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Colorado Department
of Public Health
and Environment

MAY 25 2010

Mr. Frank Filas
Environmental Manager
Energy Fuels Resources
44 Union Boulevard, Suite 600
Lakewood, CO 80228

Subject: Request for additional information #2

Mr. Filas,

As part of the Division's review of the Piñon Ridge uranium mill application, our review to this point has revealed the need for additional information.

Staff has identified issues raised by continued review of your application and has completed a detailed technical review of the cover design for the tailings cell, as presented in Exhibit K2 of the license application. Our comments are provided in the attachment.

Your response is expected within 45 days of this request, unless you provide justification for an alternate delivery schedule. If you have any additional questions, please contact Phil Egidi in Grand Junction at (970) 248-7162 or electronically at phil.egidi@state.co.us.

Sincerely,

Steve Tarlton, Manager
Radiation Control Program

SFT/sft

Cc:
Phil Egidi
Larry Bruskin

Request for additional information:

Radioactive Materials Application Vol. 1

1. Item 8.B. EF is asking for an authorization to possess yellowcake with a limit of 110,000 lbs. (equivalent to about 120, 55-gallon drums). Please be aware that any increase in this authorization will require a license amendment and associated reviews.
2. Item 8.B, footnote B. Please clarify the units.
3. Item 6.C. Please provide your best estimate of concentrations of U-nat, Th-230 and Pb-210 in the tailings in addition to the radium value provided. It is stated elsewhere in the application (e.g., public dose calculations) that the process will yield an average recovery of 96% for uranium. Please provide a justification for that value, as it is important for calculating public dose. It is our prior experience with conventional acid milling (i.e., Cotter) that uranium recoveries average about 90%.
4. Item 8.D. Where in the plant will the Cs-137 gauges be located? Please provide a figure showing the location as well as methods for securing the sources from unauthorized access.
5. Item 13. Please provide proof of adequate radiation training for Mr. Zach Rogers to be listed as assistant/alternate RSO. Certificates of training and class syllabus should be provided.
6. Item 13. You are listing five authorized users, but at least 2 of them (Brown and Filas) are not located at the mill. Please provide an adequate list of authorized users that will be able to oversee use of radioactive material at the mill, not just those responsible from a corporate level. You must have enough authorized users on the license to cover all the times that uranium processing is occurring.
7. Item 14. The list of instrumentation is logical and acceptable, however since the mill is going to have an automation system why aren't networked radiation monitors planned?
8. Attachment 2. Mill Health and Safety Organization Chart. The chart only shows 4 rad/security technicians. If the mill is going to operate 3 shifts, this may not be an adequate number of techs to cover the shifts, days off, etc.

Ore Stockpile Pad Design Report Vol 2 A5

1. The Operations plan describes in general terms a dust suppression/sprayer system for the ore dump. How will this system operate in the winter? Please provide a description of how this sprayer system, and others that use water (e.g., safety showers) will be able to operate in cold conditions?

Tailings Cell Design Vol 2 A6

1. App. I, page I-2. This paragraph states that tailings solution will only be reclaimed from the tailings cell pool and returned to the mill when water pool depth is 5 ft or greater. While tailings need to be kept moist to prevent dusting and for radon flux mitigation, keeping the tailings column saturated until cell closure may not facilitate dewatering of the cell in a timely manner such that the random fill and radon layers can be added in a reasonable time frame. Please provide a discussion of operational parameters that minimize the time needed for dewatering and settlement and yet provide adequate radon protection and dust minimization.

Evaporation Pond Design Vol 2 A7

1. Please clarify that the netting will meet FWS specifications, as noted by others.

Estimates of Radiation Dose to Members of the Public Vol 11 J2

1. Text on pages 1 and 5 says point and area sources were evaluated, yet Figure 2 only shows point sources. Please fix the figure or the text.
2. Text on page 1 states that uranium removal is estimated at 96% efficient. As discussed above, either justify using that value, or substitute a more defensible value.

Emergency Response Plan Vol. 12, J5

1. According to the Montrose County Master Plan 2010, Appendix F(4), the proposed mill site is located in an area designated as a "moderate" to "substantial" wildfire hazard area. The Emergency Response Plan does not include any provisions or procedures to address wildfire hazards. What measures does Energy Fuels propose to mitigate the impact of a wildfire on the mill, including transportation and access? What measures does Energy Fuels propose to mitigate the possibility of a fire on the site from becoming a wildfire?

Primary Cover Considerations Vol. 13, K2

1. The discussion below contains general conclusion relative to the primary cover components, followed by more specific comments related to the text and attachments. The review evaluated only the proposed cover layers used for the planned water balance approach. Please provide responses to the discussion items and specific questions below. As appropriate, provide revised documents that incorporate the comments accepted, including at a minimum the Tailings Closure Plan, the Radon Barrier Cover Thickness Design, and the Cover Infiltration Analysis.

Radon Barrier

As currently planned, the proposed radon barrier will consist of 4.6 to 7.0 feet of "compacted native soil". The native soil has been classified according to the Unified Soil Classification System (USCS) as predominantly silt (ML), silty sand (SM), and well-graded sand (SW) with some sandy clay (CL) and clayey sand (SC) lenses. According to Table C-4-1 (Appendix C-4, Geotechnical Investigation, Volume 4), undisturbed hydraulic conductivity testing showed values of this material ranging from 5.9×10^{-4} cm/sec to 3.4×10^{-5} cm/sec. This range of hydraulic conductivities is not conducive to forming a low permeability barrier. A low permeable barrier must have a hydraulic conductivity of 1.0×10^{-7} cm/sec or less. A low permeability barrier is required to meet one of the project's stated Design Objectives (Tailings Cell Closure Design Report, Section 3.0, page 2, 3rd bullet: "*Limit infiltration of moisture into, and release of contaminated liquid from, the tailings.*") as well as meet the requirements of NRC (2003)[i] guidance.

Even in theory, a water balance cover is not totally impermeable, but rather limits percolation to an acceptable amount. Acceptable percolation rates into water balance covers are typically determined for each unique project, as actual regulatory compliance values do not exist. For two water balance covers completed in Colorado, the Rocky Mountain Arsenal (RMA) Integrated Cover System uses a compliance number 1.3 mm/yr, while Landfill 5 at Ft. Carson uses 1.0 mm/yr. At the Monticello, Utah site, an EPA goal of less than 3.0 mm/yr of percolation is used for compliance. Note that fairly recent research by Benson (2006)[ii] suggests that even composite covers (e.g., combination of compacted clay/geomembrane/geosynthetic clay liner [GCL]) may have about 3 to 5 mm/yr percolation (integrated over a unit area), depending on climate and other site-specific conditions. Therefore, in order to satisfy the long-term permanence requirement (6 CCR 1007-1, Part 18, Appendix A, Criterion 6(1)) as well as achieve one of the three primary performance objects stated for this Tailings Closure Plan, the radon barrier, or another component of the cover, must be designed to limit infiltration.

Several different concepts have been used in Colorado and the Colorado Plateau area to decrease hydraulic conductivity of the radon barrier and provide protection against water infiltration where the natural soils are insufficient to meet this requirement. For example, at the disposal site constructed for the Rifle, Colorado UMTRA tailings, an 18-in radon barrier of compacted silty clay soil was designed with the upper 12-in of soil amended with bentonite. At the disposal site constructed for the Durango, Colorado UMTRA mill tailings, a GCL was placed on top of the radon barrier on the top slope. In addition, the radon barrier itself was also amended with bentonite. At the Monticello, Utah repository, a 60-mil HDPE geomembrane was designed and placed directly on the radon barrier as a water infiltration barrier. Note that, similar to this proposed cover, the Monticello repository cover was designed as a water balance cover with a capillary break overlying a compacted soil layer radon barrier.

Capillary Break

The capillary break layer used in water balance covers typically consist of fine-grained soils (in this case, defined as soils passing the No. 4 sieve [4.75 mm]) overlying coarse-grained soil. This is consistent with EPA (2003)[iii], ITRC (2003)[iv], Khire, et.al. (2000)[v] and relatively recent research on similar water balance covers at the RMA by Stormont (2007)[vi]. The concept is clearly described by ITRC (2003) as follows:

> *"The capillary barrier is formed by two layers – a layer of fine soil over a layer of coarser material (e.g., sand or gravel). The name is derived from the break in pore structure that results at the interface of the two soil types. The barrier is created in this type of cover by the large change in pore sizes between the layers of fine and coarse material. Capillary forces cause the layer of fine soil overlying the coarser material to hold more water than if there were no change in particle size between the layers. Soil water is held in the fine-grained layer by capillary forces and will not move into the coarse-grained layer until the fine-grained layer approaches saturation near the interface."*

As described in the Tailing Cell Closure Design Report (Exhibit K2, Volume 13), the proposed cover for the tailings pond incorporates a capillary barrier consisting of sand ("filter layer") over sand and gravel ("capillary break / drainage layer" [CBDL]). Several concerns are raised for this proposed configuration as described below.

First, the source of the CBDL is unknown, and has been described differently in the license application. According to Section 4.3.1 of the Tailings Cell Closure Design Report (Exhibit K2, Volume 13) the CBDL will be imported from an off-site source. However, within the radon barrier thickness calculation (Appendix B of Tailings Closure Plan, item 3 under the 4th bullet on page 8), the capillary break material will be from *"...recycled base course (No. 2 and No. 6) from reclaimed pads and roads on site (additional material may also be imported)"*. This is not acceptable for use as capillary break material. All material designed for use as a capillary break must have a specified gradation in order to assure that the contrast in pore sizes that are necessary to form the capillary break have been attained.

Secondly, although a capillary break may be possible at the interface between the filter layer and the CBDL, the concept of a "capillary break" as part of a water balance cover is to store additional moisture within the vegetative growth medium (e.g., designed depth of plant roots). As currently planned, it appears that the capillary break would allow additional moisture storage in the 0.5-ft sand filter layer, which will not provide the additional "sponge" effect for moisture storage.

Finally, prior to the Division's acceptance of a final cover design that uses the capillary barrier principle, specific capillary break testing in the laboratory must be performed with the actual materials planned for use to demonstrate that the capillary break will actually form. Section 6.1.1 of the Tailings Cell Closure Design Report commits to capillary break testing within the third year of mill operation. Provided other cover issues are resolved, the Division will accept this schedule for demonstrating that the capillary barrier will form.

It is expected that for the capillary break testing, standard geotechnical as well as hydraulic properties of the materials should be determined. In addition, column experiments should be run to collect soil tension data and suction head at breakthrough (the most relevant measure of capillary break performance) on any proposed design. The column should be designed to represent, as closely as possible, the materials planned for full-scale use.

Filter Layer
The stated design criteria of the filter layer is to work in combination with the CBDL and limit infiltration as well as prevent migration of soil fines into the CBDL in order to preserve the capillary break effect. Given the discussion above for the CBDL, the overall usefulness of this layer is questionable. Pending further discussion, this layer may not be required in the cover system.

Bio-intrusion Barrier
The biota-intrusion barrier is currently designed to be 1-ft of native soil matrix with 3-in cobbles. It is stated that "*The cobbles will be placed so that they overlap within the soil matrix*". This description is confusing and no technical basis has been provided. How the 3-in cobbles will be overlapped as well as how it will be quality assured has not been discussed. A specific gradation has not been provided. It seems that if the cobbles are not adequately distributed, the material will appear similar to the native soil above and will not discourage burrowing animals. Note that at the Monticello site, the biota-intrusion barrier is described as "cobbles filled with soil", and not a soil matrix with cobbles.

Native Soil
As you know, the native soil layer must act as the "sponge" layer that stores moisture during periods when plants are dormant (e.g., winter) and then allows the plants to transpire the moisture out of the cover during active growing seasons (e.g., summer). In addition, the layer must have adequate thickness to support vegetative root growth. The native soil layer is sometimes described as the "vegetative growth layer" or "root zone layer". For the vegetative species planned for this project (assumed to be the mix shown in Attachment F to Attachment B, Kleinfelder Memorandum, page F-5), several species are described in the literature as having root depths greater than the currently planned 2-ft. For example, Reynolds and Fraley (1989)[vii] state: "*Roots of Indian ricegrass (Oryzopsis hymenoides) and standard crested wheatgrass were both found to depths of 150 cm*... (~ 5-ft). Benson (2008)[viii] points out that another species of Indian ricegrass, *Achnatherum hymenoides*, has a rooting depth greater than 3-ft. Reynolds and Fraley (1989) also state that Squirreltail bottlebrush (*Elymus elymoides*) roots were found in their study to a depth of 100 cm (3.3-ft), and actually may have deeper roots. The above does not represent an all exhaustive root-depth search for the various vegetative species proposed.

Based on past experience in Colorado with landfill caps that have used a water balance "alternative cover" approach, a nominal thickness of 4-ft for the water storage layer is the ***minimum*** thickness that should be planned, even if numerical modeling suggests that a thinner cover is capable of the required water storage capacity. This was also the approach used for design of the water balance covers at RMA and Ft. Carson. A conservative design is required for both vegetation and water storage reasons to account for uncertainties that cannot be modeled. Note that for the Monticello, UT repository, which is geographically closer to Piñon Ridge than then the Front Range sites, a water storage layer depth of 163 cm (5.3-ft) was used.

Specific Comments – Tailings Closure Plan
In addition to the more general concerns discussed above, we have found specific items related to the cover design analysis that need to be clarified. These are detailed below.

1. Section 4.3.1, Radon Barrier, pg 6 – The last paragraph of this section generally describes the method for radon barrier placement. There is no discussion, however, on raising the moisture content of the natural soils to the required ± 2% optimum moisture content (OMC). According to EPA (1993)[ix], if the water content of a barrier layer soil is to be increased by more than 3 percentage points, at least 24 to 48 hours should be required for uniform absorption of water and hydration of soil particles. According to Table 1 of the Phase 2 Geotechnical Field and Laboratory Test Program (Volume 4), the in-place moisture content averaged about 4.5%, however, the OMC averaged about 12.2%. Therefore, the moisture content of the soils for the radon barrier will need to be raised about 7.7%. Provisions should be made for allowing adequate time for moisture conditioning as recommended by EPA. In addition, the water quantity needed for soil processing will be significant, and should be taken into account for overall planning purposes.

2. Section 4.3.1, Capillary Break/Drainage Layer, pg 7 – The last paragraph of this section states that the CBDL will limit root penetration into the radon barrier because soil moisture will be concentrated in the CBDL rather than the drier radon barrier. We disagree with this concept. As discussed above, the proposed radon barrier material OMC averaged about 12.2%. In addition, the estimated long-term gravimetric moisture content and long-term volumetric moisture content of the radon barrier material were both assumed to be 13% (Attachment B, Radon Barrier Cover Thickness Design, Section 4.2.6, page 15). When water is theoretically "draining" through this layer, the soil above in the "native soil" layer is assumed to be saturated, so the plants will obviously have adequate moisture. However, during drought or dry conditions, it is assumed that the CBDL will be dry or at least have a moisture content less than the OMC. According to standard design charts such as the U.S. Bureau of Reclamation (1987)[x], the average OMC of GW or GP material is about 11%. Therefore, we conclude that the long-term radon barrier moisture content (assumed ~ 13%) will be greater than the long-term CBDL moisture content, and the soil moisture will ***not be*** concentrated in the CBDL.

3. Section 4.3.1, Erosion Barrier/Vegetative Cover, pg 8 – The fifth paragraph discusses vegetation mix. This is a different mix than that shown in Attachment F to Attachment B, Kleinfelder Memorandum, page F-5. The proposed seeding should be clarified and made consistent between this section and the Kleinfelder memo. The percentages as well as the actual species name (in addition to common name) should be provided to eliminate confusion. For example, it is not known which of the two species of Indian ricegrass (as discussed in the Native Soil general comment above) is planned for use.

4. Section 4.3.2, Modeling Results, pg 12 - The climate set used for the modeling, as described in this section, was the data for the years between 1999 and 2007. Although this is recent chronologic data, it is not necessarily a conservative assumption, because it is unknown whether this time period was a wet, dry, or average time period. In lieu of using the entire record, Benson (2008) suggests that the climate set for water balance cover modeling consist of one of the following: 1) wettest year on record repeated sequentially to simulate a prolonged wet period; 2) wettest 10 year period; or 3) year with highest precipitation/potential evapotranspiration (P/PET) ratio. Alternative 3 was used for modeling the covers at RMA, with the year 1983 selected because it had an unusually high potential for deep percolation.

5. Section 5.3.3, ET Cover Construction, pg 19 – The last paragraph states that rock mulch will be mechanically mixed into the soil of the final lift. This procedure, as minimally described, appears to be incompatible with maintaining a low density soil layer. The low density layer is required to optimize root growth in the native soil layer. However, the use of heavy equipment to "mechanically mix" the rock mulch will clearly increase the soil density above the stated placement specification (according to pg 8, maximum 85% standard Proctor density). Once the native soil mass has been placed and graded, ***no traffic***, particularly wheeled equipment (e.g., haul truck, pickup truck, scraper, loader, etc.) should be allowed on the cover. The mixing of gravels into the native soil should be planned as an operation outside of the cover footprint and placed with low ground pressure equipment.

6. Section 6.1.2, Field Test of Cover Design, pg 22 – a) The second paragraph discusses the establishment of a test cover with vegetation but using soil amendments that would not be used on the full-scale cover. This would be used to assess the effects of vegetation on the cover. It is our understanding that the use of amendments could change the nature of the vegetation compared to non-amended areas (e.g., rate, type, quantity, etc.). The test cover should emulate the full-scale cover to the maximum extent possible; therefore, the use of amendments on the test cover only should not be done if the results are to be applied to the full-scale cover.

   b) The third paragraph discusses the use of ceramic cup lysimeters. The Division recommends the use of Alternative Cover Assessment Project (ACAP)-style pan lysimeters instead. Additional references and information concerning this type of lysimeter can be provided upon request.

Attachment B – Radon Barrier Cover Thickness Design

7. Section 2.3, Assumptions, page 8, 4th bullet, number 5 – This item states that the erosion/vegetative cover will be placed in 6 to 8-in lifts and compacted to 85% standard Proctor dry density. Based on past experience, the Division recommends that, for water balance covers, a full-thickness mass of soil be placed rather than several thinner lifts for this layer. The primary concern with constructing water balance covers with respect to density typically involves compacting the vegetative growth soil ***greater*** than their Growth Limiting Bulk Density (GLBD), thereby limiting root growth, as described by Goldsmith and others (2001)[xi]. From a geotechnical engineering perspective, a simple solution to limit compaction density is to increase the lift thickness and require the specified moisture content to be less than the soil's optimum moisture content. A full-thickness soil lift technique was used successfully at RMA with minimal failing density tests during construction.

8. Section 4.2.6, page 15, Estimated Long-term Gravimetric Moisture Content of Radon Barrier – This parameter is stated to be 13% and discussed in Section 2.3. Section 2.3 states that this parameter was based on the Kleinfelder Memo in Attachment F. The Kleinfelder Memo in Attachment F is based on a literature search, and not on actual sampling and testing of soils proposed for use. Specifically, the water content (at 15 bar) for the Kleinfelder Memo was based on a USDA Soil Survey of the area, using the Mikim Loam generic description for the input parameter. The Division recommends that actual soil data be used to determine this parameter. In particular, three soil samples were tested for hydraulic characteristics and soil water characteristic curves (SWCC) were generated (Phase 2 Geotechnical Investigation, Appendix C-7). From these curves, the 15-bar volumetric water content can be directly determined, then converted to the required gravimetric water content. Another technique is to directly read (or calculate) the wilting point on the SWCC, using the curve's inflection point as the wilting point indicator. At any rate, site-specific data is always preferred relative to data gathered from large-scale sources such as USDA reports.

Attachment D – Cover Infiltration Analysis

9. Leaf Area Index (LAI) – The memo in this attachment states that the LAI was based on the Kleinfelder memo of August 2008. The Kleinfelder memo of August 2008 is assumed to be the one contained in Attachment F to Attachment B to the Tailings Cell Closure Design Report. As discussed above, the Kleinfelder memo in Attachment F to Attachment B is based on a literature search, and not on an actual field investigation. The LAI values are significantly overstated, and do not represent a conservative assumption. In particular, a LAI of 3 is not feasible given the climate and expected vegetative conditions. In contrast, cover modeling at RMA used a maximum LAI of 0.45. At the Monticello site, measured LAI after cover construction and vegetation establishment ranged up to 0.85 maximum. The model for this cover should be rerun using a more realistic LAI for input. It may also be helpful to run a "sensitivity analysis" using a range of LAI inputs.

10. Table 1, van Genuchten Parameter α – The value used for "α" for the capillary break layer is shown as 2.41, which, the Division understands, is physically impossible. By definition, α must less than one. Typical values of α ranged from about 0.0005 to 0.005 for compacted clays to about 0.01 to <1 for clean sand with little fines. The values for α should be checked and changed where appropriate.

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[i] U.S. Nuclear Regulatory Commission, (2003), *Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978*, NUREG-1620, Rev. 1

[ii] Benson, C.H., 2006, *Introduction to Water Balance Covers*, presented at Alternative Covers for Landfills, Waste Repositories, and Mine Waste Workshop, Denver, CO, November 2006.

[iii] EPA, 2003, *Evapotranspiration Landfill Cover Systems Fact Sheet*, Solid Waste and Emergency Response, EPA 542-F-03-015.

[iv] Interstate Technology & Regulatory Council, 2003, *Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers*, Alternative Landfill Technologies Team.

[v] Khire, M.V., Benson, C.H., and Bosscher, P.J., 2000, *Capillary Barriers: Design Variables and Water Balance*, Journal of Geotechnical and Geoenvironmental Engineering, August 2000.

[vi] Stormont, J.C., 2007, *Evaluation of Capillary Barrier Design for Rocky Mountain Arsenal Covers*, prepared in support of the Integrated Cover System Design Project, Revised 100% Design Package, October 23, 2007.

[vii] Reynolds, T.D., and Fraley, L., 1989, *Root Profiles of some Native and Exotic Plant Species in Southeastern Idaho*, Environmental and Experimental Botany, Vol. 29, No. 2, pp 241 – 248.

[viii] Benson, C.H. 2008, *Alternative Covers: Theory, Design and Practice*, Workshop Sponsored by EPA Region 7 HQ, Kansas City, KS, November 2008.

[ix] EPA, 1993, *Quality Assurance and Quality Control for Waste Containment Facilities*, Technical Guidance Document, EPA/600/R-93/182.

[x] U.S. Department of Interior, Bureau of Reclamation, 1987, *Design of Small Dams*, Third Edition, U.S. Government Printing Office.

[xi] Goldsmith, W., Silva, M., and Fischenich, C., 2001, *Determining Optimal Degree of Soil Compaction for Balancing Mechanical Stability and Plant Growth Capacity*, ERDC TN-EMRRP-SR-26, U.S. Army Engineer Research and Development Center, Vicksburg, MS.