Letter/Attachment for GTCC EIS Scoping Comment #135

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Comments of the Institute for Energy and Environmental Research on the Department of Energy's Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste, Federal Register, September 21, 2007

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These are comments of the Institute for Energy and Environmental Research on the proposed scope of the various alternatives to disposal of Greater than Class C (GTCC) radioactive waste and "GTCC-like waste as published by the DOE in its *Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste* and the *Correction* to Table 1.[1] These comments may overlap with verbal comments made by Arjun Makhijani in Washington, D.C. on September 10, 2007. To the extent that they do, these written comments should be used as the final version.

The specific recommendations below for items to be included in the scope of the GTCC EIS are as follows:

→ *In so far as the radionuclides contained in DOE LLW are those listed in Tables 1 and 2 of 10 CFR 61.55, the DOE should explicitly adopt the same definition for "GTCC-like" waste as the definition of GTCC in the NRC's rule at 10 CFR 61.55.*

→ *The NOI should include the DU from DOE's enrichment plants within the scope of its GTCC-like waste for the purpose of its EIS.*

→ *Yucca Mountain should be excluded from the scope of the GTCC Disposal EIS.*

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[1] United States. Department of Energy, "Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste," *Federal Register* **72**, no. 140 (July 23, 2007), pages 40135-40139 and its "Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste: Correction," *Federal Register* **72**, no. 146 (July 31, 2007), page 41819. The page references to the NOI in these comments are to the *Federal Register* page numbers. Referred to hereafter as DOE NOI 2007.

→ *WIPP should be excluded from the scope of the GTCC Disposal EIS.*

→ *Hardened On-site Storage (HOSS) should be included as one of the GTCC management options in the EIS.*

→ *The evaluation of borehole disposal should be based on actual data and analysis of past poor experience with intermediate depth disposal.*

→ *Radiation dose calculations should include separate estimates of doses to males and females in various ages groups from infant on up. Cancer risks should be based on the results of the BEIR VII report. All cancer risks should consider incidence as well as mortality. Non-cancer risks should also be considered.*

1. The scope of the EIS should include a clear definition of "GTCC-like" waste. This definition should be at least as protective as the present definition of GTCC in the Nuclear Regulatory Commission's low-level waste regulation, as defined in 10 CFR 61.55.

The NOI proposes that the EIS should cover both GTCC waste produced by NRC licensees and "GTCC-like" waste produced by the DOE:

> In addition, DOE proposes to include DOE LLW and transuranic waste having characteristics similar to GTCC LLW and which may not have an identified path to disposal (hereafter referred to as GTCC-like waste) in the scope of this EIS. DOE's GTCC-like waste is owned or generated by DOE. The use of the term "GTCC-like" does not have the intent or effect of creating a new classification of radioactive waste.[2]

In so far as the radionuclides contained in DOE LLW are those listed in Tables 1 and 2 of 10 CFR 61.55, the DOE should explicitly adopt the same definition for "GTCC-like" waste as the definition of GTCC in the NRC's rule at 10 CFR 61.55. That rule has already gone through and EIS process. Further the DOE has stated that it "does not have the intent or effect of creating a new classification of radioactive waste." In adopting the recommendation here, the DOE would be giving effect to this intent.

Recommendation 1: In so far as the radionuclides contained in DOE LLW are those listed in Tables 1 and 2 of 10 CFR 61.55, the DOE should explicitly adopt the same definition for "GTCC-like" waste as the definition of GTCC in the NRC's rule at 10 CFR 61.55.

[2] DOE NOI 2007, p. 40135.

2. The scope of the EIS should include depleted uranium (DU) from enrichment plants and define it as "GTCC-like" waste to be managed on a par with NRC-defined GTCC waste.[3]

The Department of Energy has a vast amount of depleted uranium that has resulted from the operation of its three enrichment plants. This DU has not been included in the scope of the proposed EIS. It should be. As is clear from the analysis below, large amounts of depleted uranium from enrichment plants have not yet been given a classification within the NRC low level waste scheme. An operational waste classification for DU from enrichment plants cannot therefore be made based on current NRC rules. The analysis below shows that "GTCC-like" is the appropriate designation. This would mean that the DOE would manage DU from enrichment plants or any other large amounts of DU on a par with GTCC waste.

The classification of depleted uranium from uranium enrichment plants has become an issue in the last dozen years or so in the context of the licensing of new uranium enrichment plants. This is because at the time the low-level waste regulations were promulgated (1982), depleted uranium was still considered a "source material," in the same category as natural uranium. At that time, only the Department of Energy was in possession of a large quantity of depleted uranium hexafluoride tails in the United States.

Some have proposed that DU from enrichment plants be treated as Class A low-level radioactive waste and that it be disposed of in shallow land burial facilities that are licensed to accept such waste. This would be contrary to the current status of DU within the NRC regulations and to the hazard posed by DU.

a. Classification Status of DU

In considering the low-level waste rule in 1981, the U.S. Nuclear Regulatory Commission (NRC) at first proposed including enriched, natural, and depleted uranium within the framework of low-level waste disposal. It proposed a limit of 0.05 microcuries per cubic centimeter (0.05 μCi/cc) for Class A, B, or C waste for DU or natural uranium.[4] This would not have allowed pure depleted uranium in any chemical form to be disposed of as Class A (or B or C) waste. For instance, pure DU_3O_8, the oxide form that is the typical result of proposed deconversion plants, has a specific activity of about 340 nanocuries per gram. At relatively low density of 1.5 grams per cc (a typical density of soil), waste containing DU_3O_8 to a level of 0.05 μCi/cc is equivalent to about 33 nanocuries per gram.[5] In other words, pure DU_3O_8 is about 10 times more radioactive than the maximum that would have been allowed under the draft rule proposed in 1981, for Class A (or B or C) waste, if the draft proposal of the NRC had been adopted in 1981.

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[3] The analysis in this section is large taken from and based on Arjun Makhijani, *Regulatory and Health Protection Considerations in the Re-licensing of the EnergySolutions Low-Level Waste Disposal Facility near Clive, Utah*, report prepared for HEAL Utah, Institute for Energy and Environmental Research, Takoma Park, Maryland, September 21, 2007.

[4] NUREG-0782 1981 Vol. 2, Table 7.2 (page 7-18)

[5] Higher density assumptions would result in a lower maximum allowable concentration per unit weight.

It is clear, therefore, that even at the draft EIS stage, there was no intention of classifying pure DU in any chemical form as either Class A, B, or C waste. **Had the draft rule been finalized without modification, pure DU in any chemical form would have been GTCC waste.**

As it turns out, uranium (depleted, natural, and enriched) was deleted from the low-level waste table in the final rule.

When the NRC issued its final rule and supporting Environmental Impact Statement (EIS) in 1982, the removal of uranium from the list of radionuclides was explained as follows:

> Uranium has been removed as a radionuclide that must be considered for waste classification. The Commission's analysis shows that *the types of uranium-bearing wastes disposed of* do not present a sufficient hazard to warrant limitation on the concentration of this naturally occurring material.[6]

It is clear that the disposal of uranium, other than the small amounts typically disposed of by NRC licensees in 1982, was removed from the purview of the low-level waste rule. Specifically, disposal of large amounts of uranium, including depleted uranium, was removed from the rulemaking. Based on this decision, the results of applying the 10 CFR 61 performance assessment methodology to uranium were not presented by the NRC in the Final EIS covering the low-level waste regulation.

Even though the Department of Energy has not officially reclassified DU as a waste, it has been recognized as a practical matter for some time, including by the DOE, that most of the DU in the DOE inventory will have to be disposed of as a waste. The Nuclear Regulatory Commission recognized this reality during consideration of a license application for a new enrichment plant, called the National Enrichment Facility, filed by Louisiana Energy Services (LES). LES was granted a license to build the plant in June 2006.

The upshot of the LES licensing proceeding is that the status of DU from enrichment plants was recognized as an open question by the NRC. First, the NRC determined that DU is a "low-level" waste as part of the catch-all scheme of classifying everything as low-level waste that does not have another legal classification. The NRC also affirmed that DU contained in waste that was *within the framework of the original rule* could be considered Class A waste, under 10 CFR 61.55(a)(6). That is, small amounts of DU that were typical of those generated by NRC licensees in 1982 could be considered Class A waste. The NRC also specifically excluded DU from enrichment plants from the scope of its order.[7] This is because the environmental impacts of disposal of the large amounts of DU generated by enrichment plants were not examined in the Final EIS for low-level waste. Hence, the Commission ordered the NRC staff to conduct *a separate proceeding.*

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[6] NUREG-0945 1982 Vol. 3, Appendix F, p. 42, emphasis added.

[7] There was no uranium enrichment plant licensed by the NRC at the time. The 2006 license granted to LES was the first such license granted by the NRC.

apart from the LES license proceeding, to determine the class to which large amounts of DU from enrichment plants belong:

> The Commission is aware that in creating the section 61.55 waste classification tables, the NRC considered depleted uranium, but apparently examined only specific kinds of depleted uranium waste streams – "the types of uranium-bearing waste being typically disposed of by NRC licensees" at the time. The NRC concluded that those waste streams posed an insufficient hazard to warrant establishing a concentration limit for depleted uranium in the waste classification tables. Perhaps the same conclusion would have been drawn had the Part 61 rulemaking explicitly analyzed the uranium enrichment waste stream. But as Part 61's FEIS indicates, **no such analysis was done**. Therefore, the Commission directs the NRC staff, outside of this adjudication, to consider whether the quantities of depleted uranium at issue in the waste stream from uranium enrichment facilities warrant amending section 61.55(a)(6) or the section 61.55(a) waste classification tables.[8]

In its brief to the Court of Appeals in the LES case (the intervenors have appealed the granting of the license), the NRC explicitly acknowledged that the classification status of DU from enrichment plants under the low-level waste rule is not settled:

> [T]he Commission expressly acknowledged [in the course of the LES license proceedings] that properly classifying large quantities of DU is an *open question, requiring further study by NRC staff, a study the Commission directed its staff to undertake.*[9]

The fact that this is "an open question" was extensively discussed during the hearing before the federal Court of Appeals in Washington, D.C. on September 7, 2007. The possibility that it could be something other than Class A, including a class that would require deep disposal was discussed. The NRC's counsel acknowledged before the court that both of these contingencies could occur.[10] The NRC staff has yet to begin the study that the Commission ordered it to undertake.

b. Technical Analysis of DU Classification

DU from enrichment plants should be classified as GTCC-like waste in the definition suggested above. Radiological analyses show that disposal at shallow land disposal sites would result in doses far above the maximum allowable limits under 10 CFR 61 Subpart C. The radiochemical and radiological properties of DU are similar to those for GTCC waste except for nomenclature. Under 10 CFR 61.55, waste containing more than 100 nanocuries per gram of long-lived, alpha-emitting transuranic radionuclides are considered GTCC waste. DU fits this description, except for the fact that its atomic number is 92, and hence cannot be called "transuranic" because the latter radionuclides have atomic numbers greater than 92, by definition of the term "transuranic." In other

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[8] NRC CLI-05-20 pages 523, 535-536 (footnotes omitted), emphasis added.
[9] NRC 2007 page 40, emphasis added. .
[10] Court of Appeals 2007

respects DU fits the GTCC category. It consists entirely of long-lived, alpha-emitting radionuclides, as can be seen from Table 1.

Table 1: Radiological properties of U-234, U-238 and selected transuranic radionuclides

Isotope	Main decay mode	Alpha particle energy, MeV	Half-life, years	Comments
Uranium-238	Alpha	4.1	4.46 billion	
Uranium-235	Alpha	4.4	700 million	weak gamma emitter
Uranium-234	Alpha	4.8	245,000	
Neptunium-237	Alpha	4.8	2.14 million	
Plutonium-238	Alpha	5.5	87.7	
Plutonium-239	Alpha	5.1	24,110	
Plutonium-240	Alpha	5.1	6,537	
Americium-241	Alpha	5.5	432	strong gamma emitter

Note: All energies rounded to two significant figures. The alpha-emitting radionuclides emit alpha particles with more than one characteristic energy, with each energy level being produced with a known probability. The alpha particle energy shown is an approximate average of these particles energies, weighted by the emission probability.

The specific activities of various chemical forms of depleted uranium are shown in Table 2. Potential chemical forms for disposal are DUO_2 and DU_3O_8. The NRC staff has proposed the latter.

Table 2: Specific activities of various chemical forms of depleted uranium, TRU waste, and typical uranium ore with 0.2% natural U by weight

Chemical form	Specific activity, nCi/gm
uranium metal (DU)	400
uranium dioxide (DUO_2)	350
uranium oxide (DU_3O_8)	340
transuranic activity in TRU or GTCC waste	>100
0.2% uranium ore	4 (See Note 1)

Notes: 1. The specific activity shown for 0.2% uranium ore includes all decay products of uranium-238 up to and including radium-226, assuming they are in secular equilibrium with uranium-238. Radon-222, and its decay products are not included in this number.
2. All values in the table are rounded to one or two significant figures as indicated.

The risk of internal exposure to DU is greater than that of internal exposure to GTCC waste containing plutonium at the threshold value of 100 nanocuries per gram, as can be seen from Table 3. This is true even without taking any in-growth of the daughter products of uranium-238 into account. The problem increases with time, as the daughter products of U-238 build up in DU. If the build up of uranium-234, thorium-230, and radium-226 is considered, the ratio of the eventual radiotoxicity of DU and its decay products would be over ten times that of GTCC waste containing 100 nanocuries per gram of plutonium-239. It should be noted that Federal low-level waste regulations contain no time limit for maximum permissible dose limits (10 CFR 61 Subpart C).

Table 3: Comparison of mortality risk per Bq and mortality per gm of depleted uranium oxide at secular equilibrium to that of plutonium-239 contained in TRU waste at 100 nCi per gram[11]

	Mortality per Bq Tap Water	Mortality per Bq, Food	Ratio, DU_3O_8 to GTCC at 100 nCi/g, Tap water (See Note)	Ratio of DU_3O_8 to GTCC at 100 nCi/g, Food (See Note)
Uranium-238	1.13E-09	1.51E-09	1.14	1.20
Uranium-234	1.24E-09	1.66E-09	0.23	0.24
total mortality ratio DU_3O_8 to GTCC at 100 nCi/gram			**1.37**	**1.44**
Plutonium-239	2.85E-09	3.63E-09	1	1

Note: The source for the drinking water and dietary mortality factors is EPA Federal Guidance Report 13.[12] The two right most columns show the ratio of the mortality coefficients for uranium-238 and uranium-234 in the proportion in which they are present in DU_3O_8 initially. This table does not include any in-growth of thorium-230 and radium-226. The specific activity of DU is taken as 340 nanocuries per gram, which is the specific activity of DU_3O_8. Of this about 287 nanocuries per gram is attributable to U-238 and the rest to U-234. U-235, which makes a relatively small contribution to the total dose, is ignored for simplicity. The DU_3O_8 is compared to GTCC waste containing Pu-239 at the threshold value of 100 nanocuries per gram.

It should also be noted that quantitative evaluations conducted by the NRC, Sandia National Laboratory, and IEER of shallow land disposal of DU from enrichment plants – that is, for large amounts of DU, carried to the time of peak dose or at least well beyond

[11] Source for Table 3: Makhijani and Smith 2005 Table 4.
[12] FGR 13 1997 pages 102-103

1,000 years, have all concluded that such disposal would cause the dose limits of the low-level waste regulation, 10 CFR 61 Subpart C, to be greatly exceeded.[13]

Recommendation: The NOI should include the DU from DOE's enrichment plants within the scope of its GTCC-like waste for the purpose of its EIS.

3. Yucca Mountain should be excluded from the scope of the EIS.

The licensing of Yucca Mountain even for high-level waste and for spent fuel is open to question. The project is in deep technical trouble. It would complicate its waste acceptance criteria and its performance assessment to include it as one of the alternatives for GTCC disposal. The NOI does not discuss the implications of including GTCC in the scope of Yucca Mountain disposal for the licensing schedule or application process or for repository space and costs. Should Yucca Mountain be licensed, it is not clear whether there will be enough space in it for spent fuel and defense high-level waste. It would complicate both GTCC disposal as well as the Yucca Mountain Project to include it as one of the possible disposal locations for GTCC and GTCC-like waste.

Recommendation: Yucca Mountain should be excluded from the scope of the GTCC Disposal EIS.

4. The Waste Isolation Pilot Plant (WIPP) should be excluded from the scope of the GTCC Disposal EIS.

WIPP is supposed to be dedicated to defense transuranic waste (TRU). Besides the stored TRU waste now designated for WIPP or already disposed of these, the DOE has large volumes of buried TRU waste that should be recovered and packaged. As TRU waste these would be designated for WIPP. It is not clear that there is enough room in WIPP for GTCC waste. Further, a lengthy and costly process of certifying WIPP only for TRU waste would have to be reopened, were WIPP to be designated as the site for GTCC disposal. There is no conceivable justification for spending the time and financial resources on reopening that process.

Recommendation: WIPP should be excluded from the scope of the GTCC Disposal EIS.

5. Hardened On-site Storage (HOSS) should be included as a one of the GTCC management options.

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[13] Makhijani and Smith 2005 and 2005a, and Kozak et al. 1992 pages 19-20. In the first LES case, the NRC's EIS concluded that "Because for near-surface disposal of U_3O_8, projected doses exceed 10 CFR Part 61 limits, a deep disposal site is most likely to be selected for ultimate disposition of depleted uranium. NRC CEC EIS Final 1994, p. A-9. Kozak et al. and the NRC considered wet sites; Makhijani and Smith considered dry sites. The 10 CFR 61 standard was exceeded at all shallow land burial sites, regardless of climate.

As a result of the many costly and lengthy delays in the development of a repository for spent fuel and high-level waste, spent fuel will be stored at reactor sites for decades. Similarly, high-level waste will remain at DOE sites for decades. DU belonging to the DOE will also remain on site for a lengthy period, given that the only reasonable and protective classification (and the only one that is in line with the one implicitly proposed by the NRC in its 1981 draft EIS) is GTCC.

Given the lengthy period of storage and the risk of terrorist attacks, hardening of spent fuel storage is essential for the protection of the public. In fact, such hardening would make it much more unlikely that a terrorist attack on such spent fuel facilities would take place since the consequences of the attack would be minimized.

It makes sense from the point of view of public safety, security, and careful use of taxpayer dollars to also store GTCC and GTCC-like waste in hardened on-site storage.

HOSS should meet the following criteria:

1. It should not result in catastrophic releases and should be able to resist almost all types of attacks. The amount of releases projected in even severe attacks should be small enough that the storage system would be unattractive as a terrorist target.
2. It should be able to withstand a direct hit by a large commercial airliner full of fuel or anti-tank weapons without catastrophic offsite releases.
3. The individual canister and package locations should not be easily detectable from offsite.

As part of the examination of HOSS, the EIS should examine the how the facilities that DOE has built and is using for storage of vitrified high-level waste would perform under the above criteria and what would need to be done (if anything) to harden them sufficiently to meet the above criteria.

Recommendation: Hardened On-site Storage (HOSS) should be included as a one of the GTCC management options in the EIS.

6. Borehole evaluation in the EIS should be based on actual data and analysis of past poor experience with intermediate depth disposal.

Past experience with intermediate depth disposal, for instance, at Oak Ridge, has not been very promising. At Los Alamos, it is unclear if the effects of such disposal are well-understood, since radionuclides, including transuranic radionuclides are migrating in and around the site much faster than anticipated.

The GTCC NOI makes no mention of the process by which intermediate-depth boreholes would be evaluated. The EIS should include explicit criteria for such evaluation that include:

- Consideration of the rapid migration of radionuclides, including transuranic radionuclides, at a variety of sites, including Oak Ridge, Los Alamos, Nevada Test Site, and Idaho National Laboratory.
- Geologic data from the site for which disposal is proposed.

Recommendation: The evaluation of borehole disposal should be based on actual data and analysis of past poor experience with intermediate depth disposal.

7. Radiation dose calculations should include separate estimates of doses to males and females in various ages groups from infant on up. Cancer risks should be based on the results of the BEIR VII report. All cancer risks should consider incidence as well as mortality. Non-cancer risks should also be considered.

The BEIR VII report[14] of the National Research Council concluded that females face a much higher overall risk than males and that children face higher risks than adults. The risk factors for cancer incidence, by sex and age, published in BEIR VII should be used to estimate risks in the GTCC EIS. Non-cancer risks considered in the BEIR VII report should also be evaluated. If any EPA guidance is used it should be EPA Federal Guidance Report 13, and not Federal Guidance Report 11.

We note here that external dose risk factors FGR 13 (and FGR 12) are explicitly based on Reference Man, a hypothetical young "Caucasian" male. The EIS should explicitly reject this model. Dose estimates should be made for the most vulnerable – that is, those most at risk for a given exposure. It is critical in this area therefore to use the BEIR VII report especially for external dose estimates, since it does not suffer from this limitation.

Recommendation: Radiation dose calculations should include separate estimates of doses to males and females in various ages groups from infant on up. Cancer risks should be based on the results of the BEIR VII report. All cancer risks should consider incidence as well as mortality. Non-cancer risks should also be considered.

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[14] BEIR VII 2006

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Return to GTCC EIS Scoping Comments