

RAS: 9278

**RELATED CORRESPONDENCE**

January 28, 2005

**UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION**

DOCKETED  
USNRC

**BEFORE THE ATOMIC SAFETY AND LICENSING BOARD** February 2, 2005 (4:00pm)

OFFICE OF SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

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In the Matter of

Docket No. 70-3103

Louisiana Energy Services, L.P.  
National Enrichment Facility

ASLBP No. 04-826-01-ML

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**REBUTTAL TESTIMONY OF DR. ARJUN MAKHIJANI  
REGARDING NUCLEAR INFORMATION AND RESOURCE SERVICE  
AND PUBLIC CITIZENS'S CONTENTION EC-4**

Q1. Please state you name and what testimony will you be discussing today.

A1. My name is Dr. Arjun Makhijani and I have previously submitted direct testimony in this proceeding. I will be offering rebuttal to the pre-filed direct testimony of Rod M. Krich presented on behalf of Louisiana Energy Services, L.P and the pre-filed direct testimony of Donald E. Palmrose, presented on behalf of the NRC staff. The testimony of R.M. Krich and D.E. Palmrose was offered with respect to the Nuclear Information and Research Service and Public Citizen Environmental Contention 4 ("NIRS/PC EC-4") and filed with the court on January 7, 2005.

Template = SECY-055

SECY-02

Q2. With respect to the decision by LES to deconvert the depleted uranium hexafluoride ( $\text{DUF}_6$ ) that would be produced by the proposed LES enrichment facility to uranium oxide ( $\text{U}_3\text{O}_8$ ), what opinions were offered in the opposing experts' direct testimony that you plan to discuss?

A2. The testimony of interest from R.M. Krich was as follows

Q11. What is the basis for your decision to convert the  $\text{DUF}_6$  to  $\text{U}_3\text{O}_8$ ?

A11. (RMK) **The  $\text{U}_3\text{O}_8$  is recognized by the NRC as the more stable physiochemical form and the more compatible, as regards to safety, with the long-term disposition of tails (See LES Exhibit 19). In fact, NRC has recommended  $\text{U}_3\text{O}_8$  as a waste form for the long term storage and disposal, as it is thermodynamically stable and relatively insoluble (See LES Exhibit 20). DOE has also identified conversion to  $\text{U}_3\text{O}_8$  as the preferred alternative in its Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride (DOE/EIS-0269)(April 1999)(See LES Exhibit 18).**<sup>1</sup> (emphasis added)

The testimony of interest from D.E. Palmrose was as follows

Q7. What is meant by the conversion of depleted uranium hexafluoride waste?

A7. The uranium enrichment process that is to be used by LES at the proposed National Enrichment Facility (NEF), will produce as a byproduct, depleted uranium hexafluoride ( $\text{DUF}_6$ ).  $\text{DUF}_6$ , when stored in cylinders, emits low levels of gamma and neutron radiation. In addition,  $\text{DUF}_6$  is highly reactive to water vapor in air, forming hydrogen fluoride (HF) and uranyl fluoride ( $\text{UO}_2\text{F}_2$ ), both of which are chemically toxic substances. **Therefore, for the purposes of long-term waste management,  $\text{DUF}_6$  is converted into a more stable form.** The process of converting the  $\text{DUF}_6$  to a more stable form is the "conversion" process that is referenced.<sup>2</sup> (emphasis added)

Q3. Given that the witnesses for both LES and the NRC staff have testified that the purpose of deconversion is to place the depleted uranium tails into a form suitable for long-term management and disposal and that R.M. Krich testified explicitly that, for its preferred option of building a private facility, LES's choice of deconversion product (i.e.  $\text{U}_3\text{O}_8$ ) was based upon this form's suitability for disposal, what have you concluded with respect to the adequacy of the environmental

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<sup>1</sup> Testimony of Rod M. Krich p. 4

<sup>2</sup> Testimony of Donald Palmrose p. 4

impacts analyzed in the Draft Environmental Impact Statement for the proposed National Enrichment Facility (NEF DEIS) for the operation of the deconversion plant?

A3. The specific steps in the deconversion of  $\text{DUF}_6$  to a more stable chemical form for long-term disposal depend on the final choice for which potential form is to be produced. All parties are agreed on this point of technical principle. For instance,  $\text{DUF}_6$  is not a suitable waste form for long-term storage or for disposal. The entire issue of the impacts of the conversion plant centers on this fact – the need to convert it to a form that is suitable for long term management, *including disposal*. On this much also there is now agreement between the NRC, LES, and myself. So the rest of the issue remains about one technical detail: to what form should  $\text{DUF}_6$  be converted so that it is suitable for long term management, *including disposal*. The relevance of this question is also clear from R.M. Kirch's testimony, because it goes directly to understanding and evaluating the impacts of the conversion facility on the environment, which is the matter at hand. In particular, the steps for producing uranium oxide ( $\text{U}_3\text{O}_8$ ) or uranium dioxide ( $\text{UO}_2$ ) are different and result in different impacts such as the level of contamination in the resulting hydrofluoric acid or calcium fluoride. The choice of disposal strategy will have a significant impact on the choice of which deconversion process is to be pursued, and this is clear from the testimony offered by R.M. Krich and D.E. Palmrose.

While the NRC staff and DOE have currently settled on  $\text{U}_3\text{O}_8$  as the most promising chemical form for long-term management and disposal, no final disposal strategy has been chosen or fully analyzed by the DOE in relation to the management of its depleted uranium stockpile.<sup>3</sup> In the 1997 Lawrence Livermore National Laboratory engineering analysis of  $\text{DUF}_6$  management and disposal

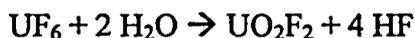
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<sup>3</sup> DOE Paducah EIS 2004 p. 2-11, 2-17, and 2-25 (NIRS/PC Exhibit 52)

options, the authors concluded that both  $U_3O_8$  and  $UO_2$  were "principal option[s]" for "long-term storage or disposal."<sup>4</sup> Both grouted  $U_3O_8$  and grouted  $UO_2$  were included as possible waste forms in the base-case of the Livermore analysis.<sup>5</sup> In addition, the Final Programmatic Environmental Impact Statement for the Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride (PEIS) retained both  $U_3O_8$  and  $UO_2$  in their discussions "because of their chemical stability" which would aid in the depleted uranium's ultimate disposal.<sup>6</sup> Finally, and perhaps most importantly, in its recent ruling on the classification of depleted uranium as low-level radioactive waste, the NRC accepted our contention that the suitability of  $U_3O_8$  for disposal is not clear, and that further environmental and safety analysis is required. Specifically they concluded that

A more difficult question [than the classification of DU] -- and one we need not answer today -- concerns whether the LES material, in the volumes and concentration proposed, will meet the Part 61 requirements for near-surface disposal. **The Commission agrees with the intervenors that a definitive conclusion on this and other disposal method questions cannot be reached at this time, and may require further environmental or safety analysis.** Our decision should not be read to intimate any Commission view on this issue, which relates both to the plausibility of LES's proposed private disposal options, and to financial assurance -- issues which remain before the Board.<sup>7</sup> (emphasis added)

LES has stated that its preferred option is the deconversion of the  $DUF_6$  to  $DU_3O_8$  followed by its disposal as a bulk powder in an abandoned mine or potentially at a shallow land disposal facility. In addition, LES has stated that it will consider the following reactions for producing the  $DU_3O_8$



followed by



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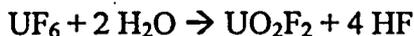
<sup>4</sup> LLNL Engineering Analysis 1997 p. 6.4-vi and 6.6-vi (NIRS/PC Exhibit 55).

<sup>5</sup> LLNL Engineering Analysis 1997 p. 3-22 (NIRS/PC Exhibit 55)

<sup>6</sup> DOE PEIS 1999 p. I-1 (NIRS/PC Exhibit 54)

<sup>7</sup> NRC Ruling on DU and LLW p. 26 (Jan. 18, 2005).

On the other hand, depleted uranium hexafluoride may also be converted into  $\text{UO}_2$  instead by the following reactions



followed by



As discussed in Makhijani and Smith, *Costs and Risks of Management and Disposal of Depleted Uranium from the National Enrichment Facility Proposed to be Built in Lea County, New Mexico* by LES, Nov. 24, 2004, the depleted uranium that would be produced as a result of the proposed LES enrichment facility is similar in hazard to transuranic waste and will likely require fabrication into a suitable waste form and disposal in a mined repository such as the Waste Isolation Pilot Plant in order to adequately meet the existing dose and exposure limits imposed by NRC and EPA regulations.

The  $\text{DU}_3\text{O}_8$  that would result from the first deconversion process shown above would be less dense and less uniform in particle size than the  $\text{DUO}_2$  that would result from the second process. These properties make it less suitable for processing into a waste form that would aid in the development of a disposal strategy protective of the public health and capable of meeting the existing regulatory limits for uranium exposure. On the other hand, the smaller more uniform particle size of the  $\text{DUO}_2$  that is an advantage in waste form processing also adds to the level of uranium contamination in the resulting byproducts (mainly the hydrofluoric acid and the calcium fluoride that would result from neutralizing the HF) as well as adding to the airborne releases of uranium from the process building stack of the deconversion facility. The estimated stack releases of uranium for a  $\text{DUO}_2$  facility are more than three-and-a-half times those of a  $\text{DU}_3\text{O}_8$  facility.<sup>8</sup>

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<sup>8</sup> LLNL 1997 (EA) p. 6.4-7-2, 6.5-7-2, 6.6-7-2, and 6.7-7-2 (NIRS/PC Exhibit 55).

In addition, the process for deconverting to  $UO_2$  requires more water, and the smaller particle size results in greater contamination of the resulting wastewater. In the 1997 LLNL engineering analysis, both the  $U_3O_8$  and the  $UO_2$  facilities would produce treated wastewater that was contaminated above the EPA safe drinking water standard of 30  $\mu\text{g}/\text{liter}$ . The water from the  $U_3O_8$  facility had an estimated 42  $\mu\text{g}/\text{liter}$  while the water from the  $UO_2$  facility had an estimated 62  $\mu\text{g}/\text{liter}$ . Both of these facilities would require large amounts of water to dilute this pollution to the EPA drinking water levels if this water was released from the site. However, the  $UO_2$  facility would pollute approximately 73.2 million additional liters per year compared to the  $U_3O_8$  plant, an increase of almost 80 percent.<sup>9</sup> For comparison, this additional volume of water would be enough for the annual drinking water needs of more than 100,000 adults. Hence, while the water impacts are not negligible in either case, especially in the context of a region where water resources are scarce, they are different and must be evaluated as such. There appears to be a trade-off between water pollution in the relatively short term (decades) and the impact over the long-term, with the former being greater for  $DUO_2$  conversion option, and the latter potentially far lower for that same option. The consideration of water pollution is evidently central to the assessment of the impact of the facility and, hence, the impacts of different conversion options, including the conversion to  $DUO_2$ , must be assessed.

The ER and the DEIS do not address the relative environmental performance of  $DU_3O_8$  and  $DUO_2$  or of their fabrication into waste forms suitable for long-term management and disposal in such a way that would have a high probability of protecting the public health. The relative impacts of deconverting to  $DU_3O_8$  or  $DUO_2$  are not analyzed in the DOE site specific EISs for the Paducah and Portsmouth facilities referred to in the NEF DEIS. In addition, as will be discussed below, the

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<sup>9</sup> LLNL Engineering Analysis 1997 p. 6.4-4-3 and 6.6-4-4 (NIRS/PC Exhibit 55).

uncertainties in process and technology choices makes it uncertain whether the impacts discussed in the PEIS truly bound the impacts of the UO<sub>2</sub> facility, and makes an accurate comparison of the two options in the context of the LES facility impossible.

Q4. With respect to the issue of whether the private deconversion facility preferred by LES would produce aqueous HF, anhydrous HF, or calcium fluoride (CaF<sub>2</sub>), what testimony will you be addressing?

A4. R.M. Krich testified that LES has not yet decided upon a specific deconversion process to produce U<sub>3</sub>O<sub>8</sub>, nor have they decided upon whether the facility would produce aqueous HF, anhydrous HF, or neutralize the acid to calcium fluoride. Despite this lack of specifics, R.M. Krich testified that the analysis in the PEIS for the impacts of AHF production would bound any possible impacts from the proposed LES facility.<sup>10</sup>

D.E. Palmrose testified that the site-specific Final EISs did not consider AHF production, but that the EISs did make note of the analysis presented in the PEIS.<sup>11</sup> In addition, he went on to testify that

Q20. Would you be able to address the impacts that would result from conversion utilizing a distillation process to convert aqueous HF to anhydrous HF with the same degree of specificity used in the DEIS regarding the neutralization process?

A20. No. Specific analyses on the impacts from the neutralization process are contained in the Paducah and Portsmouth FEISs. On the contrary, with regard to a process of distillation resulting in anhydrous HF, there is no current conversion facility that uses this technology. Furthermore, there is no plan to construct such a facility, therefore, the process used to distill HF to an anhydrous form has not been fully developed. Therefore, any assessment of the impacts resulting from distillation would have a high degree of uncertainty and any analysis would have to

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<sup>10</sup> Testimony of Rod M. Krich p. 4-5 and 12-13

<sup>11</sup> Testimony of Donald Palmrose p. 9-10

be derived from the evaluation of similar technologies. In the PEIS, DOE performed this type of analysis by relying on data from similar technologies. The PEIS presented the potential impacts as a range of impacts designed to provide a reasonable estimate of their magnitude, taking into account the uncertainty relative to the specific technology and site. PEIS at F-4.”<sup>12</sup>

Q21. Do you consider the analysis contained in the PEIS to be an adequate analysis of the impacts of distillation, given the current understanding of technology that could be used in distillation?

A21. Yes. Given these uncertainties and based on current knowledge, the analysis performed by DOE in the PEIS presents a thorough analysis of impacts of a conversion facility using an as yet to be commercially established distillation process to produce anhydrous HF. A more specific analysis would require knowledge of the specific processes which would be used to perform the distillation process and the specific site at which the facility would be constructed.”<sup>13</sup>

Q5. Given what has been testified to regarding the possibility that the LES private deconversion facility might upgraded the aqueous HF to anhydrous HF, what opinions have you formed regarding the needed analysis that has not been included in the NEF DEIS?

A5. Given the uncertainties acknowledged by LES, and the immaturity of technological development of producing AHF as the end product in the deconversion process, it is difficult to technically sustain the claim of bounding impacts. Despite the fact that R.M. Krich testified that no specific process has yet been decided, the NEF DEIS states that

In this Draft EIS, it is assumed that the proposed conversion facility would be using the same technology adapted for use by DOE in its conversion facilities. This technology would apply a continuous dry conversion process based on the commercial process used by Framatome Advanced Nuclear Power, Inc., fuel fabrication facility in Richland, Washington (DOE, 2004a; DOE, 2004b; LES, 2004a).<sup>14</sup>

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<sup>12</sup> Testimony of Donald Palmrose p. 10-11

<sup>13</sup> Testimony of Donald Palmrose p. 11

<sup>14</sup> NRC Draft EIS 2004 p. 2-28 (NIRS/PC Exhibit 41).

The Paducah and Portsmouth facilities, however, will produce aqueous HF and therefore in regards to the proposed process for the upgrading the aqueous HF to anhydrous HF, the 1997 Livermore analysis assumed that the process of direct distillation would be used. This was also the assumption used in the PEIS.<sup>15</sup> The distillation process is not used in any of the existing deconversion plants, nor in the cited fuel fabrication facility. Given this lack of commercially available experience, the Livermore analysis noted that

Although anhydrous HF is not produced as the by-product from the Cogema facility, distillation (the assumed process to upgrade the aqueous HF) is well established. Again, any uncertainties with the specific distillation process and its integration assumed for the engineering analysis (see Section 3.2.1.1) would be addressed in a subsequent engineering development phase of the Program.<sup>16</sup>

Despite the confidence of the DOE and others that, because distillation is a common industrial process that it could be straightforwardly adapted to the needs of a DUF<sub>6</sub> deconversion plant, the experience of Cogema proved otherwise. As reported in 2001, Cogema abandoned distillation as a possibility for upgrading the HF produced at their Pierrelatte facility. Specifically it was reported that

Various alternatives of the dry process were investigated. One process that received special attention was to distill the aqueous HF to obtain anhydrous acid and to recycle the remaining azeotrope by direct reinjection in the defluorination kiln. This alternative was eventually discarded since it required more sensitive kiln technology and was more corrosive.<sup>17</sup>

and that

Studies have been carried out to convert this 70% [aqueous] HF to anhydrous HF, which can be sold on the European market at a much higher price. Five different processes have been technically compared. Direct distillation has been discarded because of the lack of commercial market for the 38% azeotrope by-product and the problems associated with its direct re-injection inside the defluorination kiln (such as the design of a special super-heating system).<sup>18</sup>

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<sup>15</sup> LLNL Engineering Analysis 1997 p. 3-8 (NIRS/PC Exhibit 55) and DOE PEIS 1999 p. F-12 (NIRS/PC Exhibit 54).

<sup>16</sup> LLNL Engineering Analysis 1997 p. 3-7 (NIRS/PC Exhibit 55).

<sup>17</sup> Hartmann et al. 2001 (NIRS/PC Exhibit 61).

<sup>18</sup> Hartmann et al. 2001 (NIRS/PC Exhibit 61).

In 2001, the preferred option of Cogema was to use a liquid-liquid extraction process, but no final decision had been reached given their ability to continue selling the aqueous HF on the European market.

Given the failure of distillation at the Cogema plant, it is necessary that the NRC and LES perform additional analyses of the impacts of AHF production using technologies more likely to actually be put into operation. The PEIS itself states that

For each conversion option, the potential environmental impacts are presented as a range within each area of impact. This range is intended to provide a reasonable estimate of the magnitude of impacts, taking into account the uncertainty relative to the specific technologies and sites that could ultimately be selected for conversion. The range of impacts results from two factors: (1) fundamental differences among the technologies within each conversion option; and (2) differences in the conditions at the three representative sites that were evaluated. A more detailed assessment of specific technologies and site conditions will be conducted, as appropriate, as part of the second phase (tier) of the programmatic National Environmental Policy Act (NEPA) approach.<sup>19</sup>

and that

The cumulative impacts of conversion, long-term storage, and disposal activities could not be determined because specific sites and technologies have not been designated for these options. Further analyses of cumulative impacts would be performed as required by NEPA and DOE regulations for any technology or siting proposals that would involve these facilities.<sup>20</sup>

Given that the PEIS considers only the impacts of distillation, it is not possible to determine whether its reported impacts actually bound the possible impacts of a private facility built to handle the depleted uranium from the proposed LES enrichment facility that would use alternative technologies to upgrade the aqueous HF to anhydrous HF.

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<sup>19</sup> DOE PEIS 1999 p. F-4 (NIRS/PC Exhibit 54).

<sup>20</sup> DOE PEIS 1999 p. 4-29 (NIRS/PC Exhibit 54).

Q6. With respect to the adequacy of the analysis presented in the NEF DEIS and its reliance on the previous environmental impact states prepared by the DOE, what testimony do you plan to discuss in relation to the impacts of a UO<sub>2</sub> deconversion facility?

A6. R.M. Krich has testified that LES relied upon the DOE PEIS and the two site-specific Final EISs for the Paducah and Portsmouth facilities for their analysis of the impacts from the deconversion of the depleted uranium to be produced by the proposed LES facility.<sup>21</sup> In particular, with respect to the private facility option, he testified that

Q19. Do these EISs bound the environmental impacts of the private sector deconversion option, if LES should elect to pursue this option?

A19. (RMK) If LES should elect to pursue its "preferred" strategy of transporting the depleted uranium hexafluoride from the NEF plant to a private sector deconversion facility, the environmental evaluations published by DOE, comprising the site-specific EISs for the Paducah and Portsmouth sites and the Programmatic Environmental Impact Statement, appropriately address and bound the environmental impacts that might be associated with the construction, operation, and decommissioning of a private sector deconversion facility. Understanding that if LES elects to pursue a private sector deconversion facility, further environmental evaluation would be undertaken of the site-specific impacts of such a facility as part of the licensing process, the DOE Programmatic EIS and site-specific EISs (as well as the NRC FEIS for the CEC facility) adequately address the potential generic environmental impacts of such a facility in a way that "bounds" or "envelopes" those environmental impacts."<sup>22</sup>

Q7. In light of the use of these documents by LES and the NRC, have you reached an opinion as to whether or not the PEIS and the two site-specific Final EISs can be considered to bound the impacts of a private deconversion plant that would produce UO<sub>2</sub>?

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<sup>21</sup> Testimony of Rod M. Krich p. 8

<sup>22</sup> Testimony of Rod M. Krich p. 10

A7. As highlighted by the above discussion regarding the process for upgrading the aqueous HF to anhydrous HF, there is significant uncertainty that is introduced into the generic analyses prepared by the DOE due to the lack of existing commercial technologies for many of the options considered. The consideration of related technologies from similar industrial settings is no guarantee that they will be able appropriate to the deconversion facility under consideration.

The 1997 Lawrence Livermore engineering analysis which formed, in part, the technical basis for the PEIS states that

Due to the fact that the oxide throughput is an order of magnitude higher than that for nuclear fuel fabrication plants, the preconceptual design assumes much larger sintering furnaces than those used in commercial fuel fabrication plants. Furnaces of this size and with these performance specifications are not presently available, but furnaces with one or two of the features (high capacity, high temperature, and special gas atmosphere) are common. It is believed that sintering furnaces combining all of these features can be engineered and fabricated with moderate risk.<sup>23</sup>

Despite being smaller than the DOE facilities, the deconversion plant envisioned in the NEF DEIS would still require technology of a larger scale than that which is available today. The Framatome ANP Richland fuel fabrication facility upon which many elements of the analysis was based has an annual throughput seven-and-a-half times smaller than the 7,800 metric tons envisioned for a private deconversion facility built to handle the LES DUF<sub>6</sub>. In fact, the largest of the fuel fabrication facilities in the United States analyzed by Argonne National Laboratory had a throughput that was still nearly four and half times smaller than what would be needed to handle the depleted uranium from the proposed LES facility.<sup>24</sup>

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<sup>23</sup> LLNL Engineering Analysis 1997 p. 3-11 (NIRS/PC Exhibit 55).

<sup>24</sup> Ranek and Monette 2001 p. 4 (NIRS/PC Exhibit 60).

The scaling and technology availability uncertainties in the  $\text{UO}_2$  process make it likely that changes to the facility will be required versus the range of options considered in the PEIS. This is similar to the abandonment of direct distillation by Cogema for the production of anhydrous HF despite the common use of distillation in other industries discussed above. In the event of such process changes, it follows that the impacts presented in the PEIS and the two site-specific Final EISs do not necessarily bound the impacts of the plausible deconversion facilities that need to be considered by LES and the NRC.

An example of such a case can readily be found in a comparison of the PEIS and the site-specific Final EISs. The PEIS is claimed to bound the possible generic impacts from the operation of various deconversion facilities. However, between the time the PEIS was finalized in 1999 and when the Paducah and Portsmouth EISs were finalized in 2004, the nature of the process to be used was changed in at least one important respect that resulted in an increase to the consequences of a worst-case chemical accident at the plant, namely the ammonia stored on site for use had been changed to anhydrous ammonia.

In the deconversion process, ammonia is used to produce hydrogen gas. Depleted uranium hexafluoride can be deconverted to  $\text{U}_3\text{O}_8$  without the use of hydrogen gas and, in fact, the 1997 LLNL study assumed that no ammonia would be used in its analysis of the  $\text{U}_3\text{O}_8$  facility. The deconversion process to  $\text{UO}_2$ , on the other hand, requires hydrogen gas, and the Livermore analysis assumed an annual consumption of 1,318 metric tons per year in that case.<sup>25</sup> If an alternative process for deconversion to  $\text{U}_3\text{O}_8$  is used (the preferred option by LES), then both facilities would require the input of hydrogen gas, however, deconversion to  $\text{UO}_2$  would still require significantly

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<sup>25</sup> LLNL Engineering Analysis 1997 p. 6.4-4-3 and 6.6-4-4 (NIRS/PC Exhibit 55).

more. The PEIS assumed that a total of 500 truck shipments of ammonia would be required to a  $U_3O_8$  plant. The Paducah Final EIS, however, assumed that 1,300 truck shipments (or 650 rail shipments) of anhydrous ammonia would be required.<sup>26</sup> For comparison, the PEIS had assumed 1,100 rail shipments of ammonia would be required for a  $UO_2$  facility. How many shipments and what volume of anhydrous ammonia storage and throughput would likely be required if the  $UO_2$  option were given an additional level of detailed analysis as was done for the DOE  $U_3O_8$  option is not known and should be considered by LES and the NRC.

In addition to changing the nature of the process chemicals and the amount shipped, the accident consequences in the PEIS for an ammonia tank rupture do not bound all of the consequences reported in the Paducah Final EIS. In the PEIS the ammonia tank rupture was found to pose a risk of causing irreversible health effects to 180 to 420 non-involved workers and 8 to 1,700 members of the general public, should it occur.<sup>27</sup> The Paducah Final EIS has lower potential consequences for the public from the rupture of an anhydrous ammonia tank (2 to 370 irreversible health effects at the preferred location), but larger consequences for the non-involved workers (600 to 1,600 persons experiencing irreversible health effects).<sup>28</sup>

While the likelihood of the ammonia tank rupture accident is considered to be very small, the fact that the PEIS failed to bound the impacts presented in the Paducah FEIS for the DOE's  $U_3O_8$  facility, as well as the likely process and technology changes that would occur as the  $UO_2$  design moved from pre-conceptual to a more realistic level provides support for the conclusion that the

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<sup>26</sup> DOE PEIS 1999 p. 5-47 (NIRS/PC Exhibit 54) and DOE Paducah FEIS 2004 p. 2-33 and 5-71 (NIRS/PC Exhibit 52).

<sup>27</sup> DOE PEIS 1999 p. F-34 (NIRS/PC Exhibit 54).

<sup>28</sup> DOE Paducah FEIS 2004 p. 2-48 to 2-49 (NIRS/PC Exhibit 52).

NRC and LES have failed to adequately present a thorough analysis of the expected environmental impacts of a UO<sub>2</sub> deconversion facility by referencing the DOE PEIS. The PEIS itself states that

For each conversion option, the potential environmental impacts are presented as a range within each area of impact. This range is intended to provide a reasonable estimate of the magnitude of impacts, taking into account the uncertainty relative to the specific technologies and sites that could ultimately be selected for conversion. The range of impacts results from two factors: (1) fundamental differences among the technologies within each conversion option; and (2) differences in the conditions at the three representative sites that were evaluated. A more detailed assessment of specific technologies and site conditions will be conducted, as appropriate, as part of the second phase (tier) of the programmatic National Environmental Policy Act (NEPA) approach.<sup>29</sup>

and that

The cumulative impacts of conversion, long-term storage, and disposal activities could not be determined because specific sites and technologies have not been designated for these options. Further analyses of cumulative impacts would be performed as required by NEPA and DOE regulations for any technology or siting proposals that would involve these facilities.<sup>30</sup>

Given the likelihood that technologies other than those considered in the PEIS will need to be adopted in the development of a realistic deconversion facility of the scale necessary, the impacts of the UO<sub>2</sub> deconversion option requires further NEPA analysis by LES and the NRC. Moreover, some of this analysis will be process oriented, but some must necessarily be site specific.

Q8. With respect to the issue of transportation, what did the pre-filed direct testimony contain that you plan to discuss?

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<sup>29</sup> DOE PEIS 1999 p. F-4 (NIRS/PC Exhibit 54).

<sup>30</sup> DOE PEIS 1999 p. 4-29 (NIRS/PC Exhibit 54).

A8. The testimony of R.M. Krich, claims that the analysis in the PEIS bounds all transportation accidents given that it considers adequately long distances (250 to 5,000 km) and considers all of the types of materials that might be transported in connection to the proposed LES facility.<sup>31</sup>

Q9. With respect to their reliance on the analysis conducted in the PEIS, what opinion have you formed with respect to the adequacy of this approach?

A9. The transportation analysis presented in the DOE PEIS does not consider all of the process chemicals that might be transported in connection with a private deconversion facility built to handle the depleted uranium from the proposed LES enrichment facility. For example, the Final EISs for the Paducah and Portsmouth deconversion plants consider the transportation of anhydrous ammonia which is more volatile and hazardous than the ammonia considered in the PEIS. In addition, the site-specific EISs considered larger numbers of shipments of anhydrous ammonia than the number of ammonia shipments considered in the PEIS.<sup>32</sup> In addition, from the 1997 LLNL study, it is known that facilities to deconvert to UO<sub>2</sub> would require larger amounts of anhydrous ammonia than facilities deconverting to U<sub>3</sub>O<sub>8</sub> given the greater hydrogen needs of producing uranium dioxide. This is an example of the kind of issue that arises in transitioning from the generic to the specific technologies that were noted above in which the PEIS analysis might not bound the impacts of operation of real world facilities.

In addition, the transportation accidents considered in the DOE analysis apparently did not report the impacts of a serious train fire in general much less a bounding accident like the Baltimore CSX

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<sup>31</sup> Testimony of Rod M. Krich p. 13-14

<sup>32</sup> DOE PEIS 1999 p. 5-47 (NIRS/PC Exhibit 54) and DOE Paducah FEIS 2004 p. 2-33 and 5-71 (NIRS/PC Exhibit 52).

train fire that occurred in mid-July 2001. The CSX train derailment ignited a leak of tripropylene and burned additional cars of wood and paper products. The flames and heat prevented access to the tunnel for several days while smoke poured out both ends of the tunnel and a number of manholes along the street. Two other rail cars involved in the accident were carrying hydrochloric acid and one contained an environmentally hazardous plasticizer.<sup>33</sup> The influence of accidents such as train fires on the chemical and radiological impacts of transportation should be fully addressed in the NEF DEIS. The recent rail accident in Graniteville, S.C. on January 6, 2005 involving the release of chlorine gas in which nine people died, 250 were injured, and 5,400 (virtually the total population of the nearby town) were evacuated highlights the continued risks associated with the transportation of hazardous materials.<sup>34</sup>

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<sup>33</sup> NTSB/RAB-04/08 p. 1-2 and 6 (NIRS/PC Exhibit 62).

<sup>34</sup> Fears, D. and S.K. Goo 01/10/05 (NIRS/PC Exhibit 63).

## CERTIFICATE OF SERVICE

Pursuant to 10 CFR § 2.305 the undersigned attorney of record certifies that on January 28, 2005, the foregoing Rebuttal Testimony of Dr. Arjun Makhijani on behalf of Nuclear Information and Resource Service and Public Citizen, NIRS/PC Contention EC-4, was served by electronic mail and by first class mail upon the following:

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