SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

RE: 0634-N

September 29, 2006

Certified Mail Receipt # **7006 0100 0006 7846 9781**
Return Receipt Requested

U.S. Nuclear Regulatory Commission
ATTN: Mr. Myron Fliegel, Senior Project Manager
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
And Safeguards, NMSS
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

Subject: Sequoyah Fuels Corporation, Docket – 40-8027
Response to OIs on the Final Safety Evaluation Report – Reclamation Plan (TAC L52511)

Dear Mike,

In a telephone conference dated September 5, 2006, you identified 5 open issues (OI) on the Reclamation Plan that resulted from developing your final Safety Evaluation Report (SER). We discussed the OIs and a possible resolution to each one to move the process forward. Please find enclosed with this letter SFC responses to the OIs discussed in that telephone conference.

Once your staff has had time to review these responses, SFC is prepared to meet with you to resolve any outstanding issues that may impede development of your final SER.

If you have any questions, don't hesitate to call me at (918) 489-5511, ext. 13.

Sincerely,

John H. Ellis
President

Enclosure

XC: Alvin Gutterman, MLB
Rita Ware, EPA
Clint Strachen, MFG
Jeanine Hale, CN
Trevor Hammons, OAG

Sequoyah Fuels Corporation
Draft Safety Evaluation Report (DSER)
Remaining Open Issues as of September 2006

DSER OI.05

The licensee needs to provide particle size specifications for the synthetic liner bedding and cover materials consistent with information used in the licensee's stability analysis. (SER Section 3.3.2)

Response:

Section 4.2.3 and 4.2.5 of the Technical Specifications will be modified to specify the following particle-size distribution for synthetic liner bedding and cover materials:

Sieve Size	Percent Passing
1 inch	100
No. 4	65-100
No. 16	25-85
No. 40	5-45
No. 200	0-10

The above gradation is consistent with the gradation of the granular material used in the direct shear test of the synthetic liner/granular material (Enclosure 1 of SFC, 2004). This gradation also applies to the liner cover material above the synthetic liner in the disposal cell cover system (Technical Specifications Section 7.2.3). There is no liner bedding material below the synthetic liner in the cover system. Bedding for the synthetic liner is provided by the clay liner (Technical Specifications Section 7.2.1).

Stability analyses associated with the updated cover configuration (without liner bedding material) have been conducted and show acceptable calculated factors of safety. These analyses are included in Appendix F of the January 2006 Cell Construction plan prepared by MFG (Reclamation Plan Attachment E). NRC staff is reviewing these analyses.

DSER OI.07

The licensee needs to provide its proposed approach to addressing placement and compaction specifications for layer-C material and soils placed around such structural materials. (SER Section 3.4.2)

Response:

The Technical Specifications for material placement in the disposal cell will be modified to clarify the methods for structural materials and soils. The materials to be placed in the disposal cell are still outlined in the Technical Specifications as material types A, B, C, and D. Type C materials include structural materials and calcium fluoride sludges. Type D materials include contaminated soils that will be used to cover and fill voids within the structural materials. The updated wording of

Section 6.3 of the Technical Specifications is presented below, with the strategy for placement and compaction of materials in the cell, based on material compressibility and size.

Incompressible materials. Structural materials will be broken or cut to manageable size using typical equipment for demolition work, such as hydraulic excavators with specialized attachments for shearing and grasping. These materials will be hauled to the disposal cell for placement. The material placement strategy for incompressible structural materials is to minimize void spaces around these materials in the cell by spreading or laying out these materials in lifts. Materials of large size will be cut for loading and transport to the designated area of the disposal cell, with a maximum dimension 20 feet (unless loading or handling conditions dictate a smaller dimension). Large or odd-shaped materials will be laid flat in the disposal cell, or (in other words) placed with longest dimension oriented horizontally. Each lift of material will be covered with soil and compacted to minimize void spaces within the incompressible materials in the cell.

Large incompressible materials exceeding two feet in vertical dimension (such as thick-walled tanks or vessels) will be placed in the cell, with interior void spaces filled with sand or grout. Soil or sand will be placed outside of the large materials and compacted with standard compaction equipment (where possible) or hand-operated equipment.

Compressible materials. The material placement strategy for compressible materials is to make them incompressible by cutting, crushing, solidifying, or compacting these materials.

Compressible structural material (such as thin-walled piping and tanks) will be flattened or crushed at the disposal cell with hydraulic excavator attachments, or with a dozer or other steel-tracked equipment.

Compressible sludge material (such as calcium fluoride sludge) will be amended with fly ash, placed in lifts in the disposal cell, and compacted.

Additional clarification and wording regarding compaction of soils around large, incompressible materials is provided in Section 6.3 of the proposed specifications.

DSER OI.08

The licensee needs to provide its proposed approach to addressing placement specifications for any crushed structural materials, such as piping or tanks. (SER Section 3.4.2)

The licensee needs to address compaction specification for soil placed around disposed structural material (SER Section 3.4.2)

Response:

Crushed structural materials will be laid flat (as described for incompressible materials above), and limited to lifts of two-foot thickness, then covered with soil.

Material type D consists of soils and weathered sedimentary rock from contaminated soil cleanup. These soils will be placed over a lift of structural material and compacted to fill in voids around the structural material. Contaminated soils will be placed in lifts (two feet maximum thickness), planned to be sufficient to cover the structural material but thin enough to allow compaction of the soil and underlying material. Each lift of soil will be compacted with at least six passes with vibratory tamping-foot compaction equipment. The compacted lift of soils will provide a firm base or bedding for a subsequent lift of structural material.

For large structural materials (such as thick-walled tanks and vessels), several lifts of compacted contaminated soils or sand may be necessary to fill in around and cover these items.

Checking soil compaction with standard field density testing methods (such as with a nuclear density gauge) is not recommended because of interference with structural debris. As a result, a method specification for compaction of this material is planned. The method would be a minimum of six passes over a two-foot maximum thickness lift of soil with a vibratory tamping-foot compactor. The number of passes would be confirmed on a field test section of soils to establish a correlation between the compaction method and 95 percent of the maximum dry density for the material, as determined by the Standard Proctor test. These procedures are expanded in Section 6.3.3 of the Technical Specifications (as presented below). The September 2006 revisions are shown in italics.

6.3 Work Description

6.3.1 Type A Material Placement

Type A materials (Section 6.2.1) that are not filtered (if disposed on site), will be dewatered or solidified/stabilized to eliminate free water prior to placement in the cell. Type A materials will be placed within the disposal cell in lifts prior to covering with additional Type A materials or with Type B materials.

If disposed on site, raffinate sludge filtercake bags (Section 6.2.1) shall be placed at the south end of the disposal cell (shown on the Drawings). A supplemental liner and cover system shall be constructed around the filtercake bags, as outlined in Section 6.3.5.

6.3.2 Type B Material Placement

Type B materials will be placed within the disposal cell in lifts and spread (if necessary) to allow consolidation and drying of wet materials. Type B materials (Section 6.2.2) will be placed directly over Type A materials, within the lined area of the disposal cell, or over other prepared areas of the disposal cell liner system.

6.3.3 Type C Material Placement

Type C materials will be placed within the disposal cell in lifts. Type C materials (Section 6.2.3) will be placed directly over Type B or C materials, or over other prepared areas of the disposal cell liner system. *The preparation and placement of various Type C materials is outlined below.*

6.3.3.1 Material Sizing and Preparation

Demolition debris to be placed in the disposal cell will consist of equipment and structural material from facilities demolition. The demolition procedures are outlined in the Facility Demolition Plan (Reclamation Plan attachment F). Because of the wide variety in shape and size of demolition debris, material of odd shapes will be cut or dismantled, to the extent practical, prior to disposal to facilitate handling and placement as well as minimize void spaces in the disposal cell. The maximum size of dismantled or cut materials shall not exceed 20 feet in *the* longest dimension. Smaller dimensions may be necessary for loading, handling, hauling, and placement of material in the disposal cell.

6.3.3.2 Incompressible Debris

Material that is not compressible (steel columns and beams, concrete, and other solid material) shall be reduced in size for loading, hauling, and placement in the disposal cell. *In*compressible *debris* shall be *placed, oriented, or* spread in a manner that minimizes void spaces below, between, and above these materials. *Incompressible debris shall be placed on and covered with soils or similar* *materials (Specification Section 6.2.4). Incompressible debris* such as steel members shall be placed in the disposal cell with the longest dimension oriented horizontally.

Thick-walled pipe, conduit, tanks, vats, pressure vessels, and other hollow materials that will not be crushed or dismantled shall be transported to the planned location within the disposal cell and oriented for filling and burial. The voids on the inside of the item shall be filled with sand or grout. Contaminated soil (Section 6.2.4) *or sand* will be placed outside of the item and compacted with standard compaction equipment (where possible) or hand-operated equipment *to the compaction requirements in Specification Section 6.3.3.6.* Several lifts of compacted contaminated soil may be necessary to fill in around and cover these items.

6.3.3.3 Compressible Debris

Materials that are compressible (such as thin-walled piping and thin-walled tanks) shall be flattened or crushed in the disposal cell, prior to final placement in the disposal cell. Flattening or crushing shall be done with hydraulic excavator attachments, or with a dozer or other steel-tracked equipment.

These materials shall be placed in the disposal cell and spread to form a lift with a maximum thickness of two feet. Spreading shall be done in a manner resulting in materials laying flat and minimizing void spaces.

6.3.3.4 Calcium Fluoride Sludge

Calcium fluoride sludge and other loose or soft materials (such as pond sediments and calcium fluoride sludge) will be solidified by mixing with fly ash at a *minimum sludge to fly ash* ratio *of 1 to 1* by volume, using mixing techniques approved by SFC. The mixture shall be placed in lifts not exceeding one foot in loose thickness and compacted as outlined in Section 6.3.3.6.

6.3.3.5 Soils and Similar Materials

Soils and soil-like materials to be placed in the disposal cell will be from on-site areas identified by SFC for excavation (Section 6.2.3 and 6.2.4). Soil or soil-like material (Type C or D material) shall be placed and compacted over each lift of debris (Section 6.3.3.2 or 6.3.3.3) or other Type C materials in lifts not exceeding two feet in loose thickness and compacted prior to placement of additional lifts. Soils will also be used for interim soil cover will also be used to minimize exposure of demolition materials and other Type C materials to air and meteoric water.

6.3.3.6 Material Compaction

Soil or similar Type C material shall be compacted with a minimum of six passes with *self-propelled, towed, or hand-held* vibratory compaction equipment. The number of passes shall be confirmed with actual compaction equipment on site with a field test section of soil to establish a correlation between the field compaction method and 95 percent of maximum dry density for the soil, as determined by the Standard Proctor test.

6.3.4 Type D Material Placement

Type D materials (Section 6.2.4) will be placed directly over Type A, B, or C materials, or over other prepared areas of the disposal cell liner system. Type D soil shall be placed in lifts not exceeding two feet in loose thickness, and shall be compacted with a minimum of six passes with vibratory compaction equipment to work the soil downward into underlying void spaces (if present). The number of passes shall be confirmed with actual compaction equipment on site with a field test section of soil to establish a correlation between the field compaction method and 95 percent of maximum dry density for the soil, as determined by the Standard Proctor test.

DSER OI.09

The licensee needs to provide an evaluation of potential disposal-cell settlement. (SER Section 3.4.3). NRC staff would like to see an explanation of and range of values for initial void ratio for the settlement calculations above, as well as an explanation of the initial layer thickness.

Response:

Experience with settlement of disposed materials and cover performance is in three general areas: (1) uranium tailings impoundment reclamation, (2) uranium mill demolition and disposal, and (3) municipal landfill performance. From uranium tailings impoundment experience, settlement values on the order of 10 to 20 percent of tailings thickness have been measured. However, these values are for slurry-deposited tailings undergoing loading and decreasing porewater pressures. From uranium mill demolition, settlement has been limited to areas of void spaces between structural materials. Municipal landfill performance data included several publications estimating the typical amount of settlement at municipal landfills. Values ranged from 5 to 25 percent of the waste thickness. Because the disposal cell will not include biodegradable materials, settlement in the disposal cell would be on the lower end of this range. A value of 5 to 10 percent of waste material height was estimated in the preliminary evaluation in Reclamation Plan Attachment E.

Because the disposal cell will not have biodegradable materials (like a landfill) or low-density materials (like slurried mill tailings), the potential areas of settlement within the disposal cell are (1) within fill around structural debris, or (2) within soft materials, such as un-amended calcium fluoride sludge. Settlement of fill around structural debris cannot be calculated, but will be minimized by the proposed placement and compaction specifications outlined above.

As outlined in the June 2006 response to OI.32, the estimated thickness of the sludge/fly ash mixture placed across the bottom of the entire cell is approximately two feet (based on a ratio by volume of two parts sludge to one part fly ash). The gypsum in the sludge/fly ash mixture will allow sulfate to be used as a tracer for cell seepage leak detection. The settlement of this layer is estimated using the standard settlement equation from Holz and Kovacs (1981):

$$S = C_c/(1+e_0)\ H_0 \log(\sigma_1/\sigma_0)$$

S = calculated settlement (feet)

C_c = compression index, ranging from 0.01 to 0.10 for compacted to compressible materials

e_0 = initial void ratio (1.1) for a sludge/fly ash mixture with a dry density of 80 pcf

H_0 = initial layer thickness (2 feet)

σ_1 = final vertical stress, in psf

σ_0 = initial vertical stress, in psf

Lifts of material placed in the disposal cell will be compacted with a conventional vibratory, wedge-foot (tamping-foot) compactor. Based on manufacturer's data, the vertical stress beneath the compactor wheels would be approximately 5,000 psf (Caterpillar, Inc., 1996). This loading of the compaction equipment is generally greater than the loading of subsequent disposed materials and cover.

for σ_0 = 50 percent of compaction loading = 2,500 psf

σ_1 = 3500 psf (20 feet of contaminated soils and debris at 120 pcf and 10 feet of cover at 110 pcf)

$$S = \frac{0.01}{2.1} 2\log\left(\frac{3500}{2500}\right) = 0.0014\,feet$$

For a conservatively high compression index of 0.1, the estimated settlement of the two-foot thick layer is 0.014 feet.

For comparison, a 10-foot thick zone of contaminated soils compacted to approximately 112 pcf (equivalent to a void ratio of 0.50) at the bottom of the cell would have an estimated settlement of approximately 0.010 feet (for a compression index of 0.01). These calculations indicate that total settlement of materials in the cell will be relatively low.

DSER OI.10

The licensee needs to provide an evaluation of potential cracking damage to the cover system owing to differential settlement of the cell. (SER Section 3.4.3). NRC staff requests justification of the 35-foot lateral distance in the differential settlement calculations in the January 2006 Cell Construction Plan (Reclamation Plan Attachment E).

Response:

Based on a conservatively high total settlement of 5 to 10 percent of waste material height, and differential settlement occurring over a distance of 35 feet (representing the incompressible internal berm in the disposal cell), differential settlement values were calculated (as outlined in Appendix G of the Disposal Cell Construction Plan, Reclamation Plan Attachment E). These values were converted to estimated tensile strain values, and were compared with allowable tensile strain values developed for covers over uranium mill tailings. The estimated tensile strain values were less than allowable values, indicating that the estimated differential settlement would not adversely affect cover performance.

These calculations were based on the allowable strain relationship from Caldwell and Reith (1993):

$$e_f = 0.05 + 0.003\ PI$$

e_f = soil strain at failure (or cracking) in percent

PI = plasticity index of cover soil

For a plasticity index value of 10, the soil strain at failure is 0.08 percent

For differential settlement to reach the allowable strain value above, this would be equivalent to 0.1 feet of differential settlement over a distance of 12.5 feet, or 0.2 feet of settlement over a distance of 50 feet. The effects of changing foundation conditions (from concrete pad left in place to compacted subsoil) would be masked by compaction of subsequent lifts of material and would not be reflected to the top of fill.

The lateral distance of 35 feet was used in the original differential settlement calculations in the January 2006 Cell Construction Plan to represent the distance between the top and bottom of slope for an internal embankment of compacted soils within the cell. If a soft material (such as calcium fluoride sludge) was placed on the inside of this internal embankment, differential settlement would be based on no settlement at the top of the embankment slope and some amount of settlement of soft materials at the toe of the embankment slope.

A component of the current cover system is the clay layer at the base of the cover (beneath the synthetic liner). Using the plasticity characteristics of this material, the estimated soil strain necessary to cause cracking of the clay layer is 0.08 percent. The differential settlement necessary to cause cracking would be 0.10 feet over 12.5 feet, 0.20 feet over 50 feet, or 0.17 feet over 35 feet. The differential settlement required to cause cracking of the clay layer is an order of magnitude higher than the estimated total settlement of materials in the disposal cell, for the various distances over which differential settlement would occur.

REFERENCES

Caldwell, J. and C. Reith, 1993. Principles and Practice of Waste Encapsulation, Lewis Publishers.

Caterpillar, Inc., 1996. Caterpillar Performance Handbook, Caterpillar Inc., October.

Holtz, R., and Kovacs, W., 1981. An Introduction to Geotechnical Engineering, Prentice-Hall.