March 3, 2006

Mr. Rod Krich, Vice President
Licensing, Safety, and Nuclear Engineering
Louisiana Energy Services
2600 Virginia Avenue NW, Suite 610
Washington, DC 20037

SUBJECT: REVISED SAFETY EVALUATION REPORT SECTIONS 5.3.6.3 AND 5.5 (LOUISIANA ENERGY SERVICES GAS CENTRIFUGE URANIUM ENRICHMENT FACILITY)

Dear Mr. Krich:

On February 28, 2006, you submitted Revision 3 of your "MONK 8A Validation and Verification Report," and Revision 9 to the "National Enrichment Facility Safety Analysis Report (SAR)" for the proposed uranium enrichment facility in Lea County, New Mexico. Previous versions of the validation report were transmitted on May 7, 2004 (Revision 0) and December 22, 2005 (Revision 1). Also, on February 16, 2006, you submitted Revision 2 of the validation report and Revision 8 to the SAR. We completed our review of the revised SAR and are enclosing revised sections 5.3.6.3 and 5.5 to NUREG-1827, "Safety Evaluation Report for the national Enrichment Facility in Lea County, New Mexico."

If you have any questions, please contact Mr. Timothy C. Johnson at 301-415-7299.

Sincerely,

\RA\

Joseph G. Giitter, Chief
Special Projects Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Enclosure: Safety Evaluation Report Supplement
Docket: 70-3103
cc:

William Szymanski/DOE	Claydean Claiborne/Jal	Lindsay Lovejoy/NIRS
Monty Newman/Hobbs	James Curtiss/W&S	Troy Harris/Lovington
Peter Miner/USEC	Betty Richman/Tatum	James Ferland/LES
Glen Hackler/Andrews	Lue Ethridge/Lea Cty	John Parker/NMED
James Brown/Eunice	Richard Ratliff/Texas	M. Marriotte/NIRS
Jerry Clift/Hartsville	CO'Claire/Ohio	Lee Cheney/CNIC
Joseph Malherek/PC	Ron Curry/NMED	D. Watchman-Moore/NMED
Clay Clark/NMED	Patricia Madrid/NMAG	Glen Smith/NMAG
Roger Mulder/Texas		

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KClark/Reg II	KO’Brien/Reg III	VMitlyng/Reg III	WMaier/Reg IV
KMorrisey/TSG	FBurrows\TSG	Hearing file	LES website - YES

ML

OFC	GCFLS	GCFLS	TSG	OGC	GCFLS	SPB
NAME	TJohnson:	LMarshall	MGalloway	LClark	BSmith	JGiitter
DATE	3/02/06	3/02 /06	3/ 03/06	3/ 03 /06	3/ 03/06	3/03/06

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NUCLEAR CRITICALITY SAFETY (NCS)
REVISED SAFETY EVALUATION REPORT
SECTIONS 5.3.6.3 AND 5.5

5.3.6.3 NCS Subcriticality of Operations and Margin of Subcriticality for Safety

In Section 5.2.1 of the Safety Analysis Report (SAR) (LES, 2006b), the applicant indicated that the MONK 8A Monte Carlo code (AEAT, 1998) was used to perform the NCS Analyses. MONK 8A has accuracy over a wide range of applications and is distributed with a generic validation database comprising of critical experiments covering uranium, plutonium, and mixed systems over a wide range of moderation and reflection. However, the NRC does not allow a generic vendor validation to be used as a demonstration of meeting the regulatory requirements for NCS validation. Since NRC staff did not accept the applicant's generic vendor validation report, the applicant provided a specific validation report dated May 4, 2004 (LES, 2004).

On December 22, 2005, the applicant provided NRC with Revision 1 to the validation report (LES, 2005d). On February 16, 2006, the applicant provided Revision 2 of the validation report (LES, 2006a) and Revision 8 to the SAR Chapter 5.0 (LES, 2006b). On February 28, 2006, the applicant provided Revision 3 of the validation report (LES, 2006c) and Revision 9 to the SAR Chapter 5.0 (LES, 2006d). The validation report (as discussed below) is intended to meet the applicant's commitment to ANSI/ANS-8.1-1998 (ANSI/ANS, 1998a). It included details of validation that state computer codes used, operations, recipes for choosing code options (where applicable), cross-section sets, and any numerical parameters necessary to describe the input.

In Section 5.2.1.1 of Revision 9 to the SAR Chapter 5.0 (LES, 2006d), the applicant described the validation process. The applicant validated the MONK 8A code with the JEF2.2 cross-section library against experiments in the 2002 version of the Nuclear Energy Agency's (NEA's) *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (NEA, 2002) and experiments in NUREG/CR-1071, "Critical Experiments with Interstitially Moderated Arrays of Low-Enriched Uranium Oxide" (NRC, 1980). The validation was performed using a total of 93 experiments (i.e., low-enriched uranium (LEU) with low H/U (moderator to fuel) ratios, LEU thermal energy compounds, LEU thermal energy solutions, and intermediate-enriched uranium thermal energy compounds). The results of the validation were documented in Revision 3 to the validation report (LES, 2006c). The MONK 8A computer code and JEF2.2 cross-section library are within the scope of the facility Quality Assurance Program in Appendix A of the SAR (LES, 2006d).

In Section 5.2.1.2 of Revision 9 to the SAR Chapter 5.0 (LES, 2006d), the applicant provided the basis for the k_{eff} (neutron multiplication factor) equation (i.e., $k_{eff} = k_{calc} + 3F_{calc} < 0.95$) used at the facility. k_{calc} represents the neutron multiplication factor as calculated by the computer code and F_{calc} is the standard deviation of the calculated results. The validation process established a bias by comparing calculations to measured critical experiments. With the bias determined, an upper safety limit (USL) was determined by using the following equation from NUREG/CR-6698, (NRC, 2001): $USL = 1.0 + bias - F_{bias} - F_{SM} - F_{aoA}$, where F_{bias} is the standard deviation of the bias, F_{SM} is the administrative subcriticality margin, and F_{AoA} is the additional margin to account for extrapolating outside the area of applicability (AOA).

The critical experiments were assumed to have a k_{eff} = 1.0. The calculated k_{eff} (from Revision 3 to the validation report (LES, 2006c)) was 1.0017, which was greater than 1.0, and so the bias was positive. Since a positive bias may be non-conservative, the bias was set to zero. The F_{bias} (from Revision 3 to the validation report, (LES, 2006c)) was 0.0085. The administrative subcritical margin, F_{SM}, was assigned a value of 0.05. The F_{AoA} term is an additional margin to account for being beyond the area of applicability. For systems and components not associated with the Contingency Dump System the experiments were representative of the specific application and the F_{AoA} term was set to zero. However, for the Contingency Dump System, it was necessary to extrapolate the AOA to include 1.5 weight (wt) percent U^{235} enrichment and so, the F_{AoA} term for the Contingency Dump System was set to 0.0014.

Thus, the two USL equations were the following:

- for all facility systems except the Contingency Dump System,

  USL = 1.0 + 0.0 - 0.0085 - 0.05 - 0.0000 = 0.9415; and

- for the Contingency Dump System,

  USL = 1.0 + 0.0 - 0.0085 - 0.05 - 0.0014 = 0.9401.

The k_{eff} equation is based on the USL plus any quantitative or qualitative arguments.

NUREG/CR-6698 (NRC, 2001) indicates that, for normal and credible conditions, the k_{eff} equation should be $k_{eff} = k_{calc} + 2F_{calc} < USL$. However, the applicant intends to use the k_{eff} equation of $k_{eff} = k_{calc} + 3F_{calc} < 0.95$ for the entire facility.

In Revision 9 to SAR Chapter 5.0 (LES, 2006d), the applicant provided a qualitative risk argument for using the single k_{eff} equation above for the entire facility. In summary, the argument was that there is a very low risk of inadvertent criticality at the facility, due to: (a) at the low enrichment limit of 5.0 wt percent U^{235}, criticality requires moderation; (b) uranium will be dry/unmoderated throughout the entire process (i.e., operations do not include solutions of 5.0 wt percent U^{235}; (c) a sufficient mass for criticality can only accumulate through the reaction of uranium hexafluoride (UF_6) with moisture resulting from air in-leakage; and (d) high vacuum requirements for normal operation limit air in-leakage to very low levels, because intrusion of significant amounts of moderator would cause the centrifuges to self-destruct, which would stop the process. Based on its knowledge of similar gaseous operations at other NRC-regulated facilities, the staff concurs with this assessment. In addition, the staff recognizes other factors that ensure the risk of criticality involving the centrifuge process is very low. Gaseous UF_6 has insufficient density to sustain criticality. An inadvertent criticality requires an accumulation of UF_6 of sufficient mass and geometric arrangement to be formed and subsequently moderated. For the reasons stated above, this is extremely unlikely. In addition, any deposit, were it to form, will most likely be spread out over a large area, and thus will be unlikely to have the right geometric configuration. The staff, therefore, considers the risk of criticality in the centrifuge process to be very low.

Even where UF_6 is accumulated in large cylinders or cold traps, criticality cannot occur without the intrusion of large quantities of moderator, which is prevented by the passive confinement barriers, the fluorinating environment, and the self-protecting nature of uranyl oxyfluoride (UO_2F_2) deposits. The centrifuge and associated equipment, as well as UF_6 cylinders constructed in accordance with ANSI N14.1, "American National Standard for Nuclear Materials - Uranium Hexafluoride - Packaging for Transport" (ANS, 1995), provide the passive barrier. The vigorous reaction of UF_6 with water to form hydrogen fluoride (HF) (in a gaseous state) and UO_2F_2 inherently limits the accumulation of moderator needed to sustain criticality. In addition, these reaction products have been experimentally observed to form a self-sealing layer of UO_2F_2 that tends to limit moderator intrusion to the surface of a deposit. All these factors ensure that the risk of criticality involving large quantities of solid UF_6 is very low.

Staff reviewed the applicant's Revision 3 to the validation report (LES, 2006c) and Revision 9 to SAR Chapter 5.0 (LES, 2006d). Based on the risk considerations discussed above, and on the fact that a minimum margin of subcriticality of 0.05 has been generally found acceptable for low enriched fuel cycle facilities processing fissionable materials with the same forms and chemical compositions as those in the facility (but with more diverse and risk-significant processes, such as fuel conversion, fuel fabrication, and uranium recovery), the staff considers the following equation to be acceptable to ensure subcriticality of the applicant's operations under both normal and credible abnormal conditions: $k_{eff} = k_{calc} + 2F_{calc} < USL$ (where USL includes a 0.05 minimum margin of subcriticality). The applicant's proposed subcriticality criterion of $k_{eff} = k_{calc} + 3F_{calc} < 0.95$ is acceptable to the staff because the difference between the actual computed USL values and 0.95 (somewhat less than 1 percent) is bounded and offset by the higher calculated k_{eff} resulting from the applicant's use of $3F_{calc}$ rather than $2F_{calc}$ in the k_{eff} equation, and its qualitative low risk argument. Therefore, based on the acceptability of the margin of subcriticality (based on risk and industry practice for similar types of processes and facilities) and on the fact that the applicant's proposed subcriticality criterion is more conservative than the generally acceptable criterion of $k_{eff} = k_{calc} + 2F_{calc} < USL$, the use of the applicant's k_{eff} equation is acceptable to the staff.

In addition, NRC staff proposes the following license condition regarding changes to the validation report:

> If there are any revisions to the validation report, then the licensee shall provide a letter to NRC describing the changes and the revised validation report for NRC review. The licensee shall not implement the changes in the revised validation report until NRC approves the changes.

Regarding the specific acceptance criteria in Section 5.4.3.4.4 of NUREG-1520 (NRC, 2002) for NCS subcriticality of operations and margin of subcriticality for safety, the applicant:

- Committed to the use of NCS controls and controlled parameters to assure that under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety;

- Committed to the following policy: "Process specifications shall incorporate margins to protect against uncertainties in process variables and against a limit being accidentally exceeded;"

- Committed to the following standards, as they relate to these requirements, ANSI/ANS-8.7, "Guide for Nuclear Criticality Safety Criteria in the Storage of Fissile Materials" (ANSI/ANS, 1998b), ANSI/ANS-8.10, "Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement" (ANSI/ANS, 1988), ANSI/ANS-8.12, "Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors," (ANSI/ANS, 1993), ANSI/ANS-8.15, "Nuclear Criticality Control of Special Actinide Elements" (ANSI/ANS, 1995), and ANSI/ANS-8.17, "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors," (1997);

- Requested NRC pre-approval of administrative k_{eff} margins for normal and credible abnormal conditions;

- Committed to determine subcritical limits for k_{eff} calculations such that $k_{subcritial}$ = 1.0 - bias - margin, where the margin includes adequate allowance for uncertainty in the methodology, data, and bias to assure subcriticality; and

- Committed to perform studies to correlate the change in a value of a controlled parameter and its k_{eff} value and the studies will include changing the value of one controlled parameter and determining its effect on another controlled parameter.

Based on its review of the information provided, the staff concludes that the applicant has adequately described how it assures subcriticality of operations under normal and credible abnormal conditions and has defined an adequate margin of subcriticality for safety to meet the requirements of 10 CFR 70.61(d).

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