MAR 11 1994

Docket No. 40-4492
License No. SUA-667

Mr. William C. Salisbury, President
American Nuclear Corporation
550 North Poplar Street, Suite No. 6
Casper, Wyoming 82602

Dear Mr. Salisbury:

The U.S. Nuclear Regulatory Commission staff has completed its review of the American Nuclear Corporation's (ANC's) modifications to the design of covers on tailings ponds 1 and 2 at the Gas Hills mill site, transmitted with your letter dated April 16, 1992. As detailed in the staff review comments provided in the enclosure, additional information and design modifications need to be provided prior to the staff's approval of the proposed design.

The tailings ponds' covers were redesigned by ANC to meet the guidance in the NRC Staff Technical Position on Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites, and to limit radon emissions to acceptable levels in accordance with the NRC Regulatory Guide 3.64. The staff has reviewed all aspects of the design and has additional information needs in the areas of erosion protection, geotechnical engineering, and radiation protection. ANC should provide additional information for our review, addressing the issues discussed in the enclosure. The design should be submitted to NRC within 60 days or a submission date be provided within 10 days from the date of this letter.

If you have any questions, please contact the NRC Project Manager, Mohammad Haque at (301) 504-2580.

Sincerely,

ORIGINAL SIGNED BY

Joseph J. Holonich, Acting Chief
Uranium Recovery Branch
Division of Low-level Waste Management
and Decommissioning
Office of Nuclear Material Safety
and Safeguards

160052

Enclosure: As stated

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AMERICAN NUCLEAR CORPORATION (ANC), GAS HILLS
NRC Staff Comments on
Redesign of Tailings Ponds Covers
March, 1994

General

1. ANC should describe how, if its requested amendment extending the final radon barrier placement schedule for the Gas Hills mill is authorized, completion of final radon barrier and erosion protection placement on tailings pond 2 will be completed as expeditiously as practical.

Surface Water Hydrology and Erosion Protection

2. General Observation on the James L. Grant and Associates' 1992 Report titled "Erosion Stability Evaluation." Based on an examination of the 1992 report, "Erosion Stability Evaluation," it is difficult to determine those design changes which are now proposed that differ from the designs developed in the early 1980s and presented in earlier reports. It appears that previous water surface profiles, for example, may no longer be applicable, based on apparent changes to the alignment and slope of several ditches. It is also difficult to determine which features have been constructed or are currently under construction. To assist the staff in reviewing the proposals, American Nuclear Corporation (ANC) should provide a discussion and drawings showing those features that have been completed and those which have changed since earlier proposals. ANC should update analyses and drawings and should consolidate previous work that is still applicable into the new submittals. These submittals should show all completed and future construction activities, along with any recent design changes. ANC should also update the water surface profiles and velocity analyses where changes to ditch alignment, slope, and location have occurred.

3. Design of Riprap Protection / Settlement. The potential for differential settlement and its effects on flow rates for the design of the riprap protection should be addressed. If differential settlement occurs, surface water flow rates and design assumptions could be significantly changed. If soil covers are placed directly over slimes, for example, the compressibility of slimes would tend to cause settlement to occur. ANC should address the potential for differential settlement, particularly if tailings sands and slimes are not relatively mixed. For additional settlement concerns, see Geotechnical Engineering comment # 11.

4. Construction of Rock Mulch Layer. The NRC staff questions the ability to construct the rock mulch layer without segregation of materials. Table 2 of the 1992 report indicates that there is a very high percentage of fine-grained material in the proposed layer. Based on construction experience at various sites, a very elaborate Quality Assurance/Quality Control (QA/QC) program may be needed to assure that the various-size materials in the layer are uniformly mixed, and more importantly, uniformly placed. Even with an excellent QA/QC program, there are likely to be many places where rock of adequate size is not uniformly mixed and placed in the rock mulch layer; pockets of fines will be prevalent throughout.

Enclosure

In the past, the NRC staff has accepted other alternatives, including screening the material to sort out (1) the finer material for use in the soil layer, (2) the medium size material for use as the filter, and (3) the larger rock materials for use as the ultimate riprap layer. Overall, the same thickness would be achieved with 2 or 3 layers (instead of 1 layer) with no increase (and possibly a decrease) in the quantities of material placed. The uppermost rock layer would be visible and could be inspected to assure that uniform in-place gradations have been achieved.

Note that if the soil layer is provided only as a growth medium, it could possibly be eliminated. Further, rock and filter layer thicknesses could possibly be reduced, depending on rock size requirements. To avoid segregation potential, ANC should propose a program to screen out the larger materials, and revise the gradations of the uppermost riprap layer and the underlying filter. Alternately, ANC should provide further justification that the proposed gradation will be acceptable and can be placed in a manner that will assure uniform placement to that gradation.

5. Rock Durability. The information provided in the 1992 report is not sufficiently complete to determine the durability of the proposed rock source. It appears that a limited number of samples were tested and that the maximum (best) test results were reported. Using these data, it is not clear that all of the rock to be used is acceptably durable, particularly if the samples tested are not representative. ANC should: (1) provide durability test results for representative rock that will actually be placed; (2) provide average results, rather than maximum test results; and (3) provide results for the rock that will be used as the top and filter layers, if different rock types are used. Alternately, ANC should provide further justification that the information already provided is adequate to demonstrate rock durability and that the rock tested is representative of the rock that will be placed.

6. QA/QC Program for Rock Placement and Earthwork. Staff review of the proposed specifications and QA/QC program indicates that additional procedures for control of rock placement are needed. In general, the staff considers that the proposed program will not necessarily assure that a uniform layer of riprap will be placed. The specifications should be revised to include specific criteria for rock placement, to assure that uniform, dense, rock placement is achieved. Specific tolerances for placement should be specified for the riprap and filter, depending on the size of the material being placed. Measures should be provided to verify the thickness of the riprap, such as depth checks on a specified grid. ANC should revise the specifications or provide justification that the proposed specifications are adequate. In addition, ANC should include specifications and the QC program for earthwork operations.

7. Apron/Toe Design. The design of the riprap apron/toe to be placed at various locations around the pile does not appear to be adequate. The one-foot thickness, in particular, appears to be underdesigned, based on staff experience with toe designs in erodible soils. Various factors need to be taken into account, and the design of the apron/toe should be based on the following general concepts: (1) provide riprap of adequate size to be stable against the design storm (PMP); (2) provide uniform and/or gentle grades along the apron and the adjacent ground surface such that runoff from the cell is distributed uniformly at a relatively low velocity, minimizing the potential for flow concentration and erosion; and (3) provide an adequate

apron thickness to prevent undercutting of the disposal cell by: local scour that could result from the PMP; or potential gully encroachment that could occur due to gradual headcutting over a long period of time.

The key elements which ANC needs to consider in the design of riprap protection for the apron/toe are: (a) the lower (downstream) part of the pile side slope immediately upstream of the grade break where the side slope meets the toe; (b) the actual toe area; (c) the downstream portion of the apron/toe which is assumed to have collapsed due to scour or long-term erosion; and (d) the ground surface downstream of the apron/toe. As discussed in the NRC Staff Technical Position on Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites, ANC should use several analytical methods for designing the riprap for these key elements:

a. For the lower portion of the side slopes, ANC should provide an adequate thickness of rock, to account for turbulence and energy dissipation that may be produced if a weak hydraulic jump occurs. Several methods may be used to check the rock size required for the toe. ANC should determine the shear forces associated with PMP flows down the side slope, and assume that turbulence will be created on the lower portion of the slope where it meets the toe. To account for this turbulence (and energy dissipation), ANC should increase the shear stress by about 50 percent, in accordance with U.S. Army Corps of Engineers (COE) recommendations. The rock size may be computed using the Safety Factors Method, if the slope of the apron/toe is 10 percent or less.

b. For the actual apron/toe, which may have a relatively steep slope (greater than 10 percent after collapsing into its design configuration), ANC should use the Stephenson Method to determine the required rock size. The flow rate should be increased by a factor of about 3 to account for flow concentrations near the downstream end of the apron where it meets natural ground or a natural gully. As part of the analysis, ANC should assume that the natural ground downstream of the toe will be eroded due to cumulative local scour and/or erosion at its base, resulting in the collapse of the rock into the eroded area. The assumption of a collapsed slope of the rock of 1 vertical (V) on 3 horizontal (H) is considered acceptable. The required rock size for flow over this slope may be calculated using the Stephenson Method.

c. In order to determine the depth to which the toe must be placed, ANC needs to estimate the depth of scour which will occur at the graded natural ground slope just downstream of the toe. ANC should use the existing ground slope(s) and should assume that a flow concentration factor of about 3, corresponding to gully flows, will occur. Use of this flow rate in the Lacey Regime Equation is one acceptable method for estimating the scour depth. The toe should then be placed at least to the estimated depth of scour.

d. To further document the acceptability of the design of the rock toe/apron, ANC should provide a general summary of geomorphic conditions in the area. The geomorphic bases for the design of the rock toe around the perimeter should be provided, including a geomorphic evaluation of the potential for formation of gullies and lowering of local base levels. The geomorphic analysis may also document the depth of the gullies in the immediate area and help to justify the selection of a depth of scour and resultant toe thickness.

8. <u>Diversion Channels</u>. The staff concludes that additional information and analyses are needed regarding the design of the diversion channels. It appears that the channels may need some design revisions to accomodate natural phenomena that have not been considered. While the Probable Maximum Flood (PMF) flow rates appear to be acceptable for all of the proposed channels, additional information and analyses are needed in the following areas:

a. The riprap appears to be undersized, based on the depths shown in the 1992 report. The staff suggests that if the COE method is used to compute shear stress or rock size, Manning's 'n' should also be computed (iteratively) using the COE method. This may result in a reduction in the 'n' value and an increase in velocity. The rock size should also be checked by using the Safety Factors Method and, depending on the slope of the channel, may be roughly checked by using data generated in Development of Riprap Design Criteria by Riprap Testing in Flumes (NUREG-4651), using an approximation of cfs/ft in the trapezoidal channels. The disparities should become readily apparent. ANC should revise the analyses accordingly.

b. The design of all of the diversion ditches should consider perpendicular concentrated flows into the ditch (down the side slopes of the ditch). It is possible that the design condition for the riprap will be created by natural gullies or concentrated inflows to the ditches from the upland side or the pile side, rather than the flows directly along the ditch. At the upland side slope of the channels, severe conditions could exist where the flows from natural gullies discharge into the diversion ditches. The proposed rock size may not be adequate to prevent erosion of the slopes under PMF conditions in these natural gullies. ANC should provide revised designs of the ditches which consider the effects of such flows or, alternately, provide documentation that the proposed designs are capable of resisting the forces produced by such flows.

c. The staff considers that sediment deposition may be a problem in several of the ditches where the slopes of the ditches are less than the slope of the natural ground where flows enter the ditch. For example, the Campsite Draw channel is relatively steep and, at the location where it sharply bends and flattens out, sedimentation should be expected. In this case, and in similar cases for many of the other proposed ditches, ANC may need to provide either sufficent slope or capacity in the ditches to either flush or store any sediments which will enter the ditch. In particular, specific design features may be necessary in areas where natural gullies are intercepted by the diversion ditch. Concentrated flows and high velocities could transport large quantities of sediment, and the size of the particles transported by the natural gully may be larger than the man-made diversion ditch can effectively flush out.

For this site, a considerable amount of sediment from the upland drainage area can be expected to enter the diversion ditch, for the following reasons:

(i) The upland drainage areas generally have average slopes much greater than the proposed ditch slopes. Flow velocities in the man-made ditches will not be as high as those occurring in the natural channels or areas of concentrated flow. Therefore, sediment, cobbles, and boulders may be transported to the ditch and may not be easily flushed out by the lower velocities in the ditch.

(ii) The potential for gully development (and resulting high flow velocities) in the upland drainage area and subsequent transport of bed-load material into the diversion ditches is high. Gullies and areas of flow concentration are evident upstream of the diversion ditch, based on review of topographic maps of the area and a staff site visit to the area. Flows moving toward the diversion ditches will tend to concentrate in these gullies, increasing the potential for gully incision and transport of sediment.

In order to document the acceptability of the ditch design, ANC should justify that: (1) the ditches will have sufficiently high velocities and/or sediment-carrying capacity; (2) potential sediment deposition in the ditches will not significantly affect their capacity; (3) any sediment blockage in the ditches will not have an adverse effect on the stability of the contaminated tailings, and (4) the riprap on the embankment side of the ditches is sufficiently large and extends to a depth greater than the potential depth of scour, providing protection against direct impingment of natural gully flows caused by sediment buildup in the ditches.

First, ANC should provide analyses which indicate that the diversion ditches, with their respective slopes, will be able to flush out much of the sediment, other than the larger gravels and cobbles. Using storm events ranging in magnitude from the annual flood to the PMF, ANC should calculate the critical shear stresses and velocities needed to transport materials of various sizes. ANC should determine that the slopes of the ditches are sufficient to transport much of the smaller-sized materials during most flood events.

Second, ANC should estimate the amount of sediment that will be deposited in the diversion ditches. ANC should determine that the diversion ditches will have adequate flow capacity, even if a significant amount of blockage occurs.

Third, ANC should estimate the amount of sediment which could build up in the ditch over a long period of time. Taking no credit for sediment removal, ANC should perform analyses using HEC-2, for example, and determine the effects of sediment buildup on flow velocities and water surface profiles. Under conservative assumptions of large flow blockages, ANC should determine that PMF flows in the ditch cannot affect the slopes of the remediated embankment near the ditch. Using the Safety Factors Method, ANC should estimate the riprap size that is needed to resist the PMF forces.

Fourth, the riprap on the embankment side of the ditch should be designed to provide protection against direct impingement and concentration of natural gully flows. Since many of the ditches will be aligned generally perpendicular to the natural gullies, (and the upland side of the ditch may not be designed for these flows), it is necessary to protect the opposite side slope of the ditch, particularly if the ditch is narrow and flows are not dissipated in the ditch itself.

d. The outlets of the ditches should have a toe to prevent headward gully migration. This toe should be designed such that the maximum scour depths produced by the channel, and headward gully movement, will not undercut the riprap layer. Maximum potential scour depths due to the PMF flows may be computed using the U.S. Department of Transportation formula and

Lacey's formula. The riprap at the ditch outlets should, therefore, be extended down to the expected depth of scour below grade.

The outlet section of the ditch should be assumed to collapse due to either 1) gully headward erosion over a long period of time, or 2) the PMF flow in the ditch. In order to reduce the rock size at the outlet, a pre-formed outlet slope of 1V on 5H, for example, may be constructed. The stable rock size may then be calculated using the Stephenson Method. Riprap should be used in the immediate area of the outlet and should also be placed for some distance downstream of the outlet to prevent headward gully development.

9. Design of Cobble Layer on the East Side of Pond 2. The extent, need for, and basis for design of the cobble layer on the east side of Pond 2 is not clear. ANC should provide analyses and justification for the layer in this area and for any other area of riprap placement, where the basis is not provided in any of the submittals.

10. Effect of Curvature of Channels on Riprap size. The effects of curvature of channels on riprap size should be addressed, particularly Campsite Draw and its relocated portion. Adjustments to riprap size may be necessary in those locations where riprap is placed on the outside of a bend. Acceptable methods for increasing shear stress and/or riprap size may be found in COE EM 1110-2-1601.

11. Effect of Road Crossings/Culverts. At those locations where diversion channels encounter road crossings or culverts, road overtopping may need to be addressed, particularly the effects of blockages, hydraulic jumps, and non-uniform flow areas. ANC should provide specific designs at such locations where flows could cause significant erosion or could affect channel capacity.

Geotechnical Engineering

12. Settlement. ANC submitted records with a limited analysis of settlement for the tailings ponds. The monitoring plan discussed in ANC's letter of April 24, 1992, is satisfactory. The consultant's report of April 1991 states that 90 percent consolidation has occurred at Pond 2. Although 90 percent consolidation may have occurred at Pond 2, ANC has not adequately demonstrated the degree of settlement. The deficiencies include questionable survey methods and fluctuations in ground surface elevations. For these reasons, several of the readings are unusable and others are of questionable value. ANC should provide further justification that 90 percent consolidation has occurred, with calculations, readings, or testing which is not subject to the questions raised by the April 1991 report. Support for claims of 90 percent consolidation for Pond 1 should be based on similarly reliable data.

13. Stability. ANC should provide or reference exploration and soil testing data in support of its discussion of slope stability. Although calculations reviewed by the staff indicate satisfactory factors of safety, the basis for selecting design parameters is unknown. Additionally, ANC should provide a more detailed rationale for selecting the horizontal coefficient of acceleration used in the pseudo-static slope stability analysis.

14. Exploration and Testing. For the proposed soil cover, ANC should provide information or reference on field exploration and laboratory testing pertinent to geotechnical stability aspects of the cover design. The design basis for cover thickness, compaction requirements, gradations, permeability, and dispersivity should be addressed. If this information was included in any of the reports referenced in your submittal, copies of those reports should be provided for the NRC staff review.

Radiation Protection / Radon Barrier

15. Model Material Layering Assumptions.

a. Although ANC has shown the configuration of most of the sideslopes to include an existing clean soil berm, a portion of the sideslopes of the disposal cells apparently consists of coarse sand tailings with an interim soil cover. ANC should provide or reference drawings that show any different configurations of materials on the side slopes. In addition, ANC should demonstrate that the radon model for the top of the cell conservatively bounds the sideslope conditions, or perform separate modeling for the sideslopes.

b. ANC's submittal of May 2, 1984, states that tailings have been deposited in Pond 2 with sands at the south end and slimes at the north end. ANC should indicate, and consider in the model, the thickness of the layer of sand tailings that will exist over the slime tailings after the Pond cell has been reconfigured to the design slopes.

16. Radon Input (computer code).

a. Tailings

(i) The low number of test samples, three samples for the 900,000 cubic yards (yds^3) in Pond 1 and four samples for the 5 million yds^3 in Pond 2, is insufficient to determine statistically meaningful average values to represent the parameters for computer code input. Considering the range of values measured and the sensitivity of the code for each parameter, the Ra-226 concentration value is the primary concern. The measured Ra-226 values for Pond 1 (mostly slime tailings) are 547, 511, and 236 pCi/g; and for Pond 2 are 353, 300, 73, and 41 pCi/g. These test results may be low as discussed in 16.a.ii, below. Also, ANC's model did not take into consideration that the RADON code is more sensitive to the Ra-226 concentration in the material that is closer to the surface. ANC's RADON model should be revised to include statistically representative values of Ra-226 concentration and to consider the distribution of Ra-226 concentration in at least the upper/outer 10 feet (300 cm) of the contaminated material (top and sides). In addition, ANC should provide or reference a description of sample collection methods and a map indicating sample locations.

(ii) ANC reported radon emanation values of 0.14 and 0.15 for Pond 1 and 2, respectively. The Generic Environmental Impact Statement for Uranium Mills suggests a value of 0.20 may be typical for uranium tailings, while Regulatory Guide (RG) 3.64 recommends 0.35 as the default value. In addition, test results for tailings at other sites has generally shown higher, more conservative values.

ANC should provide justification that the procedures used for determining radon emanation coefficients and Ra-226 concentration are industry standard or, in the case of emanation coefficient determination, are comparable to the method recommended in RG 3.64. Also, documentation of the quality assurance program, in particular, leak testing of sealed canisters, should be provided. Alternatively, ANC may provide new values for these parameters based on additional testing or conservative assumptions.

(iii) The tailings moisture content value used in the estimation of radon flux should be a long-term value. Use of the measured values of 58 percent (Pond 1) and 26.5 percent (Pond 2), or the 100 percent saturation value (41.5 percent by dry weight for Pond 1) would not represent long-term conditions. Several methods for determining this value are suggested in RG 3.64. However, use of -15-bar (wilting point) measurements may not be reliable if the sample contains a high percentage of fine-grained material. The Rawls-Brakensiek equation is conservative in most cases, and should be considered for use with sandy and silty material. Based on data from other sites, a long-term moisture content value higher than 25 percent would be difficult to justify. ANC should provide tailings moisture content values that represent long-term (at least 200 years) conditions.

b. Interim Cover

(i) ANC used the porosity and density default values recommended in RG 3.64 for compacted tailings. These default values are based on material that has a specific gravity of 2.65 and that is compacted to about 90 percent of dry density. ANC should justify that the use of the porosity and density default values are appropriate (or conservative) for the interim cover material.

(ii) ANC should justify that the moisture content value for the interim cover used in the RADON code represents a long-term moisture.

c. Bullrush Heap Leach Material

(i) The lower-activity Bullrush heap leach material was modeled as a 1.5-foot-thick layer on Pond 1. ANC should demonstrate that this thickness of the Bullrush material is conservative, or otherwise indicate that at least 1.5 feet of lower-activity material will be placed over the interim cover.

(ii) The RADON input that ANC has used for porosity and density of the Bullrush material are the default values recommended in RG 3.64 for compacted tailings. ANC should justify that the use of the porosity and density default values are appropriate for the Bullrush material. In support of this, data on gradation, or a description of the range and average size of the particles should be supplied. ANC should also indicate the degree of compaction expected to be achieved for this layer of the cell.

d. Radon Barrier

(i) The April 16, 1992, submittal indicates that the Ra-226 content of the radon barrier material is 10.6 pCi/g and that the test data was attached. However, only the test data for the tailings and the Bullrush material was included in the attachment. ANC should provide the radiological data for the proposed radon barrier soil. ANC should also address how a Ra-226 concentration for the barrier soil that is twice the site background value meets Criterion 6 of 10 CFR Part 40, Appendix A. The criterion states that near surface cover soils must be essentially the same, for radioactivity, as the surrounding surface soils.

(ii) The radon attenuation modeling did not account for any change in porosity and density that may result from expected (during at least 200 years) frost penetration in the radon barrier layer. ANC should address frost penetration into the radon barrier and any resulting loss of radon attenuation capacity.

(iii) Several of ANC's submittals indicate vegetation of the cover is expected to occur. ANC should address the expected extent of vegetation occuring on the reclaimed piles, and any resulting effect of root penetration on long-term radon attenuation capacity of this material.

(iv) The data substantiating the long-term moisture content used in the model is indicated by a footnote to have been collected, but the data is not included in the 1992 or 1991 submittals. ANC should provide the moisture content data for the proposed radon barrier soil and justify the choice of this value for use as a long-term value in the RADON analysis.