energy fuels nuclear, inc.
executive offices • suite 445 • three park central • 1515 arapahoe • denver, colorado 80202 • (303) 623-8317

May 2, 1978

United States Nuclear Regulatory Commission
Fuel Processing & Fabrication Branch
Division of Fuel Cycle & Material Safety
7915 Eastern Avenue
Silver Springs, Maryland 29096

ATTENTION: Mr. Ross Scarano

RE: Docket No. 40-8681
Alternative Tailing Disposal Systems
White Mesa Uranium Mill

Gentlemen:

On February 8, 1978, Energy Fuels Nuclear, Inc. submitted to the Nuclear Regulatory Commission a Source Material License Application for the proposed White Mesa Uranium Mill near Blanding, Utah. The application was accompanied by an Environmental Report prepared by Dames & Moore, our environmental consultants (see Docket No. 40-8681).

On March 24, 1978, your letter was received requiring Energy Fuels Nuclear, Inc. to address, in more detail, alternatives for the disposal of tailings.

Western Knapp Engineering ("Western Knapp"), a Division of Arthur G. McKee & Company, was asked by Energy Fuels to perform an independent study of alternative tailings disposal systems for the proposed White Mesa Uranium Mill. Their report entitled "The Investigation of Alternative Tailings Disposal Systems" is submitted herewith and is an addendum to the Environmental Report.

The alternatives studied by Western Knapp, following a field inspection of the area, included:

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1. Conventional disposal of total tailings in above-grade containment basins which are sealed with natural soils inplace. Variations include construction of a containment embankment of the tailings material derived from the mill operations, and construction of engineered earth-filled embankments of borrow material.

2. Disposal of total tailings in excavated basins partially or completely below grade.

3. Segregated disposal involving a separation of the total tailings into a sand component and a slime component. With this method, the sand component is dry enough to allow storage in unlined excavations. The slime component is impounded in impermeable evaporation ponds.

4. Filtration of the total tailings in order to de-water them to a level where it is unnecessary to line the tailings storage basin or area. The liquid component will be evaporated in impermeable evaporation ponds.

5. Off site disposal in mines.

6. Additional matters studied include neutralization, chemical fixation, use of alternative cover materials, and use of clayey sands and plastic membranes for lining ponds.

A. Evaluation of Alternatives

The following tables represent a summary of Western Knapp's evaluation of the various tailing disposal alternatives.

Alternatives Studied	Type of Liner	Advantages	Disadvantages
Conventional Disposal:			
1. Dam construction using tailings sands.	Natural inplace soils, scarified and recompacted.	Less disturbed area, no borrow required.	Integrity and stability questionable; radon emission from face of embankment uncontrolled.
2. Engineered embankment -- Full height construction prior to mill start-up. Down slope protected with rip-rap before operation.	Natural inplace soils, scarified and recompacted.	Radon emissions low, slime portion of tailings buried below sands or water during operation, exposed sand covered with soil when final height reached. System would blend since natural material is used for reclamation cover. Stability, long term as well as short term, is excellent because down slope embankment is protected with rip-rap or concrete.	Large borrow area required.
3. Engineered embankment -- Vertical stage construction. Down slope protected with rip-rap after last stage constructed.	Same as 2, above.	Same as 2. above after project completed.	Exposure to erosion during operation greater than if dike constructed in one stage. Radon emission greater than for full height construction due to larger exposed tailings surface.
4. Engineered embankment -- Horizontal stage construction. Rip-rap after last stage constructed.	Natural soils scarified and recompacted.	Stability excellent; short term as well as long term. Radon gas emission is low during operations because of staged reclamation.	Large borrow area required.
Disposal In Excavated Basins:			
5. Disposal partially below grade. (Dames & Moore suggested method.)	Synthetic membrane.	Long term stability excellent when rip-rapped. Control of radon emission very good as bulk of tailings will be kept below water during operation.	Mound on all four sides after completion; therefore, aesthetics not as good as 2. above. Integrity of liner over long term not known.
6. Disposal in excavated basins totally below grade.	Same as 5, above.	Short term as well as long term stability excellent. Radon control during operation good. Erosion during and after operation excellent.	Extremely large excavated pit required for sands storage. Excessive amount of spoil left after project completed. Long term integrity of liner not known. Extremely high cost.
Segregated Disposal:			
7. Sand-slime separation. Sands buried below grade after being dewatered. Slimes stored in evaporation pond.	No liner used in basin for dewatered sands. Liner in evaporation pond is of scarified and recompacted natural soils.	[illegible]don emission controlled on sand portion as sand tailings covered progressively during operation. Slime portion covered with water during operation. Stability of sand disposal system is excellent as material is below grade. Stability of slime pond embankment excellent as outside slope of embankment covered with rip-rap.	Large pit required for sand burial and large mound exposed when covered. Slime portion requires large area; extremely large borrow area required for cover. Excessive amount of spoil left after project completed. Extremely high cost.

Alternatives Studied	Type of Liner	Advantages	Disadvantages
8. Same as 7., except slimes buried partially below grade.	Synthetic membrane on slimes portion. Sands dewatered and no lining used.	Advantages same as 7., except stability may be better on the partially below grade disposal of slimes.	Same as 7., plus long term integrity of liner unknown.
9. Same as 7., except slimes buried totally below grade.	Sames as 8.	Same as 8.; stability excellent for both portions.	Same as 8.
Filtered Tailing Disposal:			
10. Filtered tailings.	None, as tailings dewatered.	Stability excellent for solids. Radon emission controlled during operation as solids covered with soil.	Extremely large pit required for burial of solids. Large area disturbed for burial and solution evaporation ponds. Large spoil mound over area. Extremely high cost. Highly questionable that White Mesa Uranium tailing can be filtered due to the clay content of the various ore types.
Offsite Disposal In Mines:			
11. Disposal in mines.	None	Material is returned to previously disturbed areas and below surface storage.	Widely dispersed and scattered; hard to control; mines operating; diverse ownership of mines. No open pit available. Underground mines are widely scattered for a radius of 100 miles around the mill site.
Additional Considerations:			
12. Tailings Neutralization	None	None apparent.	Gelatinous and low density precipitate increases total volume of tailings resulting in larger pond area requirement. Underlying sandstone high in lime; therefore, if seepage occurs a non-neutralized liquid will eventually be neutralized.
13. Chemical Fixation	None	Reduced emissions could be expected.	Technology for long term unknown. Cost prohibitive.

B. Methods Selected

Based on the Western Knapp investigation, Energy Fuels recommends as the preferred system for tailings disposal the engineered embankment (full height or stage construction) using scarified and recompacted natural inplace soils for seepage control. This alternative represents an environmentally sound, reliable and reasonable method of tailings management.

The second preferred alternative is the disposal of tailings partially below grade in excavated basins (cells)(Dames & Moore suggested method) in which a synthetic membrane liner is used. An alternate clay liner could be considered for this design.

In either case, rip-rap will be extensively employed on all downslope embankments for long term stability.

C. Methods Rejected

Disposal of tailings totally below grade, with or without particle segregation or filtration, would require the excavation of approximately 9,000,000 cubic yards of material for the proposed 15-year operation. Removal of this yardage would constitute a large mining operation and produce an enormous pit. Because a major part of the pit would be in solid rock, extensive drilling and blasting would be required before loading and haulage of the broken material to adjoining areas. This would be prohibitively expensive and have serious environmental impacts. The excavating equipment required for a project of this size is as follows:

- 8 -- Truck-Mounted Rock Drills
- 2 -- ANFO Trucks
- 6 -- 15-Yard Front End Loaders
- 12 -- 85-Ton Dump Trucks
- 4 -- D-9 Ripper Tractors (Bulldozers)
- 2 -- Water Trucks
- 2 -- Graders

The time required to excavate 9,000,000 cubic yards of material (mostly from solid rock) would be one and one-half years or more. In addition, approximately 250 acres of land would be excavated. An equal (or larger) area of land would be permanently disturbed by the placement of the 9,000,000 cubic yards (11,000,000 cubic yards in loose state) of rock and soil removed from the pit. Although a part of this excavated material would ultimately be used for cover over the pit area, the bulk of it would remain as an elevated land mass scarring the surrounding area.

D. Natural Liner Material On The Property

Samples of the silty and clayey sands overlying the tailing reservoir area were taken by Western Knapp and submitted to Chen Associates of Denver, Colorado for laboratory permeability tests. The results are presented in the following tabulation:

Sample	Dry Density	Moisture Content	Pressure Head	Coefficient of Permeability
North	110.2 pcf	13.0	14.5 Ft.	0.03 Ft./Yr.
South	107.9 pcf	13.8	14.5 Ft.	0.081 Ft./Yr.

A copy of Chen & Associates' laboratory report is included in the Western Knapp report. Permeability tests performed by Dames & Moore on remolded samples of similar material, compacted to 95% of the optimum, in accordance with the specifications of AASHTO T-99, gave permeabilities (K) of 0.35 Ft./Yr.; 0.56 Ft./Yr.; and 0.19 Ft./Yr. On the basis of the above laboratory permeability rates, Western Knapp concluded that the silty and clayey sands overlying the tailing reservoir area are more than acceptable for tailings and solution seepage control when scarified and recompacted, and preclude the need for a synthetic membrane. A preliminary seismograph survey was performed over the tailing area. This survey showed the sandy clay soil and sandy silty soil varied from four feet thick up to eighteen feet thick over the entire area (refer to the attached seismograph survey).

In addition to the low permeability of the scarified and recompacted soil, the physical properties of the tailings material are such that they will tend to decrease seepage to a great extent. An average of ~~80%~~ 30% of the tailings material is minus 325 mesh.

[illegible] per telecon w/ D. Sparling (EFN) on 5/12/78

The Western Knapp Engineering report shows capital and operating cost estimates for the alternative disposal systems. A summary of these costs is attached hereto.

We feel it would be very helpful for all concerned if a representative of the Nuclear Regulatory Commission could visit the site in the very near future. This would provide a better understanding of the site characteristics and general area in relation to the proposed tailings plans.

We sincerely believe that the submission of Western Knapp's report as an addendum to our environmental report will satisfactorily complete our application such that your review may proceed expeditiously.

Sincerely,

Muril D. Vincelette
Vice President-Operations

MDV/jp

Attachments

NIELSONS INCORPORATED

General Contractors

PHONE 565-8461 P. O. BOX 1660

CORTEZ, COLORADO 81321

April 10, 1978

RECEIVED APR 1 2 1978

Mr. D. K. Sparling
Manager of Uranium Processing
Energy Fuels Nuclear, Inc.
Suite 445, Three Park Central
1515 Arapahoe
Denver, Colorado 80202

SUBJECT: Seismograph Survey of Blanding Mill Site
San Juan County, Utah

Dear Don:

On March 28, 1978, at the request of your office a seismograph survey was made of several proposed pond areas at the subject site.

The purpose of this seismic survey was to primarily determine the velocity and depth of bedrock and evaluate its excavation characteristics. At seven of the seismograph locations bedrock, which we assume to be Dakota Sandstone, was encountered with a velocity range of from 6,500 feet per second to 8,400 feet per second. Our experience has shown that in most cases it is necessary to drill and shoot sandstone of this velocity range. It is generally not economically feasiable or physically possible to rip sandstone of this velocity with a current model Caterpillar D-9 tractor using a single tooth ripper.

Material in the velocity range of from 3,100 feet per second to 5,000 feet per second was encountered over the more dense bedrock at several locations as well as at several locations where hard rock was not encountered within 33 feet of the surface.

We are also assuming this to be sandstone although we suggest that this data be correlated with your drill logs to confirm the rock type. It is anticipated that the material in this velocity range will rip with a D-9 tractor without great difficulty.

The surface material is a sandy silt of a velocity range of from 800 feet per second to 1,750 feet per second. A more compact or cemented soil often underlies the unconsolidated silty sand. This more dense soil has a velocity range of from 1,700 feet per second to 2,450 feet per second. Light ripping of the compacted or cemented soils will facilitate loading into scrapers.

NIELSONS INCORPORATED

General Contractors

PHONE 565-8461 P. O. BOX 1660

CORTEZ, COLORADO 81321

April 10, 1978

Mr. D. K. Sparling

A copy of the summary of our seismic results is attached. This is accompanied by copies of a drawing showing the location of each of our seismograph profiles.

Yours very truly,

NIELSONS, INC.

Arnold G. Hampson

Arnold G. Hampson P.E.
Vice President -
Engineering

AGH:ls

cc:file, Mr.FRank Seeton, James H. Tinto

Encl: as noted above

SEISMOGRAPH SURVEY

BLANDING MILL SITE

SAN JUAN COUNTY, UTAH

SEISMIC TEST NUMBER	VELOCITY	DEPTH	PROBABLE MATERIAL	EXCAVATION CHARACTER
1	V_1= 1,500 f.p.s.	0-11'	Sandy-Clay Soil	Unconsolidated Soil
	V_2= 7,400 f.p.s.	11-33'	Dakota Sandstone	Drill & Shoot Rock
	V_1= 900 f.p.s.	0-6'	Sandy-Clay Soil	Unconsolidated Soil
	V_2= 7,000 f.p.s.	6-33'	Dakota Sandstone	Drill & Shoot Rock
3	V_1= 1,300 f.p.s.	0-3'	Sandy-Clay Soil	Unconsolidated Soil
	V_2= 2,000 f.p.s.	3-9'	Sandy-Clay Soil	Compact Soil
	V_3= [illegible],100 f.p.s.	9-33'	Dakota Sandstone	Soft Rippable Rock
4	V_1= 900 f.p.s.	0-4'	Sandy-Clay Soil	Unconsolidated Soil
	V_2= 4,000 f.p.s.	4-33'	Dakota Sandstone	Soft Rippable Rock
5	V_1= 900 f.p.s.	0-3'	Sandy-Clay Soil	Unconsolidated Soil
	V_2= 1,700 f.p.s.	3-15'	Sandy-Clay Soil	Compact Soil
	V_3= 6,500 f.p.s.	15-33'	Dakota Sandstone	Drill & Shoot Rock
6	V_1= 1,300 f.p.s.	0-5'	Sandy-Clay Soil	Unconsolidated Soil
	V_2= 4,200 f.p.s.	5-13'	Dakota Sandstone	Medium Soft Rippable Rock
	V_3= 6,800 f.p.s.	13-33'	Dakota Sandstone	Drill & Shoot Rock

SEISMOGRAPH SURVEY

BLANDING MILL SITE

SAN JUAN COUNTY, UTAH

SEISMIC TEST NUMBER	VELOCITY	DEPTH	PROBABLE MATERIAL	EXCAVATION CHARACTER
7	V_1 = 1,250 f.p.s.	0-3'	Sandy-Clay Soil	Unconsolidated Soil
	V_2 = 2,200 f.p.s.	3-18'	Sandy-Clay Soil	Compact Soil
	V_3 = 6,500 f.p.s.	18-33'	Dakota Sandstone	Drill & Shoot Rock
8	V_1 = 1,400 f.p.s.	0-6'	Sandy-Silty Soil	Unconsolidated Soil
	V_2 = 4,400 f.p.s.	6-33'	Dakota Sandstone	Medium Soft Rippable Rock
9	V_1 = 1,300 f.p.s.	0-6'	Sandy-Silty Soil	Unconsolidated Soil
	V_2 = 5,000 f.p.s.	6-33'	Dakota Sandstone	Medium Hard Rippable Rock
10	V_1 = 1,500 f.p.s.	0-5'	Sandy-Silty Soil	Unconsolidated Soil
	V_2 = 2,450 f.p.s.	5-17'	Sandy-Silty Soil	Compact, Cemented Soil
	V_3 = 7,000 f.p.s.	17-33'	Dakota Sandstone	Drill & Shoot Rock
11	V_1 = 800 f.p.s.	0-5'	Sandy-Silty Soil	Unconsolidated Soil
	V_2 = 3,500 f.p.s.	5-13'	Dakota Sandstone	Medium Soft Rippable Rock
	V_3 = 8,400 f.p.s.	13-33'	Dakota Sandstone	Drill & Shoot Rock
12	V_1 = 1,400 f.p.s.	0-7'	Sandy-Silty Soil	Unconsolidated Soil
	V_2 = 4,500 f.p.s.	7-33'	Dakota Sandstone	Medium Soft Rippable Rock

SEISMOGRAPH SURVEY

BLANDING MILL SITE

SAN JUAN COUNTY, UTAH

SEISMIC TEST NUMBER	VELOCITY	DEPTH	PROBABLE MATERIAL	EXCAVATION CHARACTER
13	V_1= 1,750 f.p.s.	0-6'	Sandy-Silty Soil	Unconsolidated Soil
	V_2= 3,700 f.p.s.	6-33'	Dakota Sandstone	Medium Soft Rippable Rock

SUMMARY OF COSTS FOR VARIOUS TAILINGS DISPOSAL METHODS

Developed by Western-Knapp Engineering

White Mesa Uranium Project

	Estimated Total Capital, Operating, and Reclamation Cost			
Conventional Disposal				
Dam construction using tailings sands	$ 7,393,000	(253,000)*		
Engineered embankment - Full Height with rip-rap	9,893,000	(2,064,000)		
Engineered Embankment - Stage Construction:				
(a) Vertical (with rip-rap)	9,918,000	(2,064,000)		
(b) Horizontal (with rip-rap)	11,724,000	(2,931,000)		
Disposal in Excavated Basins				
Disposal partially below grade	$17,278,000	(10,131,000) - Dames & Moore Method		
Disposal totally below grade	34,757,000	(28,944,000)		
Segregated Disposal	Hydrocyclones		Hydrocyclones + Screen	
Sand-slime separation and with slime evaporation pond:				
Above grade pond (90 acres)	$18,947,000	(6,658,000)	19,173,000	(6,723,000)
Partially below grade Pond (90 acres)	27,288,000	(15,333,000)	27,513,000	(15,397,000)
Below grade Pond (90 acres)	33,423,000	(21,801,000)	33,648,000	(21,865,000)
Small ponds, above grade (multiple 25 acre ponds)	18,947,000	(6,658,000)	19,173,000	(6,723,000)
Filtered Tailing Disposal	Truck Haulage		Belt Conveyors	
With belt extractors	$25,610,000	(6,069,000)	25,528,000	(7,518,000)
With disc filters	25,449,000	(5,651,000)	25,376,000	(7,099,000)
Offsite Disposal in Mines				
No cost estimate developed				
Additional Considerations				
Total neutralization	$21,367,000	(476,000)		
Slime neutralization only	18,815,000	(476,000)		
Chemical fixation	105,500,000	(500,000)		

NOTE: *The numbers in parentheses represent the capital cost. See Western-Knapp Engineering report for break-down of estimated costs, unit rates, etc. and cost of concrete slope protection in lieu of rip-rap.

FROM	DATE OF DOCUMENT	DATE RECEIVED	NO
Energy Fuels Nuclear, Inc	05-02-78	05-15-78	09350

LTR	MEMO	REPORT	OTHER
X			

TO	ORIG	CC	OTHER
RScarano	1		

ACTION NECESSARY ☐	CONCURRENCE ☐	DATE ANSWERED
NO ACTION NECESSARY ☐	COMMENT ☐	BY

CLASSIF	POST OFFICE	REG NO	FILE CODE
U			40-8681

DESCRIPTION (Must Be Unclassified)

a letter stating that your letter of March 24, 1978 requested an more detail, alternatives for the disposal of tailings

ENCLOSURES

REMARKS

REFERRED TO	DATE	RECEIVED BY	DATE
Docket File Cy	5/15		
LCRouse (4)			
JMartin			
I&E (2)			
PDR			
		09350 ced	

U S NUCLEAR REGULATORY COMMISSION

MAIL CONTROL FORM

FORM NRC 326 (1-75)