

November 30, 2004

NEF#04-049

ATTN: Document Control Desk  
Director  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

Louisiana Energy Services, L. P.  
National Enrichment Facility  
NRC Docket No. 70-3103

Subject: Additional Clarifying Information Related to Criticality Safety

- References:
1. Letter NEF#03-003 dated December 12, 2003, from E. J. Ferland (Louisiana Energy Services, L. P.) to Directors, Office of Nuclear Material Safety and Safeguards and the Division of Facilities and Security (NRC) regarding "Applications for a Material License Under 10 CFR 70, Domestic licensing of special nuclear material, 10 CFR 40, Domestic licensing of source material, and 10 CFR 30, Rules of general applicability to domestic licensing of byproduct material, and for a Facility Clearance Under 10 CFR 95, Facility security clearance and safeguarding of national security information and restricted data"
  2. Letter NEF#04-002 dated February 27, 2004, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Revision 1 to Applications for a Material License Under 10 CFR 70, "Domestic licensing of special nuclear material," 10 CFR 40, "Domestic licensing of source material," and 10 CFR 30, "Rules of general applicability to domestic licensing of byproduct material"
  3. Letter NEF#04-029 dated July 30, 2004, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Revision to Applications for a Material License Under 10 CFR 70, "Domestic licensing of special nuclear material," 10 CFR 40, "Domestic licensing of source material," and 10 CFR 30, "Rules of general applicability to domestic licensing of byproduct material"

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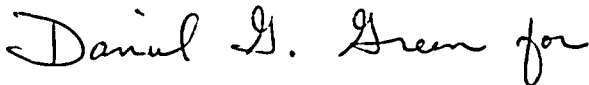
4. Letter NEF#04-037 dated September 30, 2004, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Revision to Applications for a Material License Under 10 CFR 70, "Domestic licensing of special nuclear material," 10 CFR 40, "Domestic licensing of source material," and 10 CFR 30, "Rules of general applicability to domestic licensing of byproduct material"

By letter dated December 12, 2003 (Reference 1), E. J. Ferland of Louisiana Energy Services (LES), L. P., submitted to the NRC applications for the licenses necessary to authorize construction and operation of a gas centrifuge uranium enrichment facility. Revision 1 to these applications was submitted to the NRC by letter dated February 27, 2004 (Reference 2). Subsequent revisions (i.e., revision 2 and revision 3) to these applications were submitted to the NRC by letters dated July 30, 2004 (Reference 3) and September 30, 2004 (Reference 4), respectively.

In a November 4, 2004, conference call between LES and NRC representatives, the NRC requested that additional clarifications be provided concerning criticality safety. Some of the information concerning criticality safety involves classified information (i.e., confidential national security information (CNSI)). This classified information has been separated from the unclassified information and is being submitted separately in accordance with 10 CFR 95.39, "External transmission of documents and material." The unclassified information concerning criticality safety, in the form of revised Safety Analysis Report (SAR) and Integrated Safety Analysis (ISA) Summary pages, is included in the Enclosure, "Additional Clarifying Information Related to Criticality Safety." The unclassified information will be formally incorporated into the applicable SAR and ISA Summary sections in a future revision.

If you have any questions or need additional information, please contact me at 630-657-2813.

Respectfully,



R. M. Krich  
Vice President – Licensing, Safety, and Nuclear Engineering

Enclosure:  
Additional Clarifying Information Related to Criticality Safety

cc: T.C. Johnson, NRC Project Manager

**ENCLOSURE**

**Additional Clarifying Information Related to Criticality Safety**

**National Enrichment Facility  
Safety Analysis Report (SAR)  
Revised Pages**

(Includes replacement pages for proposed Revision 4 SAR pages 5.2-3 and 5.2-6 that were previously submitted by letter NEF#04-040 dated September 30, 2004, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Clarifying Information Related to Criticality Safety")

### 5.2.1.3 General Nuclear Criticality Safety Methodology

The NCS analyses results provide values of k-effective ( $k_{\text{eff}}$ ) to conservatively meet the upper safety limit. The following sections provide a description of the major assumptions used in the NCS analyses.

#### 5.2.1.3.1 Reflection Assumption

The layout of the NEF is a very open design and it is not considered credible that those vessels and plant components requiring criticality control could become flooded from a source of water within the plant. Full water reflection of vessels has therefore been discounted. However, where appropriate, spurious reflection due to walls, fixtures, personnel, etc. has been accounted for by assuming 2.5 cm (0.984 in) of water reflection around vessels.

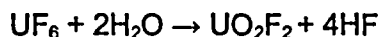
#### 5.2.1.3.2 Enrichment Assumption

The NEF will operate with a 5.0 %  $^{235}\text{U}$  enrichment limit. However, the nuclear criticality safety calculations used an enrichment of 6.0 %  $^{235}\text{U}$ . This assumption provides additional conservatism for plant design.

#### 5.2.1.3.3 Uranium Accumulation and Moderation Assumption

Most components that form part of the centrifuge plant or are connected to it assume that any accumulation of uranium is taken to be in the form of a uranyl fluoride/water mixture at a maximum H/U atomic ratio of 7 (exceptions are discussed in the associated nuclear criticality safety analyses documentation). The ratio is based on the assumption that significant quantities of moderated uranium could only accumulate by reaction between  $\text{UF}_6$  and moisture in air leaking into the plant. Due to the high vacuum requirements of a centrifuge plant, in-leakage is controlled at very low levels and thus the H/U ratio of 7 represents an abnormal condition. The maximum H/U ratio of 7 for the uranyl fluoride-water mixture is derived as follows:

The stoichiometric reaction between  $\text{UF}_6$  and water vapor in the presence of excess  $\text{UF}_6$  can be represented by the equation:



Due to its hygroscopic nature, the resulting uranyl fluoride is likely to form a hydrate compound. Experimental studies (Lychev, 1990) suggest that solid hydrates of compositions  $\text{UO}_2\text{F}_2 \cdot 1.5\text{H}_2\text{O}$  and  $\text{UO}_2\text{F}_2 \cdot 2\text{H}_2\text{O}$  can form in the presence of water vapor, the former composition being the stable form on exposure to atmosphere.

It is assumed that the hydrate  $\text{UO}_2\text{F}_2 \cdot 1.5\text{H}_2\text{O}$  is formed and, additionally, that the hydrogen fluoride (HF) produced by the  $\text{UF}_6$ /water vapor reaction is also retained in the uranic breakdown to give an overall reaction represented by:



For the MONK8A (SA, 2001) calculations, the composition of the breakdown product was simplified to  $\text{UO}_2\text{F}_2 \cdot 3.5\text{H}_2\text{O}$  that gives the same H/U ratio of 7 as above.

In the case of oils,  $\text{UF}_6$  pumps and vacuum pumps use a fully fluorinated perfluorinated polyether (PFPE) type lubricant, often referred to by the trade name "Fomblin." Mixtures of  $\text{UF}_6$

- The reference manual and validation report are incorporated into the configuration management program.
- The NCS analyses are performed in accordance with the methods specified and incorporated in the configuration management program.
- The NCS methodologies and technical practices in NUREG-1520 (NRC, 2002), Section 5.4.3.4, are used to analyze NCS accident sequences in operations and processes.
- The acceptance criteria in NUREG-1520 (NRC, 2002), Section 3.4, as they relate to: identification of NCS accident sequences, consequences of NCS accident sequences, likelihood of NCS accident sequences, and descriptions of IROFS for NCS accident sequences are met.
- 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 are used.
- As stated in ANSI/ANS-8.1-1998 (ANSI, 1998a), process specifications incorporate margins to protect against uncertainties in process variables and against a limit being accidentally exceeded.
- ANSI/ANS-8.7-1998 (ANSI, 1998b), as it relates to the requirements for subcriticality of operations, the margin of subcriticality for safety, and the selection of controls required by 10 CFR 70.61(d) (CFR, 2003b), is used.
- ANSI/ANS-8.10-1983 (ANSI, 1983b), as modified by Regulatory Guide 3.71 (NRC, 1998), as it relates to the determination of consequences of NCS accident sequences, is used.
- If administrative  $k_{eff}$  margins for normal and credible abnormal conditions are used, NRC pre-approval of the administrative margins will be sought.
- Subcritical limits for  $k_{eff}$  calculations such that:  $k_{eff\text{ subcritical}} = 1.0 - \text{bias} - \text{margin}$ , where the margin includes adequate allowance for uncertainty in the methodology, data, and bias to assure subcriticality are used.
- Studies to correlate the change in a value of a controlled parameter and its  $k_{eff}$  value are performed. The studies include changing the value of one controlled parameter and determining its effect on another controlled parameter and  $k_{eff}$ .
- The double contingency principle is met. The double contingency principle is used in determining NCS controls and IROFS.
- The acceptance criteria in NUREG-1520 (NRC, 2002) Section 3.4, as they relate to subcriticality of operations and margin of subcriticality for safety, are met.

#### 5.2.1.6 Nuclear Criticality Safety Evaluations (NCSE)

For any change (i.e., new design or operation, or modification to the facility or to activities of personnel, e.g., site structures, systems, components, computer programs, processes,

**National Enrichment Facility  
Integrated Safety Analysis (ISA) Summary  
Revised Pages  
Associated with Criticality Safe-By-Design Components**

(Includes replacement pages for the following proposed ISA Summary pages that were previously submitted by letter NEF#04-038 dated October 4, 2004, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Integrated Safety Analysis Accident Sequences for Criticality Safe-By-Design Components"

- Addition to Section 3.1.1.3.2
- Addition to Table 3.1-9
- Addition to Table 3.7-2
- Table 3.7-14 page 28 of 30
- Table 3.7-16 page 6 of 19
- Table 3.7-16 page 9 of 19
- Table 3.7-16 page 15 of 19
- Table 3.7-16 page 16 of 19
- Table 3.7-17 page 2 of 4)

**Pages 8 through 84 removed under 10 CFR 2.390.**