Canada's Nuclear Regulator

Management of Uranium Mine Waste Rock and Mill Tailings

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SUPPORT DOCUMENT:
DISCUSSION PAPER ON THE MANAGEMENT OF
URANIUM MINE WASTE ROCK AND MILL TAILINGS

Introduction

Canada's longstanding experience in uranium mining has resulted in world-leading practices for the protection of health and safety of people and the environment. These practices have evolved over time to reflect changes in scientific knowledge as well as societal expectations. Uranium mining in Canada is closely regulated by the Canadian Nuclear Safety Commission (CNSC).

It is anticipated that the CNSC will receive licence applications from proponents of newly proposed mines that would include several different options for the management of mine waste. It is important that the proponents understand CNSC's expectations for managing this waste before they dedicate resources to waste management and before they engage the public concerning their management plans. Moreover, considering recent public interest in uranium mining and exploration, the CNSC believes it is necessary to clarify its position on the key issue of management of radioactive and non-radioactive waste resulting from mining and milling.

Existing regulatory documents for the management of tailings and mine waste rock

The solid waste that is generated from mining and milling requires long-term management (for decades or centuries) and techniques have been developed to safely isolate this waste from the environment. These techniques follow the same principles applied to all radioactive waste management which are contained in CNSC Regulatory Policy P-290:

- The generation of radioactive waste should be minimized to the extent practicable.
- The future impacts of radioactive waste must be assessed.
- The predicted long-term impacts should be no greater than the impacts that are currently permissible.
- Measures to protect present and future generations should be developed, funded and implemented as soon as reasonably practicable.

The CNSC Regulatory Guide G-320 *Assessing the Long-Term Safety of Radioactive Waste Management* describes the approaches for assessing the potential long-term impact that radioactive waste storage and disposal may have on the environment and on the health and safety of people. This guide addresses several main fundamentals:

- long-term care and maintenance considerations
- setting post-decommissioning objectives
- establishing assessment criteria
- assessment strategies and level of detail
- selecting time frames and defining assessment scenarios
- identifying receptors and critical groups
- interpretation of assessment results

For uranium mines and mills, applying these principles has resulted in early development of waste management plans prior to mine construction and the application of effective waste management practices throughout the life of the mine or mill. Furthermore, the CNSC requires a financial guarantee for decommissioning (including long-term waste management) to be in place before facility construction and operation.

The CNSC Policy P-223 *Protection of the Environment* describes the CNSC's expectation of the measures that proponents must take to prevent unreasonable risk to the environment. This policy includes the following:

- Applicants must provide evidence that their provisions to protect the environment are adequate.
- The measures taken to protect the environment should be commensurate with the likelihood and magnitude of potential environmental effects.
- Applicants must recognize that uncertainty exists in science so releases to the environment should be kept As Low as Reasonably Achievable (ALARA).
- Performance of measures to protect the environment will be judged against performance indicators and targets based on sound science.

The approach for managing mine waste rock and tailings is determined on a case-by-case basis for each facility but is expected to be based on Best Available Techniques (BAT). In this way, the operator would select the option that best protects the environment as a whole, taking into consideration technical and socio-economic factors as appropriate. This selection process would be based on an alternatives assessment supported by consideration of best industry practices, scientific data and appropriate techniques for assessing the performance of the management alternatives throughout the life-cycle of the mine (site preparation and construction, operation, decommissioning, abandonment and long-term monitoring and maintenance).

Overview of the management of mine waste rock

In a very general sense, the potential environmental risks associated with the management of mine waste rock arise when the rock is removed from areas where it was formerly isolated from weathering and, for the most part, from biological processes. Mine waste rock is broken and the reactive surface area increases as it is placed in an active weathering environment. This increases the weathering rates and the rates of release of hazardous substances (for example, arsenic and nickel) and nuclear substances (for example, uranium and radium) to the adjacent environment.

Operators are required to classify and separate the rock removed from the mine so that 'clean rock,' which is not an environmental hazard, is separated from 'mine waste rock,' which contains radioactive or hazardous materials, or is potentially acid generating. This separation reduces the volume of waste rock requiring ongoing management and allows the clean rock to be used for other purposes such as gravel for road construction. The waste rock needs to be analyzed and characterized and the appropriate control management methods developed, for both the short-term and long-term, based on these characteristics.

FIGURE 1: On-surface disposal of mine waste rock with an engineered cover

Historically, the management of mine waste rock in Canada involved deposition in stockpiles on a stable land surface adjacent to the mine. Beyond economics, the key considerations for this approach were related to physical stability, with some consideration of slopes to allow construction of a cover to act as a growth medium for revegetation after closure (see Figure 1). More recently, it has been recognized that chemical reactivity of some mine waste rock represents a liability for reclamation and restoration of the environment after closure. A good strategy for the more reactive mine waste rock can be to return it to an environment similar to that from which it was mined. This approach can include using the mine waste rock as backfill in underground mines or placing it in a mined-out pit. In any case, the modern practice is to develop, prior to the start of mining, a waste strategy for this mine rock that allows for long-term environmental protection.

Overview of the Management of Tailings

The tailings produced as part of the ore milling process are one of the key environmental concerns associated with uranium mining. Tailings are the materials left over after the uranium is removed from the ore. The milling of uranium ore also liberates other radiological and hazardous materials requiring tailings preparation processes for long-term stability of these contaminants. Uranium mill tailings can contain several hazardous materials such as arsenic, nickel and molybdenum. The main radiological constituent is usually radium.

Tailings need to be isolated from the environment for the long term and require specially engineered tailings management facilities that use natural and/or engineered barriers

between the tailings and the environment. The goal is to minimize the need for ongoing active management (for example, water treatment) or maintenance (for example, dams that separate the tailings from natural waterbodies). In certain cases, placing chemically stabilized and consolidated tailings under water may be a preferred option since the water limits oxidation and release of contaminants to the environment.

Historical practice in Canada for managing uranium tailings has evolved over time as the science has developed and the consequences of certain management practices became better understood. Initially, end-of-pipe dumping of tailings directly to land or natural waterbodies with no means of control or, disposal of tailings into natural waterbodies with control structures such as dams was considered appropriate. Today, these practices would not be acceptable for tailings management because they have directly impacted several natural waterbodies near the disposal site. These impacts can last for decades.

Above-ground engineered containment structures have had some success for the management of tailings. However, they can create issues related to long-term stability because physical structures must be inspected and maintained over long periods of time. The CNSC's regulatory document G-320 *Assessing the Long-term Safety of Radioactive Waste Management* and the draft IAEA document DS355 *Safety Case and Safety Assessment for Radioactive Waste Disposal***,** both recommend that management options should be selected with minimal reliance on institutional control. Above ground structures need to be well engineered to minimize institutional control and avoid the need for active controls.

FIGURE 2: In-pit disposal of tailings

Another option for tailings disposal is an engineered in-pit facility (see Figure 2). This involves the deposition of tailings within a mined-out pit, engineered in a manner that isolates tailings from the environment. Proper design can effectively protect groundwater during tailings deposition and provide effective long-term isolation. Additionally, since the tailings are deposited below ground surface, they are less susceptible to natural degradation processes such as erosion, frost, seismic activities, etc. Consequently, the need for long-term maintenance and institutional control can be minimized. This tailings management technique allows the implementation of adaptive management measures

should the monitoring results indicate that performance is not as predicted. This method is currently being used at most uranium mills in Saskatchewan.

While this option is ideally suited for the high-grade ore bodies in Saskatchewan, it is recognized that it may be challenging for mines with lower-grade deposits that result in much larger volumes of tailings. However, in all cases, the CNSC expects an applicant for new mines or mills to consider in-pit disposal (or another means of placing the material in an engineered sub-surface repository) where practicable.

Consideration of the use of natural waterbodies frequented by fish for managing tailings and mine waste rock

The use of natural waterbodies for tailings or mine waste rock management could result in the following benefits:

- Natural waterbodies lie in basins so the tailings or mine waste rock would be physically stable relative to placing the material on a sloped surface.
- Water limits ingress of oxygen to the minerals, thereby reducing the rate of release of contaminants to the environment.

However, the use of natural waterbodies for tailings or mine waste rock disposal can result in the following environmental impacts:

- If the lake is filled with waste, it can be permanently lost.
- There can be a loss of resident biota and habitat.
- The waste can contaminate the lake water.
- The lake can impact other natural waterbodies, depending on the site configuration.

It is acknowledged that natural waterbodies can offer similar benefits as in-pit facilities, in terms of physical containment and reducing releases of hazardous and nuclear substances to the environment. However, there are also inherent risks to this approach because of the proximity of the waste material to the aquatic environment. There would be little opportunity for interception and management of unanticipated releases from the waste to the environment.

Consequently, for this option to be considered by the CNSC an alternatives assessment must demonstrate that the proposed use of a natural waterbody is the most appropriate option for mine waste disposal from an environmental, technical and socio-economic perspective.

Summary

The CNSC has considerable experience with management of uranium mine waste (tailings and mine waste rock). Given that applicants for new uranium mines may propose using natural waterbodies frequented by fish for the disposal of uranium mine

waste, the CNSC is setting out regulatory expectations that best available techniques be used and natural waterbodies frequented by fish be avoided for waste disposal and long-term management (see attached document). The CNSC intends to formalize its position in a regulatory document and welcomes comments from all stakeholders on the attached draft.