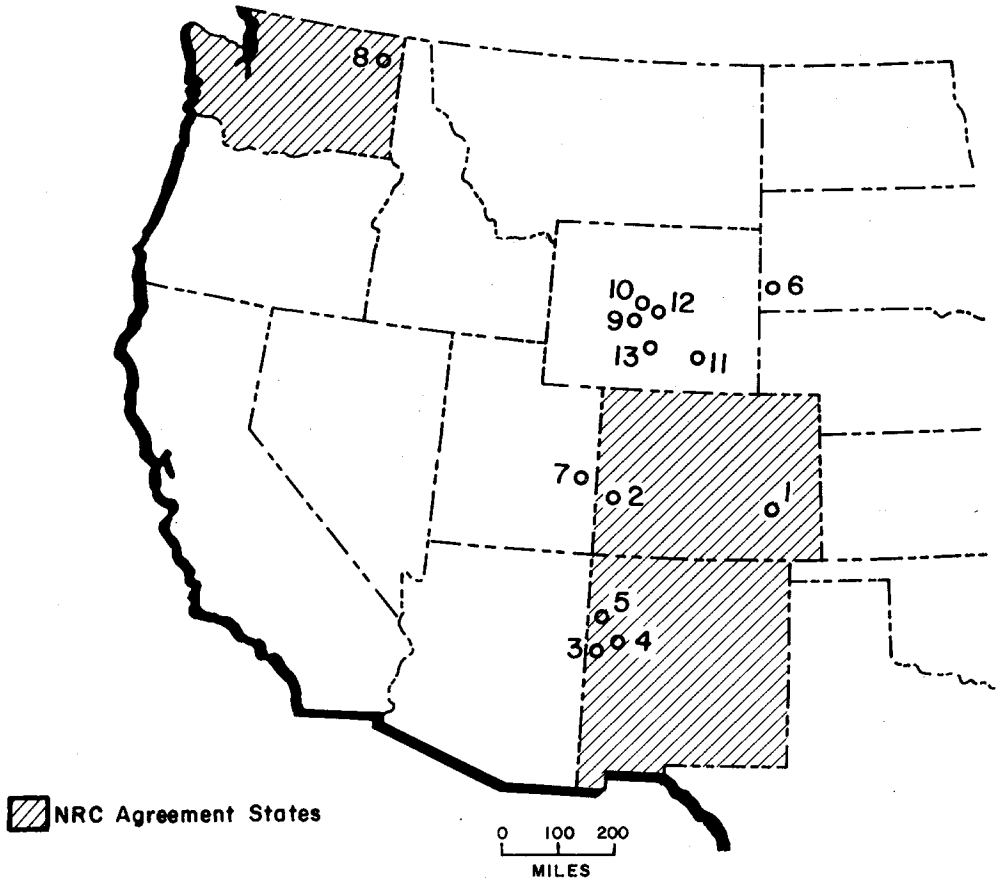
*Submission date subsequently extended to June 30, 1982.



SITE NO.	MILL	OWNER/CONTROLLER	LOCATION	RATED CAP.-TPD	MILL STATUS
1	Cotter Corp.	Cotter Corp.	Canon City, CO	1,500	Active
2	UCC-Uravan	Union Carbide	Uravan, CO	1,300	Active
3	Anaconda-Bluewater	Anaconda Minerals Co.	Bluewater, NM	7,000	Shutdown 3/82
4	Homestake	Homestake Mining Co.	Grants, NM	3,500	Active
5	Kerr-McGee	Kerr-McGee Nuclear Corp.	Ambrosia Lake, NM	7,000	Active
6	TVA-Edgemont	Tennessee Valley Auth.	Edgemont, SD	750	Shutdown 1974
7	Atlas	Atlas Minerals	Moab, UT	1,500	Active
8	Dawn	Newmont Mining Co.	Ford, WA	600	Active
9	Fed. American Partners	Fed. American Partners	Gas Hills, WY	950	Shutdown 11/81
10	Pathfinder Mines	Pathfinder Mines Corp.	Gas Hills, WY	2,800	Active
11	Petrotomics	Petrotomics Co.	Shirley Basin, WY	1,500	Active
12	UCC-Gas Hills	Union Carbide Corp.	Gas Hills, WY	1,400	Active
13	WNI-Split Rock	Western Nuclear Inc.	Jeffrey City, WY	1,700	Shutdown 6/81

Figure 1.

Location of Licensed Uranium Mills Having AEC-Related Tailings Commingled with Tailings from Commercial Production

- "Answers to Questions on Commingled Tailings at Currently Operating Uranium Ore Processing Mills that Produced Uranium Under Atomic Energy Commission (AEC) Contracts," DOE, January 29, 1979. This report acknowledged the inequity of P.L. 95-604 in authorizing Federal assistance to stabilize tailings produced under some Government contracts and not under others. The report concluded that accurate cost estimates for stabilization of commingled sites could not be developed due to uncertainty of the standards to be developed by the EPA and lack of information on specific conditions at each site.

- "Cleaning Up Commingled Uranium Mill Tailings: Is Federal Assistance Necessary?," GAO, EMD-79-29, February 5, 1979. This report recommended that Congress provide assistance to the owners of sites with commingled tailings.

The Department does not have any current statutory or contractual legal responsibility for the decontamination, decommissioning, or restoration of the commingled uranium millsites. All of these sites, whether operating or shutdown, are presently covered by licenses issued by either the Nuclear Regulatory Commission (NRC) or Agreement States under the Atomic Energy Act of 1954, as amended. These licenses govern the possession, cleanup, and disposal of the tailings. Prior to the termination of the licenses, the mill owners will be required to decontaminate and decommission their sites and to safely dispose of the tailings pursuant to the regulatory requirements of the NRC or Agreement States. In addition, DOE would not be liable under the prior contacts between the Atomic Energy Commission and the mill owners for the cleanup costs as the contracts were entered into solely for the procurement of uranium and did not contain provisions relating to the decontamination and decommissioning or restoration of the millsite after the cessation of operations.

The establishment of a program of financial assistance to the mill owners could prevent or defer time consuming, costly, politically embarrassing, and precedent setting litigation. On the other hand, such a program could itself set a precedent for providing Government assistance to solve problems where there is no legal requirement to offer such assistance. The future costs of such a precedent are unknown.

Section III

AMOUNT AND CONDITION OF THE TAILINGS

The quantities of tailings attributable to the AEC uranium concentrate purchase program at each of the 13 commingled sites are summarized in Table 1. Site-specific information for each of the sites is given in Volume II of this report.

There are a total of 138 million tons of tailings at the 13 sites; 134 million tons of tailings are "AEC only" and commingled piles, of which 56 million tons or approximately 42 percent are defense related. Of this amount, only 4.8 million tons of the defense-related tailings, or 8 percent, are contained in physically segregated "AEC-only" piles.

The quantities of defense-related tailings are derived from AEC or company weigh-in records of "ore fed to process" (equivalent to tons of tailings generated). "Ore fed to process" figures were adjusted for toll milling and mine backfill activities, uranium production from non-ore sources (e.g., mine waters and heap-leach liquors), and tailings losses due to natural causes.

The total surface area affected by commingled tailings at the 13 sites included in this study is 3296 acres, 2331 acres of which are covered with solid tailings while solution and evaporation ponds cover about 965 acres. The total surface area disturbance associated with the AEC contract activity is 1773 acres or 76 percent of the total area covered by solid tailings impoundments. Since defense and commercial tailings are indistinguishable from one another and accurate records of areas covered by tailings have not been maintained, area estimates are not as reliable as tonnage estimates.

Table 1. Summary of Tailings Quantities: Commingled Tailings Study (Millions of Tons)

Mill	Total Through 1981	AEC-Related (Base Case)	Commercial (Base Case)	Commingled Piles	AEC-Only Piles	Commercial Only Piles
Cotter, Colo.	1.9	0.3	1.6	1.5	0	0.4
UCC, Colo.	9.9	5.7	4.2	9.4	0.5	0
Anaconda, N. Mex.	23.6	8.8	14.8	22.8	0.8	0
Homestake, N. Mex.	21.2	11.4	9.8	19.9	1.3	0
Kerr-McGee, N. Mex.	30.4	10.0	20.4	30.4	0	0
TVA, S. Dak.	2.0	1.6	0.4	1.5	0.5	0
Atlas, Utah	10.2	6.0	4.2	10.2	0	0
Dawn, Wash.	3.0	1.2	1.8	0	1.2	1.8
FAP, Wyo.	5.9	2.1	3.8	5.4	0.5	0
Pathfinder, Wyo.	9.5	2.7	6.8	8.2	0	1.3
Petrotomics, Wyo.	5.5	0.7	4.8	5.5	0	0
UCC, Wyo.	7.3	2.1	5.2	6.5	0	0.8
WNI, Wyo.	7.7	3.4	4.3	7.7	0	0
Totals	138.1	56.0	82.1	129.0	4.8	4.3

Section IV

REGULATORY REQUIREMENTS

The regulatory structure for control of uranium mill tailings is defined by the Atomic Energy Act (AEA) which has been amended by the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. Until the enactment of the UMTRCA, the regulatory authority of the NRC (formerly part of the AEC) over uranium mill wastes was incident to its authority, under 42 U.S.C. Section 2092, to license the receipt or transfer of source material.

The NRC's authority over source material does not extend to raw ore; however, a license is required once processing of the mined ore begins, since it becomes source material. The license is issued by the NRC or by the state if the processing occurs in an Agreement State.* The UMTRCA provisions amended the AEA by defining byproduct material to include "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content," and provided express regulatory authority over byproduct material.

The UMTRCA also directed EPA to promulgate "standards of general application for the protection of the public health, safety, and the environment from radiological and nonradiological hazards associated with the processing and with the possession ... and disposal of the newly defined byproduct material at active uranium mills and at tailings disposal sites" [Section 2022 (b) (1)]. The EPA standards, when issued, are to be enforced by the NRC in its licensing program and by the Agreement States. The UMTRCA also provided for eventual Federal or state ownership and management of tailings disposal sites. The NRC has promulgated new regulations pursuant to its regulatory authority under the AEA as amended by the UMTRCA (45 Federal Register 65521, October 3, 1980), but has been barred from enforcing them by Congress in the Fiscal Year 1982 Continuing Resolution because they are too costly to implement.

The NRC regulations for disposal of new active tailings require that a cover of at least 3 meters of earth plus riprap or vegetation must be placed on the pile to stabilize it, and that the pile be contoured to conform to a 10-to-1 slope. The design objective of these actions is to limit the radon emanation rate to 2 pCi/m^2-sec for 1000+ years and to prevent ground-water degradation. The EPA-proposed standards for the inactive uranium mill tailings sites were similar to those promulgated by the NRC for new active tailings piles.

*Agreement States are those states which entered into agreements with the NRC calling for the states to regulate radioactive hazards provided the state standards conform to those of the NRC.

New Mexico, an Agreement State, has uranium mill tailings regulations in effect which require that radon concentrations in air be limited to 30 pCi/l over the pile and 3 pCi/l at the site boundary, and that ground water meet New Mexico water quality criteria.

Table 2 summarizes the requirements of the proposed EPA standards and NRC and State of New Mexico regulations.

Table 2. Proposed Uranium Mill Tailings Stabilization Standards and Regulations

Standard/Regulation	NRC[a]	EPA[b]	New Mexico[c]
Longevity (years)	1000+	1000	200
Radon Emanation Rate (pCi/m^2-sec)	2	2	Not Specified
Ground Water Requirements	No Degradation	EPA Drinking Water Standards	New Mexico Water Quality Criteria
Radon Concentration (pCi/l)			
On Tailings Area	30[d]	Not Specified	30
At Area Boundary	3	Not Specified	3
Cover Thickness (meters)	3	Not Specified	Not Specified

[a]For new tailings piles.

[b]For inactive tailings piles.

[c]State of New Mexico Environmental Improvement Board, "Amended Radiation Protection Regulations and Statement of Reasons for Their Adoption," October 9, 1981.

[d]Same as 10 CFR Part 20, App. B-II.

The Senate version of the 1982 NRC Authorization Bill criticizes specific aspects of NRC uranium mill licensing requirements as excessive in terms of necessary protection to the public health, safety, and the environment, and as unduly costly. The NRC regulations were suspended by Congress in the Fiscal Year 1982 Continuing Resolution (Public Law 97-88), and the Senate bill reiterates this suspension. It also directs the EPA to propose standards for active sites by October 1, 1982, and finalize them by April 1, 1983. The NRC has 90 days after issuance of the final EPA standards to initiate rulemaking proceedings for revision of its regulations to conform with the EPA standards.

Section V

STABILIZATION COST ESTIMATES

Cost estimates for stabilizing all commingled tailings (134 million tons), excluding those in "commercial-only" piles, range from $130 million for meeting New Mexico State regulations (stabilization of tailings only) to $590 million for meeting NRC regulations. The costs are summarized in Table 4 (Section VI). Ford, Bacon & Davis Utah, Inc., have estimated an average stabilization cost of $4.80 per ton of tailings at six inactive sites.* Using this cost factor for the commingled tailings, the total cost would be $640 million. Details for cost estimates are included in Volume II (a summary is provided in this volume). A more precise evaluation will require enforceable regulations and detailed engineering studies of site-specific factors affecting stabilization costs.

*Ford, Bacon & Davis Utah, Inc., "Engineering Assessment of Inactive Uranium Mill Tailings, Durango Site, Durango, Colorado," prepared for U.S. Department of Energy, June 1981. Engineering assessments were also prepared for inactive uranium mill tailings at Grand Junction and Rifle, Colorado; Shiprock, New Mexico; Salt Lake City, Utah; and Monument Valley, Arizona.

Section VI

COST-SHARING ALTERNATIVES

ITEMS FOR COST-SHARING

The following categories of reclamation activities are candidates for cost sharing:

1. Stabilization of commingled solid tailings impoundments, including engineering assessments, purchase, haulage, emplacement and contouring of cover materials, erosion control and revegetation, water management, and purchase of land for buffer zones.

2. Movement of the commingled tailings piles, including engineering assessments, disposal site selection and preparation, transport of the tailings, decontamination of the original tailings area, and stabilization of the permanent impoundment.

3. Mill decommissioning activities such as dismantling and disposal of structures and equipment used specifically for production of U_3O_8 in concentrate sold to the Government.

4. Decontamination of the millsite, evaporation ponds, vacated tailings areas, areas contaminated with windblown tailings, and backfilling and drainage repair, excluding commercial-only areas.

5. Ground-water cleanup and protection, including drilling and maintaining wells, and water pumping, treatment, and storage.

6. Long-term surveillance activities, such as drilling and maintaining monitoring wells, radon measurement, and site maintenance.

7. Other cost items such as purchase of land for buffer zones, interest on capital, financial surety or bonding, interim stabilization, administration, overhead, and judicial awards for damages related to the commingled pile or any pollution it caused.

COST-SHARING APPROACHES

Four cost-sharing approaches are considered:

1. <u>Tonnage Ratio</u>

   The Government's share is determined on the basis of the ratio of tons of tailings produced from Government contracts to total tons of tailings impounded. This ratio is referred to as the "basic tonnage ratio." It can be modified by subtracting the tons of tailings contained in "commercial-only" piles from the total tons of tailings impounded. This second ratio is referred to as the "modified tonnage ratio."

The basic tonnage ratio, calculated at mill closure, appears reasonable and equitable to use as a basis for sharing the cost of decontamination, mill decommissioning, and perpetual care following stabilization. As of January 1982, the Government's share of the commingled tailings is 42 percent.

A modified tonnage ratio should be used to determine the Government's share of the costs directly related to interim stabilization, moving, and final stabilization of physically commingled tailings piles.

2. Acreage Ratio

The Government's share of the costs can alternatively be determined on the basis of the ratio of the area (acres) disturbed or covered with tailings during the Government contract period to the total area covered or disturbed. This "basic acreage ratio" can be modified by multiplying by the ratio of tons of defense-related tailings to the tons of tailings generated during the Government contract period. This ratio is referred to as the "modified acreage ratio."

Cost-sharing on the basis of the modified acreage ratio has been suggested for determining the Government's share of the cost of in-situ stabilization of tailings piles because these costs are largely area dependent. The modified acreage ratio is, however, difficult to determine with accuracy because the area of the piles may have to be estimated where maps and aerial photographs of the piles at the end of the Government contract period are not available. In addition, commercial tailings added to the top of piles containing only tailings from Government contracts would not be accounted for in this method, thus allocating an unreasonably large share of the costs to the Government.

3. Flat Fee

The Government's share of the costs for tailings stabilization could be established unilaterally as a fee for each:

a. pound of U_3O_8 produced at the site and sold to the Government; or
b. ton of tailings at the site attributable to the Government; or
c. acre of land at the site covered by tailings impoundments during Government contracts.

This approach would be easy to administer; however, it would be inequitable for some sites because site-specific factors and owner concerns would not be considered.

4. Engineered Assessment

Finally, if it were assumed that the 13 mills had ceased operation upon termination of the Government contract (before January 1,

1971), the costs for reclamation of sites as they existed at that time could be estimated and become the basis for the Government's share.

This approach would assure the mill owners of treatment equitable to those who ceased operation and are included under the UMTRCA program. It could, however, be impossible to implement because accurate records of past conditions are not available for all sites.

RECOMMENDATIONS FOR COST-SHARING

Since each active millsite included in this study has unique characteristics, no single cost-sharing approach is likely to be fair and equitable to every owner and the Government. Cost-sharing approaches are recommended for each of the seven categories of reclamation activities identified earlier in this Section VI and are summarized in Table 3. This makes it possible to account for certain site-specific factors.

Table 3. Recommended Cost-Sharing Approaches

Cost Factors	Recommended Approach
1. Stabilize Commingled Pile	Modified Tonnage
2. Movement of Commingled Pile	Modified Tonnage
3. Mill Decommissioning	Basic Tonnage
4. Decontamination of Millsite	Basic Tonnage
5. Ground-Water Cleanup	Modified Tonnage
6. Long-Term Surveillance	Modified Tonnage
7. Other	Basic Tonnage

The largest costs will be for stabilization of solid tailings areas. If in-place stabilization of the tailings is permitted by regulations, the costs will depend to a large extent on the area to be covered, and cost-sharing could be done on the basis of a modified area ratio. This ratio is difficult to determine. Since some tailings impoundment areas were originally determined by the amount of process water requiring evaporation, this approach results in a disproportionately large share of Governmental costs. Thus, cost-sharing on the basis of the modified tonnage ratio is recommended as more reasonable. If local movement of some tailings is required, the costs should also be shared on the basis of the modified tonnage ratio.

The costs for other activities are much smaller and should also be shared on the basis of the basic tonnage or modified tonnage ratio. Since commercial-only

tailings disposal impoundments will be designed according to current NRC regulations which will reduce ground-water pollution, the modified tonnage ratio should also be used as the basis for cost-sharing for ground-water cleanup. The costs for mill decommissioning, site decontamination, long-term surveillance, and items in the "Other" category, if allowed, should be shared on the basis of the basic tonnage ratio, because these activities are associated with all tailings at the site.

Based on the recommended cost-sharing approach, the Government share of costs for millsite reclamation would range from $110 million for meeting New Mexico State regulations to $260 million for meeting current NRC regulations. The low cost option can be reduced to $50 million if cost-sharing is based on the basic tonnage ratio and limited to tailings stabilization only, in compliance with New Mexico regulations. This would amount to about $28,000 per acre of land disturbed by tailings from Government contracts (1773 acres). These costs are summarized in Table 4.

Table 4. Cost Summary for Commingled Tailings Site Reclamation: January 1982 (millions of dollars)

Assumptions	All Tailings[a]	Defense-Related Tailings
Current NRC Regulations (recommended approach)	590	260[b]
New Mexico Regulations	260	110[c]
New Mexico Regulations (tailings stabilization only)	130	50
Flat Fee ($4.80 per ton)	640	270
GAO Estimate (1979 dollars)	315	129

[a]Tailings quantities as of January 1982, excluding "commercial-only" impoundments.

[b]Using multiple tonnage ratios.

[c]Based on basic tonnage ratio for cost-sharing.

Section VII

ADMINISTRATIVE OPTIONS AND PLAN IMPLEMENTATION

ADMINISTRATIVE OPTIONS

Establishing a program to provide assistance for millsite reclamation requires that arrangements be made for conducting administrative activities. These include review and approval of reclamation plans, justification of annual budget requests, and approval of payments and disbursement of funds to the mill owners.

Administration by Mill Owners

Since reclamation is required under the mill owner's license, the mill owners would be responsible for stabilization projects for their millsites (including the Government portion), subject to NRC or Agreement State regulations. The mill owner would maintain responsibility for administering millsite reclamation activities. The Government would reimburse the mill owner for the appropriate percentage of allowable costs after submission of invoices for the completed work. Performance would be subject to Government audit and other controls.

Administration by the Federal Government

A Federal agency would be assigned complete responsibility for administering the commingled millsite reclamation program and for reimbursement of the mill owners for work completed.

Administration by the State Government

The states would administer the millsite reclamation projects if they share costs with the Federal Government. The Federal portion of the costs would be provided to the states through a designated Federal agency. The mill owners would be responsible for all reclamation activities and would be reimbursed through the states for work completed.

RECOMMENDATION FOR ADMINISTRATIVE OPTION

Administration by the states is recommended because the states can best administer the projects in their jurisdictions, and especially for commingled sites that are licensed by Agreement States, the expertise to administer the program is available within the state government. To avoid potential conflicts of interest, separate state organizations would be required for regulating the mills and administering the assistance program.

Legislation would be required to authorize such a program. An appropriate cost-sharing formula between the Federal Government and the states would

have to be established for activities associated with defense-related tailings. One option for cost-sharing would be the 90 percent/10 percent arrangement now authorized under UMTRCA for the inactive uranium mill tailings program. Another option would be the 75 percent/25 percent arrangement with the State of Colorado under the Grand Junction Remedial Action Program. These formulas represent legislative precedents and are not based on a new analysis.

The proposed assistance programs would be administered by the states similar to the Grand Junction Program, and cost-sharing under a 75 percent/25 percent formula is recommended. The mill owners would be responsible for millsite reclamation to assure that radioactive and other emissions meet existing standards and regulations.

PLAN IMPLEMENTATION

This section summarizes a plan for a cooperative program to provide Federal assistance to licensed mill owners for the stabilization and management of the approximately 56 million tons of defense-related uranium mill tailings.

Assumptions

1. Some level of Federal assistance will be rendered for stabilizing defense-related tailings to meet Federal regulations

2. Mill owners will be required to prepare reclamation plans for their sites which meet revised EPA standards and NRC regulations to be promulgated in 1983.

3. The Federal share of the costs to implement the site reclamation plans will be based on an equitable combination of tonnage ratios for the various categories of reclamation activities.

4. Mill owners will implement reclamation programs at their sites and shall comply with NRC or state regulations; if state regulations are more restrictive, there will be no Federal contribution to the incremental costs to comply with them.

5. Federal assistance will be rendered, from funds appropriated by Congress, based on invoices presented by the mill owners for work completed according to approved reclamation plans.

Implementation and Follow-Up Activities

Following receipt of this report by the Congress, the DOE will:

1. Consider Congressional comments on the plan, particularly any specific limits for Federal assistance.

2. Coordinate with mill owners, the six affected states, and with Federal regulatory agencies.

3. Draft legislation, if necessary, to implement a Federal assistance program for consideration by Congress.

When these actions are completed, the DOE will have completed its responsibilities for this report. Upon promulgation of final regulations, the mill owners would develop reclamation plans for each site, and the DOE would negotiate cost-sharing under each of these plans after their approval by regulatory authorities.

LONG-TERM OWNERSHIP

Title II of the Uranium Mill Tailings Radiation Control Act provides for the transfer of the millsites upon termination of the licenses either to the Federal Government or to the states (at the states' option) at no cost to the Federal or state governments; or the sites may remain in private ownership, if the Nuclear Regulatory Commission believes such action would be necessary or desirable to protect public health and safety. The DOE does not recommend a change in this approach.

Section VIII

STANDARDS AND REGULATIONS

INTRODUCTION

Standards and regulations are an important factor in developing plans for stabilizing uranium mill tailings. The costs of implementing the standards and regulations proposed by the EPA and the NRC for controlling uranium mill tailings may not be commensurate with the benefits. The standards do not recognize the difficulty of distinguishing the prescribed low radiation levels from the natural background. The potential risk to the public in moving the tailings could even exceed the risk of abandoning certain tailings in place without remedial action. Another issue has been the relative hazard of radon and its decay products generated by mill tailings compared to that of radon from other sources.

RADON SOURCES

The residual low level radioactivity in uranium mill tailings is one of many potential sources of radiation in the environment. The dominant potential source of radiation exposure from these tailings is the radon gas from the decay of uranium and radium. Other sources of exposure are direct radiation from radium in the tailings and ground-water contamination.

Radon and its daughter products can accumulate indoors in dwellings constructed on or with mill tailings or natural materials with high natural radon emanations. They can, however, also accumulate in well-sealed (energy-efficient) homes built of more conventional materials. It is for the latter reason that indoor radon from natural sources accounts for more than half the radon lung dose to the U.S. public.

Outdoor radon from mill tailings at active mills in the West would constitute about 0.02 percent of the radon lung dose to the U.S. population, even if it is assumed that the entire population within 50 miles of millsites is exposed. Radon from mill tailings, however, dissipates to normal background levels within one-quarter to one-half mile from the site and becomes indistinguishable from natural radon. Natural outdoor sources of radon are responsible for about 43 percent of the radon lung dose to the U.S. population. Other major sources of outdoor radon lung doses are from agriculture (1 percent) and natural gas (1 percent).

Some sources of radon in the United States are given in Table 5. Mill tailings at active sites contribute about 150,000 curies per year of radon, or about 0.1 percent of the 128,800,000 curies from natural sources in the United States. Another 3,200,000 curies of radon are released in the United States from technology sources, such as mining of minerals and from moving or tilling soil. Mill tailings release about 0.1 percent of the radon from natural sources.

Up to 3 million curies of radon may have been released in the eruption of Mount St. Helens in 1980, or about 20 times the annual radon release from mill tailings.

Table 5. Radon Sources in the United States[a]

Source	Amount Released (curies/year)	Percent of Total Radon Dose in U.S.
Natural		
Natural Soil	120,000,000	40
Evapotranspiration	8,800,000	3
Volcanic Eruption (1980)	3,000,000[b]	
Technology Enhanced		
Building Interiors	28,000	55
Tillage of Soil	3,100,000	1
Natural Gas	11,000	1
Phosphate Mines	53,000	0.018
Coal Mines	14,000	0.005
Phosphate Fertilizer	48,000	0.016
Geothermal Power	580	0.2
Uranium		
Mining	200,000	0.074
Milling (active sites only)	150,000	0.026

[a]NUREG/CR-0573, A Radiological Assessment of Radon-222 Released from Uranium Mills and Other Natural and Technologically Enhanced Sources, February 1979.

[b]Fruchter, Jonathan S., et al, "Mount St. Helens Ash from the 18 May 1980 Eruption: Chemical, Physical, Mineralogical, and Biological Properties," Science, Volume 209, September 5, 1980.

HEALTH IMPACTS

Health effects have not been calculated for radon from commingled tailings sites. Most health risk estimates for radon are derived from studies of underground uranium miners and animal experiments, a very small population compared to the population over which the results were extrapolated. Underground uranium miners were also exposed to much higher levels of radiation than those found near mill tailings, and differ from the general population in other factors such as age, extent of cigarette smoking, and employment history. Health effects estimates for the low levels of radon from uranium mill tailings assume the conservative "linear, nonthreshold" hypothesis in extrapolating from the high exposure rates encountered in uranium mining.

Health risks to the public from exposure to radium and radon from uranium mill tailings should be compared with risks from exposure to other natural sources of radium, radon, and their daughters. In the United States, the radon release from soils is 800 times that from mill tailings. Table 6 provides a comparison of background concentrations of radon and radium with those associated with uranium mill tailings.

Table 6. Comparison of Background Concentrations of Radon and Radium with Those Associated with Uranium Mill Tailings[a]

	Radon Radium Concentration
Radon Concentration in Air (pCi/liter)	
Background for U.S. (outdoors)	0.2 (0.01-1)
Mill Tailings (over the pile)	
Grand Junction, Colorado	11-15
Monticello, Utah	2-4
Salt Lake City, Utah	10
Durango, Colorado	12-19
Energy-Efficient Homes	1-4
Ordinary Homes	0.2-2
DOE Standard (off-site)	3
EPA-Proposed Standard (indoors)	1.5[b]
Radium Concentration in Soils (pCi/gram)	
Background for Soil (U.S.)	1.1 (0.2-4)
Uranium Mill Tailings (unstabilized)	400 (50-1000)
EPA-Proposed Standard for Open Lands	5
Radium Concentration in Water (pCi/liter)	
Background (U.S. well water)	0.1-40
Uranium Mill Discharge (tailings solution)	30-900
EPA Standard for Drinking Water	5

[a]"Uranium Ore Residues; Potential Hazards and Disposition, Ninety-Seventh Congress, Hearings Before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services," Washington, D.C., 1981, p. 91.

[b]Assuming equilibrium between radon and its daughter products.

To gain a perspective on the health risks from active tailings piles, the NRC has estimated annual deaths in the United States from tailings stabilized under controls used during past milling practices (base case) to be less than 3. This hypothetical rate should be compared with other hypothetical rates from nontailings radon sources in the United States: 30 from soil tillage, 86 from evapotranspiration from soil and vegetation, 1152 from natural soil, and 1594 from building interiors.*

*U.S. Nuclear Regulatory Commission, Office of Nuclear Materials Safety and Safeguards, "Final Generic Environmental Impact Statement on Uranium Milling," Volume I, Government Printing Office, Washington, D.C., September 1980.

PROPOSED STANDARDS

The EPA proposed disposal and cleanup standards for inactive uranium processing sites in the Federal Register (40 CFR 192) on January 9, 1981. The basis for these proposed standards was discussed in EPA 520/4-80-011, "Draft EIS for Remedial Action Standards for Inactive Uranium Processing Sites," December 1980. The NRC issued NUREG-0706, "Final Generic Environmental Impact Statement on Uranium Milling," September 1980, and regulations for licensed uranium mills on October 3, 1980.

A number of Federal and state agencies, industrial groups, scientists and engineers, and congressional groups took issue with these proposed standards and regulations. The Procurement and Military Nuclear Systems Subcommittee of the House Armed Services Committee held hearings on "Uranium Ore Residues: Potential Hazards and Disposition" on June 24 and 25, 1981.

In summary, the hearings revealed the following:

- The actual risks to the public, the basis for the proposed standards, were overestimated by the EPA and NRC. Evidence of actual radiation injuries and health effects from radon and radium associated with the tailings is nonexistent.

- The standards were not coordinated with or agreed to by Federal agencies, states, and mill operators responsible for implementing them.

- The standards, if implemented, would require in many cases excavation, transfer, and interment of the tailings at new locations, increasing the risk of radon exposure and traffic and occupational accidents to the public and remedial action workers.

- The cost of implementing the standards had been underestimated. In addition, the standards were so restrictive that compliance would be difficult to measure and expensive to demonstrate.

- In developing the standards, the EPA assumed that institutional controls would not be effective beyond 100 years in restricting access, land use, and occupation of the tailing sites.

A summary of the proposed standards and regulations for uranium mill tailings management, as well as alternatives proposed by the DOE and in Congressional hearings,* is given in Table 7.

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*"Uranium Ore Residues; Potential Hazards and Disposition, Ninety-Seventh Congress, Hearings Before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services," Washington, D.C., 1981.

Table 7. Summary of Standards and Regulations Pertaining to Uranium Mill Tailings Management

Standard	NRC	EPA	New Mexico[a]	Evans[b]	DOE[c]	Background
Radon Flux (pCi/m^2-sec)	2	2	Not Specified	Not Specified	Not Specified	0.1 to 1
Radon Concentration (pCi/l air outdoors)	3	Not Specified	3	3 to 4	3	0.2 (indoors 4)
Radium Concentration (pCi/g soil)	Not Specified	5	Not Specified	5	15	0.2 to 4
Longevity (years)	1000	1000	200	100	100	N/A
Cover Thickness (meters)	3	3	Not Specified	0.3	Not Specified	N/A

[a]State of New Mexico Environmental Improvement Board, Amended Radiation Protection Regulations and Statement of Reasons for Their Adoption, October 9, 1981.

[b]Evans, Robley D., in U.S. House of Representatives, Ninety-Seventh Congress, "Uranium Ore Residues: Potential Hazards and Disposition, Hearings Before the Procurement and Military Nuclear Systems Subcommittee of the Committee on Armed Services," Washington, D.C., 1981, p. 68.

[c]UMTRA/DOE/AL-167, "Project Plan - Uranium Mill Tailings Remedial Actions Project," p. 4.

IMPLEMENTATION OF STANDARDS AND REGULATIONS

There seems to be a concensus that mill tailings should be stabilized in order to prevent their future inadvertent use for dwellings and to prevent their dispersion by wind and water. Stabilization costs, however, can vary by several hundred million dollars depending upon the standards and regulations. The cost of stabilization for the active and inactive tailings could exceed one billion dollars if the proposed standards and regulations are implemented.

Implementation of the standards and regulations has proven to be difficult, as discussed below:

- Radon Flux Standard. The EPA and NRC propose a radon flux limit of 2 pCi/m^2-sec to assure that radon exhalation rates from stabilized piles remain near natural background ranges (0.01-1 pCi/m^2-sec).

  Although radon flux at an unstabilized tailings pile can average 1000 pCi/m^2-sec, radon concentrations from the tailings approach natural background at a distance of one-quarter or one-half mile from the pile on open lands. Also, verification of compliance will be difficult because measured radon flux can vary by a factor of 5 at sampling points within 0.1 meter of each other on the pile.

- Radium Soil Concentration Standard. A radium-226 soil concentration standard of 5 pCi/g in any 15-cm thickness below 1 foot was proposed by the EPA for open lands. This compares to an average background of 1.1 pCi/g (0.2 min. to 4 max.), 42 pCi/g in phosphate ore, 2.5 pCi/g in brick, 33 pCi/g in gypsum, and 10 to 300 pCi/g in some industrial wastes.

  Application of this standard is impractical because of the difficulty in making field measurements at this level. The standard should also indicate the area over which concentrations are to be averaged, or the depth to which concentrations are a concern.

- Soil Cover Thickness. A 3-meter minimum cover thickness is required by the NRC to meet the 2 pCi/m^2-sec proposed EPA radon flux standard. Although compliance with this standard can be determined through measurement, in view of the large areas of the tailings piles (100-300 acres) to be covered and the small number of people living within one-quarter to one-half mile of the tailings piles, this standard should be replaced with a design objective to prevent migration and erosion. To the extent that radon is of concern, the standard should relate to concentration rather than to flux. This would allow selection of cost-effective protective covers at each site and recognition of site-specific factors, such as type and availability of cover material.

RECOMMENDATIONS

The responsibility for Federal regulations rests with the EPA and the NRC. The DOE has communicated its concerns to these agencies for consideration.

Practical working standards and regulations for mill tailings should contain the following general provisions:

- Health Effects Assessments. Health effects assessments using representative parameters for the site should be performed on a site-by-site basis considering the unique aspects of each site, its specific environmental parameters, and its off-site population density and distribution. The assessment should be a prerequisite to remedial action and bear heavily upon the selection of alternatives and their effectiveness in reducing public risk.

- Remedial Action. Remedial actions, such as stabilization, should also include prevention of public entry and occupancy by physical and institutional means. Maintenance and controlled self-insurance requirements should be permitted to assure that stabilization designs remain intact in the future.

- Numerical Values. If numerical values are to be used, a range of values should be utilized as opposed to single values. The range approach recognizes the practical uncertainties of field measurements, and the natural variation of background radiation and environmental pathway parameters from site to site.

- Public Dose. Reducing the dose to the public to acceptable levels is a goal of remedial action programs. The application of accepted standards, such as 10 CFR Part 20, which are developed in terms of the external and internal doses to the off-site public, should be considered in place of specific design requirements such as radon flux and radium concentration in soil. Basing remedial actions on accepted standards for dose to the public permits recognition of site-specific features.

Based on this discussion, specific revisions to the proposed EPA tailings stabilization standards and NRC regulations should be considered to permit a more cost-effective program of implementation. These include:

- Replacing the radon flux standard with 10 CFR Part 20 concentration limits, since tailings are under some Government control and access is restricted.

- Raising the radium concentration limit for decontaminated surface soil (a range of 15 pCi/g has been recommended*).

- Shortening the longevity requirements from 1000 (100 years has been recommended*) and relying on active maintenance under institutional controls.

- Eliminating the uniform cover thickness requirement since it restricts stabilization design alternatives. The standard should instead set realistic performance objectives for radon concentration at the site boundary and for tailings migration due to wind, water, and human activities.

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*UMTRA/DOE/AL-167, "Project Plan - Uranium Mill Tailings Remedial Actions Project," p. 4.