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RELATED CORRESPONDENCE

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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket No. 70-3103
Louisiana Energy Services, L.P.	ASLBP No. 04-826-01-ML
National Enrichment Facility	

REBUTTAL TESTIMONY OF DR. ARJUN MAKHIJANI IN SUPPORT OF NIRS/PC CONTENTIONS EC-3/TC-1, EC-5/TC-2, AND EC-6/TC-3 CONCERNING THE CONTINGENCY FACTOR APPLICABLE TO LES'S COST ESTIMATE

Q1. Please state you name and what testimony you will 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 and Thomas LaGuardia presented on behalf of Louisiana Energy Services, L.P. dated September 16, 2005, and the pre-filed direct testimony of Timothy C. Johnson, Jennifer Mayer, and Craig Dean presented on behalf of the NRC Staff dated September 15, 2005. The testimony of Rod Krich,

SECY-055

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Timothy Johnson, Jennifer Mayer, and Craig Dean was offered with respect to issues of the contingency allowance relied upon by LES as they relate to Nuclear Information and Research Service and Public Citizen Contention EC-5/TC-2.

Q2. With respect to the NRC guidance on the appropriate size of the contingency factor for use what opinions were offered by the opposing experts in their direct testimony that you plan to discuss?

A2. The testimony of interest from Rod Krich and Thomas LaGuardia was as follows:

> A13. (RMK, TSL) ... In a related guidance document that is intended to facilitate compliance with the foregoing regulations, the NRC Staff has directed materials license applicants to apply a 25 percent contingency factor to their overall decommissioning cost estimate.[1]

> A22. (RMK, TSL) The 25 percent contingency factor that LES has applied to its overall cost estimate for DU dispositioning is more than adequate.... Accordingly, LES's compliance with NUREG-1757 provides clear evidence that LES has applied an appropriate contingency factor to its estimated facility decommissioning and DU disposition costs. In addition, extensive historical experience in decommissioning nuclear power plants has shown that 25 percent is an appropriate contingency for those more complex types of facilities.[2]

The testimony of interest from Timothy Johnson, Jennifer Mayer, and Craig Dean was as follows:

> Q.12. How did you determine whether the contingency factor used by LES was appropriate?

> A.12. (TJ, JM, CD) First, I determined that the contingency factor met the requirements of NRC guidance in NUREG-1757. Second, I compared the contingency factor of 25 percent to contingency factors used in NUREG/CR-6477, Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities (July 1998) attached as Staff Exhibit 38. NUREG/CR-6477 uses a contingency factor of 25 percent for a variety of facilities that are similar to the proposed LES facility. Third, I concluded that the decommissioning activities to be

[1] LES Contingency 2005 p. 5.
[2] LES Contingency 2005 p. 12-13.

performed were relatively simple and straightforward, and therefore extremely unlikely to result in unforeseen costs so large that a 25 percent contingency would not be sufficient.[3]

Q3. What opinions have you formed regarding the conclusions presented in the above testimony?

A3. In the *Consolidated NMSS Decommissioning Guidance: Financial Assurance, Recordkeeping, and Timeliness* the NRC states that "*[a]t* ***minimum,*** all cost estimates for unrestricted or restricted release must" include the application of "a contingency factor of ***at least*** 25 percent to the sum of all estimated costs."[4] Thus, a 25 percent contingency factor is considered by the NRC to be a minimum regulatory requirement and not a maximum.

In addition, there has not been what I would classify as "extensive historical experience" at decommissioning commercial nuclear power plants as claimed by Rod Krich and Thomas LaGuardia. To date, only five nuclear power plants have completed the DECON decommissioning alternative. Of these five plants only two had a rated power greater than 250 MW-thermal. These two plants were the Fort St. Vrain gas-cooled reactor (842 MWt), which achieved a lifetime capacity factor of just 14.5 percent and had a forced outage rate of nearly 61 percent, and the Shoreham boiling-water reactor (2436 MWt) which was shutdown just 68 days after receiving its operating license. The DECON process in currently listed as "in progress" at just five other nuclear power plants (which had a rated power between 23.5 MWt and 3411 MWt).[5]

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[3] NRC Staff Contingency 2005 p. 4-5.
[4] NUREG 1757, Vol. 3 (NIRS/PC Ex. 249) p. 4-9 to 4-10 (emphasis added).
[5] NRC 2005b (NIRS/PC Ex. 264) p. 111-112.

Q4. With respect to the complexity of DU dispositioning what opinions were offered by the opposing experts in their direct testimony that you plan to discuss?

A4. The testimony of interest from Thomas LaGuardia was as follows:

> A17. (TSL) In short, my experience tells me that because 25 percent is an adequate cost contingency for the complex decommissioning of a power plant, it is, *a fortiori*, an adequate cost contingency for the comparatively simpler decommissioning and DU dispositioning activities required for the NEF.[6]
>
> A18. (TSL) ... With respect to the dispositioning of DU from the NEF, there are fundamentally three activities or operations to consider: transportation, deconversion, and disposal of DU. ***All three of these activities, in my expert opinion, have relatively low levels of uncertainty.***[7]
>
> Q19. Please state the basis for your opinion that the three DU dispositioning activities identified above have relatively low levels of uncertainty.
>
> A19. (TSL) ... As set forth in the testimony of other LES witnesses, the deconversion of depleted UF_6 to U_3O_8 is based on a well-understood chemical process that been [sic] successfully deployed on a commercial scale in Europe for over two decades. Moreover, LES's estimate of the potential costs associated with such a deconversion operation in the U.S. is based principally on specific cost information obtained from Urenco and COGEMA (the pertinent vendor of deconversion services). These facts do not suggest significant potential for large unforeseen cost increases within the scope of anticipated deconversion activities.
>
> Finally, LES's DU disposal cost estimate reflects disposal of DU in an engineered trench, a procedure which I consider to be fairly predictable in terms of both logistics and cost.... I can say with confidence that low-level radioactive waste disposal costs have stabilized considerably over the past several years, and more recent cost increases have largely coincided with the inflation rate. At Envirocare, for example, disposal costs typically average about $25 per cubic foot, though they are subject to negotiation. In some instances they may be less than $25 per cubic foot; in other situations they may be [sic] exceed that amount (mainly when smaller quantities of waste are involved). Under any scenario, the proprietary disposal cost estimate (stated in dollars per cubic foot) that LES obtained from a [sic] Waste Control Specialists, LLC, and which underlies LES's $1.14/kgU cost figure, is certainly conservative for the type (bulk DU_3O_8) and volume of DU_3O_8 to be disposed of by LES.[8]

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[6] LES Contingency 2005 p. 7.
[7] LES Contingency 2005 p. 8-9 (emphasis added).
[8] LES Contingency 2005 p. 9-10.

A21. (TSL) A contingency factor is meant to account for the differences between the base cost and unforeseen costs. The base cost estimate defines the project scope and accounts for the known and reasonably anticipated costs of decommissioning. A contingency factor, by contrast, is intended to account for any unforeseen costs within the defined project scope, *i.e.*, events that may occur in the field during implementation of the work, and which are not accounted for in the base cost estimate. In the case of DU dispositioning, the "defined project scope" includes the transportation of DU to and from a deconversion facility, the deconversion of DUF_6 to DU_3O_8, and the near-surface disposal of DU_3O_8 at a licensed low-level radioactive waste disposal facility.[9]

The testimony of interest from Timothy Johnson, Jennifer Mayer, and Craig Dean was as follows:

Q.8. What about costs that can be foreseen but are not known for certain?

A.8. (TJ, JM, CD) Those costs are expected to be included and accounted for in the decommissioning cost estimate. The Staff recognizes that some costs cannot be predicted with certainty but nevertheless can be expected. In these cases, applicants such as LES must account for them in their cost estimate, using the best available documentation.[10]

Q.12. How did you determine whether the contingency factor used by LES was appropriate?

A.12. (TJ, JM, CD) First, I determined that the contingency factor met the requirements of NRC guidance in NUREG-1757. Second, I compared the contingency factor of 25 percent to contingency factors used in NUREG/CR-6477, Revised Analyses of Decommissioning Reference Non-Fuel Cycle Facilities (July 1998) attached as Staff Exhibit 38. NUREG/CR-6477 uses a contingency factor of 25 percent for a variety of facilities that are similar to the proposed LES facility. ***Third, I concluded that the decommissioning activities to be performed were relatively simple and straightforward, and therefore extremely unlikely to result in unforeseen costs so large that a 25 percent contingency would not be sufficient.***[11]

Q5. With respect to the deconversion of DUF6, what conclusions have you drawn regarding the suitability of the 25 percent contingency factor applied by LES?

A5. The deconversion of the depleted uranium hexafluoride (DUF6) to uranium oxide (DU3O8) has been carried out at the Pierrelatte Plant in France for more than 20 years. To make use of this

[9] LES Contingency 2005 p.12 (emphasis in the original).
[10] NRC Staff Contingency 2005 p. 3.
[11] NRC Staff Contingency 2005 p. 4-5 (emphasis added).

deconversion service, in 2004 Urenco was paying 3.2 euros per kilogram of uranium excluding transportation, storage, and other costs. Using the exchange rate proposed by LES ($1.291 per euro) this would amount to cost of $4.13 per kilogram of depleted uranium. Instead of relying on this baseline cost estimate, which is based on experience at a real-world operating facility, LES has proposed to rely primarily on a paper study for the cost of a plant that has yet to be built or even have its design finalized. The cost derived by LES ($2.69 per kilogram or uranium) is 35 percent less than that which would be expected based on Urenco's contract with Cogema for deconversion at the operating Pierrelatte Plant. Significantly, the paper study that LES is relying upon itself represents the cost estimates as being "based on preliminary design information and therefore are +/- 30% confidence."[12] The modifications made by LES to the Urenco cost estimates to account for scaling the plant to double the throughput, for modifications to "Americanize" the plant, and for adding funds to cover decontamination and decommissioning, would not be expected to decrease the level uncertainty inherent in the final cost estimate. Therefore it is not correct to conclude, as was done by both the NRC Staff witnesses and the LES witness Mr. LaGuardia, that a 25 percent contingency added to the current baseline estimate would be adequate to cover the additional costs that could be encountered in deconverting the depleted uranium hexafluoride from the proposed NEF. As I testified in my direct testimony and as testified to by Mr. LaGuardia, the NRC requirement of a contingency of <u>at least</u> 25 percent, relates to unforeseen costs such as industrial accidents and equipment malfunction which may occur in any industrial undertaking. The fact that (1) the business study relied upon by LES itself states that the cost estimates are based on "on preliminary design information" and that they therefore have a "+/- 30% confidence," (2) the fact that the current LES cost estimate ($2.69 per kg U) is 35 percent less than historical experience would suggest based on operational experience at the Pierrelatte Plant ($4.13 per kg U), (3) the fact

[12] LES Business Study (LES Ex. 91) p. 8/15.

that the proposed scale of the LES deconversion facility (10,350 MT DUF6 per year) is roughly half of the throughput of the Pierrelatte Plant, and (4) the fact that the Portsmouth deconversion plant was already 12 to 14 months behind schedule as of July 2005 due to difficulties encountered in finalizing the design, all undermine the above claims by Thomas LaGuardia, Timothy Johnson, Jennifer Mayer, and Craig Dean that the existing contingency factor applied by LES is sufficient. Indeed, the existing evidence indicates that even the foreseeable costs may not be adequately covered by the 25 percent which NUREG 1757 requires to be used for unforeseen costs.

Q6. With respect to the disposal of depleted uranium oxide, what conclusions have you drawn regarding the suitability of the 25 percent contingency factor applied by LES?

A6. Contrary to the claims by NRC Staff and LES witnesses that the disposal of the depleted uranium oxide will be a relatively simple matter, the National Research Council of the National Academy of Sciences reached the exact opposite conclusion. Specifically, the NRC concluded that

> ***If disposal [of depleted uranium oxide] is necessary, it is not likely to be simple.*** The alpha activity of DU is 200 to 300 nanocuries per gram. Geological disposal is required for transuranic waste with alpha activity above 100 nanocuries per gram. If uranium were a transuranic element, it would require disposal in the Waste Isolation Pilot Plant (WIPP) based on its radioactivity. The chemical toxicity of this very large amount of material would certainly become a problem as well.[13]

The disposal of deleted uranium on the scale that would be generated by the proposed NEF is unprecedented and carries a significant degree of uncertainty. Despite the claim by Mr. LaGuardia, the "defined project scope" is not "the near-surface disposal of DU_3O_8 at a licensed low-level radioactive waste disposal facility," but is instead the safe disposal of depleted uranium in accordance with all appropriate rules and regulations. As detailed in the November 2004 and July

[13] NAS/NRC 2003 (NIRS/PC Ex. 151) p. 64 (emphasis added).

2005 reports and my direct testimony it is very unlikely that the depleted uranium from the proposed NEF could be disposed of by shallow-land burial in such a way that it would meet the performance criteria set forth in 10 CFR 61 Subpart C, even in a dry climate. In particular, the annual dose limit of 25 millirem per year would likely be exceeded by orders of magnitude, even if the drinking water and food ingestion pathways are not considered. Consistent with the conclusion of the National Research Council and the International Atomic Energy Agency, we have concluded that the safe disposal of depleted uranium will require isolation comparable to that provided at WIPP for TRU waste (see Makhijani and Smith 2004 pages 19 to 29 and Makhijani and Smith 2005 p. 7 to 24). In regard to this conclusion, IEER sought an independent opinion from Dr. John Bredehoeft, one of the most eminent hydrogeologists in the United States and a member of the National Academy of Engineering. His statement, originally included in our November 2004 report, is quoted in full below:

> Any processing facility must somehow dispose of the waste stream that contains radioactive constituents in a safe manner. A number of investigators, including me, have suggested strategies that can lead to safe geologic disposal facilities for nuclear wastes (Bredehoeft et al., 1978; Bredehoeft and Maini, 1981). However, the devil is in the details of how safe facilities, are designed, engineered, and built.
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> The U.S. Department of Energy (DOE) opened one facility that is now receiving nuclear wastes generated by the U.S. weapons program—WIPP. WIPP was licensed for operation after several decades of investigation and scientific review, including building an exploratory mine in which experiments were conducted in-situ. The scientific community, as represented by the National Academy of Sciences/National Research Council, went on record indicating that the facility was safe. However, it took several decades of scientific work to reach this consensus.
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> DOE is currently attempting to license a repository for high-level nuclear wastes at Yucca Mountain in Nevada. Investigations at Yucca Mountain have also gone on for several decades. This work includes an exploratory tunnel into the mountain.
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> ***At both WIPP and Yucca Mountain data from the tunneling in the subsurface revealed unexpected results—surprises.*** At WIPP the original concept, going back to a National Academy of Sciences Committee in the mid 1950s, was that salt was a good medium for nuclear waste disposal because it was thought to be dry. Once the salt at WIPP was tunneled into, it was found to contain brine—1 to 3% in the interstices between salt crystals. Experiments in the mine demonstrated that this brine would migrate into the mine rooms. ***A***

mine that was originally conceived of a dry now was observed to be damp. This caused a rethinking of the conceptual model for WIPP.

At Yucca Mountain chlorine 36 and tritium produced by bombs were found in the underground tunnel. This suggested that there existed fast paths for moisture movement in the mountain that the prevailing theory for moisture movement in unsaturated media does not predict. The theory has had to be modified to accommodate the fast paths for moisture movement.

Both of these site-specific examples demonstrate the level of scientific and engineering effort necessary to license a nuclear waste facility. One cannot simply draw upon generic calculations to justify that nuclear wastes can be disposed of safely. Prudent design would dictate that one must propose a specific site and method of sequestering long-lived nuclear wastes. Only after a specific site and design are proposed can one assess its safety.

I reviewed the discussion of the two disposal sites in the 2004 draft environmental impact statement for the National Enrichment Facility (NEF) and the longer discussion of such sites in the text and appendix to the 1994 final environmental impact statement for the Claiborne Enrichment Center. The results (i.e., releases) for the two sites reported in these documents are calculations for hypothetical sites, not actual sites under investigation to receive the wastes of the NEF. No actual site for radioactive waste disposal of NEF wastes is identified in these documents—both are hypothetical sites.

As suggested above, to identify a suitable disposal site requires years of investigation, modeling, and additional investigation along with further modeling. It is an iterative process that typically includes construction of a site conceptual model, attempts to calibrate the model, and concurrent investigations to determine whether the conceptual model is appropriate or, perhaps, must be drastically revised or reconstructed. There is a continuing risk during the investigation that the site may fail to meet basic criteria for suitability.

The type of site required for disposal of depleted uranium from NEF is roughly comparable to the WIPP site in terms of the level of isolation required. All three isotopes contained in depleted uranium have very long half-lives, with the half-life of the principal one, U-238 extending to the billions of years. The specific activity of depleted uranium exceeds 300 nanocuries per gram of alpha-emitting radionuclides, and radium 226 and thorium 230 would build up over time to exceed 100 nanocuries per gram. The transuranic waste disposed of at WIPP has a concentration of at least 100 nanocuries per gram of alpha-emitters. The WIPP project involves deep disposal in a sealed mine in bedded salt more than 2000 feet below the surface. The plan for WIPP was examined in a detailed performance assessment, which was reiterated several times. It required well over 20 years of analysis by a large team of scientists and engineers to achieve a level of understanding such that a consensus was reached that the WIPP facility is safe and could receive waste.

Only after a specific site and design are proposed can one assess its safety. It would be prudent to assume that, before a site could be qualified to receive depleted uranium waste, a similar amount of time, effort, expense, and scrutiny to that which went to qualify WIPP would be required.

REFERENCES

Bredehoeft, J.D., England, A.W., Stewart, D.B., Trask, N.J., and Winograd, I.F., 1978, *Geologic Disposal of High-Level Radioactive Wastes--Earth Science Perspectives:* U.S. Geological Survey Circular 779, 15 p.

Bredehoeft, J.D., and Maini, T., 1981, *Strategy for radioactive waste disposal in crystalline rocks:* Science, v. 213, p. 293-296.[14]

When considering the difficulties that may arise in developing a disposal site for depleted uranium we note that even the history of developing shallow land burial disposal sites gives no reason to expect that such development will be easy or expeditious. The development of LLRW disposal facilities has encountered numerous problems in the past. For example, a disposal facility approved in 1993 and planned for construction in California was stopped when the Department of the Interior refused to transfer ownership of the federal land to the state as expected. Disposal sites in Ohio and Nebraska have also been abandoned by the Midwest and Central compacts, respectively.[15] A previous attempt to license a LLRW disposal site for the Texas Compact near Sierra Blanca was refused in 1998, following opposition by members of the local community and others.[16] The Lawrence Livermore engineering analysis also noted this potential difficulty and concluded that

> The licensing of new low-level waste (LLW) disposal facilities under the AEA would be a major compliance issue. ***Licensing under the AEA by NRC or authorized states may be difficult due to the extensive regulatory requirements and the inherently controversial nature of the subject.*** Approvals under the AEA by DOE for new LLW disposal facilities may be difficult due to extensive performance assessment requirements. Disposal facilities could potentially be required to comply with RCRA storage and permitting requirements if offsite treatment and disposal options for mixed waste continue to be limited.[17]

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[14] As quoted in Makhijani and Smith 2004 (NIRS/PC Ex. 190) p. 27-28 (emphasis added) [NOTE: Dr. Bredehoeft worked for the U.S. Geological Survey for 32 years before starting The HydroDynamics Group, a consulting firm, in 1995. He was a member of the National Academy of Sciences/National Research Council Committee on the Department of Energy's Waste Isolation Pilot Plant (WIPP) as well as a member of the NAS/NRC Panel responsible for reviewing groundwater issues at the Yucca Mountain Nuclear Repository.]
[15] Holt 2005 (NIRS/PC Ex. 219) p. CRS-14.
[16] TCEQ 2003 (NIRS/PC Ex.228).
[17] LLNL 1997 EA (NIRS/PC Ex. 55) p. 2-13 (emphasis added).

The uncertainty raised by delays in developing and licensing a geologic repository for the depleted uranium would likely be even more severe. The delay in opening the WIPP facility is instructive here. The WIPP project commenced in the late 1970's. Construction was essentially finished in 1988, but WIPP did not finally obtained EPA certification to begin accepting waste until 1998. Two decades is a reasonable estimate of the time that may be required for developing such a repository.

Given the conclusions of the National Research Council, Dr. John Bredehoeft, and the analysis presented by IEER in both the November 2004 and July 2005 reports and my pre-filed direct testimony, the conclusion of Thomas LaGuardia, Timothy Johnson, Jennifer Mayer, and Craig Dean that the disposal of depleted uranium is likely to be a relatively simple undertaking with few unknowns appears to lack adequate foundation and analysis or reference to independent scientific bodies. The lack of any environmental impact analysis for shallow land burial of depleted uranium presented in either the Draft or Final Environmental Impact Statements for the proposed NEF as well as the lack of any such environmental impact analysis presented in the pre-filed testimony of any witness for the NRC Staff or LES makes these conclusions even more shaky. Indeed they are untenable as part of the basis for estimating an adequate contingency factor that should be part of a plausible strategy

Q7. Given that Rod Krich (the LES witness) explicitly introduced the issues of the DOE cost estimate in his pre-filed direct testimony on deconversion, did any NRC Staff or LES witness testify as to the adequacy of a 25 percent contingency factor for the DOE cost estimate?

A7. No. There was no testimony presented as to the appropriate contingency factor that should be applied to the presently available DOE estimate provided by LMI. This was a notable omission from the LES and NRC Staff testimony.

Q8. What is your conclusion regarding an appropriate contingency factor that should be applied to the DOE cost estimate testified to by Rod Krich?

A8. The LES estimate for the DOE option rests on a study conducted by LMI for the Department of Energy to examine the costs of using the proposed Paducah or Portsmouth deconversion facilities to handle the depleted uranium from LES.[18] This study is not a firm offer from the DOE to accept the depleted uranium at this price, but is, instead, a business study that presents a variety of scenarios based on the information available to the contractor as of December 2004. Significantly, as noted in my November 2004 and July 2005 reports, the DOE has yet to select a final disposal site for the depleted uranium and thus the use by LMI of disposal cost estimates for Envirocare was not based on a DOE <u>decision</u>, but on an <u>assumption</u> that we have shown is very likely to change when the required NEPA analysis is carried out by the DOE.[19] The LMI study omits any discussion of this potential need for more costly disposal.

In determining what level of contingency would be appropriate to include in dealing with this initial DOE estimate in order to have any confidence that adequate financing might be available assuming that LES chose to pursue the DOE option, the most reliable method is to draw upon the actual real-

[18] LMI 2004 (LES Ex. 86).
[19] See Makhijani and Smith 2004 (NIRS/PC Ex. 190) p. 19-29 and Makhijani and Smith 2005 (NIRS/PC Ex. 224) p. 7-24.

world experience of past DOE cost escalations. However, the LMI estimate omits any consideration of DOE's experience at managing complex programs. This is a notable omission given that the DOE has a long history of poor management, technical problems, and cost overruns in programs it oversees, particularly waste management programs. The Table below details some of the major cost overruns that have occurred at DOE projects in the past two decades.

Project	Early Estimate	Later Estimate
Superconducting Super-collider	$5.3 billion (1987)	$8.25 billion (1991)
National Ignition Facility	$1.074 billion (FY1996)	$1.196 billion (FY1998) $2.12 billion (June 2000)
	$0.8331 billion (FY1998)	$1.137 billion (June 2000)
	Total $2.03 billion (FY1998)	Total $3.26 billion (June 2000)
Savannah River Site Defense Waste Processing Facility	$1.2 billion (1987)	$2.1 billion (1992)
		$1.8 billion (1992) cost of supporting facilities in addition to the above $2.1 billion
Hanford Tank Waste Project (Phase I)	$4.3 billion (before September 1996)	$8.9 billion (August 1998)
All High-Level Waste Management Programs	$63 billion (1996)	$105 billion (2003)
Fernald Vitrification Project	$14.1 million (February 1994)	$20.6 million (December 1994) $56 million (July 1996) $66 million (September 1996)
Yucca Mountain	$17.5 billion (30 year cost estimated in 1990 adjusted to year 2000 dollars)	$58 billion (100 year cost estimated in 2000). DOE contractors said cost was understated by $3 billion since repository would not likely open in 2010 as claimed

[GAO/RCED-93-87 (NIRS/PC Ex. 212) p. 2, GAO/RCED-97-63 (NIRS/PC Ex. 213) p. 5, GAO/T-RCED-99-21 (NIRS/PC Ex. 215) p. 2-4, GAO-02-191 (NIRS/PC Ex. 216) p. 19, GAO/T-RCED-93-58 (NIRS/PC Ex. 214) p. 8, GAO-03-593 (NIRS/PC Ex. 217) p. 17, GAO/RCED-92-183 (NIRS/PC Ex. 211) p. 3, and Rowberg 2001 (NIRS/PC Ex. 227) p. CRS-3 and CRS-5]

The average cost increase of these seven programs was 2.6. The smallest increase was 56 percent on the superconducting supercollider; however, this program was abandoned before it was actually

completed and so the final cost increase is not known. The largest cost increase was 368 percent on the Fernald Vitrification Plant, which was abandoned before a single log of radioactive waste was ever processed. If the weighted average of the seven projects is used (weighting by the cost of the individual programs), an average increase of 2.0 times is found. Thus, a contingency of 25 percent for the DOE option would be grossly inadequate to cover the cost increases that could be expected to occur based on DOE's performance over the past two decades. The fact that the Portsmouth deconversion facility was already 12 to 14 months behind schedule as of July 2005 due to problems finalizing the plant design strongly supports the inclusion of a much larger contingency factor than 25 percent for this option.[20]

LES has suggested that the triennial adjustments can be used to take any additional contingencies beyond 25 percent into account. However, as I have testified the triennial adjustments are not meant for large unforeseen contingencies dealing with disposal method or poor performance of the participating parties. Further, the size of the contingency factor to be applied to the DOE estimate requires a considerably more firm baseline estimate based on real-world expenses. This is because a contingency factor for unforeseen costs cannot reasonably be applied to a cost estimate that has not adequately accounted for foreseeable costs. In other words, the inclusion of such a contingency is not a satisfactory means of dealing with the DOE cost estimate testified to by Rod Krich in the deconversion panel. It would be most appropriate for LMI, or another DOE contractor, to redo the analysis in a more realistic fashion taking into account the delays that have already occurred at the Portsmouth facility as well as those that are likely to occur given DOE's actual real-world experience. This new estimate would also have to take into account the results of the NEPA analysis for DU disposal when it is completed so that the cost of a legal and environmentally

[20] Barron 2005 (NIRS/PC Ex. 207).

suitable disposal option could be included. Once this was done, the NRC required minimum contingency factor of 25 percent for unforeseen contingencies could then be added.

Q9. In light of what you have testified to, what is your conclusion for the overall cost of deconversion, transportation, and disposal for the DUF6 that would be produced by the proposed NEF facility?

A9. I have concluded that, if DU is treated in a manner that respects the risks it poses, the likely cost of dispositioning the depleted uranium hexafluoride from the proposed NEF facility would fall between $18 per kilogram of uranium and $24 per kilogram of uranium after taking into account the Board-imposed subtractions from the estimates in our November 2004 and July 2005 report. Unlike the cost estimates in our report, this range of costs does not include (1) any contingency to incorporate the findings from the 1999 Federal Guidance Report 13, from the U.S. Environmental Protection Agency, or the 2005 BEIR VII report from the National Academy of Sciences Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation which show that women have a 52 to 58 percent higher risk of developing cancer than men from the same level of radiation exposure[21] and (2) any costs associated with deconverting the DUF6 to a chemical form other than DU_3O_8 even though alternative chemical forms have been considered or discussed by such agencies as the U.S. Department of Energy, the Lawrence Livermore National Laboratory, the International Atomic Energy Agency, the OECD Nuclear Energy Agency, and the U.S. Nuclear Regulatory Commission.[22] Finally, the $18 to $24 per kilogram of uranium range does not include

[21] EPA FGR 13 (NIRS/PC Ex. 111) p. 179 and 182 and NAS/NRC 2005 (NIRS/PC Ex. 225) p. 28 and 494-95.
[22] See for example DOE 1999 PEIS (LES Ex. 18), LLNL 1997 CA (NIRS/PC Ex. 56), LLNL 1997 EA (NIRS/PC Ex. 55), IAEA/NEA 2001 (NIRS/PC Ex. 186), and Leeds 2000 (NIRS/PC Ex. 248).

any allowance for fabricating the depleted uranium into a waste form more suitable for geologic disposal than U3O8.[23]

In the table below, which is restricted to cost elements allowed by the October 4, 2005 directive of the Board, the "IEER WIPP Disposal Scenario 1" includes a low-end cost estimate for DU disposal based on experience at WIPP and an estimated calcium fluoride dispositioning cost based on the Lawrence Livermore National Laboratory analysis while the "IEER WIPP Disposal Scenario 2" includes a medium WIPP cost estimate and an estimated calcium fluoride cost based on a report from the National Research Council of the U.S. National Academy of Sciences.

Cost element*	IEER WIPP Disposal Scenario 1	IEER WIPP Disposal Scenario 2
Deconversion to U_3O_8, Transportation, and Storage**	$7.10	$7.10
Disposal	$5.40	$8.00
CaF_2 (Neutralization and Disposition)	$2.00	$4.00
Contingency - NRC- minimum required (25 percent)	$3.63	$4.78
Total Cost per kg U	**$18.13**	**$23.88**

* This table is based on Table 9 of the November 2004 report and includes only those cost elements allowed by the October 4, 2005 directive of the Board.[24]
** The cost of deconversion, transportation, and storage were taken from the actual contractual arrangement between Urenco and Cogema in which depleted uranium hexafluoride has changed hands and has been deconverted to DU_3O_8 at the operating Pierrelatte Plant. The contract price of 5.50 euros per kilogram was converted to 2004 dollars by using the exchange rate currently employed by LES ($1.291 per euro).

Our costs are significantly larger than the $5.85 per kilogram of uranium currently proposed by LES ($4.68 per kilogram of uranium plus a 25 percent contingency factor).

[23] For more information see Makhijani and Smith 2004 (NIRS/PC Ex. 190) p. 35-51.
[24] Makhijani and Smith 2004 (NIRS/PC Ex. 190) p. 51.

Q10. Does this conclude your testimony for today?

A10. Yes.

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CERTIFICATE OF SERVICE

Pursuant to 10 CFR § 2.305 the undersigned attorney of record certifies that on October 18, 2005, the foregoing Rebuttal Testimony of Dr. Arjun Makhijani in Support of NIRS/PC Contentions EC-3/TC-1, EC-5/TC-2, and EC-6/TC-3 concerning the Contingency Factor Applicable to LES's Cost Estimate was served by expedited delivery upon the following:

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