# URANIUM MILL TAILINGS
# REGULATION AND THE GENERIC ENVIRONMENTAL IMPACT STATEMENT

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## INTRODUCTION

Potential health hazards from uranium milling have been recognized almost since its inception. However, in the past, the major regulatory attention was directed towards the safe operation of nuclear reactors and the safe handling and storage of radioactive wastes generated during the irradiation of the nuclear fuel. During the reactor irradiation portion of the nuclear fuel cycle, fission products and transuranic isotopes are produced with an initial radiotoxicity far greater than the original fuel. Conversely, during the milling operation on the uranium ore, no additional radioactive materials are produced, but the uranium is removed from the ore body. Typical ores in the United States contain less than 0.3 percent uranium, so that esentially all of the ore ends up in the tailings pile. About 85 percent of the radioactivity in the ore finally resides in the mill tailings pile. Some change in the physical and chemical properties of the radioactive material also occur during the milling.

The management and regulation of uranium mill tailings has received increasing attention and interest in recent years from involved federal and state agencies and from environmental conservation groups. This interest has resulted from past events that have indicated that a potential public hazard could be associated with mill tailings piles even though the concentration of radioactivity in tailings is relatively low. The factors contributing to this potential hazard are: large quantities of material, the long half-life of the parent radionuclides, and the high radiotoxicity of the daughter products of radioactive radon gas which is readily transported in the environment. A landmark example is the situation that occurred in Grand Junction, Colorado, which involved the widespread use of tailings in the construction of homes, schools and other public structures.

With the projected significant increase in the mining and milling of uranium, and with the development of additional regulations presently being considered, it is instructive to examine the recent historical record of control measures for uranium tailings management.

## HISTORY

In the late 1960's, the regulation of uranium mill tailings piles was exemplified by the approach used in the state of Colorado. The main items from their "Regulation Requiring Stabilization of Uranium and Thorium Mill Tailings Piles,"[1] published in 1966, are listed in Table I.

TABLE I. Colorado State Regulations

1. Drain ponds and cover piles.
2. Level and grade piles.
3. If pile is next to a river, dike and riprap.
4. Dig drainage ditches around pile.
5. Stabilize against wind and water erosion.
6. Control site access.
7. Maintain pile.
8. Notify state if title is transferred.
9. Obtain prior approval before removing materials.

Industry was a major contributor to these regulations. The first five items are generally directed towards prevention of contamination of waterways and the last four items pertain to site control. The regulation specifies that tailings ponds shall be drained, piles will be leveled and graded so as not to accumulate water, and then the pile is to be covered for stabilization against wind and water erosion. A six inch cover was generally considered acceptable. Additionally, drainage ditches were to be dug around the pile to divert surface water runoff.

Other items listed in that regulation include controlled access and maintenance of the site by the owner. Written approval must be obtained before removing any materials from the site and often this written permission was given. An additional item in the regulation is that notice must be given if title to the site is transferred to a new owner.

Another regulation applicable to reclaimed mill tailings sites is the restriction of radon concentration at the site boundary. A limit of 3 pCi/l is specified in 10CFR20.(2)

In some uranium ore processing areas in the west, enforcement of many of the above regulations was lax. Consequently, reclamation of some tailings piles did not conform to these regulations. Tailings material was being removed for construction, stabilization deteriorated, and population increased around the tailings sites which further compounded the problem. As the problem escalated congressional representatives began actions to provide for federal funds for remedial action at several locations.

At about this same time, several reports were published that presented the evnironmental impacts of the entire nuclear fuel cycle. It soon became apparent to the newly formed Nuclear Regulatory Commission that the risks associated with the milling of uranium were a significant part of the risks of the entire fuel cycle.

In the rulemaking proceedings on the Environmental Effects of the Uranium Fuel Cycle, it was determined that the NRC needed to provide additional support for Table S-3 of 10CFR51.20(d). The effects of radon releases from tailings piles were also to be examined in more detail and tabulated in Table S-3. This was also brought out in the hearings on the Generic Environmental Statement for mixed oxide fuels.

In the spring of 1977, the Fuel Processing and Fabrication Branch of the NRC presented a set of eight performance objectives regarding tailings management.(3) The objectives, listed in Table II, reflected current NRC thinking and were used in all licensing actions prior to the development and publication of formal regulations. The stated purpose of the objectives was to develop acceptable tailings management programs that would minimize ratcheting and endless research,

and argument. It was also a means for greatly reducing the potential risks from the present tailings piles in a relatively short period of time. The performance objectives were successful in achieving these purposes. The objectives are organized into three categories: siting, operations, and post-reclamation. The first four objectives specify that the tailings shall be sited in an isolated area remote from people, that the site is to be designed so as to minimize seepage to toxic materials into the groundwater and to minimize the potential for disruption or dispersion by natural forces. In addition, the blowing of tailings is to be eliminated during normal operation. The last four objectives pertain to the reclaimed tailings after milling operations cease. They include reducing gamma radiation to background and radon emanation flux to twice background. Also, the need for on-going monitoring and maintenance was to be eliminated and surety arrangements were to be provided to assure sufficient funding to complete the full reclamation plan.

TABLE II. NRC Performance Objectives

1. Locate tailings in remote area.
2. Minimize distruption and dispersion by natural forces.
3. Minimize seepage of toxic materials.
4. Eliminate blowing of tailings.
5. Reduce gamma radiation to background.
6. Reduce radon emanation rate to twice background.
7. Eliminate need for an on-going monitoring and maintenance program.
8. Provide surety arrangements for reclamation costs.

Specific preferred management plans to meet these objectives have varied the past few years. For example, about the time the performance objectives were issued, a six-foot composite cover of wet clay (30 percent moisture) and soil was often used as the method to reduce the radon flux to

acceptable levels, More recently below ground burial with at least 10 feet of cover has been preferred.

The increased attention to the control and improvement of mill tailings management was accompanied by an increased desire to improve the reclamation and management programs of some 22 inactive uranium tailings piles. This attention in Congress led to the passage of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. Title II of this Act deals with the licensing and regulation of active and new uranium milling sites. It defines uranium mill tailings as by-product material and calls for the Nuclear Regulatory Commission licenses of such activities to contain terms and conditions to assure that prior to termination of the license "the licenses will comply with decontamination, decommissioning and reclamation standards prescribed by the Commission" and that "ownership of any by-product materials...which resulted from such licensed activity shall be transferred to the United States."

## GENERIC ENVIRONMENTAL IMPACT STATEMENT ON URANIUM MILLING

In June of 1976, the NRC published in the Federal Register, a notice of intent to prepare a generic environmental impact statement on uranium milling (GEIS).

The stated purpose of the GEIS was to "assess the environmental impact of uranium milling operations including the management of uranium mill tailings and to provide an opportunity for public participation in decisions concerning any proposed changes in NRC regulations..." The draft GEIS[4] was issued in April 1979. In the GEIS a model mill and operation were developed and analyzed, then alternatives to that baseline analysis were also considered. The following items were assessed:

1. Radiological Impacts
2. Air Quality
3. Land Use
4. Mineral Resources

5. Water Resources and Impacts

6. Soil Resources

7. Biota

8. Community Impacts

The model case was not intended to be the recommended action. In fact it contained the minimal reclamation effort.

Four interdependent aspects of tailings disposal programs formed the basis for selecting nine alternatives to the base case. Tailings treatment, disposal location, tailings area preparation, and tailings stabilization and isolating cover aspects upon which the alternatives, given in Table III, were selected.

TABLE III. Mill Tailings Reclamation Alternatives

| Alternatives | Description |
|---|---|
| 1 | Compact Subsoil Cover is - 0.6m clay, 2.7m fill, 15cm topsoil. |
| 2 | Below grade disposal with Alternate 1 cover, clay liner sides and bottom, above groundwater. |
| 3 | As 2, but bottom liner, no side liner. |
| 4 | As 2, but special pit, no liner. |
| 5 | Special "Landfill Trench," lined sides and bottom. |
| 6 | Above grade disposal, dam has clay core, beach areas wetted or stabilized with chemical spray, lined bottom. |
| 7 | Below grade in groundwater, overburden cover at least 10m thick, no liner. |
| 8 | Deep mine disposal greater than 100m, fix |

slimes in cement or asphalt.

9 Nitric Acid leach for 90 percent Ra removal. Tailings disposed of as Alternative 6. Cover is 0.2m clay and 1.25m overburden.

## PROPOSED REGULATIONS

On August 24, 1979, the NRC published for comment their proposed regulations and criteria pertaining to uranium mill tailings licensing.[5] These regulations are divided into two parts: 1) Immediately effective final regulations issuing a general license for possession and storage of uranium mill tailings and 2) Proposed regulations amending uranium mill license regulations (10CFR140) that are tailored to a set of criteria based upon the major conclusions of the draft GEIS.[4]

The criteria in the proposed regulations, incorporated from the basic conclusions of the GEIS, can be grouped into technical criteria, financial criteria, and site ownership and surveillance criteria. They are summarized in Table IV.

TABLE IV. NRC Licensing Criteria

1. Locate at remote sites.
2. Minimize disruption by natural forces.
3. "Prime Option" - below grade.
4. If above ground, protect against wind and water erosion.
5. Minimize seepage of toxic materials.
6. Cover (3m) to reduce radon flux to 2 $pCi/m^2S$ above background.
7. One year preoperational environment monitoring program.
8. Reduce milling operation to ALARA.

9. Establish financial surety arrangements for reclamation costs.

10. Pay $250,000 for long term surveillance.

11. Post Reclamation-Transfer Title to United States.

12. Tailings should not need active maintenance.

It is of interest to note the similarity between these criteria (C) and the performance objectives (P.O.). The first criteria states that tailings or waste disposal areas shall be located in remote sites, similar to P.O.1, and C-2 states that tailings shall be located at sites where disruption and dispersion by natural forces are minimized, similar to P.O.2. Criteria 3 states that the prime option for disposal of tailings is below grade, none of the P.O.'s state this. The C-4 specifies that, if tailings are located above ground, then rainfall catchment must be utilized to reduce the possibility of water erosion, topological features shall provide good wind protection, embankment slopes shall be relatively flat, a self-sustaining vegetative cover or riprap shall be provided, tailings shall not be located near a potentially active fault, and if possible, the tailings shall be located in an area of net soil deposition.

Criteria 3 and 4 appear to be specific extensions of C-2 and P.O.2. Seepage reduction, specified in C-5, is also given in P.O.3 and the addition of sufficient cover (recommended minimum ~3m) to reduce radon fluxes to a calculated value of 2 $pCi/m^2S$ above natural background as given in C-6 is very similar to the limitation of radon flux to twice background given in P.O.6. Criteria 7 requires at least one year of preoperational environmental monitoring, and C-8 states that milling operations shall be conducted so that all airborne releases are as low as reasonably achievable (ALARA), a generalization of P.O.4.

The financial criteria, C-6 states that financial surety arrangements shall be established to assure sufficient funds to perform the full tailings reclamation program, a provision also given in P.O.8. In a similar vein, C-10 provides for a $250,000 charge to cover long term surveillance of the site.

Criteria 11 provides for eventual ownership of the tailings by the United States Government in compliance with UNTRCA, and C-12 states that the financial disposition of the tailings should be such that the need for ongoing active maintenance is not necessary, a provision also in P.O.7.

Finally, it is also of interest to note the cost-benefit (C/B) comparisons of the new regulations with those of other regulations. Recent site specific EIS's for mills have resulted in C/B ratios from $700/man rem to $3400/man rem. These values are similar to the $1000/man rem guideline given in 10CFR50 Appendix I for operating reactors.

## REFERENCES

1. "Rules and Regulations Pertaining to Radiation Control," State of Colorado Regulations, part VIII, (December 1966).

2. Title 10 Code of Federal Regulations, Part 20.

3. R. A. Scarano, J. B. Martin and P. J. Magno, "Current Uranium Mill Licensing Issues," (April 25, 1977).

4. "Draft Generic Environmental Impact Statement on Uranium Milling," NRC Report NUREG-0511. (April 1979).

5. Uranium Mill Tailings Licensing and Criteria, Federal Register 44, 50012, (August 24, 1979).