ECONOMIC EVALUATION OF REMANDED CLEAN AIRACT STANDARDS FOR URANIUM MILL TAILINGS PILES

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ABSTRACT

In 1986 the Environmental Protection Agency (EPA), under authority of the Clean Air Act (CAA), established standards for controlling radon emissions from uranium mill tailings piles. As a result of a court decision on a related standard, EPA voluntarily remanded all of its CAA Standards for radionuclides in December 1987, including the 1986 Standards for Uranium Mill Tailings. EPA currently plans to promulgate final CAA Standards for uranium mill tailings piles by August 31, 1989. Three separate standards are under consideration. The costs and benefits associated with these options are discussed.

INTRODUCTION

Radon emissions from uranium mill tailings are subject to control under two separate acts of Congress. The first of these is the Uranium Mill Tailings Radiation Control Act (UMTRCA), the second is the Clean Air Act (CAA) as amended in 1978. Under UMTRCA two standards were promulgated, both in 1983. The first of these UMTRCA standards provides for remedial action and final disposal at inactive uranium processing sites, and the second provides for the final disposal of tailings at licensed sites. Both of these standards required that measures be taken to control radon emissions to 20 pCi/m^2s. In addition, UMTRCA provides for the long term stabilization of the tailings piles, prevention of access to the tailings, protection of the quality of groundwater, and shielding from gamma radiation.

In 1986 EPA elected to promulgate standards for the control of radon from these same piles under provisions of the CAA. The radon emission levels allowable under UMTRCA were reexamined. EPA concluded the allowable limit under UMTRCA was protective of the environment. Therefore, no additional reduction of radon emissions was required. However, EPA did introduce two requirements not provided for in UMTRCA. The first mandated work practices, or design criteria, that are to be met when new tailings piles are to be constructed in the future, and the second restricted the future use of all currently licensed piles not meeting the work practice standards for the disposal of tailings. Depending on circumstances, some exceptions to these restrictions on the use of currently licensed piles were allowed, but under no circumstances could any pile not meeting the work practice standards be used after the year 2001.

In the vinyl chloride decision [National Resources Defense Council, Inc. v. EPA, 824 F. 2d 1146 (1987)] the D.C. Circuit Court ruled that EPA had not used costs of control properly in its decision making process. The court went further and laid out a framework which EPA could use to meet the intent of the act and, at the same time, consider costs of control in its decision making process.

In December 1987 EPA voluntarily remanded all of its standards for radionuclides. This was in recognition of the fact that the issues relating to the use of costs in establishing the vinyl chloride regulation were also issues in the regulations for radionuclides. In remanding the standards for radionuclides EPA agreed to reconsider all issues related to standards for uranium mill tailings piles.

This paper discusses the economics associated with various regulatory alternatives. The numbers presented are abstracted from EPA's Background Information Document on the forthcoming CAA standards [1]. The first section of the paper deals with regulatory economics and provides some background on the way EPA addresses economics under the CAA. The second section is a brief discussion of the uranium milling industry. The third discusses the benefit-cost analysis for inactive and licensed mill tailings piles and presents some of its more important findings. Lastly, a summary of the impacts of various combinations of possible regulations is presented.

REGULATORY ECONOMICS

In the regulatory framework for establishing regulations, there are two primary components to an economic evaluation. They are a benefit-cost analysis and an economic impact analysis. In the benefit-cost analysis, the costs of regulation are compared to the benefits derived from the regulation. The objective is to determine the level of regulation where the cost of achieving the last incremental increase in regulatory stringency is judged to be equal to the last incremental increase in the benefits of regulation. This is the appropriate level of regulation from an economics perspective. The second component of the evaluation, the economic impact analysis, is an examination of the impact of the costs the regulation imposes on the businesses and industries involved, and, in instances in which the costs are particularly large, the impact on the economy as a whole.

The courts recommended method for meeting the intent of the CAA requires that health risk considerations alone, with no consideration of cost, be used to establish an acceptable level of risk for regulation. The agency can then use other information, including the consideration of costs and benefits, to establish an ample margin of safety below the acceptable level of risk.

EPA is now developing a methodology for establishing standards conforming to this two step procedure. The costs and benefits of various levels of stringency in the regulationof radon emissions are discussed here independently of the courts recommended method.

THE URANIUM MILLING INDUSTRY

The uranium milling industry, which provides fuel for nuclear power reactors, has suffered a severe contraction the last eight years. Import restrictions on foreign produced yellow cake have been lifted recently and imports are now unrestricted. In addition, in the late 1970s and early 1980s, the industry greatly over estimated the future demand for nuclear fuel and overproduced yellow cake. At present there is an estimated ten year inventory of uranium fuel in the form of yellow cake and higher stages of production.

In August 1988, the industry consisted of 26 licensed uranium mills. Only five were operating, seven were on standby, and 14 were being or had been decommissioned. The mills on standby were being maintained, but were not processing ore. These mills can resume milling if the demand for uranium increases. The decommissioned mills have been dismantled and have either been removed off-site or disposed of on site. There are approximately 50 uranium mill tailings piles at these 26 mills. These piles are subject to regulation under the CAA, and all costs will be borne by the industry.

In addition there are 24 inactive uranium mill tailings piles at abandoned sites which are subject to these regulations. All costs of disposal of these inactive sites will be shared by the Federal government and the states in which they are located.

The business firms that own the 26 licensed mills are all large, diverse, companies that can absorb the costs of regulation without threatening their solvency, although these costs will not be covered by profits from their milling operations if they are shut down or are not operating at a profit. The poor financial shape of the uranium milling industry probably precludes their passing these costs on to their customers through higher prices.

BENEFIT-COST ANALYSIS

This analysis deals with the regulatory options being considered for inactive and licensed mill tailings piles. For inactive mill tailings piles only one regulatory action is being considered, requiring additional cover to reduce radon-222 emissions below 20 $pCi/m^{2}s$. Three regulatory actions are being considered for licensed tailings piles. These are: requiring additional cover to reduce radon emissions, mandating dates for final disposal, and requiring new work practice standards.

The starting point for this analysis (i.e. the baseline) is the assumption that all controls required by UMTRCA are met; specifically that radon emission levels will be limited to 20 pCi/m^2s and that measures will be undertaken to achieve the long-run stability required by the UMTRCA rules. Benefits are measured as reductions in the estimates of committed fatal cancers resulting from lower allowable emissions. For the calculation of total benefits a 100-year time period is assumed. All costs are measured in present value 1988 dollars discounted at a 5% rate of interest.

INACTIVE URANIUM MILL TAILINGS

For inactive uranium mill tailings two alternatives to the 20 pCi/m^2s limit are evaluated: reductions to 6 pCi/m2s, and to 2 pCi/m^2s. The benefits and costs of reducing the allowable radon emissions from 20 pCi/m^2s are discussed here.

The thickness of cover required to achieve a given radon flux is a function of the flux from the pile. It is assumed that reductions in the radon flux provided by increasing depth of cover will yield proportional reductions in committed cancers. Five operations are required to place earth covers on inactive tailings piles. These are: regrading slopes, procurement and placing of dirt cover, placing gravel on the pile tops, placing of rip-rap on the pile sides, and reclamation of the borrow pits.

Table I presents the estimates of committed cancers for the 20, 6 and 2 pCi/m^2s options. Over the 100-year time period the 6 pCi/m^2s option reduces committed cancers by 4.5, and the 2 pCi/m^2s option reduces committed cancers an additional 1.3.

The estimates of total costs for the 20, 6 and 2 pCi/m^2s options are also presented in Table I. The costs shown include a DOE cost factor of 1.4. This is a multiplier used to adjust EPA's cost estimates to the costs that have been experienced by DOE in its clean up efforts. This factor adjusts for costs such as community participation, technology development and evaluation, site acquisition, contractor planning, management support, design, construction management, and associated services. Expenditures to meet the 20 pCi/m^2s standard or the 6 and 2 pCi/m^2s options are assumed to begin in 1989 and be accomplished over five years. Dollar expenditures are in equal amounts in each of the five years and are expressed in current dollars. The cost of achieving the 20 pCi/m^2s option is estimated to be \$154 million. The 6 pCi/m^2s option is estimated to cost an incremental \$55 million over the 20 pCi/m^2s option. Compliance with the 2 pCi/m^2s option would entail an incremental cost of \$50 million over the 6 pCi/m^2s option, for a total cost of \$259 million.

LICENSED URANIUM MILL TAILINGS PILES

Three separate decisions are addressed in promulgating the new Clean Air Act standards for release of radionuclides from licensed uranium mill tailings piles. The first of these addresses radon-222 emissions after closure. The second decision establishes the final date for the disposal of all presently licensed tailings piles. The third decision addresses alternative work practices for the control of radon emissions from *operating* mills in the future.

Reducing Radon Emissions

The thickness of the earth cover required to achieve a given radon-222 flux is a function of the flux from the pile and the properties of the soil used for cover. Licensed mill tailings piles require the same five basic

TABLE I

20 pCi/m²s Baseline		6 pCi/m²s Options		2 pCi/m²s Option	
Total	Total	Total	Incremental From 20 pCi/m²s Option	Total	Incremental From 6 pCi/m²s Option
RISK	13.7	9.3	4.5	8.0	5.8
COST	154	209	55	259	105

steps needed to implement controls for inactive tailings piles.

The options which are evaluated for reducing the allowable radon emissions after closure (from the 20 pCi/m²s limit established under UMTRCA) are 6 pCi/m²s and 2 pCi/m²s. Table II summarizes the estimated risk for the three regulatory options. Over the 100-year time frame the 6 pCi/m²s option lowers risks by 12.2 committed cancers from the 49.9 committed cancers occurring at the 20 pCi/m²s. The incremental benefit of lowering the allowable flux rate further, from 6 pCi/m²s to 2 pCi/m²s, is an estimated further reduction of 3.5 committed cancers.

The estimates of total costs of achieving the 20, 6 and 2 pCi/m²s limits are also presented in Table II. The cost of achieving the 20 pCi/m²s option is estimated to be $534 million. The additional cost of lowering emissions to 6 pCi/m²s option is estimated to be $154 million. Compliance with the 2 pCi/m²s option would entail estimated additional costs of $295 million. Expenditures to meet each limit are assumed to begin in 1991 and to extend over five years. Dollar expenditures are assumed to be in equal amounts in each of the five years, measured in current dollars.

Date for Final Disposal

The benefits and costs of establishing a date for final disposal of all existing licensed tailings piles were evaluated for closure dates of 1991, 1996, and 2001. Final disposal in each of these cases is assumed to occur five years after closure, thus allowing a five-year period for the piles to dry. Under the current UMTRCA regulations, there is no mandatory date for the final disposal of existing impoundments.

EPA has developed "strawmen" assumptions for the length of delay in final disposal of these piles in the absence of the CAA Standard. The first "strawman" assumption is that there will be a 40-year delay in closure under UMTRCA, and the second assumes a 15-year delay. The benefits and costs are evaluated against these two different delays, which serve as alternative baselines. In both cases, the delay occurs after the five year drying period. Assuming the 40-year baseline, and forcing closure in 1991, 1996, or 2001 reduces committed cancers by 161 (see Table III). This reduction is constant for all closure dates because the committed cancers averted are those estimated to occur during a constant, 40-year delay, regardless of the date of closure of the piles. This estimate is based on the emissions from totally dry piles. Similarly, 60 committed cancers are avoided under the 15-year assumption.

Total costs for each alternative at existing licensed mills under the 40- and 15-year baselines are derived by comparing the baseline disposal cost streams with the cost streams for each date of closure. All costs are discounted at 5%. The results presented in Table III show, as expected, that early closure increases costs. For example, the incremental present value cost of forcing closure in 2001 is $215 million for the 40-year baseline. The incremental cost increases to $275 million for closure in 1996, and to $351 million for closure in 1991.

Future Work Practice Standards

This standard specifies work practices that must be followed in the construction of future tailings impoundments rather than some specified limit on emissions.

Tailings impoundments constructed in the future must meet current Federal standards for prevention of groundwater contamination and airborne particulate emissions. The baseline tailings pile is assumed to be a single large impoundment with a synthetic liner. It is to be built partially below grade, and to have earth dams or embankments. Two alternatives to this single large impoundment are evaluated in this analysis.

The first alternative is phased disposal. In phased, or multiple-cell disposal, the tailings impoundment area is partitioned into cells that are filled sequentially. This disposal method reduces emissions because each cell can be covered, after it is filled and drys out, without interfering with the filling of succeeding cells.

Phased disposal is effective in reducing radon-222 emissions since tailings are initially covered with water and, when finally disposed, covered with earth. Only during the dry-out period (about 5 years for each cell) are there any significant radon-222 emissions, and these are

TABLE II

Costs and Risks of Lowering the Allowable Limit for Licensed Mill Tailings to 6 and 2 pCi/m^2/s. (Committed cancers and millions $)

20 pCi/m^{2}s Baseline		6 pCi/m^{2}s Option		2 pCi/m^{2}s Option	
Total	Total	Total	Incremental From 20 pCi/m^{2}s Baseline	Total	Incremental From 20 pCi/m^{2}s Baseline
RISK	49.9	37.7	12.2	34.3	15.6
COST	534	688	154	828	295

TABLE III

Costs and Risk Reductions for a Date for Final Disposal of All Existing Tailings. (Committed cancers, millions $)

UMTRACA BASELINE		Close 2001 Cover 2006 Incremental From Baseline	Close 1996 Cover 2001 Incremental From Baseline	Close 1991 Cover 1996 Incremental From Baseline
BASELINE: 40Year UMTRACA				
RISKS	190.4	96.3	116.4	136.5
COSTS	78	173	259	352
BASELINE: 15Year UMTRACA				
RISKS	90.1	4.0	16.1	36.1

from a relatively small area. During standby periods, a water cover can be maintained on the cell.

The second alternative impoundment, continuous disposal, utilizes procedures to dewater the tailings slurry prior to disposal. The relatively dry (25 to 30% moisture) tailings can then be covered immediately. This alternative minimizes ground water problems.

Benefits of phased and continuous disposal are the incremental reductions in committed fatal cancers. Risk reductions are shown in Table IV. As can be seen, continuous disposal offers the lowest risk.

Table IV also demonstrates the costs for new model tailings impoundments. Phased disposal is slightly more expensive than continuous disposal, with an incremental cost of $31 million.

SUMMARY

Any estimates of the potential aggregate impact of these standards requires assumptions on the most likely options to be chosen for both *inactive and* licensed mill tailings piles. The combinations selected for discussion in this summary are entirely those of the authors, and do not necessarily represent those that will eventually be selected in EPA's decision making process.

Two combinations are used to estimate the aggregate impact of these standards. The first causes relatively small cost impact and goes little beyond the requirements imposed by UMTRCA. Assuming the UMTRCA imposed

TABLE IV

Costs and Risk Reductions Resulting from Alternative Work Practices (Committed cancers, millions $)

	Single Cell Baseline Total	Phased Disposal Total	Phased Disposal Incremental from Baseline	Continuous Single Cell Total	Continuous Single Cell Incremental from Baseline
RISKS	0.546	0.429	-0.117	0.334	-0.212
COSTS	129	161	31	159	30

limit on emissions, 20 pCi/m^{2}s, in combination with requiring final closure of all presently licensed piles (not meeting the requirements of phased or continuous disposal) by 1996, and requiring phased or continuous disposal for all future tailings impoundments, imposes a total present value cost of $196 million and averts a total of 60 committed cancers over the next 100 years. These are the costs and benefits of the CAA standards, assuming that all the provisions of the UMTRCA have already been met. These results assume there would have been a 15 year delay in the closure of presently licensed piles under the provisions of UMTRCA in the absence of these standards.

The second combination assumes a 6 pCi/m^{2}s emission limit in combination with the final closure of all presently existing piles by 1991 and phased or continuous disposal for all future tailings impoundments. This combination imposes a present value cost of $451 million and averts a total of 77 committed cancers over the next 100 years. As above these results assume the provisions of UMTRCA have already been met, but with a 15 year delay in the closure of presently licensed piles.

REFERENCES

1. U.S. Environmental Protection Agency, "Economic Assessment, Draft Environmental Impact Statement for Proposed NESHAPS for Radionuclides, Vol. 3, Background Information Document," U.S. Environmental Protection Agency, Technical Report EPA 520/1- 89-007.