Introduction

This document provides justification for NRC approval of a revised license possession limit for License Number SNM-928 to facilitate timely and cost-effective decommissioning operations. The proposed limit includes specific conditions for the possession and storage of materials that meet the requirements for exemption from classification as fissile material as per 10 CFR 71.15. This change is focused on safety and control of materials containing low concentration of special nuclear material generated during decommissioning operations involving treatment of groundwater. This change will allow an acceptable means to store packaged "fissile exempt" materials prior to transport to an off-site facility for disposal. This change is necessary to facilitate efficient and timely decommissioning operations by allowing greater flexibility for removal of low concentration special nuclear material (SNM) and more efficient transportation.

The proposed license amendment is compatible with NRC's goals for the decommissioning program. As stated in the NRC's *Program Evaluation of Changes to the Decommissioning Program* (September 2003), "Because of the persistent challenges facing the Decommissioning Program as well as the high cost to licensees for decommissioning, the staff believes that its near-term goal should be to continue improving the efficiency and timeliness of decommissioning activities at all decommissioning sites without impacting safety or public confidence." The proposed change will allow the licensee to perform decommissioning more efficiently. In addition, this approach reduces unnecessary regulatory burden associated with decommissioning at the Cimarron Site and has no adverse impact on public safety.

The primary basis for the requested changes is to facilitate handling, transportation, and disposal of large volumes of materials containing low concentrations of SNM. NRC regulations pertaining to SNM, particularly 10 CFR Part 70 and 73, were established primarily for the safe handling and control of various quantities of stock material for the fuel cycle. Low concentration residues being stored prior to transportation and disposal as waste do not pose the same hazards and concerns as stock material and therefore should not require the same level of regulatory control to maintain comparable safety. The NRC has previously approved similar activities as discussed in this Appendix.

Due to the limited number of active SNM-licensed sites undergoing decommissioning, the NRC has deferred changes in the regulations and the current practice is to address decommissioning regulatory issues through the amendment and exemption process.

Authorization for Possession and Specific Conditions of Use of Fissile Exempt Materials

The efficient and effective decommissioning of the Cimarron Site will require the treatment of groundwater. The treatment process generates ion-exchange resins containing low concentrations of uranium. The current license contains mass possession limits for enriched uranium. Although appropriate for higher concentration SNM, these limits place significant constraints on the decommissioning process when material contains low concentrations of low enriched uranium.

The proposed license amendment requested in this application incorporates a new possession limits based on the limitations of "fissile exempt" material. NRC and Department of Transportation (DOT) regulations for the transportation of radioactive material provide for the safety of packaged materials that are stored on site pending transport for either recycling or disposal. 10 CFR 71.15 exempts from classification as fissile material any material which meets a specified ratio of fissile to nonfissile material mass.

Section 6.2 of *Facility Decommissioning Plan - Rev 1* proposes the addition of Item D to the possession limit table. Item D would enable the licensee to accumulate and store containers of waste meeting the transportation requirements for fissile exempt materials, independent of the U-235 mass possession limit. This would enable the licensee to store containers of low level radioactive waste until a full load is accumulated for transportation to an off-site disposal facility. To place an additional limit on the mass of SNM that could be placed into storage, Section 6.2 of *Facility Decommissioning Plan - Rev 1* also incorporates a new Note 1 that states:

> *Note 1: The total mass of U-235 possessed under conditions 8A and 8D shall be limited to less than 0.5 effective kilograms of special nuclear material of low strategic significance. The requirements of 10 CFR Part 74.31 for the Nuclear Material Control and Accounting are therefore not applicable.*

This provision of the site possession limits would apply to the entire site inventory of SNM and therefore it effectively places an upper limit on the total amount of SNM that could be possessed under Item 8D of the site possession limit.

In addition to evaluations related to criticality safety to transportation, similar studies have been performed for disposal of similar materials. In November 1994 NRC issued NUREG/CR-6284, *Criticality Safety Criteria for License Review of Low-Level Waste Facilities.* This study provided nuclear criticality safety levels for disposal of materials in terms of areal density (grams per square foot). Later the NRC issued NUREG/CR-6505, *The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities* in June 1997. This study provided nuclear criticality safety levels for disposal of materials in terms of concentration limits. NUREG/CR-6505 is the technical basis for the current waste acceptance criteria (WAC) for disposal of SNM. WAC for enriched uranium (comparable to transportation requirements) include a limit of 1,900 pCi/g U-235 for enrichments less than 10% or a limit of 1,190 pCi/g U-235 for enrichments of 10% or greater.

Given that there are different criteria for transportation (mass ratio) and disposal of low concentration enriched uranium (radionuclide concentration), a comparison will be useful. Conversion of the of transportation requirements from mass ratio (2,000 grams nonfissile for every gram fissile) to radionuclide concentration results in 1,080 pCi/g U-235. Since this is less than the WAC for enriched uranium, the fissile exempt concentration for transportation is the most conservative and limiting value. Furthermore, materials that meet the transportation requirements for fissile exempt will also be acceptable for disposal since U-235 concentrations will be less than WAC limits.

In addition, shipments of spent resins must adhere to the definition of "Fissile Exempt". The definition of "fissile exempt" is based on the assumption that the fissile material is pure U-235 (i.e. 100% enrichment), therefore the applicable regulations for the transport of the waste from the nuclear criticality safety standpoint are conservative for any material that may be encountered during decommissioning at the Cimarron Site where the enrichment of the uranium is limited to approximately 4% U-235.

Another potential concern regarding fissile exempt materials is security. In NRC Regulatory Guide 5.59, *Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance* states that the quantity of concern for gross theft is estimated as 75 kg of U-235. At the fissile exempt concentration (1,080 pCi/g U-235) this converts to approximately 165 tons of waste material. Moreover, as part of the evaluation for WAC and an Order exempting the disposal facility from requirements relative to possession of SNM published in 68FR74986-74988, the NRC stated, *"Safeguarding SNM against diversion or sabotage is not considered a significant issue because of the diffuse form of the SNM in waste meeting the conditions specified."*

Since the fissile exempt criteria for transportation is less than the WAC, material meeting fissile exempt should not be considered a significant security issue, since diversion or sabotage of low concentration material is not a practical threat. Therefore, once material has been demonstrated to meet fissile exempt criteria, no additional physical protection measures under 10 CFR Part 73 for SNM should be required. This concept of a specific exemption from the regulations in 10 CFR 70 for a waste disposal site was given to both the Clive, UT and Andrews, TX disposal sites. A license provision to exempt packaged materials from the license possession limit was issued to ABB for the Windsor Site by License Amendment #66 dated October 29, 2009 (License # 060-00217-06, Docket # 030-03754).

Resin which accumulates uranium will be mixed with sufficient non-fissile material to comply with both fissile exempt criteria and disposal site WAC. The mixed LLRW will be transferred into appropriate transport containers meeting transportation requirements for fissile exempt materials. The initial demonstration that the waste material meets the transportation requirement will be based on process control measurements that conservatively determine the mass of U-235 accumulated in each batch of LLRW mixture (spent resin). This initial mass determination will be added to the site SNM inventory, but will not count against the mass possession limit for U-235. Samples of each batch of the LLRW mixture will be collected, and the concentration and mass of SNM for each container will be determined. Adjustments will be made to the site SNM inventory as necessary to reflect the revised mass concentrations determined from analytical results and the measured container weights to establish the final mass of U-235 in each container and document that the transportation regulations have been met.

This process will maintain sufficient documentation and control of the material to ensure nuclear criticality safety during decommissioning operations, as well as accountability of the material while it remains at the Site. Reporting of SNM transactions and inventory to Nuclear Materials Management & Safeguards System (NMMSS) will be in accordance with NRC regulations.

Resin Waste Criticality Evaluation

The resin processing operation involves blending resin with non-resin material. Blending will result in uniform distribution of SNM throughout the packaged waste matrix in compliance with the transportation requirements. The blended waste will be containerized for shipment and will be certified to meet all the requirements of the Waste Acceptance Criteria (WAC) for the disposal site. The blended waste will comply with the following specific WAC requirements:

1) The SNM will be uniformly distributed throughout the matrix of the resin, a hydrocarbon material. This material is considered soil-like but is not a SiO2 matrix.

2) The waste form will be in containers which will be disposed at the licensed disposal site in accordance with license requirements for containerized waste for the disposal site.

Discussions have been held with the proposed waste disposal site to confirm that the packaged waste does conform to the WAC. This Appendix provides the analysis used to demonstrate that a critical condition related to the transportation or disposal of the spent resin mixture is not credible.

Summary of NUREG/CR-6505 Assessment

The analysis in NUREG/CR-6505 is based on a conservative model where the SNM in the disposed waste has been mobilized and transported to a lower elevation, then concentrated on soil in an optimum geometry with an optimum water content.
The analysis performed in NUREG/CR-6505 is not based on the form of the waste at the disposal site that meets the WAC. NUREG-6505 Vol. 1 Section 10.1.3 identified the following basic assumptions that were used to model the waste disposal site for the disposal of Special Nuclear Material (SNM). Using these assumptions, the transported fissile material yielded subcritical conditions:

1) the SNM is uniformly distributed throughout the soil,
2) the soil matrix is SiO_2, and
3) the SNM-contaminated soil matrix has a spherical geometry and an optimal water content for nuclear criticality.

The analysis further stated that the probability of transporting the ^{235}U and concentrating it into a suitable geometry and density to achieve criticality is very low. Additionally, the results confirmed that SiO_2 is a conservative soil matrix for nuclear criticality evaluations. Finally, the analysis concluded that a slab configuration seemed the most likely to yield a potential for criticality.

The analysis did not model the SNM bearing waste at the point of placement in the disposal site. Instead, it modeled the mobilization of the uranium from the original waste disposal location, transport to and concentration at another location by hydrogeochemical processes into a specific geometry that was evaluated for nuclear criticality safety.

The form of the initial waste in the disposal site is not considered in this analysis. However, this analysis was used to justify the concentration limits that have been established for the waste disposal sites as issued by the NRC.

Comparison of Cimarron Waste Stream to a SiO_2 Matrix

The uranium bearing waste streams that will be generated at the Cimarron Site meet the requirements of the Waste Acceptance Criteria (WAC) for the planned disposal site. To compare the resin waste matrix with a comparable SiO_2 matrix, the model named in NUREG/CR-5342, "Assessment and Recommendations for Fissile-Material Packaging Exemptions and General Licenses Within 10 CFR Part 71" was used for comparison of the two different matrices in the transportation mode.

The transport criticality calculations from NUREG/CR-5342 model an array of 55-gallon Transport drums containing a resin or soil matrix. The drums are assumed to be 55-gallon, 20-gauge 316 stainless steel, DOT-17E drums. The array size was chosen to represent 5 transport vehicles worth of fissile material. The array size is 27 x 27 x 6, with a hexagonal pitch and surrounded by a 30.48-cm thick water reflector. A VISED plot of the MCNP geometry for this calculation is shown in Figure 1. The fissile concentration is 0.5 g ^{235}U/ kg matrix material with an enrichment of 7.33 wt. % ^{235}U. The fissile concentration is the maximum concentration permitted under the Transportation regulations.

The following assumptions are made for the transport model (these are consistent with the parameters described in the NUREG/CR-5342):

1. The pitch between transport drums is assumed to be equal to the drum outer diameter. Increasing the pitch only increases neutron leakage and decreases reactivity.
2. The interstitial area between drums is set to a void to decrease neutron absorption between drums.
3. The resin is assumed to be composed of carbon and hydrogen with an atomic ratio of 1 with a density of 0.96 g/cm^3. (Table 3-1 of NUREG/CR-5342)
4. The soil is assumed to be SiO_2 with a density of 1.6 g/cm^3. (Table 3-1 of NUREG/CR-5342)

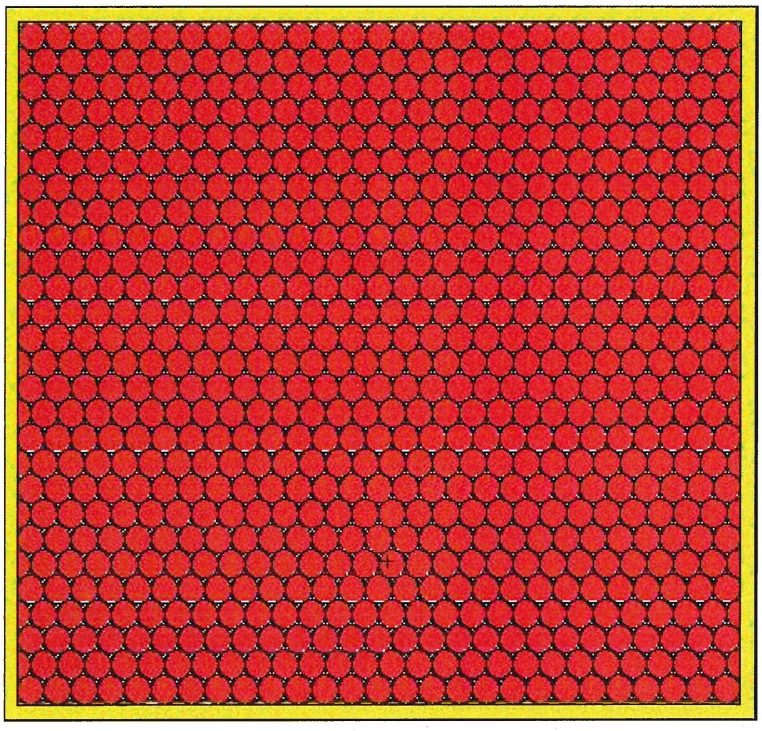

Figure 1 – X-Y Slice of MCNP Geometry for 27x27x6 Transportation Array of 110 gal. Drums

Table - k_{eff} Results for a 27x27x6 Array of 110 gal. Drums containing 0.5 g ^{235}U /kg Matrix Material

Matrix Material	Fissile Concentration (g U^{235}/kg Matrix)	Enrichment (wt. % U^{235})	keff	σ	keff + 3σ
Resin	0.5	7.33	0.10091	0.00005	0.10106
Soil (SiO_2)	0.5	7.33	0.28866	0.00023	0.28935

Criticality Evaluation Conclusions

These calculations demonstrate that the Cimarron waste stream, consisting primarily of a resin matrix, has a lower k_{eff} than the SiO_2 matrix used as the basis for establishing the limits in the transportation regulations. The assumptions used for the calculations are conservative for the waste to be transported from the Cimarron site to the waste disposal facility.

Summary

Fissile exempt materials have been evaluated by the NRC and shown not to pose any nuclear criticality safety or SNM physical security concerns. These changes will reduce unnecessary regulatory burden associated with decommissioning. In addition, it will allow more effective transportation of waste to the disposal site, reducing the risk of accidents. NRC has approved or allowed similar activities for such materials at other licensed facilities. This change will allow EPM to complete decommissioning in a timely and efficient manner and achieve license termination for unrestricted use, with no adverse consequences to safety.