ATTACHMENT A

Tailing Cell Closure Criteria

TAILING CELL CLOSURE DESIGN REPORT
ENERGY FUELS RESOURCE CORPORATION
PIÑON RIDGE PROJECT

TAILING CELL CLOSURE CRITERIA
per 6 CCR 1007-1, Part 18, App. A.
Licensing Requirements for Uranium and Thorium Processing
Colorado Department of Public Health and Environment (CDPHE)

The criteria contained in 6 CCR 1007-1, Part 18, App. A. applicable to tailing cell closure and cover design are presented below. Some citations have been abbreviated to exclude non-essential text.

- **Criterion 1** for tailing facility siting and design
  - **1D** "*Tailings should be disposed of in a manner that no active maintenance is required to preserve conditions of the site."*

- **Criterion 4** for siting and design
  - **4C** "*Embankment and cover slopes must be relatively flat after final stabilization to minimize erosion potential and to provide conservative factors of safety assuring long-term stability. The broad objective should be to contour final slopes to grades which are as close as possible to those which would be provided if tailings were disposed of below grade: this could, for example, lead to slopes of about 10 horizontal to 1 vertical (10h:1v) or less steep. In general, slopes should not be steeper than about 5h:1v. …."*

  - **4D** "*A full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.*
    (1) Where a full vegetative cover is not likely to be self-sustaining due to climatic or other conditions, such as in semi-arid and arid regions, rock cover must be employed on slopes of the impoundment system. The Department will consider relaxing this requirement for extremely gentle slopes such as those which may exist on the top of the pile.
    (2) The following factors must be considered in establishing the final rock cover design to avoid displacement of rock particles by human and animal traffic or by natural process, and to preclude undercutting and piping: (a) Shape, size, composition, and gradation of rock particles (excepting bedding material average particles size must be at least cobble size or greater); (b) Rock cover thickness and zoning of particles by size; and (c) Steepness of underlying slopes.
    (3) Individual rock fragments must be dense, sound, and resistant to abrasion, and must be free from cracks, seams, and other defects that would tend to unduly increase their destruction by water and frost actions. Weak, friable, or laminated aggregate may not be used.
    (4) Rock covering of slopes may be unnecessary where top covers are very thick (on the order of 10m or greater); impoundment slopes are very gentle (on the order of 10h:1v or less); bulk cover materials have inherently favorable erosion resistance characteristics; and, there is negligible drainage catchment area upstream of the pile and good wind protection as described in Criteria 4A and 4B.
    (5) Furthermore, all impoundment surfaces must be contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. In addition to rock cover on slopes, areas toward which surface runoff might be directed must be well protected with substantial rock cover (rip rap). In

addition to providing for stability of the impoundment system itself, overall stability, erosion potential, and geomorphology of surrounding terrain must be evaluated to assure that there are not ongoing or potential processes, such as gully erosion, which would lead to impoundment instability."

- **Criterion 5** for groundwater protection
  - **5A (1)** "…*For impoundments that will be closed with the liner material left in place, the liner must be constructed of materials that can prevent wastes from migrating into the liner during the active life of the facility."*
  - **5A (2)** "*The liner required by paragraph 5A(1) above shall be: (a) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation; (b) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and (c) Installed to cover all surrounding earth likely to be in contact with the wastes or leachate."*
  - **5A (5)** "*When dikes are used to form the surface impoundment, the dikes must be designed, constructed, and maintained with sufficient structural integrity to prevent passive failure of the dikes. In ensuring structural integrity, it must not be presumed that the liner system will function without leakage during the active life of the impoundment."*
  - **5B (1)** "*Uranium and thorium byproduct material in definition (2) of RH 1.4 shall be managed to conform to the following secondary ground-water protection standard: hazardous constituents entering the ground water from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period."*
  - **5E (1***) "In developing and conducting ground water protection programs, applicants and licensees shall also consider ….. Installation of bottom liners (Where synthetic liners are used, a leakage detection system must be installed immediately below the liner to ensure major failures are detected if they occur."*
  - **5E (3)** "*Dewatering of tailings by process devices and/or in situ drainage systems (At new sites, tailings must be dewatered by a drainage system installed at the bottom of the impoundment to lower the phreatic surface and reduce the driving head of seepage, unless tests show tailings are not amenable to such a system. Where in situ dewatering is to be conducted, the impoundment bottom must be graded to assure that the drains are at a low point. The drains must be protected by suitable filter materials to assure that drains remain free running. The drainage system must also be adequately sized to assure good drainage)."*

- **Criterion 6** for tailing cover design

  - **6 (1)** *"In disposing of waste byproduct material, licensees shall place an earthen cover (or approved alternative) over tailings or wastes at the end of milling operations and shall close the waste disposal area in accordance with a design which provides reasonable assurance of control of radiological hazards to (i) be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years, and (ii) limit releases of radon-222 from uranium byproduct materials, and radon-220 from thorium byproduct materials, to the atmosphere so*

as not to exceed an average release rate of 0.74 Becquerel per square meter per second (Bq/m2s), or 20 picocuries per square meter per second (pCi/m2s), to the extent practicable throughout the effective design life determined pursuant to (1)(i) of this criterion. In computing required tailings cover thicknesses, moisture in soils in excess of amounts found normally in similar soils in similar circumstances may not be considered. Direct gamma exposure from the tailings or wastes should be reduced to background levels….."

- **6 (2)** *"As soon as reasonably achievable after emplacement of the final cover to limit releases of radon-222 from uranium byproduct material and prior to placement of erosion protection barriers or other features necessary for long-term control of the tailings, the licensee shall verify through appropriate testing and analysis that the design and construction of the final radon barrier is effective in limiting releases of radon-222 to a level not exceeding 0.74 Bq/m2s (20 pCi/m2s) averaged over the entire pile or impoundment using the procedures described in 40 CFR Part 61, Appendix B, Method 115, or another method of verification approved by the Department as being at least as effective in demonstrating the effectiveness of the final radon barrier."*
- **6 (3)** *"When phased emplacement of the final radon barrier is included in the applicable reclamation plan, the verification of radon-222 release rates required in paragraph (2) of this Criterion must be conducted for each portion of the pile or impoundment as the final radon barrier for that portion is emplaced. In the case of thorium byproduct materials, the standard applies only to design. Monitoring for radon emissions from thorium byproduct materials after installation of an appropriately designed cover is not required. This average applies to the entire surface of each disposal area over a period of a least one year, but a period short compared to 100 years. Radon will come from both byproduct materials and from covering materials. Radon emissions from covering materials should be estimated as part of developing a closure plan for each site. The standard, however, applies only to the emissions from byproduct materials to the atmosphere."*
- **6 (4)** *"Within ninety days of the completion of all testing and analysis relevant to the required verification in paragraphs (2) and (3) of this Criterion, the uranium mill licensee shall report to the Department the results detailing the actions taken to verify that levels of release of radon-222 do not exceed 0.74 Bq/m2s (20 pCi/m2s) when averaged over the entire pile or impoundment. The licensee shall maintain records until termination of the license documenting the source of input parameters including the results of all measurements on which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. These records shall be kept in a form suitable for transfer to the custodial agency at the time of transfer of the site to the U.S. Department of Energy or State for long-term care if requested."*
- **6 (5)** *"Near surface cover materials, i.e., within the top three meters (10 feet), may not include waste or rock that contains elevated levels of radium; soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding surface soils. This is to ensure that surface radon exhalation is not significantly above background because of the cover material itself "*
- **6 (7)** *"The licensee shall also address the non-radiological hazards associated with the wastes in planning and implementing closure. The licensee shall ensure that disposal areas are closed in a manner that minimizes the need for further*

maintenance. To the extent necessary to prevent threats to human health and the environment, the licensee shall control, minimize, or eliminate post-closure escape of non-radiological hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or to the atmosphere."

- **6A (1)** *"For impoundments containing uranium byproduct materials, the final radon barrier must be completed as expeditiously as practicable considering technological feasibility after the pile or impoundment ceases operation in accordance with a written, Department-approved reclamation plan. (The term as expeditiously as practicable considering technological feasibility as specifically defined in RH 18.2 includes factors beyond the control of the licensee). Deadlines for completion of the final radon barrier and, if applicable, the following interim milestones must be established as a condition of the individual license: windblown tailings retrieval and placement on the pile and interim stabilization including dewatering or the removal of freestanding liquids and recontouring. The placement of erosion protection barriers or other feature necessary for long-term control of the tailings must also be completed in a timely manner in accordance with a written, Department-approved reclamation plan."*

- **Criterion 7** Leakage of hazardous constituents

  "The licensee shall establish a detection monitoring program needed for the Department to set the site-specific ground water protection standards in paragraph 5B(1) of this appendix. ….. The initial purpose of the program is to detect leakage of hazardous constituents from the disposal area so that the need to set ground water protection standards is monitored."