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WASTE DISPOSAL

by

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Introduction

In an earlier submission by the Atomic Energy Control Board (AECB) to the Commission, waste management aspects of uranium mine and mill wastes and their regulation were briefly discussed. It is my intention here to elaborate on this subject, specifically on matters pertaining to uranium tailings. I will emphasize, from the regulatory agency's point of view, where we are today with regard to uranium mine and mill wastes, the degree to which existing technology and practices meet our requirements and objectives on health, safety and environmental protection and our concerns as they relate to the "long-term" management of uranium tailings. Time permitting I will identify a number of the principles, criteria and guidelines that have been developed by the AECB to ensure the safe operations of waste management facilities, specifically those established for the management of uranium mine and mill wastes.

Requirements and Objectives

A fundamental point to be emphasized is that all operations which are part of the nuclear fuel cycle, including uranium mining and milling, result in some discharge of radioactive and conventional wastes. The responsibility rests with the regulatory bodies such as the AECB to determine, on the basis of health, safety and environmental protection, how much and in what form these discharges are permitted. As a general statement of policy the AECB requires that waste management facilities (including handling, transport, and retention facilities for uranium tailings, waste rock piles, etc.) be sited, designed, constructed and operated in such a manner that resulting exposures of workers and the public to radiation and radioactive and toxic substances, and
releases of contaminating materials to the environment are:

i) as low as reasonably achievable;

ii) within the regulatory limits on maximum releases and exposures; and

iii) within the limits of acceptable levels as determined for each specific facility by the appropriate regulatory agencies.

In order to place the matter in a proper perspective it is useful to recognize three phases or periods through which the management and control of uranium tailings will logically progress. The first is the operational period (typically 10-30 years) during which continuous attention to waste handling and retention is exercised. When operations cease a transition phase is entered in which the necessary controls are available and maintained, and stabilization of the tailings and retention structures is undertaken as required to place the system in a passive condition. It might be reasonable to expect this phase to continue for several decades during which time surveillance can be maintained and the transition from storage to passive disposal is effected. The third (or long-term) phase is entered either by design (the facility satisfies the "walk-away" conditions of disposal) or through the loss of institutional controls.

Requirements are set by the AECB and the industry is regulated to ensure the protection of health and safety and the environment during the operational phase. The safe and effective performance of operating facilities is confirmed; however, improvement and optimization will continue to be pursued. The attention of the industry is necessarily directed towards the second and third phases, and the development of innovative techniques and continuous research directed towards the optimization of methodologies for the safe containment and disposal of tailings are both encouraged and required by the regulatory agencies. Our objective is the establishment of uranium tailings disposal facilities that will function without surveillance in the long term where all discharges are at or near background levels and where catastrophic events are improbable or are of little or no consequences.
Experience and Projections

Technologies available and in use today, or being designed into new facilities, coupled with appropriate site selection, quality construction and good operating procedures, can ensure that the impacts on health, safety and the environment will be acceptably low over the period of operations. Further, the methods are compatible with close-out procedures; namely chemical and physical stabilization of the tailings and the retention structures, which will ensure that any releases to the environment and radiological exposures of man will continue to be within the requirements, assuming the continued availability of surveillance.

Historically, tailings have been contained in a saturated state behind some combination of natural and man-made retention structures. There is some concern that these man-made structures or dams could be susceptible to failures following extended periods of neglect or mismanagement. Therefore, recent advances have been made in making tailings impoundment facilities less reliant on care and surveillance. "Impermeable" dams are now being required to minimize seepage; however, the long-term performance of synthetic liners being used in some operations to effect the required impermeability is suspect. The industry, with encouragement from the regulatory agencies, is now giving serious consideration to the placement of thickened tailings behind structures made of natural materials such as compacted tills and clays; thus improving the longer-term integrity of the dams and impounded tailings and minimizing seepage. While certain of these methods would be difficult to backfit into existing operations, new facilities could benefit considerably from their use.

In the long term, assuming the absence of surveillance, the natural erosional forces, whether resulting in a gradual or mass transfer of materials, will almost certainly lead to eventual integration of the wastes with the environment. The resulting impact is impossible to predict with certainty and one should not jump to the conclusion that the impact will be catastrophic or even of substantial concern. Innovative methods of tailings placement with good dam design and close-out procedures can alleviate the concerns of a catastrophic dam failure. In the absence of a catastrophic,
natural event, such as glaciation, the integration of the wastes with the environment is likely to be gradual. In the event of a natural catastrophe (such as glaciation), the consequences of the wastes are likely to be secondary to that of the event itself.

The radium content in the tailings presently emplaced is assured for many thousands of years; hence, the ensuing radon gas emissions are likely to render closed-out sites unacceptable for the construction of dwellings and for subsequent habitation. Thus in the long term, in the absence of adequate controls to limit public access and use, persons could be subjected to unexpected exposures. Removal of radium and other contaminants from the mill tailings is being considered and researched as a possible solution to the long-term problems posed by uranium tailings. Whether the tailings could be stripped of radium to the extent that long-term restrictions on land could be avoided is as yet uncertain. The possibility does exist that land-use restrictions will be necessary and will be enforced throughout that period in which institutional controls permit.

Principles, Criteria and Guidelines

Principles, criteria and guidelines have been formulated by the AECB to advise and guide the industry in its responsibility to protect the health and safety of workers and the public and the environment.

In the management and licensing of radioactive wastes a distinction is made between storage and disposal. Disposal is a method of management which does not rely for its integrity on the continued provision of human intervention, whether this be for monitoring, treatment or restriction of access. Where disposal is not available, management will be by storage which necessarily requires both surveillance and retrievability of the stored wastes. The use of storage as the management method carries with it the obligation to dispose of the wastes as soon as possible.

AECB criteria and guidelines state that:

1. waste management facilities should be designed and operated such that resulting exposures to workers and the public and the releases to the environment are as low as reasonably achievable;
2. waste storage facilities should be designed and operated to ensure that the stored wastes are retrievable;

3. radiation fields at the boundary of radioactive waste management facilities should not differ significantly from natural background levels;

4. waste handling and transport systems should be designed to minimize the risks of accidental occurrences while keeping exposures of the operators to a minimum;

5. it should be demonstrated (based on comprehensive field investigations) that seepage from the facility during operations will have an acceptably low impact on the downstream environment. Otherwise appropriate sealing methods such as grouting or the use of liners or low-permeability blankets must be considered in the design, or an alternate site chosen. A permeability of $10^{-7}$ m/s over the tailings basin is suggested as a guideline value for satisfying the seepage criterion. In the construction of dams or other retention structures the corresponding permeability for the core (a vertical section of the dam engineered, to control the phreatic surface through the dam) is $10^{-8}$ m/s; the design and construction of embankment systems must conform to currently accepted practices and safety criteria. A dam stability analysis must be included in the facility safety report. (The Pit Slope Manual, Chapter 9, Waste Embankments, CANMET Energy, Mines and Resources Canada, is the recognized Canadian reference).

the use of mill tailings for dam construction downstream of the impermeable core section is unacceptable. Waste rock may be used downstream of the core provided it can be demonstrated that its impact on the downstream environment will be acceptably small. Parameters that must be considered in demonstrating the acceptability of waste rock for dam construction include:

1) concentrations of radioisotopes and associated radiation fields;
ii) leachability of contaminants, particularly radium-226;

iii) acid generating potential: waste rock can be placed downstream of the dam core only if analysis shows it to be a non-acid generating material. (*Prediction of Acid Generating Potential, A.R. Ballantyne, Technology Transfer Seminar Notes, November, 1975, Effluent Regulations/Guidelines and Effluent Treatment Technology, EPS, Fisheries and Environment Canada, is the reference document)*;

8. sufficient free board shall be maintained at all times such that over-topping and/or damage to embankment crests or slopes will not occur in the event of flood conditions associated with the 100 year recurring storm. In certain regions, a historical storm may be used for design purposes. Spillways in dam design to provide emergency protection for the crest and downstream face of the dam are encouraged;

9. where chemical treatment such as the addition of barium chloride or flocculant is required to remove radium-226 and other contaminants, the precipitate removal system will have sufficient capacity, retention time or other features which assure that any process water being released to the environment will meet effluent requirements. Precipitation ponds if used must be engineered for ease of retrievability of the settled precipitate. The use of natural lakes, with no prior provision for retrievability and restoration, is unacceptable;

10. management of precipitates, filtrates, etc., usually high in radium-226 content, removed from settling ponds or other engineered systems will include immobilization and storage pending the establishment of a suitable means of disposal. The consequences and hence the acceptability of returning the sludge material to the tailings is currently under investigation;
11. recycle of decant water from the tailings pond to the mill circuit (to the extent permitted by the process) is strongly encouraged. Fresh water demand should be minimized;

12. environmental monitoring will normally include discharge flows and qualities at the last point of control (e.g., at the weir discharge) and at a sufficient number of points downstream of this location to determine the impact of the effluent discharge on ground and surface waters. Seepage pathways should be monitored for flow and quality and downstream impact. Contaminated seepage should be collected and returned to the system.

Sampling and analytical methods shall be as recommended by the appropriate federal and provincial regulatory agencies and as approved by the AECB.

Analyses for radium-226 must include both total and dissolved concentrations. While the present federal standard for mine effluent specifies 10 pCi dissolved radium-226 per litre of effluent, a standard based on total radium is being investigated;

13. site close-out will include chemical and physical stabilization of the tailings and retention structures such that any airborne emissions and drainage streams from the site will continue to meet acceptable regulatory levels of contamination and that the site is acceptable from the standpoint of aesthetics and safety. The criterion will normally preclude the existence of ponds after close-out. The need for the operation of decant systems and other mechanical equipment following close-out is undesirable.

Siting can have a significant influence on the impact or potential impact of a tailings retention facility on the environment. Geographical features of the tailings basin and its relative position to the mill are...
important in avoiding or controlling accidental spills and their consequences. Criteria and guidelines to be considered in siting a tailings management facility include:

14. the site selected should have sufficient capacity to accommodate the projected quantities of tailings. In any event the number of water sheds influenced by a facility should be kept to a minimum, ideally one;

15. the size of the drainage basin relative to the tailings basin is an important consideration. Otherwise fresh water diversion is likely to be required;

16. moving streams or water courses are unacceptable for placement of tailings. The use of lakes is discouraged where dry land sites are available. Deep lake disposal has not been ruled out as a method of tailings management; however, extensive research and investigation would be required before such a method could be approved;

17. unique areas, areas of recreational and commercial use or value and otherwise sensitive areas should be avoided in the siting of facilities;

18. the site should be chosen giving due consideration to erosional forces such as wind and water and geographical instabilities.

Concluding Comments

The approach taken by the AECB in the regulation of nuclear facilities is one which encourages technical innovation on the part of the operators. This is considered to be of particular importance if advancement in uranium tailings technology is to continue at a reasonable pace. The Canadian uranium mining industry is actively encouraged to lead and participate in research and development programs intended to further optimize present-day operations and to resolve the longer-term concerns associated with tailings and their management.
In closing I would like to reiterate that present technology and practices are sufficiently advanced to ensure the safe operations of uranium tailings management facilities - in the present and, with minimal effort, as far into the future as institutional controls are ensured. There are concerns for the longer term and these concerns are being addressed by the industry and government. Our confidence that these concerns can and will be resolved within the foreseeable future contributes to the basis, to our justification, for allowing new tailings facilities to be developed.