## TECHNICAL EVALUATION REPORT

## U.S. NUCLEAR REGULATORY COMMISSION STAFF REVIEW OF UMETCO MINERALS CORPORATION, GAS HILLS RECLAMATION PROJECT, ABOVE-GRADE TAILINGS IMPOUNDMENT AND A-9 REPOSITORY EROSION PROTECTION ENHANCEMENT DESIGN REPORT

**DATE:** August 22, 2011

**LICENSE NUMBER:** SUA-648 **DOCKET NUMBER**: 040-0299

**LICENSEE:** UMETCO Minerals Corporation

**FACILITY:** Above-Grade Tailings Impoundment (AGTI) and A-9 Repository (A-9), Gas Hills Uranium Reclamation Project, Fremont and Natrona Counties, Wyoming

**TECHNICAL REVIEWERS:** Dominick Orlando, Douglas Mandeville, Ted Johnson, Roman Przygodzki, and Zahira Cruz.

**SUMMARY AND CONCLUSIONS:**

On December 21, 2010, Umetco Minerals Corporation (Umetco) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for approval of an enhanced erosion protection design for the erosion protection layer of the rock cover at Umetco's Gas Hills Reclamation Project in Fremont and Natrona Counties, Wyoming [Umetco 2010a]. This enhancement was necessary to address sub-grade erosion which resulted in shallow incisions in the erosion protection layer. NRC staff reviewed the repair approach in Umetco's erosion protection design report and found that the proposed changes to the bedding layers of the rock cover are acceptable. Staff also reviewed the proposed work activities and radiation safety program and found them to be acceptable and protective of the public health and safety and the environment. Finally, staff reviewed Umetco's cost estimate for completing erosion protection enhancements and found it to be acceptable.

**DESCRIPTION OF PROPOSED ACTIVITY:**

Monitoring and inspection activities performed by Umetco on the AGTI and A-9 Reclamation Covers have identified isolated areas of concern associated with the erosion protection layer, namely sub-grade erosion that resulted in isolated, shallow incisions of the underlying cover soils, caused by what Umetco believes is a design error in the cover. It does not appear that these incisions have resulted in a release of tailings or degradation of the radon attenuation capacities of the completed reclamation covers. Umetco proposed placing a bedding layer under the AGTI and A-9 covers by either of two methods. The first method would involve removing the Type C rock[1] cover, laying down a bedding layer, and re-emplacing the cover. The second method would involve laying the bedding layer material on top of the Type C rock

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[1] The rock cover consists of 3 rock layers referred to as Type A, B, or C rock depending on the mean diameter ($D_{50}$) of the rock. Type A rock has a $D_{50}$ of 0.5 inches, Type B rock has a $D_{50}$ of 3 inches and Type C rock has a $D_{50}$ of 6 inches. Type C rock is placed on the lowest portion of the tailings pile, Type B the middle and Type A on the top of the pile. The bedding layer would consist of 30% quarry fines and 70% rock with a $D_{50}$ of less than 2 inches.

and using a mechanical vibrator to move the bedding layer material under the Type C rock. Umetco also proposed to install multi-layer filters zones on the upstream and downstream sides of the launch rock structure to reduce erosion and repair erosion sink holes that have developed upstream of the launch rock structure. Finally, Umetco proposed repairing the erosion control apron on the southeast corner of the AGTI by placing riprap around the apron channel.

**BACKGROUND:**

Umetco uranium mill reclamation project site is located in the East Gas Hills area of central Wyoming, approximately 50 miles (80 kilometers) southeast of Riverton, Wyoming and west of East Canyon Creek. The Umetco site is licensed by the NRC under Source Materials License SUA-648 to possess byproduct material in the form of uranium mill tailings, as well as other radioactive wastes generated by past uranium milling operations.

The mill operated from 1960 to 1979 and has since been dismantled. The current Umetco site consists of three primary tailings disposal areas on the 1,920 acre parcel – the 170 acre AGTI, the 55 acre A-9, and the 60 acre Heap Leach Area. In addition, the Gas Hills Pond No. 2 area, adjacent to the Heap Leach Area, also contains waste from heap leach operations.

Umetco submitted a reclamation plan for the AGTI area of the site in 1980 [D'Appolina 1980]. During the mid-1990s, the existing reclamation plan was reevaluated to address potential erosion of the cover design, as well as additional contamination identified adjacent to the existing cover. In addition, in view of NRC's position on the acceptance of previously approved reclamation plans and license termination requirements, Umetco re-examined the AGTI reclamation design and the completed work, and concluded that license termination would not be possible with the existing erosion protection design. Umetco submitted an enhanced reclamation plan for the AGTI area on October 6, 1997, that involved: (1) extending the existing radon barrier to address the additional contamination; (2) regrading areas of the impoundment; (3) installing a 137.16-cm (54-inch) frost protection layer; and (4) installing riprap erosion protection [SMI 1997]. The NRC approved this enhanced plan in 1999 [USNRC 1999a]. In 2000, Umetco submitted a request for approval of modification of the erosion protection design to prevent potential disturbance of cultural resources discovered during reclamation activities [Umetco 2000]. The modification was approved by NRC in April 2001 [USNRC 2001]. Work in this area was completed in 2002.

The A-9 is a former open pit uranium mine that was used for tailings disposal, including tailings from the Riverton, WY Title 1 site. The original reclamation plan was previously approved by the NRC, but the cover was never constructed. Umetco submitted a revised reclamation plan in 1998 to implement modifications to the A-9 [SMI1998]. The NRC approved the revised reclamation plan in 1999 [USNRC1999b]. This approval allowed for the North and South Evaporation Pond liners to be placed in the A-9 and for the slopes of the North and South Evaporation Ponds to be regraded. The A-9 reclamation cover includes a 45.72-cm (18-inch) thick radon barrier, 137.16-cm (54-inch) thick frost protection layer and an erosion protection layer. Work in this area was completed in 2006.

On June 29, 2007, Umetco submitted the Construction Completion Report documenting the completed construction activities at the site inclusive of the AGTI and A-9 reclamation covers [Umetco 2007]. The Construction Completion Report was subsequently approved by License Amendment 60, dated September 8, 2008 [USNRC 2008].

On December 21, 2010, Umetco submitted an evaluation that identified what Umetco believed was the reason for the sub-grade erosion, namely a deficiency in the design of the erosion protection system in the areas of the incisions, and requested approval of an enhanced design to correct this deficiency [Umetco 2010]. The incisions were first identified by Umetco during routine field inspections. Subsequent field investigations and review of approved design documents by Umetco identified the cause of the sub-grade erosion as an error in the calculation of the interstitial velocity for determining if a filter or bedding layer is necessary in the erosion protection design. Umetco stated that they had completed a review of approved designs associated with all reclamation cover systems constructed at the site to ensure the design deficiency is confined to AGTI and A-9 and that other potential contributing factors are adequately addressed.

## TECHNICAL EVALUATIONS:

### NRC Staff Evaluation of Licensee's Analysis of the Cause of the Erosion

On April 20, 2011, NRC staff provided written comments on Umetco's analysis of the cause of the sub-grade erosion and Umetco's proposed erosion protection enhancement design [USNRC 2011a]. The NRC staff stated that, contrary to Umetco's assertions, the staff believed that the sub-grade erosion in the Type C rock layers may have been produced by freezing of the rock layers above the soil layer, causing a "bridging" effect where "tunnels" occurred under the rock - and above the soil layer - providing a low-resistance pathway for snowmelt runoff to produce sufficiently high velocities to erode the soil cover. After the snow had melted and the rock bridges had thawed, the rock collapsed into its current configuration. The staff based its conclusion on the following:

1. The staff believes that interstitial velocities alone (in the Type C rock) are not great enough to cause the significant erosion that occurred at the Umetco site. The interstitial flow velocities estimated by Umetco using NUREG/CR-4620 [NRC 1986], of 0.5 to 1.0 feet per second (ft/sec), are usually not great enough to cause such erosion. The staff also examined methods other than those found in NUREG-4620 for computing interstitial flow velocities, including *"Estimation of Flow Through and Over Armored Slopes,"* [Codell 1990]. Using information in this article, the computed interstitial velocities for 6-inch rock on a 10 percent (10%) slope were about 0.5 ft/sec, less than normally required for significant erosion.

2. If a larger flow area than the area of the rock voids is assumed to occur, caused by freezing and "bridging" of the rock layers, a gully on a 5% - 10% slope could cause extensive erosion of the underlying soil. As shown on photos provided by Umetco, the gullies appear to be about 1-2 feet wide and 1-2 feet deep, indicating that freezing and bridging of the Type C rock layers may have produced openings with an area of at least one square foot. Concentrated flows in large openings on such steep slopes could produce flow velocities in excess of 2-3 ft/sec, which would be sufficient to cause the observed significant erosion.

3. The staff considers that some soils that become saturated, freeze, and then thaw may have a significantly reduced resistance to erosion and movement in the recently-thawed condition. The staff examined information provided in references such as *"Effects of Freeze-Thaw Cycling on Soil Erosion," (L. W. Gatto, et al)*, indicating that recently-thawed soils may have significantly reduced resistance to erosion [Gatto 2001].

4. Particularly large shear stresses can be produced in those areas where the Type B layer ends and the Type C layer begins. These excessive shear stresses can be produced where there is a slope change and the flow passes through critical depth.

5. Based on the aerial photographs of the snow cover that were provided by Umetco, and Umetco's interpretation of the snow cover, it appears that snow drifts tend to concentrate in certain areas where the slope changes or in areas where the rock size transitions from one size to the other [USNRC 2011b]. Such concentrations of snow could result in concentrations of runoff due to rapid melting. Coupled with decrease in shear strength and the increase in shear stresses discussed above, this could lead to erosion problems.

On May 10, 2011, Umetco responded to the NRC staff's comments and reiterated their belief that the sub-grade erosion was caused by a lack of bedding layer beneath the Type C rock [Umetco 2011a]. Umetco based their conclusions on the following:

1. In order for the rock layer to freeze it would have to be saturated. As both the Type B and Type C erosion protection layers are comprised of coarse-grained free draining materials and the erosion protection material is placed on a fairly steep uniform slope (≥ 10-percent), it is difficult to envision a condition in which the rock layer would become completely saturated, freeze and subsequently develop the proposed bridging effect. While the presence of drifting snow is apparent and snow could be driven into the voids in the rock covers, there is not enough water content in a snow pack/drift to completely saturate the layer and provide for freezing/bridging conditions to occur. Typically fresh snow exhibits a water content of 7% - 12% and a deep, high altitude, compacted snowpack exhibits a water content of 30% - 50%, with the 50% value occurring during spring melt conditions. The physics of snow melt are such that a snow pack/drift begins to melt when its temperature from top to bottom equalizes at 32-degrees Fahrenheit. Before reaching this isothermal state, the snowpack has different temperatures at different depths and some edge effect melting/runoff can occur. Due to the free draining characteristics of the rock layers and steepness of the slope it seems reasonable that melt water would runoff of the slope and not have the residence time required to freeze or re-freeze the rock layer. Snow pack/drift water content and snow melt references include *Martin A. Baxter, Charles E. Graves, and James T. Moore, "A Climatology of Snow-to-Liquid Ratio for the Contiguous United States", Weather and Forecasting, Vol. 20, Issue (5), pgs. 729 – 744(October 2005); California Data Exchange Center, snow "Depth and Density", Department of Water Resources California (2007); and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and U.S. Department of the Interior-U. S. Geological Society web sources.*

2. In addition to the lack of adequate water content/saturated conditions, the subnivean conditions which exist in and underneath a snow pack/drift would inhibit freezing of the rock layers.

3. The erosion rills which have formed on the AGTI (under the Type C riprap cover) exhibit dimensional and depositional characteristics which are identical to those found on the southern slope of the A-9 Repository. Due to the prevailing wind, little, if any, snow would accumulate on the southern slope and the possibility of conditions contributing to a frozen rock layer on the A-9 Repository are nonexistent, as the rock layer is free draining, a steep/well drained slope is present and unsaturated moisture conditions exist within the rock layer.

4. Umetco agreed that interstitial flow velocities less than 0.5 ft/sec are not great enough to cause significant erosion on the structure slopes in question. No erosion has been detected on slopes covered with Type A, Type B and/or Type C riprap where the computed interstitial velocity is 0.5 ft/sec or less. Erosion rills have only formed or been detected on slopes where the interstitial velocity exceeds the 0.5 ft/sec threshold velocity cited in NUREG-1623 [USNRC 2002].

5. Umetco reviewed a reference published subsequent to the reference cited in the NRC staff comment 3, above, *Quantifying the Effect of a Freeze-Thaw Cycle on Soil Erosion, M.G. Ferrick and L.W. Gatto, July 2004*. The focus of this study was to quantitatively test the hypothesis that soil freeze-thaw processes significantly increase the potential for upland slope erosion during runoff events that follow thaw. According to this study, three conditions must exist for ground ice to become a substantial component of a soil mass:

1. Adequate supply of soil moisture,
2. Sufficiently cold air temperatures to cause heat loss and freezing, and
3. A frost-susceptible soil with a significant silt component (Anderson, et.al., 1978).

While the first two conditions may exist at the Gas Hills site the third does not (i.e., silts with available soil water are most susceptible to changes in strength and erodibility caused by the freeze-thaw cycle). The results of this study were based on a soil composed of 82% silt- and clay- sized particles and a liquid limit of 28%. Frost protection soils at the Gas Hills site classify as a SC (clayey sand) with only an average 36% silt and clay sized particles with an average Plasticity Index of 18 (very low silt content), and significant portions of medium and coarse grained sand. Accordingly, the cover soils at the Gas Hills site would not be considered as susceptible to reduced resistance to erosion as those soils identified by the referenced study.

Staff reviewed the information provided by Umetco and found the explanation of the current problem and the potential for future erosion of the cover to be reasonable. Based on the review of Umetco's responses to staff questions, the staff agrees that: (1) it is unlikely that the rock layer will be saturated; (2) freezing conditions under the snowpack are inhibited by the snowpack thickness; (3) snow drifts may not be the cause of the excess runoff conditions; (4) there are no rills/gullies formed on the flatter slopes in both the Type B and Type C rock layers, indicating that NUREG-1623 provides proper design criteria and that interstitial velocities are less than 0.5 ft/sec in the Type B rock; and (5) changes in soil strength are unlikely due to the types of soil present under the rock layers [USNRC 2002].

**NRC Staff Evaluation of Licensee's Proposed Repair and Approach**

The NRC staff evaluated the proposed enhancement, which includes the placement of a bedding layer under portions of the Type B, and all of the Type C rock, and has concluded that the proposed enhancement is acceptable and should ensure that sub-grade erosion is minimized. This conclusion is based on the following:

1. Umetco provided information in their December 2010 Design Report showing that the sub-grade erosion was not occurring in areas at the site where a bedding layer had been emplaced during the initial construction. During evaluation and testing, Umetco had placed some bedding material in several limited areas of the Type C rock, and the small gullies that occurred had actually "stopped" in those locations where bedding had been placed. That is, where bedding had been placed, gullies had occurred upstream of the bedding, but did not progress further downstream into the areas where bedding existed. Placement of a bedding layer is currently considered a typical "good practice" for riprap covers on steep slopes to prevent sub-grade erosion. Umetco committed to increasing the width of the bedding layers under the Type C rock to include a 25 foot wide strip under the existing Type B rock layers. This will provide a 50-foot-wide bedding layer beneath the Type B/C rock interface.

2. The staff reviewed the design of the Type C rock and concluded that the design bases for the rock layers placed on the steeper side slopes of the tailings cells are very conservative. Even in the unlikely event that future gullying occurred, the Type C rock is sufficiently large to prevent further erosion of the soil cover and radon barrier under the gullied areas.

3. The licensee's proposed bedding design provides a reasonable approach to stabilizing the rock cover until the rock voids are eventually filled with wind-blown soils. After the voids are filled (assuming 20-50 years), the rock layer will be even more stable than it is in its present condition.

4. The NRC staff evaluated the two methods proposed by Umetco to repair the erosion protection layer. Based on the information provided by Umetco, both methods should be adequate to ensure that bedding layer is properly emplaced. The first method, removal of the existing layer and placing a bedding layer on the soil, does not involve any new or innovative activities and thus should be adequate. The second method, vibrating the bedding layer into the existing Type C rock layer, was evaluated by Umetco in a demonstration project at the Rattlesnake Quarry near the site in 2010 (Section 3.3 of 12/10/report). Based on this evaluation, Umetco concluded that the proposed process should be adequate. However, in order to ensure that the bedding material is behaving as assumed in the demonstration project, Umetco will incorporate a Quality Control Plan that includes an evaluation of the placement of the bedding layer (Section 5.0 of 12/10 report).

On July 13, 2011 Umetco requested latitude in completing erosion protection enhancements [Umetco 2011b]. Specifically, Umetco requested using the method involving the removal the Type C rock cover, laying down a bedding layer, and re-emplacing the cover, for some or all areas previously identified to use the method involving laying the bedding layer material on top of the Type C rock and using a mechanical vibrator to move the bedding layer material under the Type C rock. As both methods are acceptable, the staff finds this request acceptable.

**NRC Staff Evaluation of Licensee's Proposed Work Activities and Radiation Safety Program**

In its May 2011, response to NRC staff comments on the initial Design Report, Umetco provided additional information regarding the staging and placement of the bedding layer materials. In summary, Umetco will perform the activities either on the existing tailings pile or on areas that were previously evaluated by NRC. Umetco stated that, when using the first method, the existing rock layers will be removed and placed on other portions of the existing cover. Some bedding material may be staged onsite to transfer from haul trucks to front-end loaders. However, as bedding material will be brought to the site on a load-by-load, as needed, basis, the amount of material staged at the site should be minimal. With respect to the second method, the bedding material will be delivered directly to a previously prepared area on the pile, deposited directly on the Type C or B rock, and vibrated into the cover. On July 13, 2011, Umetco requested latitude in using the two methods discussed in the Design Report [Umetco 2011b]. Specifically, Umetco request approval to use either of the two methods at any location on the cover. Umetco's rational was that that this was more efficient and would result in a higher quality bedding layer. The NRC staff has concluded that both methods described by Umetco are adequate to ensure that the proposed work activities do not adversely impact the existing tailings pile.

In its December 2010, request Umetco discussed the various procedures it will employ to ensure protection of workers, the public and the environment from the radioactive material tailings. Umetco committed to conducting work at the site in accordance with Umetco's existing radioactive materials license and Radiation Monitoring Program. The NRC staff has reviewed Umetco's existing license and the procedures described in the December 2010, Design Report and the May 2011, revisions to the report and has determined that they are adequate. In addition, based on the activities discussed in Umetco's reports, it is not anticipated that the tailings will be disturbed, thus reducing the potential for radiation exposure of workers or the release of tailings.

**NRC Staff Evaluation of Licensee's Cost Estimate**

Uranium Recovery facilities licensed under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material," are required to establish adequate Financial Assurance (FA) for decommissioning and reclamation of any tailings or waste disposal areas pursuant to 10 CFR 40, Appendix A, Criterion 9, "Financial Criteria" [CFR]. Consistent with 10 CFR 40, Appendix A, Criterion 9, Source Materials License SUA-648, License Condition 55 requires Umetco to provide a cost estimate and FA for the planned erosion protection enhancements.

In its December 2010, submittal, Umetco provided a cost estimate to complete the erosion protection enhancements [Umecto 2010]. The staff reviewed the submittal and requested additional information (RAIs) in the following areas [USNRC 2011a]:

1. Clarification with respect to the scope of activities covered by the cost estimate;

2. A basis (e.g., a source) for the unit costs relied on and clarification as to whether the cost estimate is based on the costs of a third party;

3. Clarification on the units of measure used in the estimate (e.g., dollars per cubic yard);

4. A basis for the overhead and profit rate of 10-percent; and

5. Clarification with respect to computations (e.g., the amount of bedding material needed).

By letter dated May 10, 2011, Umetco provided responses to the RAIs (RAI Responses) and a revised cost estimate [Umetco 2011a]. The cost estimate described Umetco's estimated costs associated with completing erosion protection enhancements using the methods described in the above "Description of Proposed Activities" of this report. By letter dated June 8, 2011, Umetco further clarified its RAI Responses, and provided a revised cost estimate based on an actual third party bid [Umetco 2011c].

In its RAI Responses, Umetco clarified the scope of activities covered by the cost estimate and grouped the various construction activities into twelve tasks, many of which had several sub-tasks: mobilization and demobilization; construction of water system and dust control during construction; establishment of access and haul routes; radon barrier test trenches; erosion protection enhancements; launch rock filter trench excavation; apron channel construction; stabilization of off-site erosion features; well abandonment; fencing; site reclamation; and new quarry operations [Umetco 2011a].

Umetco's RAI Responses clarified the basis for the unit costs and stated that all costs are based on the costs of a third party contractor. Additionally, in its June 8, 2011, letter, Umetco revised certain unit costs and quantities based on an actual third party bid [Umetco 2011c].

The RAI Responses stated that the estimated unit costs are applied to the units cited in the cost estimate associated with each task. Umetco clarified that the overhead and profit rate of 10-percent was in reference to an additional margin for construction oversight. Umetco increased this to 12-percent and applied it to all unit costs.

The RAI Responses provided calculation verification sheets. These estimated quantities are then applied to the cost estimate to determine the estimated cost for each task. Umetco's June 8, 2011, letter, further clarified the calculations of certain quantities (e.g. the area of the AGTI). Additionally, Umetco's June 8, 2011, letter, revised certain unit costs and quantities based on an actual third party bid [Umetco 2011c].

By letter dated July 13, 2011, Umetco requested latitude in completing erosion protection enhancements [Umetco 2011b]. Specifically, Umetco requested using the method involving the removal the Type C rock cover, laying down a bedding layer, and re-emplacing the cover, for some or all areas previously identified to use the method involving laying the bedding layer material on top of the Type C rock and using a mechanical vibrator to move the bedding layer material under the Type C rock. As part of its July 13, 2010, submittal, Umecto stated that the existing cost estimate for erosion protection enhancements is not affected [Umetco 2011b] by Umetco's request. However, the staff was unable to verify Umetco's calculations and requested clarification.

By letter dated July 18, 2011, Umetco revised its cost estimate for completing erosion protection enhancements from $3,502,312.28 to $3,768,458.16 [Umetco 2011d]. Relying on the site specific data in the May 10, 2011, submittal, and the July 18, 2011, submittal, the staff verified Umetco's calculations leading to its cost estimate of $3,768,458.16.

Umetco's cost estimate for completing erosion protection enhancements, based on third party contractor costs and including a 15-percent contingency factor, is $3,768,458.16. Relying on Umetco's December 2010 submittal, its RAI Responses, and its June 8, 2011, supplemental information, its July 13, 2011, submittal, and its July 18, 2011, submittal, the staff finds that the cost estimate is reasonable, is based on the costs of a third party contractor, does not take credit for salvage value, and includes a 15-percent contingency factor, as required by License Condition 55 of SUA-648. Therefore, the staff finds Umetco's cost estimate for completing erosion protection enhancements acceptable.

**CONCLUSIONS AND RECOMMENDED LICENSE CHANGE:**

NRC staff reviewed the repair approach in Umetco's erosion protection design report and found that the proposed changes to the bedding layers of the rock cover are acceptable. Staff also reviewed the proposed work activities and radiation safety program found them to be acceptable and protective of the public health and safety and the environment. Finally, staff reviewed Umetco's cost estimate for completing erosion protection enhancements and found it to be acceptable.

Staff recommends that Source Materials License SUA-648 be revised to include the following language:

"Licensee is authorized to perform repairs and enhancements to the erosion protection cover in accordance with statements and commitments made in letters dated December 21, 2010; May 10, 2011; June 8, 2011; July 13, 2011; and, July 18, 2011. If any cultural materials are discovered during construction, work in the area shall halt immediately and the licensee shall contact the NRC, the Casper Field Office of the US Department of the Interior Bureau of Land Management, and the State of Wyoming State Historic Preservation Office and the materials shall be evaluated by an archaeologist or historian meeting the Secretary of the Interior's Professional Qualification Standards"

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