



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

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MEMORANDUM FOR: H. R. Denton, Director, NRR
W. J. Dircks, Director, NMSS
S. Levine, Director, RES
V. Stello, Director, IE
R. B. Minogue, Director, SD
H. K. Shapar, Executive Legal Director
J. J. Fouchard, Director, PA

FROM: Norman M. Haller, Director
Office of Management and Program Analysis

SUBJECT: PROPOSED ABNORMAL OCCURRENCE - MILL TAILINGS
IMPOUNDMENT DAM FAILURE

Enclosed is a draft Commission paper with a proposed Federal Register Notice in regard to the mill tailings impoundment dam failure at the United Nuclear Corporation Church Rock Uranium Mill.

This event is under consideration as an abnormal occurrence since it appears to satisfy Example III.B.1 of the abnormal occurrence policy statement; i.e., an event which seriously compromised the ability of a confinement system to perform its designated function.

The event was originally submitted as an Agreement State item. However, as suggested by NMSS, we feel that it should be reported as a fuel cycle facility item because of both the extensive involvement of NRC staff in the response to the event, and the concurrent regulatory jurisdiction of the NRC over uranium mill tailings in agreement states.

If required, MPA will arrange for an informal briefing of the Commission. Suggested participants are SP, IE, NMSS and MPA. It is suggested that NMSS take the lead at the briefing.

Contact:
P. Bobe/R. Dennig, MPA
49-27735

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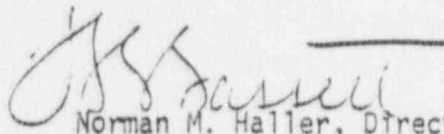
Those Listed

- 2 -

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Your review, comments and written (or telephone) concurrence are requested by close-of-business November 9, 1979.

If you have questions or wish to discuss details, please contact P. Bobe or R. Dennig of my office at 49-27735.


Norman M. Haller, Director
Office of Management and
Program Analysis
for

Enclosure:
Commission Paper

cc: w/enclosure
L. V. Gossick, EDO
T. A. Rehm, EDO
D. G. Eisenhut, NRR (2)
G. Zech, NRR
R. L. Fonner, ELD
G. C. Gower, IE (7)
G. G. Beveridge, NMSS
R. L. O'Connell, NMSS
R. H. Gramann, NMSS
G. Eadie, NMSS
E. Tourigny, NMSS
H. H. Scott, RES
M. A. Taylor, RES
R. Whipp, ADM-SEC
W. Kerr, SP
~~R. McGrath, SP~~
R. L. Dennig, MPA (3)
P. E. Bobe, MPA

For: The Commissioners

From: Lee V. Gossick
Executive Director for Operations

Subject: ABNORMAL OCCURRENCE RECOMMENDATION - MILL TAILINGS
IMPOUNDMENT DAM FAILURE (UNITED NUCLEAR CORPORATION
CHURCH ROCK MILL)

Purpose: Approval of an abnormal occurrence determination.

Discussion: Enclosure 1 is a proposed determination of an abnormal
occurrence involving the mill tailings impoundment dam
failure at the United Nuclear Corporation Church Rock
Mill near Gallup, New Mexico.

Example III.B.1 of the abnormal occurrence policy
statement notes that an event which seriously
compromised the ability of a confinement system to
perform its designated function can be considered
an abnormal occurrence.

The event was originally submitted for consideration
as an Agreement State item. However, the staff
recommends that it be reported as a fuel cycle
facility item because of both our extensive
involvement in the response to the event, and
our concurrent regulatory jurisdiction over uranium
mill tailings in agreement states.

This event has been the subject of extensive public
discussion.

Contact:
P. Bobe/R. Dennig, MPA
49-27735

Following approval, the Office of Congressional Affairs will notify the Congressional Committees of the intent to publish the Federal Register Notice.

Coordination: The Offices of Nuclear Materials Safety and Safeguards, Nuclear Reactor Regulation, Nuclear Regulatory Research, Inspection and Enforcement, Standards Development, the Division of Security and Public Affairs concur. The Executive Legal Director has no legal objections.

Lee V. Gossick
Executive Director for Operations

NUCLEAR REGULATORY COMMISSION
ABNORMAL OCCURRENCE
MILL TAILINGS IMPOUNDMENT DAM FAILURE

Section 208 of the Energy Reorganization Act of 1974, as amended, requires the NRC to disseminate information on abnormal occurrences (i.e., unscheduled incidents or events which the Commission determines are significant from the standpoint of public health and safety). The following incident was determined to be an abnormal occurrence using the criteria published in the Federal Register on February 24, 1977 (42 FR 10950). Appendix A (Example III.B.1) of the Policy Statement notes that an event which seriously compromised the ability of a confinement system to perform its designated function can be considered an abnormal occurrence. The following description of the event also contains the remedial action taken.

Date and Place - On July 16, 1979 a uranium mill tailings impoundment dam failed at the United Nuclear Church Rock Uranium Mill, located near Gallup, New Mexico. United Nuclear Corporation is licensed by the State of New Mexico under the provisions of the NRC State Agreements Program.

Nature and Probable Consequences - On July 16, 1979 the mill tailings impoundment dam failed at the United Nuclear Corporation (UNC) Church Rock Uranium Mill. Mill tailings solution and solids poured through the break into a catchment area below the dam. The catchment embankment was subsequently breached and tailings solution flowed into an arroyo and on into the Rio Puerco River which flows past Gallup, New Mexico.

The dam is located on a site containing alluvial soils overlying bedrock having an irregular surface. Depths of this relatively loose soil ranged from less than 20 feet up to a maximum of 100 feet.

During design and construction of the dam, tests were conducted to determine how much the alluvial soil would compress under a load. These tests indicated that settlement of about 5 percent would result from the loading of the embankment under dry conditions. With water in the impoundment, additional settlement ranging from 1-1/2 percent to 13 percent was experienced due to collapse of the soil structure. As a result of the high compressibility of the alluvial soil and the irregular bedrock surface, large differential settlement of the dam occurred. Settlement in excess of 3 feet was measured in January 1979 by a consultant to United Nuclear Corporation. As a result of differential settlement, cracks developed in the embankment. These cracks allowed tailings water to penetrate and weaken the embankment.

The break in the dam allowed approximately 100 million gallons of tailings solution and 1100 tons of tailings solids (sand) to flow out of the impoundment before it could be closed. Most of the solids were deposited in an area very near the impoundment in a backup containment area on United Nuclear Corporation property and in an adjacent stream, the "Pipeline Arroyo." The tailings solutions travelled in the Pipeline Arroyo to the Rio Puerco which flows through Gallup, New Mexico, a town about 20 miles southwest of the mill site, and into Arizona. The spilled solutions eventually dissipated at a point estimated to be about 20 miles into Arizona.

The radioactive isotopes in the mill tailings and tailings solutions are those which naturally occur in the soil of the area but which have been concentrated by the milling process. These isotopes, primarily thorium-230 and radium-226 did not present any immediate health hazard when released by the dam failure. The immediate health hazard arose from the acidic nature of the tailings solution which could cause chemical burns if ingested or brought in contact with skin. The potential for chemical effects persisted for approximately 2 days, until water from the upstream mining operations and the natural alkalinity of the stream bed neutralized the tailings solution.

The contamination of normally dry areas of the Pipeline Arroyo, the presence of tailings solids in the Arroyo, and the future possibility of contamination of groundwater all present long run radiological health hazards to the local population. If no corrective or precautionary measures were taken, the soil contamination could contribute a calculated maximum dose rate of 1.3 mrem/year to the whole body, 22 mrem/year to the bone above the estimated normal background dose rate of 140 mrem/year to the whole body for an adult living near the Arroyo. Cleanup of tailings solids and Arroyo contamination to the standards established by the NRC will decrease the calculated incremental dose rate to 1.1 mrem/year to the whole body, 18 mrem/year to the bone. To date there have been no indications of groundwater contamination. Wells in the area will continue to be monitored.

Cause or Causes - The tailings impoundment dam failed as a result of differential settlement and direct exposure of the dam to tailings solutions. The first factor was the result of the manner in which the dam was constructed; the second factor was the result of failure of the operator to maintain a buffer of mill tailings between the dam and the tailings solutions.

Actions Taken to Prevent Recurrence -

Licensee - The United Nuclear Corporation (UNC) performed an evaluation of the dam failure and is currently examining the servcibility of the remaining portions of the dam. UNC is also performing a study of alternate sites for the tailings impoundment. UNC is conducting cleanup operations at the instruction of various regulatory bodies, including the NRC.

NRC - The NRC has worked in conjunction with numerous other State and Federal organizations in responding to the accident and formulating longer-term corrective action, including cleanup of contamination and continued radiological monitoring.

The NRC issued an order on October 12, 1979 banning further milling operations until a review provided adequate assurance that all causes of the dam failure had been identified and that the remaining portions of the embankment were free of deficiencies. The NRC reviewed the licensee's evaluation of the dam failure, concurred in the findings with regard to the major causes, and determined that limited generation and storage of uranium tailings could be conducted with reasonable assurance of protection

for the public and the environment. The staff issued an order to this effect on October 24, 1979. The order allows operation for a limited time, prohibits planned expansion of the current tailings area until NRC staff approval is given, and requires that UNC submit a proposal by January 30, 1980 for development of a new tailings site for ultimate disposal.

The staff reviewed docket files on the tailings dams at operating mills in non-Agreement States and in all but one case found that differential settlement was satisfactorily addressed. The exception was a dam authorized in 1971 and documentation does not indicate that differential settlement was addressed. However, no evidence of excessive differential settlement leading to cracking has shown up in routine inspection of the dam. Arrangements have been made for geotechnical and hydrology consultants to assess each of the Agreement States' uranium tailings impoundment systems.

The NRC had also proposed prior to the accident regulations which specify requirements for mill tailings disposal. These regulations identify certain siting and design features which must be incorporated into tailings disposal programs to assure long-term isolation and containment of tailings without continuing active maintenance. The regulations identify burial of tailings below the surrounding grade as the preferred mode of tailings disposal. In this way, dams such as the one which failed at the Church Rock mill would be avoided.

Future reports will be made as appropriate.

DEC 10 1979

Distribution:

J. Kendig

WMUR r/f
NMSS r/f
Project WM-28
PDR
DCS
WMUR c/f
~~W111~~ File
JBMartin
REBrowning
RAScarano

Mr Thomas E. Baca, Director
Environmental Improvement Division
P. O. Box 953, Crown Building
Santa Fe, New Mexico 87503

Dear Mr. Baca:

In conformance with my discussion with Mr. Cubia Clayton of your staff on November 8, 1979, I have enclosed the up-to-date letter reports by our consultants on the safety review of the proposed addition to the northern embankment and cross dikes of the Church Rock tailings impoundment.

These reports are not a final evaluation but they identify what conclusions can be made now and include a compilation of outstanding issues to be resolved before a final stability determination can be made.

Please note that our safety evaluation did not include an independent assessment of the geological, seismological and hydrological considerations covered in Regulatory Guide 3.11.

As requested by Mr. Clayton, this report marks the termination of our technical assistance related to the stability evaluation of the existing Church Rock embankment.

Sincerely,

Original Signed by:
R. A. Scarano

Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management

Enclosures:
As stated

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Geotechnical Engineering Program
Civil Engineering Department

Colorado State University
Fort Collins, Colorado
80523

November 28, 1979

Ross A. Scarano
Mail Stop 483SS
Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, Maryland 20910

Subject: Church Rock Tailings Dam Failure (our reference E7.01b)

Dear Ross:

The following points represent general conclusions on the outstanding issues pertaining to the stability of the proposed addition to the Church Rock Tailings Dam. These conclusions have been drawn on the basis of discussions between Joseph Kane and myself. In addition to the following issues, Joe Kane will submit some discussion concerning some other pertinent points.

1. Geometry of Proposed Main Dam in Northern Zone

Drawings dated October 10, 1979 (Job No. UNC-063:SHB E-79-1096, sheet no. 4) shows typical sections for the main dam from Stations 35+00 to 63+55. In general, these typical sections include Zone I of cohesive core material to be placed over the existing starter dam. Zone II consists of a low plasticity shell material to be placed on the downstream side of the existing starter dam. A vertical chimney drain will be placed between Zones I and II and will drain to horizontal finger drains. This general geometry of the embankment is considered to be adequate. The cross section between Stations 31+00 and 35+00, however, still needs to be specified.

The vertical and horizontal drains consist of three feet of Zone III material with an additional three feet of Zone IV material placed on either side of it. The Zone III material will be a coarse vesicular basalt derived from a dune sand deposit near the site. This geometry provides for a total thickness of drain material of 9 feet and is considered adequate.

Computations have been presented by Sergeant Hauskins and Beckwith (SHB) to show compliance with filter criteria between the different zone materials. These are presented in the document entitled "Supplementary Data", SHB Job No. E 79-1096, dated October 31, 1979. The computations indicate that some processing of the dune sand and cinder material may be necessary in order

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to assure that filter criteria is met. Before the drain material is placed in the embankment, grain size distributions and computations indicating that filter criteria have been met should be approved.

Details are not provided to indicate the manner of disposing of the drainage water from the chimney drains and horizontal finger drains. Conversations with personnel from Sergeant, Hauskins and Beckwith indicate that a collection system downstream from the embankment will be provided. Details of this collection system should be presented and approved prior to construction.

2. Settlement Analyses

Settlement analyses have not been provided to indicate what magnitude differential settlement may be expected beneath the embankment.

A primary question exists as to the potential for collapse of the foundation soils under the embankment. In a letter to me dated October 26, 1979, George Beckwith stated that, in his opinion, most of the soils in the embankment foundation above the water table are of moisture contents well above the threshold for collapse. He states that at most about a 10 foot thickness of soils susceptible to collapse is present. Reference is also made in that letter to publications which document the existence of such a threshold water content. I have plotted initial water content vs percent collapse for all of the consolidation presented to date. Considerable scatter exists in that data. Only three tests were performed on samples of foundation materials at initial water contents above 15% water content. Below 15% water content the percent collapse of the soils ranges from zero to 14.5%. The scatter in the data is sufficiently large to preclude any conclusions being drawn regarding the value of these threshold water contents. However, it appears to be of a value greater than 15%. Shear strength data indicates that at a water content of about 20% a decrease in strength occurs. It may be expected, therefore, that the threshold water content is around 20%.

Water content data in Borings 76, 77, 78, 85 and possibly others, indicate that thicknesses of foundation soils of 15 to 20 feet have water contents below 20%. If collapse of these soils occur in amounts up to 13 to 14%, differential settlement could be excessive.

Differential settlement may occur along the axis of the embankment due to differences in the depth to bedrock from the abutment to the zones of deeper foundation materials. The seismic refraction data presented indicates that the bedrock profile is relatively uniform and no abrupt changes in depth to bedrock are expected. However, due to the additional weight of the embankment material compression of the deep deposit of foundation soils will occur. Settlement analyses should be presented to indicate the general magnitude of differential settlement which may occur along the dam axis.

Differential settlement may also occur in the direction transverse to the axis of the embankment. This differential settlement may result from changes in the stress distribution below the embankment after placement of the additional load on the downstream face of the starter embankment. In addition more collapse of the soil is to be expected on the downstream side of the existing dam than directly below it. Variations in water content and densities throughout the site may also contribute to differential settlement. Settlement analyses must be presented which indicate the general magnitudes of differential settlement that can occur as a result of the above factors.

3. Liquefaction Potential of Tailings Underlying Cross Dikes

An analysis of the liquefaction potential for the tailings underlying the southern cross dike has been presented by SHB in the report entitled "Supplementary Data" dated October 31, 1979. In that analysis assumptions were made pertaining to the nature of the tailings sand and the location of the ground water level. In this analysis the mean grain size diameter of the tailings sand was considered to be about 0.2 mm. This value was selected on the basis of grain size tests performed on samples of tailings sand sampled by Sergeant Hauskins and Beckwith. However, Seed and Idriss (1971) noted that a finer grain size will be more susceptible to liquefaction. Segregation of the tailings during deposition can cause zones of finer grained tailings sands to exist within the impoundment. A more conservative but realistic assumption would consider the mean grain size to be on the order of 0.1 mm.

The analysis presented by Sergeant Hauskins and Beckwith also considers the groundwater level in the tailings to be 10 feet below the ground surface. During operation of the tailings impoundment the groundwater level in the tailings sand in the vicinity of the cross dike would more reasonably be expected to be near the ground surface. I have performed a liquefaction analysis for the tailings at a depth of 20 feet (this depth is considered to be a critical depth by Seed and Idriss). I assumed the groundwater level to be at the surface and considered the mean grain size of the tailings to be in the range of 0.1 mm. My analysis indicates that for relative densities less than about 50% a maximum acceleration of 0.1g would cause liquefaction for 10 cycles of shaking. Blow counts observed in Bore Holes No. 12 through 18 and 53 through 57 indicate many areas in which the blow counts are less than 5. That value roughly corresponds to a relative density of about 50% (Figure 13 in Seed and Idriss, 1971).

It is evident, therefore, that the foundation material underlying the cross dikes is highly susceptible to liquefaction should an earthquake occur. The applicant should show by means of further analysis that includes laboratory results of cyclic testing on the loose tailings, that the stability of the cross dikes will be adequate to withstand the acquired design earthquake, or demonstrate that the consequences of the cross dike failure is acceptable and will not endanger public health or property.

4. Borrow Materials

The data that has been presented along with discussions with Sergeant Hauskins and Beckwith personnel indicate that the borrow materials required for construction of the main dam during Stage II exists in sufficient quantities.

Gradation analyses presented for the drain materials before and after compaction indicate little breakdown of the material during compaction. At the initiation of construction additional tests should be performed on a section of the material prior to and after compaction by methods to be actually used during construction. If breakdown of the material occurs in sufficient magnitude to prevent the material from meeting filter criteria, modifications in construction procedures should be instituted. Approval by the responsible government agency should be required on proposed modifications.

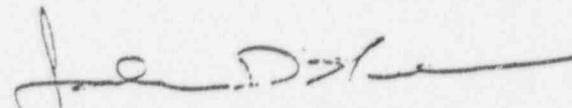
Grain size distributions were presented in the appendix to the "Supplementary Data" dated October 31, 1979 for Zone III (drain) material both before soaking in tailings solution and after 241 hours of soaking. This data indicates a significant increase in the fraction of the material finer than 3/8 in. after soaking. Although the pH of the acid both before and after the tests did not change, the observed increase in the fine fraction indicates that some breakdown of the Zone III material had occurred. That data provides question as to the stability of the Zone III material in the environment to which it will be subjected.

5. Stability of Sandstone Foundation Materials

When the main dam is raised, the abutments will be keyed into the sandstone and shale at the north end of the dam. The foundation materials must be shown to be stable under the low pH environment to which they will be subjected. If this cannot be demonstrated, a potential for piping in the abutment areas could develop.

Additional conclusions regarding shear strength, piezometer readings, and continued monitoring and observations of the operations will be presented by Joe Kane. The above statements will be documented more fully in a report to be presented to you at a later date. In the interim, if you have any questions concerning this please call.

Very truly yours,



John D. Nelson, Ph.D., P.E.
Professor



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555
DEC 10 1979

J. Kendig

MEMORANDUM FOR: Ross A. Scarano, Chief
Uranium Recovery Licensing Branch, DWM

FROM: Robert E. Jackson, Chief
Geosciences Branch, DSS

SUBJECT: CHURCH ROCK REVIEW - OUTSTANDING GEOTECHNICAL
ENGINEERING REVIEW ISSUES (TAC 5294, R53)

PROJECT: Church Rock - United Nuclear Corporation
RESPONSIBLE BRANCH: Uranium Recovery Licensing Branch and
Office of State Programs
REQUESTED COMPLETION DATE: November 23, 1979

In the past, Uranium Recovery Licensing Branch has expressed the need for Geotechnical Engineering Section, Geosciences Branch, to be satisfied with the safety of the revised design of the Church Rock tailings dam which had failed in July 1979. In more recent telephone conversations between you and J. Kane of my staff, you had requested Mr. Kane to work closely with NMSS Consultant, J. Nelson, from Colorado State University in identifying the important geotechnical engineering safety issues which have not been satisfactorily resolved. In response to your request we have enclosed a partial list of the outstanding issues. It is our understanding that other issues are being separately forwarded to you by your consultant and cover concerns on unacceptable levels of settlement, verification that drain materials meet required filter criteria, adequate stability of the internal cross dikes under dynamic loading and the adequacy of seepage collection measures and proposed borrow materials.

We have identified the issues by number in the attachment to simplify our review of the Applicant's responses, United Nuclear should be requested to directly respond to the numbered issue. In the past, questions raised by the Corps of Engineers, J. Nelson and J. Kane of my staff have not been directly answered, but only partially responded to by the issuance of a new report which does not state or identify our original concerns. This response approach by the applicant has been the major reason that safety issues identified early in regulatory reviews are still continuing.

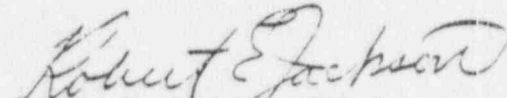
We would like to reiterate our past comment on the need for careful evaluation on the Church Rock project concerning geological, seismological and hydrological considerations. These considerations, which could have a significant impact on dam safety and performance, should be reviewed and followed up by NMSS and your consultants.

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NRC should request a list of license conditions to be imposed by the State of New Mexico to cover United Nuclear's plans for raising the North Starter Dam to Elevation 6980. Some of the important license conditions of interest to the Geosciences Branch would be related to embankment construction control, slope protection, dam safety monitoring and inspection requirements during operation.


Robert E. Jackson, Chief
Geosciences Branch
Division of Systems Safety

Enclosure:
As stated

cc: w/o enclosure
R. Mattson
J. Martin
G. Kerr

cc: w/enclosure
J. Knight
R. Jackson
L. Hulman
T. Sullivan
L. Heller
L. Reiter
J. Kendig
H. Miller
J. Linehan
J. Nelson
J. Kane
PDR

CHURCH ROCK URANIUM MILL TAILING PROJECT
TAC NO. 5224, R53
PARTIAL LIST OF OUTSTANDING GEOTECHNICAL ENGINEERING ISSUES
PREPARED BY: Joseph D. Kane, NRR, DSS, GB, GES

SELECTED SHEAR STRENGTHS - STABILITY ANALYSES

Our concern for selecting reasonably conservative shear strengths representative of the embankment and foundation materials is directly related to our concern that an adequate margin of safety against an embankment failure (as listed in R.G. 3.11) is available at the Church Rock project when ultimate tailings reservoir loading will be imposed. The summary plots of triaxial test results in Volumes 3 and 4 "Stability and Integrity Assessment" are misleading and past selections of design strengths from these graphs have been unconservative. These plots combine shear test results on samples without regard to similar soil type, depth differences in foundation layering, and, most importantly, disregard the significant effect of raised soil moisture contents on shear strength. The end result of this past selection method is to adopt a shear strength which is heavily influenced by the preponderance of testing on samples at low insitu moisture contents. This method fails to fully anticipate the wetting of soils as the water mound develops from the raising tailings reservoir. The effect on shear strength from higher moisture contents can be observed in the following test results:

<u>Boring No.</u>	<u>Depth (ft.)</u>	<u>Report Source</u>
27	29.5'	SHB Report, Vol. 4, App. B, Plates B45 thru B47
28	34.5' 64.5'	SHB Report, Vol. 4, App. B, Plates B51 thru B53 SHB Report, Vol. 4, App. B, Plates B54 thru B56
42	29.5'	D&M Report, Section 3
44	39.5'	D&M Report, Section 3
47	9.5'	D&M Report, Section 2

Lower shear strengths more representative of the strength available following bulging have been indicated in some of the results on samples recovered and tested since the July 1979 failure. The reduced shear strengths that were used in the stability study in "Final Design Analysis Report"

(October 15, 1979) appear more reasonable, with the exception of the adopted cohesion values, but no basis for the strengths selected has been given.

The correctness of the selected design strengths takes on greater importance because the results of the stability study presented in the Final Report (page 7) indicate that NRC minimum required factors of safety for steady seepage condition are just being met when the dam would be raised to crest Elevation 7004. The following item 362.1 attempts to give guidance for providing the information that should permit resolution of the shear strength issue. Item 362.2 calls attention to the work which may need to be performed when the shear strength issue is fully resolved.

- 362.1 New summary plots of Mohr circles should be presented from which the appropriate design shear strengths should be selected. Considerations which should be addressed in the development of the new plots would include:
- a. The grouping of results on materials that exhibit similar soil classification and characteristics (e.g., plasticity, etc.) at comparable foundation stratification and depth and within similar embankment zones.
 - b. The grouping of materials which attempts to clearly distinguish the effect of higher moisture contents on collapsing foundation soils.

- c. The presentation of separate graphs for each type of anticipated drainage condition (U-U, C-U, and C-D) with the data labeled with the appropriate boring number, depth of sample and moisture content of the tested samples.

362.2 The need for additional stability studies and the determination of the margin of safety against failure should be established following an evaluation of the new graphs and selected design shear strengths for each embankment and foundation material.

CONSTRUCTION

The comments of items 362.3 through 362.6 attempt to correct apparent omissions or errors in the previously submitted construction plans.

362.3 The specifications for controlling fill placement moisture content should be revised (Sheet 4 of 7, Construction Plans) to require an upper limit. The Construction Notes (Sheet 4 of 7) and the specifications for Zone IV material (Sheet 4 of 7) should limit moisture content between optimum and two percent above optimum.

362.4 Zone III and IV materials are engineered fill materials therefore, Construction Note 3 (Sheet 4 of 7) would not apply to chimney and finger drain materials and these materials should be excepted in Note 3.

362.5 Note 1 under Tailings Deposition Sequence (Sheet 2 of 7, Construction Plans) should be revised to exclude the use of tailings for Chimney Drain material.

362.6 The frequency of field testing and laboratory testing to meet proposed construction specifications should be submitted. This testing includes gradation, field density and moisture content, Atterberg Limits, compaction and relative density tests.

EMBANKMENT SAFETY INSTRUMENTATION

Items 362.7 and 362.8 address the adequacy of needed embankment instrumentation which will permit observation and evaluation of the retention dam stability during construction and operation.

362.7 United Nuclear's plans and installation details should be presented for approval for installing a reasonable number of piezometers beneath the new embankment at varying depths within the compressible foundation materials. The piezometers are need to monitor possible development of excess pore pressures and to locate the developing top seepage line within the foundation.

362.8 The survey monuments discussed in Vol. 4 "Stability and Integrity Assessment" would eventually be lost beneath tailings sand beaches and are not suitably located for the new construction to Elevation 6980. Plans for continued monitoring of settlement should be provided and include type of monument; approximate locations, elevations and time to be installed; typical installation details; and frequency of readings to be surveyed. Settlement plates installed only at the downstream toe are not considered adequate for measuring settlement beneath the new embankment construction.