Shootering Canyon Tailings Retention System
Plateau Resources Limited
Docket No. 40-8698 (TAC No. 5063)
Safety Evaluation Input - Geotechnical Engineering Section,
GB, DSS
Prepared by: D. M. Gillen

Introduction

The proposed uranium tailings retention system is to be constructed at the Shootering Canyon site in Garfield County, located in southeastern Utah. The impoundment area will be 14 miles from the nearest existing permanently occupied area (Bullfrog Basin Marina). The tailings impoundment will be located in a valley which slopes gently downward to the south. A high steep butte lies immediately west of the valley and several low-lying mesas lie to the east. The ground surface elevations range from approximately 4576 at the north end of the mesa where the plant will be built, to about 4350 in the proposed tailings pond.

The design of the impoundment was based on a requirement to store 20 years of tailings output from the plant at 750 tons per day. Design of the embankment was based on construction in 2 stages - to an initial crest at Elevation 4433 and a final crest at Elevation 4466. The 1400 feet long zoned embankment will have an impervious, sloping core, transition zones, shells constructed of local pediments, and a downstream blanket drain. A clay liner will be provided in the impoundment area. The tailings management plan anticipates initial deposition at the upstream end of the impoundment.

Subsurface Investigations

A total of twenty exploratory borings ranging in depth from 16.5 to 152.5 feet below the existing ground surface were drilled at the site. Soil samples were obtained with a 2-inch outside diameter split spoon sampler and a 2-inch inside diameter modified California drive sampler lined with thin, brass segmented tubes. Rock core was obtained using an NX double-tube core barrel

with diamond bit. Twenty-eight shallow test pits were excavated for the purpose of exploring the potential borrow areas, the foundation for the proposed tailings dam and the plant site. Water pressure testing with packers was done in a number of borings in order to evaluate the in-situ permeability of the geological formation.

Laboratory Testing

Representative samples were selected for laboratory testing in order to establish engineering properties of the embankment and foundation materials. Laboratory testing included water content, dry density, Atterberg limits, grain size, compaction, unconfined compression, triaxial shear and permeability tests. We conclude that the laboratory testing was adequate and that the applicant has properly established foundation and embankment material properties required for design.

Foundation Conditions

Exploratory borings in the foundation materials for the portion of the dam across the main valley showed a thin surface layer of loose fine sand, a maximum of 2 feet in thickness. Soft to medium hard and occasionally moderately hard, fine-grained sandstone with occasional thin zones of silty, clayey fine sandstone was encountered beneath the sand and extended throughout the depth of the borings (152.5 feet). Borings drilled in the saddle area of the embankment, to be used as an emergency spillway, encountered shallow alluvial deposits consisting of about 12 feet of dense fine sand with some gravel overlying dense cobbles, gravel and sand to a depth of from 23 to 29.5 feet. Soft to medium hard fine-grained sandstone underlies the alluvial deposits.

From available information, the depth to groundwater is in excess of 100 feet in the area of the proposed tailings impoundment. The field exploration program did not indicate any apparent impervious boundaries at depth. Permeability coefficients of the sandstone foundation obtained from the in-situ permeability tests ranged from 1×10^{-6} cm/sec to 1×10^{-5} cm/sec.

Embankment Foundation Preparation

The embankment across the valley and the saddle section was aligned to take advantage of the naturally occurring abutments and to minimize foundation excavation. Loose soil remaining after topsoil has been stripped from dam and reservoir areas will be removed and stockpiled for possible later use as fill. All soil will be excavated to sound bedrock in the core (Zone 1) foundation and the exposed bedrock will be slush grouted. Irregular bedrock surfaces will be removed to obtain a generally smooth surface. All soil will not necessarily be removed beneath the transition zones and shells. The suitable foundation soil remaining after excavation will be scarified and recompacted. Upon completion of foundation preparation, the bedrock and soil foundation conditions will be documented as detailed in the attached license conditions.

Embankment Design

a. Cross-section - The zoned embankment to contain the tailings will be constructed in two stages. The stage 1 crest will be at Elevation 4433 (crest width of 85 feet). The maximum height of the stage 1 dam is 85 feet and the maximum height of the stage 2 dam is 118 feet. Upstream and downstream embankment slopes will be 2 horizontal on 1 vertical. Internal zoning will consist of an impermeable sloping core (Zone 1), shells constructed from local pediments (Zone 2) and upstream and downstream sand transition zones

between the core and shells (Zone 3). A 24 inch thick gravel blanket drain and 6 inch thick blanket filters will be provided under the downstream shell and tied into a toe drain. The crest of each stage is to be covered with 2 feet of roadbed material.

b. Upstream Liner - An upstream liner has been designed to inhibit seepage of the effluent into the foundation rock and the concomitant contamination of the groundwater and surrounding areas. The liner will consist of impermeable clay constructed of Zone 1 material and tied into the core. The liner will be covered by a granular sub-drain and a layer of waste rock. The thickness of the compacted clay is to be 10 percent of the applied hydraulic head with a minimum thickness of 2 feet. The sub-drain will be a fine sand meeting the criteria for Zone 3 and will have a minimum thickness of 18 inches. The protective waste rock layer will have a minimum thickness of 12 inches.

c. Materials - The fill for the impoundment clay liner and the impervious core will consist of sandy silty, clayey soil obtained by breaking down natural sandy, clayey shales of the local Brushy Basin, Mancos or Summerville formations. No material larger than one inch in size will be permitted in the clay liner or the impervious core and the percentage of fines (finer than the No. 200 mesh sieve) will be greater than or equal to 50 percent. Other specification controls require a minimum density of 95 percent of maximum dry density established in the standard Proctor compaction test (ASTM D698-70), placement at moisture as detailed in the license conditions, and a maximum loose lift thickness of 8 inches.

The shell sections (Zone 2) will be constructed from the pediment boulders, cobbles, gravel and sand which cap the mesa tops. The maximum size of the Zone 2 material will be 12 inches and material larger than 12 inches in size will be raked to the outer portion of the zone to serve as slope protection material. A test fill for Zone 2 material will be constructed prior to commencement of fill placement to establish the compaction characteristics of this material and to verify the adequacy of the present "method" specification of 4 passes on each layer with a 10-ton vibratory roller. Layers of Zone 2 materials will not exceed 12 inches in loose thickness except in the outer 10 feet of shell (slope protection) where a maximum of 18 inch lifts may be used. The material in this zone will be uniformly wetted prior to compaction. In order to meet filter criteria between Zones 2 and 3, the finer fraction of Zone 2 material will be placed adjacent to Zone 3. This will be accomplished during Zone 2 construction by continuously raking the material larger than 4 inches out of the area adjacent to Zone 3. The transition zone (Zone 3) between the core and the shells will be constructed of fine sand available in local dune sand deposits. The Zone 3 materials meet filter criteria and thus will act as a filter to protect against piping of the Zone 1 material into Zone 2. The Zone 3 fine sand will be compacted to either (1) an average of 85% but not less than 80% relative density as determined by ASTM D-2049, or (2) at least 95% of the maximum dry density as determined by ASTM D-698-70, whichever results in the higher in place dry density. Other specification controls of the fine sand include gradation limits, placement at moisture contents as detailed in the license conditions and a maximum loose lift thickness of 8 inches.

The blanket drain and filter will be constructed of processed material meeting specified gradation requirements. Granular material in these zones will be uniformly wetted then compacted by 4 passes of 20 ton vibratory equipment.

The proposed specification controls on material type, placement and compaction for the proposed dam are consistent with methods used today in embankment construction, and are considered to be acceptable.

d. Stability Analysis

The proposed stage 2 dam configuration was analyzed for stability of the upstream and downstream faces along its maximum cross-section. The Morgenstern-Price method was used for analysis of non-circular failure surfaces under loading conditions that are consistent with the guidelines of Regulatory Guide 3.11. Analysis for seismic conditions consisted of pseudostatic analysis; additional forces due to .08g in the horizontal direction and .04g in the vertical direction were applied to account for loading under earthquake conditions. The applied seismic forces are considered conservative based on Algermissen and Perkins, 1976 (Ref. 5). It should be noted however, that GSB has not made a detailed geology-seismology review of this site.

Results of stability analyses equaled or exceeded the minimum safety requirements of Regulatory Guide 3.11 for all loading conditions.

e. Seepage Control - The contouring of the impoundment will be such that the upstream sub-drain can carry the effluent to a collection pipe system which ultimately discharges into a sump to be recycled back to the processing plant or the impoundment. Construction of the liner against the steep slopes along the western margin of the impoundment will be accomplished by trimming the slopes to allow for conventional placement of the clay blanket or, wehre this is not practical, by placing the blanket in stages as a buttress to the same elevation as the rising tailings elevation. Although the entire impoundment is to be prepared for the ultimate construction of the liner, the liner will be constructed at this time only to the stage 1 limits of tailings disposal (upstream end of impoundment area).

A series of groundwater monitoring wells have been placed around the outside perimeter of the embankment and impoundment to monitor any seepage through the liner. In addition, any seepage through the embankment will be collected by the downstream toe drain and recycled to the plant.

f. Liquefaction Potential

A liquefaction analysis was not performed. The granular materials of Zones 2 and 3 in the embankment are to be densified under strict specification requriements which should ensure their stability against liquefaction. The alluvial deposits found beneath the saddle portion of the embankment exhibit "N" values in the standard penetration test sufficiently high that further consideration of liquefaction potential is not considered to be necessary.

g. Instrumentation

The installation of piezometers and surface displacement monuments is not considered necessary for the stage 1 embankment since it will not be subjected to the hydraulic pressures and external forces from the tailings effluent. Instrumentation of the embankment will be required at stage 2 or in the event that tailings management plans change and tailings effluent is placed against the Stage 1 embankment (see license condition 2).

Construction

The applicant has provided plans and specifications (Reference 3). The results of construction inspection and control testing by the applicant are to be summarized in a concise construction report. This report must be submitted to the NRC not later than six months following completion of construction in order to show that the impoundment has been constructed as designed. Recommended minimum inspection of the construction by the NRC has been provided in license condition 1.

Conclusion

Based on the review of the submitted documents, we conclude that the proposed Shootering Canyon tailings retention system meets the intent of Regulatory Guide 3.11 and will result in a safe system providing the recommended licensing conditions attached to this report are carried out.

References

1. "Tailings Management Plan and Geotechnical Engineering Studies, Shootering Canyon Uranium Project," Woodward-Clyde consultants, September, 1978.

2. Letter from M. B. Bennedsen, Senior Project Engineer, Woodward-Clyde Consultants to Mr. Ross A. Scarano, NRC, January 19, 1979.

3. "Stage I - Tailings Impoundment and Dam Final Design Report Shootering Canyon Uranium Project," Woodward-Clyde Consultants, May 1, 1979.
   Supplemental Data; June 12, 1979.

4. Letter from R. B. Sewell, Manager of Operations, Plateau Resources Limited to Mr. Pete Garcia, NRC, July 31, 1979.

5. Algermissen, S. T. and Perkins, D. M., 1976 "A Probabilistic Estimate of Maximum Acceleration in Rock in the Contiguous United States," U. S. Geological Survey, Open File Report 76-416.

Recommended License Conditions

1. Provide commitment to notify the NRC at least three weeks prior to construction of the following features in order to provide adequate time for arrangements of on-site inspections by the NRC.
   a. Near completion of foundation preparation but prior to placement of backfill in the trench or over excavated surfaces.
   b. During early stage of embankment fill placement.
   c. At approximately 75 percent completion of embankment fill placement.
2. Provide commitment to submit a detailed embankment instrumentation program for NRC review one (1) month prior to either construction of stage 2 of the embankment or to implementation of any plans for placing tailings effluent against the stage 1 embankment.
3. Density of Zones 1 and 3 shall be controlled in the field in accordance with ASTM D-1556, D-2167 or by approved nuclear devices in accordance with ASTM D-2922 and D-3017. One test shall be made for each 2,000 cubic yards or less for each layer. Moisture density tests (ASTM D-698 or D-2049) Atterberg limits (Zone 1), and gradation tests shall be performed at the frequency of one test for each 30,000 cubic yards of fill placed. Field density tests will be made in Zone 2 at the frequency of one test for each 50,000 cubic yards in order to verify that the degree of compaction demonstrated in the test fill is being maintained. The results of all quality control tests shall be submitted to the NRC within six months of completion of construction.

4. A report documenting the embankment foundation conditions shall be submitted to the NRC within six months of completion of the foundation preparation. The report shall include but not be limited to the following:

   a. Plan views of the foundation area showing material-types, locations of any anomalies or potential seepage paths, and the extent of slush grouting.

   b. Photos taken during foundation preparation

   c. Description of procedures used to proof test the foundation soil.

5. All fill placed in Zones 1 and 3 shall have moisture contents meetings the following limits:

   a. Zone 1: optimum moisture content to 3 percent wet of optimum.

   b. Zone 3: 1 percent dry density of optimum to 1 percent wet of optimum.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

UNITED NUCLEAR , MORTON RANCH

OCT 1 3 1977

MEMORANDUM FOR: J. Carl Stepp, Chief, Geosciences Branch, DSE

FROM: Joseph D. Kane, Geotechnical Engineer, GB, DSE

THRU: Lyman W. Heller, Section Leader, Geotechnical Engineering Section, Geosciences Branch, DSE

SUBJECT: SITE VISIT - GEOTECHNICAL ENGINEERING

PLANT NAME: Morton Ranch - United Nuclear Corp.
LICENSING STAGE: Application for new uranium tailings retention system
DOCKET NUMBER: 40-8602 (TAC No. 4611)
RESPONSIBLE BRANCH: Fuel Processing and Fabrication Branch, L. Rossbach

A meeting in Casper, Wyoming with United Nuclear Corporation (UNC) which included their consultant, Dames and Moore, was held with NRC and its consultant, the U. S. Army Corps of Engineers on October 4, 1977. Attending representatives are noted on the enclosed list.

The morning session held in the Applicant's Casper office included discussions on hydrologic and geotechnical engineering considerations which are being addressed in the UNC report to be submitted in late October 1977. Clarification of several design features covered in Reg. Guide 3.11 were also discussed.

A visit to the Morton Ranch site followed the morning session and afforded the opportunity to inspect geologic features in an existing open pit which averaged 70 feet in depth and had similar features to the proposed tailings dam foundation. The alignment and abutments of the south retention dam were inspected. Typical drive spoon samples and rock cores taken in recent explorations were available for inspection.

Joseph D. Kane, Geotechnical Engineer
Geotechnical Engineering Section
Geosciences Branch
Division of Site Safety and Environmental Analysis

Enclosure:
As stated

cc: See attached page

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cc w/o encl:
R. Boyd
R. DeYoung

cc w/encl:
H. Denton
R. Cunningham
D. Muller
F. Miraglia
W. Gammill
J. Stepp
L. Hulman
R. Scarano
L. Rossbach
T. Johnson
P. Garcia
J. Kane
F. Williams
PDR
LPDR
ACRS (18)
L. Heller
W. Bivins

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SURNAME ▶	JKane:ms	LHeller				
DATE ▶	10/11/77	10/12/77				

ATTENDANCE LIST
MEETING ON MORTON RANCH PROJECT - 10/04/77

Name	Representing
A. Wood	UNC, Vice-President
C. Wolff	UNC, Plant Supt.
P. Palmer	UNC, Envir. Engr.
L. Murdock	Dames & Moore, Associate
G. Condrat	Dames & Moore, Geot. Engr.
A. DePhilippe	USCOE, Chf., Fdns. & Matls. Br.
A. Depman	USCOE, Geologist
T. Johnson	NRC, Hydr. Engr
P. Garcia	NRC, Intern
J. Kane	NRC, Geot. Engr.

SEP 2 7 1978

MEMORANDUM FOR: L. C. Rouse, Chief
Fuel Processing and Fabrication Branch, NMSS

FROM: J. C. Stepp, Chief
Geosciences Branch, DSE

SUBJECT: SAFETY EVALUATION INPUT - GEOTECHNICAL ENGINEERING

PROJECT NAME: Morton Ranch Mine and Mill Project - United Nuclear Corp.
DOCKET NUMBER: 40-8602
TAC NUMBER: 4611, 253
RESPONSIBLE BRANCH: Fuel Processing and Fabrication Branch,
L. Rosshach
REVIEW STATUS: Complete except for acceptance of enclosed license conditions

The review of the documents submitted by the United Nuclear Corporation including the contract drawings and specifications dated June 1978 has been completed by our Consultant, the U. S. Army Corps of Engineers, Philadelphia District.

The enclosed Safety Evaluation Input (Encl. 1) concludes that the retention system design meets the intent of R.G. 3.11 and should result in a safe system when constructed in conformance with the enclosed license conditions (Encl. 2). Principal reviewer was A. A. DePhilippe.

The recommended license conditions, with the exception of the first, attempt to highlight important commitments reached during the review. License condition no. 1 addresses an outstanding issue caused by a disagreement on the adequacy of the margin of safety against liquefaction reported by the Applicant. The reported safety factor of 1.1, that is based on an analysis which has needlessly been complicated by the use of a non-standardized soil sampler, is not considered adequate by the NRC staff and its Consultant. Condition no. 1 requires either a re-assessment that clearly demonstrates an adequate margin of safety against liquefaction or a plan and commitment to perform remedial treatment on the loose foundation sands.

Enclosures:
As stated

cc: See next page

DUPLICATE DOCUMENT

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JAN 11 1979

Docket No. 40-8602

MEMORANDUM FOR: L. C. Rouse, Chief
Fuel Processing and Fabrication Branch, NMSS

FROM: L. G. Hulman, Chief
Hydrology-Meteorology Branch, DSE

SUBJECT: HYDROLOGIC ENGINEERING SUMMARY

PLANT NAME: Morton Ranch Uranium Mill
LICENSING STAGE: License Application
DOCKET NUMBER: 40-8602
TAC NUMBER: 4611, T-53
RESPONSIBLE BRANCH: Fuel Processing and Fabrication Branch
L. Rossbach
REVIEW STATUS: Complete

Attached is a Hydrologic Engineering Summary for subject tailings system prepared by R. Gonzales.

The freeboard proposed by the applicant for the ultimate dam is not conservative. Therefore, the applicant should be informed that 9 feet of freeboard will be required in the event that the dam is raised to the ultimate elevation of 5202 feet. The riprap gradation proposed by the applicant contains an excessive percentage of material smaller than 2 inches. This small material will not remain in the voids between the larger rocks once the riprap is exposed to wave action. Therefore, we suggest that the minimum size material be increased from 2 to 5 inches.

Original Signed by
L. G. Hulman

L. G. Hulman, Chief
Hydrology-Meteorology Branch
Division of Site Safety and
Environmental Analysis

Attachment:
As stated

cc: w/attachment
R. DeYoung
D. Muller
R. Denise
J. [illegible]
W. Divine
R. Scarano
P. Garcia
I. [illegible]
L. Heller
R. Gonzales

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*See previous yellow for concurrences

OFFICE	DSE:ST:HMB*	DSE:ST:HMB*	DSE:ST:GB*	DSE:GA:HMB		
SURNAME	RGonzales:sb	WSBivins	LHeller	LGUlman		
DATE	1/9/79	1/9/79	1/10/79	1/10/79		

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Docket No. 40-8604

MEMORANDUM FOR: L. C. Rouse, Chief
Fuel Processing and Fabrication Branch, NMSS

FROM: L. G. Hulman, Chief
Hydrology-Meteorology Branch, DSE

SUBJECT: HYDROLOGIC ENGINEERING SUMMARY

PLANT NAME: Morton Ranch Uranium Mill
LICENSING STAGE: License Application
DOCKET NUMBER: 40-8602
TAC NUMBER: 4611, R-33
RESPONSIBLE BRANCH: Fuel Processing and Fabrication Branch
L. Rossback
REVIEW STATUS: Complete

Attached is a Hydrologic Engineering Summary for subject tailings system prepared by R. Gonzales.

The freeboard proposed by the applicant for the ultimate dam is not conservative. Therefore, the applicant should be informed that 9 feet of freeboard will be required in the event that the dam is raised to the ultimate elevation of 5282 feet. The riprap gradation proposed by the applicant contains an excessive percentage of material smaller than 2 inches. This small material will not remain in the voids between the larger rocks once the riprap is exposed to wave action. Therefore, we suggest that the minimum size material be increased from 2 to 5 inches.

L. G. Hulman, Chief
Hydrology-Meteorology Branch
Division of Site Safety and
Environmental Analysis

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SURNAME ▶	RGonzales:mp	LHulman	WBivins	L. Heller		
DATE ▶	1/ /79	1/ /79	1/9/79	1/16/79		

Hydrologic Engineering Summary
Morton Ranch Uranium Mill,
Wyoming

INTRODUCTION

The Morton Ranch Uranium Mill is located in Converse County in eastern Wyoming, about 18 miles northwest of the city of Douglas. The applicant, United Nuclear Corporation, proposes to construct a zoned earth dam to store tailings effluent. This dam will be constructed in two phases. The initial phase will be a dam with a crest elevation of 5243 feet mean sea level (MSL). The second phase will consist of raising the dam to elevation 5282 feet MSL.

SLOPE PROTECTION

The applicant proposes to use a 12 inch layer of riprap (rock) for protection of the dam embankment against destructive wave action We conclude that this riprap is of sufficient thickness. However, the gradation proposed by the applicant contains an excessive amount of very fine material. A well graded riprap should not have a greater percentage of fines than is required to fill the voids in the large rock. Therefore, it is our position that the minimum rock size be 5 inch material and that this not exceed fifteen percent by weight of the total riprap material. The gradation range proposed for 12 inch

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Docket No. 40-8602

MEMORANDUM FOR: L. C. Rouse, Chief
Fuel Processing and Fabrication Branch
Division of Fuel Cycle and Material Safety, NMSS

FROM: L. G. Hulman, Chief
Hydrology-Meteorology Branch
Division of Site Safety and Environmental Analysis, NRR

SUBJECT: SUPPLEMENTAL SER INPUT

PLANT NAME: Morton Ranch Uranium Mill
LICENSING STAGE: License Application
DOCKET NUMBER: 40-8602
TAC NUMBER: 04011, R-03
RESPONSIBLE BRANCH: FPFD; L. Rossbach
REVIEW STATUS: Hydrologic Engineering Section (HMB) - Complete

In the SER input which we submitted to you on January 11, 1979, we expressed that the freeboard proposed by the applicant for the ultimate dam was not conservative and should be increased from 6 to 9 feet for the ultimate dam. Freeboard of 13 feet for the starter dam, as proposed by the applicant, was acceptable.

A later submittal from the applicant (December 29, 1978) showed that an area upstream of the tailings pond was to be used for waste disposal. This area, designated waste area no. 3, altered the drainage pattern and increased the area draining into the tailings pond from 307 acres to about 570 acres. We have rechecked our analysis to assure that there is sufficient storage available to contain the runoff from this increased drainage area. The area-capacity curves used in this analysis were the original curves submitted by the applicant in the Dames and Moore report titled, "Report of Investigation and Design, Tailings Disposal Area, Morton Ranch Mine and Mill, Converse County, Wyoming for United Nuclear Corporation," dated October 31, 1977. We did, however, adjust these curves to account for the 3 foot clay liner to be placed in the pond.

Our reanalysis shows that almost all the storage available in the starter dam will be needed for flood control and wave runup. We understand that the applicant does not intend to initiate storage of tailings until the

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MAY 10 1979

dam is at the ultimate height. There should be a license condition to assure this. The 9 feet of freeboard for the ultimate dam which we previously determined was necessary is still adequate. This provides 5 feet for flood control and an additional 4 feet for wave run-up.

Original Signed by
William S. Bivins

L. G. Hulman, Chief
Hydrology-Meteorology Branch
Division of Site Safety and
Environmental Analysis

cc: R. C. DeYoung
D. Muller
R. Denise
R. Jackson
W. Bivins
R. Scarano
L. Rossbach
P. Garcia
J. Kane
R. Gonzales

OFFICE ▶	DSE:HMB	DSE:HMB	DSE:HMB			
SURNAME ▶	RGonzales:km	WSBivins	LGHulman			
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Docket No. 40-8602

MEMORANDUM FOR: L. C. Rouse, Chief
Fuel Processing and Fabrication Branch
Division of Fuel Cycle and Material Safety, NMSS

FROM: L. G. Hulman, Chief
Hydrology-Meteorology Branch
Division of Site Safety and Environmental Analysis, NRR

SUBJECT: SUPPLEMENTAL SER INPUT

PLANT NAME: Morton Ranch Uranium Mill
LICENSING STAGE: License Application
DOCKET NUMBER: 40-8602
TAC NUMBER: 44611, R-53
RESPONSIBLE BRANCH: FPFD; L. Rossbach
REVIEW STATUS: Hydrologic Engineering Section (HMB) - Complete

In the SER input which we submitted to you on January 11, 1979, we expressed that the freeboard proposed by the applicant for the ultimate dam was not conservative and should be increased from 6 to 9 feet for the ultimate dam. Freeboard of 13 feet for the starter dam, as proposed by the applicant, was acceptable.

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MAY 10 1979

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Original Signed by
William S. Bivins

L. C. Hulman, Chief
Hydrology-Meteorology Branch
Division of Site Safety and
Environmental Analysis

cc: R. C. DeYoung
D. Muller
R. Denise
R. Jackson
W. Bivins
R. Scarano
L. Rossbach
P. Garcia
J. Kane
R. Gonzales

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SURNAME ▶	RGonzales:km	WSBivins	LCHulman			
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 15 1979

MEMORANDUM FOR: Docket File 40-8602

THRU: J. Linehan, Section Leader
Operating Recovery Section

FROM: L. Rossbach
Uranium Recovery Licensing Branch

The enclosed reports and drawing should be placed in Docket File 40-8602. They were prepared under contract No. NRC 02-79-021, FIN B-6436-9, for the United Nuclear Morton Ranch, Wyoming, uranium mill project.

L. Rossbach
Uranium Recovery Licensing Branch
Division of Waste Management

Enclosures:
1. "Assessment of Diversion Ditch Design at United Nuclear Corporation's Morton Ranch Uranium Mill, Wyoming," prepared for the NRC by Daryl B. Simons and R. M. Li, Colorado State University, March, 1979.
2. United Nuclear Corporation drawing 20-000-2087, "Mill Site & Pit areas Postulated for Tailings Disposal System." Drainage areas drawn in by D. B. Simons and R. M. Li, Colorado State University.
3. Trip Report, from D. B. Simons and R. M. Li, to L. Rossbach, U. S. NRC, March 22, 1979.

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Engineering Research Center
Office of the Dean
303/491-8655
Cable: ENGRCSU

Colorado State University
Fort Collins, Colorado
80523

March 22, 1979

MEMORANDUM

TO: Lawrence W. Rossbach, U. S. Nuclear Regulatroy Commission

FROM: Daryl B. Simons and Ruh-Ming Li

SUBJECT: Assessment of Diversion Ditch Design at United Nuclear Corporation's Morton Ranch Uranium Operation, Wyoming

REMARKS:

The United Nuclear Corporation's Morton Ranch Uranium operation was visited on February 26, 1979. The site visit provided the opportunity to overview the total drainage area and to discuss the design of proposed diversion ditches with the United Nuclear Corporation's staff; Mr. Wolff, Mr. Routon and Mr. Hiscox.

The proposed mill and tailings pond will be located within the drainage of the South Fork of Box Creek. The proposed mill will be located on a hill top to minimize the drainage problems. The proposed tailings pond dam is in the upper reach of a tributary channel of the South Fork of Box Creek. The current natural-drainage is quite stable. It is covered with sagebrush and native grass and shows no significant tendency of rilling and gully development. The annual precipitation ranges from 10 to 16 inches per year and averages less than 12 inches. Observing the dimensions of existing swells and channel suggest that flow is not large. The selection of a 100-year flood for design of important diversion ditches and [illegible] unimportant diversion ditches se[illegible]

ASSESSMENT OF DIVERSION DITCH DESIGN AT UNITED NUCLEAR CORPORATION'S MORTON RANCH URANIUM MILL, WYOMING

Prepared for

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Prepared by

Daryl B. Simons
Associate Dean for Engineering Research
and Professor of Civil Engineering

and

Ruh-Ming Li
Associate Professor of Civil Engineering

Colorado State University
Fort Collins, Colorado

March,

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

Atlas Minerals, Moab

APPENDIX A

Terry R. Howard, P.E.
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

July 11, 1979

Mr. Ross A. Scarano, Chief
Mill Licensing Branch
Waste Management Division
U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Scarano:

Please find enclosed ten (10) copies of my report entitled "Review of Expansion of Atlas Tailings Retention System". This work was completed under a letter agreement from Mr. John J. Wray of Argonne National Laboratory to Dr. Roy E. Williams, University of Idaho.

My review of the Dames and Moore reports as well as my site visit indicates that the results presented by Dames and Moore are acceptable. Specific recommendations for the design and monitoring of the proposed embankments are included at the end of my report.

Should you have any questions, please call.

Yours very truly,

Terry R. Howard

Terry R. Howard, P.E.

TRH:sl

Terry R. Howard, P.E.
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

September 20, 1979

Mr. Ross A. Scarano
Chief
Mill Licensing Branch
Waste Management Division
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Scarano:

Please find enclosed ten copies of my report entitled, "Review of Contract Specifications and Drawings for Tailings Embankment Expansion Project, 12-foot Raise, for Atlas Minerals, Moab, Utah". This work was completed under a letter of agreement from Mr. John J. Wray of Argonne National Laboratory to Dr. Roy E. Williams, University of Idaho.

My review of the Dames and Moore "Contract Specifications and Drawings" as well as personal discussions with Dames and Moore personnel indicates that this document is generally acceptable. However, several questions as outlined in my report require further amplification. Should you have questions about the content of my review, please feel free to call.

In addition please find enclosed ten copies of my report entitled, "Review of Expansion of Atlas Tailings Retention System, Addendum No. 1". The intent of this report is to add and clarify several points in the original document. Again should you have any questions concerning this report, please call.

Yours very truly,

TRH:sl

enc.

7 PP

Terry R. Howard, P. E.
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

October 3, 1979

Mr. Pete Garcia
Mill Liscensing Branch
Waste Management Division
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Garcia:

This letter is in regard to my report entitled "Review of Contract Specifications and Drawings for Tailings Embankment Expansion Project, 12-foot Raise for Atlas Minerals, Moab, Utah." In this report I pointed out that a further stability study of the proposed 18-foot high embankment should be required, but that I had not reviewed that work. Since then I have received a copy of the computer print out of such a study from Mr. James Boddy of Dames and Moore.

I have reviewed the Dames and Moore stability analysis and find it to be satisfactory. Both the static and seismic stability was obtained for an embankment section judged to be the most critical. The factors of safety for these two conditions are 1.58 and 1.24 respectively. These safety factors meet the requirements of USNRC Regulatory Guide 3.11.

Should you have any questions, please contact me. It has been a pleasure working with you on this project.

Yours very truly,

Terry R. Howard

Terry R. Howard

TRH:sl

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APPENDIX B

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 16 1979

MEMORANDUM FOR: John Linehan, Leader
Uranium Recovery Licensing Branch

THRU: L. G. Hulman, Chief
Hydrology-Meteorology Branch, DSE

FROM: William S. Bivins, Leader
Hydrologic Engineering Section, HMB, DSE

SUBJECT: ATLAS URANIUM MILL - MOAB, UTAH - HYDROLOGIC ENGINEERING SUMMARY

Enclosed is a hydrologic engineering summary for the subject uranium mill, prepared by T. L. Johnson. This report principally addresses the flooding and safety criteria as outlined in Regulatory Guide 3.11, which was issued subsequent to our initial review of this facility in 1974.

William S. Bivins

William S. Bivins, Leader
Hydrologic Engineering Section
Hydrology-Meteorology Branch
Division of Site Safety and
Environmental Analysis

Enclosure:
As Stated

cc: w/enclosure
J. Martin
D. Muller
W. Kreger
R. Jackson
W. Bivins
L. Heller
J. Greeves
P. Garcia
T. Johnson

40-3453

Terry R. Howard
Consulting Geotechnical Engineer
Route 4, Box 399
Moscow, Idaho 83843

November 30, 1979

Mr. Peter Garcia
Mill Licensing Branch
Waste Management Division
U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20555

Dear Mr. Garcia:

This letter reports the results of my recent site visit to Atlas Minerals, Moab, Utah to inspect the construction of the 18-foot rise to the existing tailings pond. The site inspection took place November 13, 1979 from approximately 9:00 a.m. to 4:00 p.m. in the company of Mr. Jim Boddy and Mr. Jim Zitnik from Dames and Moore Consulting Engineers from Salt Lake City and with Mr. Larry Jacobs representing Atlas Minerals.

Approximately 6 feet of the 18 feet of fill material has been placed on all but the western embankment. Approximately 3 feet have been placed along the western embankment. As of friday, November 9, 123,280 yards plus or minus 2 percent have been placed representing approximately half of the total estimated yardage. The construction is being accomplished by Neilson, Inc. from Cortez, Colorado. Mr. Rick Keck is the project superintendent and has on the job six cat scrapers type 633C, two D-8 cats, one D-6 cat, one cat patrol and two 50-ton pneumatic tire rollers. The equipment all seems to be in relatively good condition and the overall construction procedure is well organized.

Soils testing for the project is being accomplished by American Testing Laboratories from Salt Lake City by Mr. Neil Backman. Mr. Backman runs 4 to 5 compaction tests and one gradation test per day. In addition, he checks the Proctor curve for the compaction tests approximately once per week. This is in slight excess of the actual number of tests required for the amount of fill placed per day. I inspected Mr. Backman's test results and his procedures seem to be correct. Approximately 10 percent of the compaction tests taken fail; Mr. Backman then retests the area after it has been rerolled.

The red silty sand material being used as fill is being obtained from the borrow site just north of the tailings pond. Some large boulders are being encountered in the fill material and as they are encountered they are being pushed aside with one of the cats. Dames and Moore feels that the quantities in the designated borrow area will be sufficient to complete the job. As a backup, however, they have accomplished testing on two other potential sources. The onsite material is being premoisened by sprinkling with water from the river prior to picking up and placing on the embankment. The in place moisture content runs approximately 7 percent and the required compacted density and moisture content is 119 pounds per cubic foot and 9 percent respectively. This means that the soil is being compacted slightly less than the optimum moisture content.

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Existing piezometers are read once per day by Atlas Minerals personnel. Mr. Jacobs then collects these data and reviews them visually. His procedure is simply to visually scan for a sudden rise in pore pressure and if such is noted to stop the work in that area and immediately call Dames and Moore in Salt Lake. This procedure did not seem adequate to me and I therefore requested that Mr. Jacobs plot the piezometric data each day to obtain an overall view of the piezometric levels. In addition, I requested that the Dames and Moore project engineer, who visits the site once a week, inspect the data that is being plotted by Mr. Jacobs. In addition we discussed the additional piezometers to be installed on the western embankment. I have asked Mr. Jacobs to see that these piezometers are installed immediately after construction on the western embankment is completed. In addition should there be piezometric level rises in the existing piezometers that would tend to indicate an overall rise in pore pressure in the embankment, work should be stopped on the western embankment and the three piezometers installed.

In my opinion the construction project is proceeding satisfactorily. The Neilson construction company is providing a good job under the supervision of Mr. Keck and American Testing is providing adequate testing procedures. The material as placed, in my opinion, is meeting the design specifications for the soils. Should you have any questions concerning the content of this report, please call.

Yours very truly,

Terry R. Howard

Terry R. Howard, P.E.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

Energy Fuels Nuclear, White Mesa

Colorado State University
Fort Collins, Colorado
80523

Geotechnical Engineering Program
Civil Engineering Department

August 23, 1979

U.S. Nuclear Regulatory Commission
Office of Nuclear Materials
Safety and Safeguards
Washington, D. C. 20555

Attn: Mr. E. A. Trager

Dear Gene:

Enclosed herewith is the report on our *Review of the Tailings Management System for White Mesa Uranium Project.* As a result of this review, a number of recommendations have been made for inclusion in the licensing conditions. In general, the engineer's report was complete and included all necessary items. A few questions have arisen concerning foundation treatment and crest elevation of the Cell 1-Enlargement. Nevertheless, I believe that it would not be unreasonable to allow construction to proceed under the condition that all outstanding questions can be resolved easily. If any major problems arise with regard to the foundation soils beneath the embankment during the analyses recommended herein, the license condition could, as a last resort, require removal of all problematical soils underlying the embankment. For that reason, it is believed that there are no insurmountable outstanding problems.

The licensing conditions should also include a provision for construction of the impoundment in accordance with the various pieces of documentation that have been received by your office in regard to this project. I have not included those with our recommendations because there may be additional documentation in your files which you wish to include. The major construction documents will be the specifications included in the Appendix of the Engineer's report (Ref. 2 in our review).

If you have any questions concerning our review or wish to discuss this with me at anytime I would be happy to do so.

Very truly yours,

John D. Nelson
Professor of Civil Engineering

JDN/rv
Encl:

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Info only

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40-8681

Review of Proposed

Tailings Management System

White Mesa Uranium Project

NRC Docket No. 40-8681

August 23, 1979

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Review of

Proposed

Tailings Management System

White Mesa Uranium Project

Energy Fuels Nuclear, Inc.

NRC Docket No. 40-8681

for

U.S. Nuclear Regulatory Commission

Review by

John D. Nelson, S. R. Abt, and T. V. Edgar

Geotechnical Engineering Program

Civil Engineering Department

Colorado State University

Fort Collins, Colorado 80523

August 23, 1979

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REVIEW OF PROPOSED TAILINGS MANAGEMENT SYSTEM

WHITE MESA URANIUM PROJECT

ENERGY FUELS NUCLEAR, INC.

NRC DOCKET NO. 40-8681

Reviewed By

John D. Nelson, S. R. Abt and T. V. Edgar

Geotechnical Engineering Program

Civil Engineering Department

Colorado State University

Fort Collins, Colorado

I. INTRODUCTION

The White Mesa Uranium Project, Energy Fuels Nuclear, Inc. is a proposed uranium ore mill facility located in southeastern Utah about six miles south of the town of Blanding. The proposed tailings management system consists of the construction of a series of cells or storage reservoirs to hold the tailings water and solid waste. The cells are located in a shallow valley on the top of White Mesa and are designed to minimize exposure of the tailings and to provide storage below the existing grade of the swales or ridges.

The multiple-cell system will be sequentially constructed, operated and reclaimed. Each cell will be formed by construction of an embankment across the shallow valley as operations proceed.

Water will be decanted from the tailings pond into evaporation ponds. The evaporation ponds and tailings impoundment will be fully lined with a PVC liner to minimize seepage to the maximum extent possible. It

is intended that all water will be disposed of by evaporation with no seepage into the underlying soils or rocks. A system of diversion ditches and small berms are included in the proposed plan to divert precipitation runoff from entering the tailings impoundment, the evaporation pond or the facilities area.

A groundwater monitoring system is proposed to monitor groundwater quality and to provide for the detection of seepage, if it should occur.

The initial phase of this construction will include construction of an evaporation pond (Cell 1-Initial) and the first tailings impoundment (Cell 2). Approximately two years subsequent to the start-up of operations, an additional evaporation pond (Cell 1-Enlargement) will be constructed. Construction of Cells 3, 4 and 5 will continue in the future as operating needs dictate.

Construction of the particular cells will be by excavation of the subsoils and rippable rock within the impoundment area and construction of an embankment across the valley on the downstream side.

Major embankments will be constructed as follows:

1. Between Cell 1-Enlargement and Cell 1-Initial
2. Between Cell 1-Initial and Cell 2
3. On the downstream side of Cell 2
4. Below Cell 2 to form the downstream side of Cell 3 in the future.

The downstream embankment of Cell 3 will be constructed during the initial phase to serve as a catchment dam in case of any unexpected spills.

The maximum embankment height will be approximately 30 feet. Spillways will be provided in each embankment at an elevation of 1.5 feet

below the crest elevation. A spillway will be provided between Cell 1-Enlargement and Cell 1-Initial.

The scope of this review and report includes the geotechnical and hydrologic aspects of the design of Cell 1-Initial, Cell 1-Enlargement, and Cell 2 impoundments. The principal documents reviewed were the "Tailings Management System, White Mesa Uranium Project" dated June, 1979 by D'Appolonia Consulting Engineers, Inc. (Ref. 2) and the "Final Environmental Statement, White Mesa Uranium Project" by the U.S. Nuclear Regulatory Commission, dated May, 1979 (Ref. 6).

II. GEOLOGY

The proposed project site is located near the center of White Mesa which is near the western margin of the Blanding Basin in southeastern Utah. The surface of the mesa is nearly flat and has a thin cover of loess overlying a resistant sandstone caprock. In the project area exposed rocks are Jurassic, Cretaceous, and Pleistocene-Recent age. The Jurassic and Upper Cretaceous rocks are represented in ascending order by the San Rafael group, the Morrison formation, the Burro Canyon formation, the Dakota sandstone, and the Mancos shale. The rocks are primarily cross bedded sandstone, conglomeratic sandstones, claystones, mudstones, and limestones. Cenozoic rocks include aeolian loess, stream borne alluvium, colluvium and talus. The Dakota sandstones and Burro Canyon formations are essentially flat and are commonly jointed. Two joint directions are found, usually perpendicular to each other. The major joints that have been measured in the Dakota sandstone and Burro Canyon formation are reported as N10-18°E and N60-85°E with both sets being nearly vertical.

III. SEISMICITY

Within a 100 mile radius of the project area 15 earthquakes have been recorded. One of these earthquakes had an intensity of V and all others were of magnitude IV or less. It is stated in the Final Environmental Statement (Ref. 6) that "based on the region's seismic history, the probability of a major damaging earthquake occurring at or near the proposed site is remote."

The seismic coefficient used for all pseudostatic stability analyses was 0.1g. Selection of any seismic coefficient for pseudostatic stability analyses has little justification on the basis of authoritative design criteria. The site area is in a Zone 2 seismic risk area. For a Zone 2 seismic risk area the use of a seismic coefficient of 0.1g is reasonable (Ref. 4).

IV. SURFACE CONDITIONS

The general site area is at an elevation of approximately 5,600 feet. The relief across the site is approximately 75 feet from the center of the valley to the high points near the mill site. The evaporation ponds and tailings impoundment will be placed near the head of the drainage area forming the boundary.

V. SUBSURFACE INVESTIGATION

Subsurface investigation consisted of two series of borings conducted by Dames and Moore and by Chen and Associates. Approximately 28 borings were conducted by Dames and Moore and approximately 124 borings were performed by Chen and Associates. The boring program was supplemented by seismic refraction surveys. A total of 13 seismic surveys were performed by Neilson's Inc.

The borings by Dames and Moore were conducted in January 1978 and consisted of shallow borings which penetrated 10 to 15 feet into the bedrock. Several deep borings were also conducted into the bedrock. Some cores were taken in the deeper borings and in-situ permeability tests were conducted at some intervals.

The borings by Chen and Associates were made with an auger and extended only a few feet into rock in most cases. Most tests performed on samples consisted of soil classification and compaction tests.

It is our opinion that the subsurface investigation program was adequate to define with sufficient accuracy the bedrock contours and subsurface soil conditions across the site.

VI. LABORATORY TESTING

Laboratory tests were conducted on remolded samples to determine engineering properties for use in design of the embankment. Laboratory tests consisted of Atterberg Limits and grain size analyses for classification purposes. Several compaction tests were conducted. Consolidated undrained triaxial tests with pore pressure measurements were conducted on samples compacted to 95% AASHTO T-99 maximum dry density and samples tested at natural density.

Only three triaxial tests were performed on each of two samples. The number of tests conducted to determine the shear strength of the foundation soils and the embankment material was the minimum acceptable. Nevertheless, the test results appear to be reasonable for the particular type of soils indicated.

VII. SUBSURFACE AND FOUNDATION CONDITIONS

Soil conditions at the site consist primarily of silty sands of aeolian origin. Soil descriptions range from silty sands to sandy clays throughout the site. Beneath the embankment the depth of the soil ranges from nearly 20 feet down to only a few feet (1 to 2 feet in some areas).

Aeolian soils are frequently collapsible upon wetting. No laboratory test data is presented to indicate whether soils at this site are collapsible or not. Also, there are indications that in some areas the foundation soil may be calcareous.

The bedrock consists of Dakota sandstone and is a yellowish-brown to light-gray massive cross-bedded and fine to coarse grained quartzose sandstone. Seismic velocities of the bedrock indicate that in many areas the rock is rippable. However, in some areas blasting would be necessary for excavation.

Groundwater at the site is at a depth of approximately 50 to 100 feet below the ground surface. It is believed that the groundwater exists in an unconfined aquifer in the Dakota sandstone. Recharge of the aquifer is by infiltration of precipitation falling on the surface of White Mesa.

The groundwater appears to have a gradient in the southwesterly direction. The groundwater model is based on water level measurements in the deep borings at the site. The data is insufficient to define with certainty the actual groundwater conditions. D'Appolonia Consulting Engineers (Ref. 2) note that the additional groundwater wells installed as part of the monitoring program will provide additional data to further assess this model.

VIII. PRECIPITATION AND EVAPORATION

Reference No. 2 reports that the average annual precipitation at the site is 11.8 inches based on National Weather Service Station data for Blanding. On the basis of data obtained from the National Oceanic and Atmospheric Administration (NOAA) an annual evaporation rate of 47.4 inches with monthly evaporation rates ranging from 0 to 9.4 inches were used to develop the tailings system water balance requirements.

Utilizing PMF values for design storms as given in the "Design of Small Dams" by the U.S. Bureau of Reclamation and utilizing a flood equivalent to 40% of the probable maximum flood (PMF) followed in 3 to 5 days by the PMF, all of which was preceded or followed by a 100 year storm, the required design flood determined by D'Appolonia Consulting Engineers was equivalent to about 15 inches of rainfall. Because there is no tributary runoff the design PMF is equal to the design PMP. Our analysis indicated that the PMF determined utilizing the Soil Conservation Service method in accordance with the PMF series suggested in the USNRC Regulatory Guide 3.11 produced a PMF in excess of 16 inches of precipitation. Differences between the two results are probably due to use of an alternative technique or differences in graph interpolation. It is recommended that the more conservative value be utilized.

IX. FOUNDATION PREPARATION AND CONSTRUCTION

Topsoil over the entire area will be removed and stockpiled for use in reclamation. Embankments will be constructed on top of the stripped natural soils using soil excavated from the cells. Materials excavated during cell construction will also be used in reclamation.

The construction specifications call for removal of all unsuitable materials, as determined by the Engineer prior to placement of any fill for the embankment. Recommendations will be made at a later point in this review to include collapsible and calcareous soils in the category of unsuitable materials.

A 30 mil synthetic liner will be placed over the entire impoundment system. A prepared bedding layer 6 inches thick will be constructed in all areas where lining will be placed. The lining will be covered by 12 inches of soil on the bottom of the cells and 18 inches on all slopes.

X. EMBANKMENT DESIGN

A. General

Around Cell 1-Initial, primary construction will consist of excavation and no embankment construction on the west or east side. The north side of Cell 1-Initial will consist primarily of excavation with construction of a very low small embankment over one section. An embankment will be constructed on the downstream side of Cell 2 with excavation behind it. Major embankment cross sections exist between Cell 1 and Cell 2 and on the south end of Cell 2.

B. Cross-Section

The initial dike between Cell 1 and Cell 2 consists of a homogeneous embankment constructed of compacted fine silty sand overlying the in-situ fine silty sand. Maximum height of the embankment is 30 feet with a crest width of 20 feet. On the Cell 2 side a berm 26.5 feet high with a crest width of 10 feet will be constructed. The purpose of the berm on the Cell 2 side is for placement of the lining. The lining will extend to the crest of the dike on the Cell 1 side. On the downstream

side of Cell 2 the embankment will be 25 feet high with a crest width of 20 feet. The embankment is a homogeneous embankment constructed of compacted fine silty sands.

All embankment slopes are to be constructed on a 3H:1V slope. At the toe of all embankments a berm 5 feet wide will be maintained between the toe of the embankment and the beginning of the excavated area for the impoundment.

C. Materials

Materials for all embankments will be obtained from the excavation areas. All materials will consist of the excavation aeolian soils compacted to 90% of the Modified Proctor Density. The embankment material will be compacted at a water content of 1 to 2% above optimum water content. All fill will be placed in 6 to 8 inch lifts.

D. Seepage Control

Seepage into the foundation and embankment will be controlled by the PVC liner. For that reason drains, impervious cores and other methods of seepage control within the impoundment and foundation are not necessary.

E. Settlement

Settlement analyses beneath the embankment are not presented. However, silty sands would not be expected to exhibit large settlements unless they were collapsible. Also, most settlement would take place during construction. Therefore, settlement is not expected to be problematical. Sharp changes in bedrock depth are not indicated from topographic maps of the soil surface and the top of the bedrock. For that reason large differential settlement is not expected.

However, because the soils are aeolian it is to be expected that areas of collapsible soils will exist. No data was presented as to the collapsible nature of these soils. Analyses should be conducted to indicate whether the foundation soils may be collapsible. Any collapsible soils which are below the embankment should be removed prior to construction or should be treated to eliminate the potential for collapse.

Zones of calcareous soils are also indicated. Potential leakage through the liner would be of low pH and calcareous soils would therefore be subject to collapse under action of the seepage. All areas in which calcareous soils exist should also be removed prior to construction of the embankment.

F. Stability Analaysis

Stability analyses of the dikes were conducted by the applicant utilizing a Quality Assurance verified computer program. The method of analysis utilized was the Modified Bishop Method of Slices using a pseudostatic earthquake loading. Three critical design sections were analyzed for stability. Two sections were for Cell 1-Initial dike and one was for the Cell 2 dike. Two cases were analyzed for stability. One case corresponded to the maximum pool under flood conditions with steady seepage, the other case considered no phreatic surface and was intended to represent End-of-Construction conditions.

The results of the stability analyses were verified in this review utilizing a program on-line at Colorado State University titled "STABL". This program utilizes Carter's method of analysis which is similar to the Modified Mishop Method of Slices except that it represents the circular arc by a series of straight line segments. For the two cases

noted above, the stability analyses yielded factors of s[illegible]y greater than those recommended by USNRC Regulatory Guide 3.11. Furthermore, the analyses utilized a phreatic surface corresponding to full steady state seepage conditions. Due to the presence of the liner it is doubtful whether such a condition could actually develop and the analyses are therefore considered to be conservative.

Analyses were not presented for partial pool with steady seepage conditions. However, because of the free-draining nature of the material in the embankment, construction pore pressures are expected to dissipate during the construction phase. Consequently, partial pool conditions will result in a factor of safety greater than those for full pool conditions.

Rapid drawdown conditions were not analyzed for the embankment. However, because of the liner system and the fact that the Cell 1-Initial impoundment is constructed mostly below grade, reasonable scenarios which would include rapid drawdown conditions cannot be constructed. For that reason rapid drawdown conditions are not considered to be necessary for analysis.

Stability analyses for the downstream phase of Cell 2 dike were not presented by the applicant. For conditions of steady seepage utilizing the phreatic surface indicated on Sheet 12 of the Engineer's report by D'Appolonia Consulting Engineers (Ref. 2), a factor of safety of 1.39 was indicated by our analysis. This value is less than the value of 1.5 required by Regulatory Guide 3.11. The factor of safety under earthquake loading was greater than 1.0 which is in accordance with the requirements of Regulatory Guide 3.11.

It is recommended that the applicant's engineer should review this condition. However, because of the existence of a liner it is doubtful whether a phreatic surface as shown in Ref. 2 will actually develop. Furthermore, this embankment will be required to remain operational for only a period of approximately four to five years after which tailings will be deposited on the downstream face, thereby increasing stability.

The stability of this embankment is not considered to be critical. Nevertheless, it is recommended that unless the applicant's engineer can indicate that the section will remain stable, either the slopes should be flattened or a berm should be placed on the downstream toe of Dike 2.

G. Liquefaction Potential

No analyses of liquefaction potential were presented for this embankment. For liquefaction to be a serious concern, saturated soils will need to be present in the foundation or in the embankment. Because of the placement of a lining system it is doubtful whether such saturated conditions would be developed. Furthermore, the site is one of low seismic activity with maximum recorded earthquakes of intensity V or less.

H. Freeboard Analysis

The tailing impoundment site is situated such that only a small area could potentially contribute to runoff into the impoundment. A series of berms and diversion ditches are proposed to divert runoff away from the mill site. Evaluation of the critical ditch sections indicates that the applicant's diversion ditch design is adequate, and consequently the design PMF is equivalent to the design PMP.

For storm conditions, a wave height of slightly less than 3 feet was estimated from References 1 and 5. Analyses of the two evaporation cells indicate that the estimated minimum freeboard for Cell 1-Initial is 3 feet above the operating and flood levels, which would be adequate. The estimated freeboard for Cell 1-Enlarged is just under 3 feet in the event that the maximum operating level, PMP and severe wave action occurs simultaneously. It is recommended, therefore, that the embankment crest of Cell 1-Enlarged be raised 1 foot to an elevation of 5641.0 feet.

In the tailings storage cell (Cell 2) the minimum operating freeboard is 5 feet. This value of freeboard is considered adequate in view of the existence of a sand beach against the embankment.

I. Slope Protection

No specifications are provided for the grain-size distribution of the cover material over the liners. It is stated that they will contain no oversized material. Control of cover erosion by wave action is specified to be accomplished by adding soil binders or by other suitable means. Details of the slope protection method to actually be used should be presented for evaluation.

XI. EVAPORATION POND MANAGEMENT SCHEME

A water balance analysis was conducted to check the applicant's proposed evaporation pond management scheme. It is believed that the applicant's water model using evaporation pond Cell 1-Initial and Cell 1-Enlarged would operate as proposed.

It was not possible to fully check the design of the spillway connecting Cell 1-Enlarged and Cell 1-Initial due to lack of available information. It is recommended that a stage-discharge rating curve be computed for each spillway on the site.

XII. GROUNDWATER MONITORING PROGRAM

A total of ten wells will be located in order to provide for detection of possible tailings cell leakage, and in order to monitor groundwater quality. Five deep wells will be completed into the existing groundwater aquifer and five shallow, twin wells with monitoring zones in the surface soils and at the top of the unweathered rock will also be located. In addition, one well within a 2 km radius of the site will also be sampled and tested prior to operation.

The groundwater monitoring program is designed to detect seepage which would be introduced into joints and fractures within the underlying sandstone, water which may perch on top of the bedrock and move within the zone of weathered sandstone or water in the alluvial soils. The system is also designed to monitor groundwater quality up-gradient, down-gradient and cross-gradient from the cells. The location of the monitor wells is believed to be adequate and the location of sampling appears to be adequate. License conditions will include submission of water levels and groundwater quality measurements to NRC for review and evaluation.

XIII. CONSTRUCTION

Drawings and specifications have been prepared to provide increased assurance that the embankment and liner system will be constructed in accordance with the design. The specifications call for on-site inspection and technical supervision by a qualified outside engineer and quality control during the construction of the dam. A license condition should require submission of quality control and specification compliance tests to NRC.

NRC inspection of the embankment construction is recommended during the following stages of construction:

1. When cell excavation is nearing completion.
2. When foundation treatment for the embankment has been completed and prior to placement of compacted fill.
3. At an early stage of embankment construction.
4. When embankment construction is about two-thirds complete.
5. During placement of the liner system at various time. This inspection may be conducted concurrently with inspections 3 and 4 if liner placement is being done at that time.
6. At completion of the cell and embankment construction.

XIV. RECOMMENDED LICENSE CONDITIONS

On a basis of the foregoing review the following licensing conditions are recommended to be included for the White Mesa Tailings Management System. The applicant should provide a commitment to:

1. Submit to NRC analyses to indicate that the in-situ soils beneath the embankment will not produce intolerable settlement. These analyses should also include assurance that the foundation soils will not be subject to collapse or liquefaction due to earthquake loading of a magnitude to be expected at the site.
2. Provide additional analyses and data and/or subsequent design changes to indicate that the downstream face of the Cell 2 dike exhibits adequate stability.
3. Increase the elevation of the embankment crest of evaporation pond Cell 1-Enlarged to an elevation of 5641.0 feet in order to provide adequate freeboard for wave action at the time of a maximum PMF series as defined by Regulatory Guide 3.11.

4. Provide stage-discharge rating curves for each spillway to be constructed.

5. Include in the construction specifications provisions for removal of all zones of collapsible soils or soils which are calcareous in nature. The specifications should provide for identification of such soils, overexcavation of such soils, and inspection of areas of removal of such soils prior to placement of compacted fill.

6. Maintain a minimum freeboard of 5 feet in the tailings impoundment (Cell 2), a minimum freeboard of 6 feet in Cell 1-Initial and a minimum freeboard of 4 feet in Cell 1-Enlargement.

7. Notify the NRC at least six weeks prior to the following construction features to provide adequate time for on-site inspections by the NRC.

    a. When cell excavation is near completion and prior to placement of the liner system.
    b. When foundation excavation is near completion and prior to placement of embankment fill.
    c. At intermediate stages during the liner construction to allow time for inspection of the compacted bed material underneath the liner, construction of joints in the liner and replacement of cover over the liner.
    d. During embankment fill placement at approximately 10% and 70% stages of completion.

8. Conduct and document a daily inspection of the embankments and the exposed protective soil cover over the liner and make repairs if any erosion occurs.

9. Provide details for review of the method of slope protection to be employed on the embankment to prevent erosion due to wave action.

10. Submit to NRC within 6 months after completion of each stage of construction, as-built drawings showing construction details of the liner system, embankment foundation and subsoil profile prior to embankment construction and a construction report summarizing the following:

    a. Compaction control test results.

    b. Classification of all soils used in the embankment.

    c. Construction equipment and procedure.

    d. Unexpected conditions and problems encountered in construction, and method employed to resolve these problems.

11. Insure that programs for inspection and monitoring of dam safety and water quality are conducted and evaluated by an experienced registered professional engineer. The responsible engineer should insure that all field inspectors are able to recognize signs of possible distress or abnormalities. The records of regular scheduled surveillance and inspection reports that will include water quality tests should be required to be submitted periodically to the NRC in a report bearing the seal of the professional engineer.

REFERENCES

1. Creager, W. P., Justin, J. D., and Hinds, J. (1945), Engineering for Dams, John Wiley and Sons, New York.

2. D'Appolonia Consulting Engineers, Inc. (1979), Engineers Report, Tailings Management System, White Mesa Uranium Project, Blanding, Utah, Energy Fuels Nuclear, Inc., Project Number RM78-632.

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4. Seed, H. B. (1973), "Stability of Earth and Rock Filled Dams During Earthquakes", in Embankment-Dam Engineering, by Hirschfeld and Poulos, John Wiley and Sons, New York.

5. Sherard, J. L. et al., (1963), Earth and Earth Rock-Dams, John Wiley and Sons, New York.

6. U. S. Nuclear Regulatory Commission (1979), Final Environmental Statement, related to Operation of White Mesa Uranium Project, Energy Fuels Nuclear, Inc., Docket No. 40-8681.

Regulatory Docket File

CU

Geotechnical Engineering Program
Civil Engineering Department

Colorado State University
Fort Collins, Colorado
80523

October 4, 1979

Gene Trager
Uranium Mill Licensing Section
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, Maryland 20910

Dear Gene:

I have reviewed Energy Fuel's response to the dam safety questions presented by D'Appolonia Consulting Engineers dated September 27, 1979, Project No. RM78-682. On the basis of that review I believe that all the questions and problem areas noted in our review of the White Mesa Uranium Project Tailings Impoundment have been adequately addressed.

An important part of the response is the addition of a drain and collection system beneath the liner along the upstream side of the embankment and embankment foundation. In this review I have assumed that Energy Fuels has made a commitment to install that drain and collection system. If that is not the case, the outstanding questions have not been adequately addressed. On the assumption that the commitment has been made, the following comments are offered regarding Energy Fuel's response.

The gravel material that is used for the drain should consist of clean gravel free from organic material and containing less than 2% passing a No. 100 sieve. After placement, the gravel material should have a permeability greater than 1000 times the permeability of the underlying material. Filter criteria must be met between the drain and the underlying material as well as for the slotted PVC collection pipe. These specifications can be made as a license condition and need not delay placement of embankment fill.

With the installation of the collector/drain system all other questions concerning stability and earthquake protection have been adequately addressed. I believe that drain will provide adequate protection against piping of the calcareous material and if all collapsible soils are removed, as provided for in the addendum to the specifications, stability of the foundation soils will not be a problem.

I believe that all questions concerning the stage-discharge capacities of the spillways have been adequately addressed and the provisions for freeboard as noted in our review can be considered in the licensing conditions. If you have any questions concerning this please feel free to call me.

Very truly yours,

John D. Nelson
Professor of Civil Engineering

JDN/rv

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