



# U.S. NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

## NOTE TO FILE: Regarding Attachments Document Date

**DATE:** October 16, 2009

**Name :** Priya Yadav, Project Manager /RA/  
**Department:** Materials Decommissions Branch  
**Division:** DWMEP

**Summary:** Following documents should be added to ADAMS with a date of October 16, 2009.

ADAMS Package No.: ML092890284  
License No.:

Mail Control:  
Docket No.:

**Walker-Smith, Antoinette**

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**From:** Kennedy, James  
**Sent:** Thursday, October 08, 2009 9:07 AM  
**To:** Yadav, Priya  
**Subject:** FW: depleted uranium workshop  
**Attachments:** Uranium Workshop September 2-3 2009.docx; DU workshop presentations.pdf

Priya, I ran into Mike Ryan in the cafeteria this morning and he offered to send this summary of the DU workshop that he participated in, FYI.

Jim

---

**From:** Michael T. Ryan Ph.D., C.H.P [mailto:hpeditor@burkinc.com]  
**Sent:** Thursday, October 08, 2009 8:00 AM  
**To:** Kennedy, James  
**Subject:** FW: depleted uranium workshop

Jim,

As we discussed!

Best regards,

Mike Ryan

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**From:** Hackett, Edwin [mailto:Edwin.Hackett@nrc.gov]  
**Sent:** Wednesday, October 07, 2009 11:38 AM  
**To:** Michael T. Ryan Ph.D., C.H.P  
**Cc:** Flack, John  
**Subject:** RE: depleted uranium workshop

Thanks Mike - looks right on point to me. Thanks for summarizing this for the members. I would recommend working this through John Flack.

Ed

---

**From:** Michael T. Ryan Ph.D., C.H.P [mailto:hpeditor@burkinc.com]  
**Sent:** Tuesday, October 06, 2009 10:39 AM  
**To:** Hackett, Edwin  
**Subject:** depleted uranium workshop

Ed,

Here is what I propose to send to members regarding the DU workshop I attended. Your comments or suggestions are welcome. If you think it is OK please let me know who best ot get it in the record and distributed.

Best regards,

Mike Ryan

Michael T. Ryan Ph.D., C.H.P.  
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October 6, 2009

Note to: ACRS Members

From: Michael T. Ryan, Chairman  
Subcommittee on Radiation Protection and Nuclear Materials

**Subject: NRC Public Workshop 1 on Uranium Waste Streams – Depleted Uranium**

On September 2 and 3, 2009 I attended the subject workshop and participated as a workshop panel member. Attendees included NRC staff, Operators of current LLW disposal facilities in South Carolina and Utah staff, from the DOE waste disposal program and facilities, state regulators from states with LLW sites and representatives from a number of interest groups.

**Outcomes from the meeting were:**

The staff gathered a range of views on the following topics regarding issues related to performance assessment for depleted uranium disposal. These topics included:

- Uranium and Radon
- Uranium Geochemistry
- Scenarios and Receptors
- Period of Performance

**Follow Up Actions**

I plan to continue to follow this activity as it proceeds toward rulemaking.

**Detailed Information**

In the NRC Meeting announcement it was reported:

“Staff Schedules Workshops on Safe Disposal of Depleted Uranium

The Nuclear Regulatory Commission staff has scheduled two public workshops to seek public views on proposed new regulations on shallow-land disposal of unique radioactive wastes, including significant quantities of depleted uranium.

The first workshop will be held next Wednesday and Thursday, September 2 and 3, at the Hyatt Regency in Bethesda. The second will be September 23 and 24, in Salt Lake City Utah.

Last March, the Commission directed the staff to initiate a rulemaking to specify a requirement for a site-specific analysis for the disposal of large quantities of depleted uranium and other unique waste streams, such as reprocessing wastes, and the technical requirements for such an analysis. The Commission also directed the staff to develop a guidance document for public comment that outlines the parameters and assumptions to be used in the site-specific analyses.

The Commission said the staff should conduct a public workshop to discuss issues associated with disposal of depleted uranium and other unique waste streams, potential issues to be considered in rulemaking, and technical parameters of concern in the analysis so that informed decisions can be made in the interim before the rulemaking is final.

In a Federal Register notice published in June, the agency staff announced the workshops and discussed several questions to be addressed at the workshops.”

Additional background information can be found at the links in the text below.

## Unique Waste Streams

*Many links on this page are to documents in Adobe Portable Document Format (PDF). See our [Plugins, Viewers, and Other Tools](#) page for more information. For successful viewing of PDF documents on our site please be sure to use the latest version of Adobe.*

Existing NRC regulations at [10 CFR 61.55](#), "Waste Classification," specify criteria for determining the classification of low-level radioactive waste for land disposal at a near-surface facility. The original development of [10 CFR 61.55](#) did not explicitly consider the impacts resulting from the disposal of unique waste streams such as significant quantities of depleted uranium from the operation of a commercial [uranium enrichment](#) facility. When [10 CFR Part 61](#), "Licensing Requirements for Land Disposal of Radioactive Waste," was initially developed, there were no commercial facilities generating significant quantities of [depleted uranium](#) waste streams. As a result the analysis only considered the types of uranium-bearing waste streams being typically disposed of by licensees at the time. For additional information on the impacts considered in the development of 10 CFR Part 61, see the following documents:

- Draft Environmental Impact Statement on 10 CFR Part 61 Licensing Requirements for Land Disposal of Radioactive Waste ([NUREG-0782](#))
- Final Environmental Impact Statement on 10 CFR Part 61 Licensing Requirements for Land Disposal of Radioactive Waste ([NUREG-0945](#))

Depleted uranium is a source material, in accordance with [10 CFR Part 40](#), "Domestic Licensing of Source Material," and if treated as a waste would fall under the definition of a low-level radioactive waste per [10 CFR 61.55\(a\)](#). The Commission reaffirmed this waste classification in [Memorandum and Order CLI-05-20](#) dated October 19, 2005. Consistent with Commission policy to increase the use of risk assessment technology in all regulatory matters, the NRC staff considered in a screening analysis ([SECY-08-0147](#)), dated October 7, 2008, whether quantities of depleted uranium at issue in the waste stream from commercial uranium enrichment facilities warrant amending [10 CFR 61.55\(a\)\(6\)](#) or [10 CFR 61.55\(a\)](#) waste classification tables.

The Commission directed the staff in a Staff Requirements Memorandum ([SRM-SECY-08-0147](#)), dated March 18, 2009, to pursue a limited rulemaking to specify a requirement for a site-specific analysis and associated technical requirements for unique waste streams including, but not limited to, the disposal of significant quantities of depleted uranium. In pursuing this limited rulemaking, the NRC is not proposing to alter the waste classification scheme. However, for unique waste streams including, but not limited to, significant quantities of depleted uranium, there may be a need to place additional criteria on its disposal at a specific facility or deny such disposal based on unique site characteristics. Those restrictions would be determined via a site-specific analysis, which satisfies the requirements developed through the rulemaking process.

On June 24, 2009, the NRC announced in the [Federal Register](#) [EXIT](#), [74 FR 30175](#), that it is seeking early public input on major issues associated with potential rulemaking for land disposal of unique waste streams including, but not limited to, significant quantities of depleted uranium in near-surface, low-level radioactive waste facilities. NRC staff will host public workshops in Rockville, Maryland on September 2-3, 2009, and in Salt Lake City, Utah on September 23-24, 2009 to discuss issues associated with rulemaking. An agenda for the public workshops will be noticed on the NRC [Public Meeting Schedule](#) no later than 10 days prior. Written comments on the issues discussed at the workshops may be submitted at ([Regulations.gov](#) [EXIT](#)) under Docket ID [NRC-2009-0257](#) [EXIT](#).

**AGENDA**  
**NRC Public Workshop 1 on Unique Waste Streams - Depleted Uranium**  
 (see Federal Register 74 FR 30175)  
 September 2-3, 2009  
 Hyatt Regency Bethesda  
 One Bethesda Metro Center, 4800 Wisconsin Avenue  
 Bethesda, MD 20814

**Wednesday, September 2, 2009**

**Speaker**

8:00 – 8:45 am	Registration	
8:45 – 9:15 am	Facilitator Opening Comments Participant Introductions	C. Cameron, NRC
9:15 – 9:30 am	Context: NRC Welcome & Overview	L. Camper, NRC/FSME <sup>1</sup>
9:30 – 9:45 am	Context: NRC Rulemaking Process	G. Comfort, NRC/FSME
9:45 – 10:00 am	Break	
10:00 – 10:45 am	<b>Site-Specific Performance Assessment and NRC Depleted Uranium Technical Analysis Overview</b>	D. Esh, NRC/FSME
10:45 ~ 12:00 noon	<b>Issue 1: Significant Quantities of Depleted Uranium</b> <b>Issue 1.1: Definition of Significant Quantities</b> Introduction Round Table Discussion Public Comments <sup>2</sup>	D. Esh, NRC/FSME Panel Members All Participants
12:00 ~1:00 pm	Lunch	
1:00 – 2:15 pm	<b>Issue 1.2: Time Period of Performance for a Site-specific Analysis</b>  Introduction	  D. Esh, NRC/FSME
2:15 – 3:30 pm	<b>Issue 1.3: Exposure Scenarios for a Site-specific Analysis</b> Introduction	D. Esh, NRC/FSME
3:30 – 3:45 pm	Break	
3:45 – 4:30 pm	<b>Issue 1.4: Source Term Issues for a Site-specific Analysis</b> Introduction	K. Pinkston, NRC/FSME

<sup>1</sup> Office of Federal and State Materials and Environmental Management Programs (FSME)

<sup>2</sup> All agenda topics will allow for an introduction, roundtable discussion, and public comments



Preliminary; 8/21/09

PARTICIPANTS LIST  
U.S. NRC WORKSHOP ON DEPLETED URANIUM  
HYATT REGENCY BETHESDA  
ONE BETHESDA METRO CENTER  
BETHESDA, MD, SEPTEMBER 2D, 3D, 2009

Robert Alvarez (invited)  
Yakama Nation representative  
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U.S. Department of Energy  
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Representative TBD

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Transcripts for the Bethesda workshops are attached:



Workshop 1 Day 1  
Transcript.pdf



Workshop 1 Day 2  
Transcript.pdf

Slides are attached to this report separately.

## Walker-Smith, Antoinette

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**From:** Gelles, Christine [Christine.Gelles@em.doe.gov]  
**Sent:** Tuesday, August 11, 2009 3:40 PM  
**To:** McKenney, Christopher  
**Cc:** Yadav, Priya; Tonkay, Douglas; dawn.gillas@srs.gov; Senderling, Mark  
**Subject:** FW: FW: Follow up questions on SRS DU Shipments to EnergySolutions Clive

Christopher

Please see the blue text below. It provides the information that I obtained from the SME in the field, Ms. Dawn Gillas. She is the project manager for this effort. I don't know that we answered all of your questions as thoroughly as you would like. This was what we were able to get together somewhat on the fly yesterday. If you need more, let me know, and we'll do our best to help you. We at DOE want to be sure we are working closely with NRC as you move into these public meetings.

Thanks,  
Christine

-----Original Message-----

From: McKenney, Christopher [mailto:Christopher.McKenney@nrc.gov]  
Sent: Thursday, August 06, 2009 11:12 AM  
To: Gelles, Christine  
Cc: Yadav, Priya; Bubar, Patrice; Suber, Gregory; Pinkston, Karen; Esh, David; Grossman, Christopher  
Subject: Follow up questions on SRS DU Shipments to EnergySolutions Clive

Ms. Gelles,

I was forwarded your response below from Patty and Priya and I have a couple of additional questions. The answers to these questions would allow us at NRC to be better prepared to answer questions at both NRC's upcoming public workshops and other venues. Obviously at the NRC public workshop we would likely ask DOE to field any specific questions on the SRS DU shipments; however in one-on-one discussions and other venues where DOE may not be immediately available, answers to the following questions would be extremely helpful.

1) Is the average concentration and range of concentrations of DU per drum for the 5th Campaign known? If so, what are they?

The material is essentially pure depleted uranium trioxide powder with small amounts of Pu (parts per trillion) and fission products all of which are well within the WAC for a Class A waste stream. It is very hygroscopic and thus carries on the order of 4% water that makes the material clump. The contents of the drums within this 5th campaign are very consistent in concentration and form (throu. The only real difference could be in the particle size - some is finer than others - but chemically it is very consistent.

2) What is the total activity of DU across the 5th Campaign?

A rough calc based on the last campaign shows that we will ship ~3150 Ci of DU in this final campaign.

3) If available, how does the answers to 1 and 2 compare with the previous 4 campaigns?

The material in this campaign is basically identical to the previous campaign. All the DU came from the same historical processes. If you need the total activity of the previous campaigns (b/c the # of drums varied), please let us know... and I'll request that information from the site.

Christopher McKenney, Chief  
Performance Assessment Branch

Environmental Protection and  
Performance Assessment Directorate  
Division of Waste Management and  
Environmental Protection  
Office of Federal and State Materials  
and Environmental Management Programs

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[Christopher.McKenney@nrc.gov](mailto:Christopher.McKenney@nrc.gov)<<mailto:Christopher.McKenney@nrc.gov>>

Website: <http://www.nrc.gov/waste.html>

-----  
Priya and Patty

Thanks for the time today.

Thanks for asking the question on the SRS DU, because it prompted to me to make a call that yielded a lot of valuable information that I really needed to have in any case.

Here's the gist: 14,600 drums make up the last of the SRS DU inventory that will be disposed. The original inventory was 35,800 drums. Four previous shipping/disposal campaigns have been conducted since 2003. Campaign 1 - in 2003: 3,270 55 gallon drums were disposed at Clive. In the 2005/2006 timeframe, another approximate 7,000 containers -- these were 85 gallon overpacks -- were disposed at Clive. In November 2008, 5,408 drums (I think 55's) were disposed at Clive. Also in Fall 2008, 4,015 containers were shipped to NTS in Sealand containers for disposal.

This 5th campaign, as currently planned, will be completed in 3 shipments to Clive. The first train (52 cars) would leave in late October. Takes considerable time to turnaround the rail cars, so, the 2nd (52 cars) shipment won't be until the until after the holidays/worst winter weather - in March. The 3rd shipment (about 48 cars) could happen in April.

The DU was generated as a byproduct by SRS' Pu production activities in the F Canyon. It is a legacy inventory - and some of it was probably generated as long ago as the 70's. It's currently stored in two different locations -- N Area and F canyon. D&D of portions of the F Canyon are funded by the Recovery Act, which is what has this on the near term shipping plan.

I hope this answers the questions.

## **Walker-Smith, Antoinette**

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**From:** Cameron, Francis  
**Sent:** Tuesday, September 29, 2009 2:25 PM  
**To:** Yadav, Priya  
**Subject:** FW: REVISION Fwd: Arjun Makhijani's DU meeting (Sept 2-3, 2009) own minutes - attached  
**Attachments:** NRC meeting on DU Sept 2-3 2009 - notes of Arjun Makhijani 21sept09 REV-1.pdf

Priya - I guess we can circulate these to the group

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**From:** Lois Chalmers/IEER [mailto:lois@ieer.org]  
**Sent:** Tuesday, September 22, 2009 10:51 AM  
**To:** Cameron, Francis  
**Subject:** REVISION Fwd: Arjun Makhijani's DU meeting (Sept 2-3, 2009) own minutes - attached

Dear Chip:

Yesterday I sent you a file called: NRC meeting on DU Sept 2-3 2009 - notes of Arjun Makhijani 21sept09.pdf.  
Today I send REVISED file called: NRC meeting on DU Sept 2-3 2009 - notes of Arjun Makhijani 21sept09 REV-1.pdf.

The revised version is now up on the web at <http://www.ieer.org/comments/DU-NRCmeeting2009sept2-3-notes.pdf>. (This now says published on 22 September 2009).

Arjun had meant to remove one sentence and remembered after I had gone home last night.

Sorry for the confusion.

Lois

Date: Mon, 21 Sep 2009 17:19:17 -0400  
To: Francis Cameron <[francis.cameron@nrc.gov](mailto:francis.cameron@nrc.gov)>  
From: Lois Chalmers/IEER <[lois@ieer.org](mailto:lois@ieer.org)>  
Subject: Arjun Makhijani's DU meeting (Sept 2-3, 2009) own minutes - attached

Dear Chip:

Arjun asked me to send you the links to IEER's LES reports for Dr. Esh and Dr. Pinkston and also a the copy of his notes on the two day meeting on Unique Waste Streams.

The transcripts posted by the NRC are very helpful. We will also post Arjun's notes to ieer.org.

The LES reports:

[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 \(2004\) PDF 418kB](#) [Update to this report \(2005\) PDF 861kB](#)

by Arjun Makhijani, Ph.D. and Brice Smith, Ph.D.

Reports prepared for the Nuclear Information and Resource Service and Public Citizen. Redacted versions for public release.

<<http://www.ieer.org/reports/du/lesrpt.pdf>> and <<http://www.ieer.org/reports/du/LESrptupdate.pdf>>

Thanks very much for all your help.

Lois

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**The NRC's September 2-3, 2009, workshop on Depleted Uranium Waste Rulemaking**  
**Arjun Makhijani's notes**  
Published on 22 September 2009

The NRC held a two day workshop on a proposed change in the low-level waste disposal regulation, 10 CFR 61.55, to accommodate large amounts of depleted uranium (DU) from uranium enrichment plants and other "unique" waste streams. I participated in this workshop, at the invitation of the U.S. Nuclear Regulatory Commission (NRC). The proceedings were transcribed. The transcript and slide presentations have been posted on the NRC's website.<sup>1</sup>

The reader should remember that these are my notes on the workshop discussion. They include my notes on what was said as well as my own observations and conclusions. Others will undoubtedly have their own conclusions. The last section represents my conclusions alone.

The notes are preceded by some background information. The NRC is preparing its own minutes of the meeting, which will be published. The NRC staff expressed the hope that these minutes would be available before the next workshop in Salt Lake City, to be held on September 23 and 24, 2009.

NRC staff person Chip Cameron, who moderated the workshop, said that the conclusions of the workshops would be brought to the attention of the Commissioners. Public comment on the course of the rulemaking is open until October 30, 2009.

**A. Background**

In March 2009, the Commission directed the staff to proceed in a rather specific investigation pursuant to a recommendation in an October 2008 NRC staff paper, SECY-08-0147.<sup>2</sup> That staff paper was prepared pursuant to a Commission finding three years prior, in October 2005, known

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<sup>1</sup> The transcripts, slide presentations, and background documents are available on the NRC's web page: *Unique Waste Streams*, at <http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html>. The Transcripts are hereafter cited as NRC DU meeting transcript, September 2, 2009 and NRC DU meeting transcript September 3, 2009.

<sup>2</sup> R.W. Borchardt (Executive Director for Operations), to the Commissioners [of the NRC], *Response to Commission Order CLI-05-20 Regarding Depleted Uranium, Rulemaking Issue, SECY-08-0147*, October 7, 2008, on the Web at <http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2008/secy2008-0147/2008-0147scy.pdf>.

as CLI-05-20,<sup>3</sup> that large amounts of depleted uranium had not been analyzed in the low-level waste Environmental Impact Statement (EIS), which, in turn, was prepared a decade-and-a-half earlier. The present low level waste classification scheme, specified in regulations at 10 CFR 61, is derived from the EIS analysis. The Commission's recognition of the fact that the EIS did not contain an analysis of the impacts of disposal of large amounts of depleted uranium, such as those from uranium enrichment plants, was a determination long sought by intervenors in enrichment plant proceedings, first during a proposed plant in Louisiana in the 1990s (which was never built) and then during the license proceedings for the National Enrichment Facility, which is being built in New Mexico. The Commission's order, CLI-05-20, came in that context and the October 2008 staff paper, SECY-08-0147, was prepared as a result.

SECY-08-0147 developed four options:

- *Option 1:* This would follow a January 2005 Commission finding<sup>4</sup> that DU was low-level waste within the meaning of the low-level waste regulations, but without further sub-categorization of DU within the Class A, B, C, and Greater Than Class C scheme. Option 1 would publish guidance stating that whatever disposal method was adopted, a demonstration of compliance with the radiation protection part of the low-level waste rule (10 CFR 61 Subpart C) would be required. Licensees proposing to dispose of DU could not assume that it would be Class A low-level waste. Such a classification for DU from enrichment plants has been suggested by the nuclear industry in the past in the context of enrichment plant licensing proceedings, whereas IEER has argued that DU is akin to GTCC waste and should be classified as such within the low-level waste rule.
- *Option 2:* SECY-08-0147 did some generic analysis, based on a model that has not been published, and a number of assumptions, indicating that shallow disposal of DU was (i) unsuitable at humid sites, and (ii) may be suitably disposed of, if meeting the requirements of 10 CFR 61 Subpart C, at arid sites, even if the period of performance (dose estimation) is extended to one million years. This is the order of magnitude of time at which a peak dose from DU disposal might be expected. Since shallow land disposal was indicated to be unsuitable at some sites, and may be suitable at others, Option 2 was to modify 10 CFR 61.55(a)(6) to allow disposal of large amounts of DU and other "unique" waste streams by adding a new paragraph to the disposal rule. This new paragraph, to be numbered 61,55(a)(9) would require a site specific analysis for shallow land disposal of such waste streams. Disposal of such waste at low-level waste sites (including those licensed only for Class A waste) would be allowed if the site specific analysis met the performance objectives of the low-level waste regulation, specified at 10 CFR 61 Subpart C.
- *Option 3:* This option would be to analyze the characteristics of large amounts of DU to determine its classification within the Class A, B, C, or GTCC framework. This would

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<sup>3</sup> U.S. Nuclear Regulatory Commission, *Memorandum and Order, In the Matter of Louisiana Energy Services, L.P. (National Enrichment Facility) Docket No. 70-3103-ML, CLI-05-20, October 19, 2005, on the Web at <http://www.nrc.gov/reading-rm/doc-collections/commission/orders/2005/2005-20cli.pdf>.*

<sup>4</sup> U.S. Nuclear Regulatory Commission, *Memorandum and Order: In the Matter of Louisiana Energy Services L.P. (National Enrichment Facility), CLI-05-05, January 18, 2005, on the Web at <http://www.nrc.gov/reading-rm/doc-collections/commission/orders/2005/2005-05cli.pdf>.*

essentially amount to filling the gap left behind by the omission in the low-level waste Final EIS.

- *Option 4:* This option would be to go back to the drawing board and reevaluate the whole low-level waste classification framework, “using updated modeling and performance assessment techniques to evaluate and revise the existing waste classification tables for all radionuclides, if necessary, not just for DU.

In March 2009, after reviewing SECY-08-0147, the Commissioners chose Option 2:

Previously, in the adjudicatory proceeding for the Louisiana Enrichment Services (LES) license application, the Commission determined that depleted uranium is properly classified as low-level radioactive waste. Although the Commission stated that a literal reading of 10 CFR 61.55(a)(6) would render depleted uranium a Class A waste, it recognized that the analysis supporting this section did not address the disposal of large quantities of depleted uranium. Outside of the adjudication, the staff was tasked to evaluate this complex issue and provide specific recommendations to the Commission. SECY-08-0147 is the result of the Commission’s direction and provides recommendations for a path forward.

As an initial approach to addressing this complicated issue, the Commission has approved the staff’s recommended Option 2 to 1) proceed with rulemaking in 10 CFR Part 61 to specify a requirement for a site-specific analysis for the disposal of large quantities of depleted uranium (DU) and the technical requirements for such an analysis; and 2) to develop a guidance document for public comment that outlines the parameters and assumptions to be used in conducting such site-specific analyses.<sup>5</sup>

However, the vote was not unanimous. Commissioner Jaczko, who has since been appointed the Chairman of the NRC, voted against Option 2, having earlier stated his preference for Option 3:

In my original vote on SECY-08-0147, I approved Option 3 (determine classification for depleted uranium within existing classification framework) and I disapproved the staff’s recommendation for Option 2 (rulemaking to specify requirement for site-specific analyses for the disposal of large quantities of depleted uranium). Since that vote, which was dated November 3, 2008, more information has come to light that I would like to address in my vote.

The disposal of large quantities of depleted uranium (DU) is a unique challenge because, unlike typical low-level waste, the doses increase over time rather than decrease. The technical analysis included with SECY-08-0147 indicates that additional requirements are likely needed for disposal of large quantities of DU in order to protect public health and safety; for example, increased waste disposal depth or robust radon barriers may be required. However, Option 2 does not explicitly change the classification of DU as presently provided for in 10 CFR 61.55 and therefore the waste would remain classified as Class A. I do not

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<sup>5</sup> Annette L. Vietti-Cook (Secretary [of the Commission]), Memorandum to R. W. Borchardt (Executive Director for Operations), *Staff Requirements – SECY-08-0147 – Response to Commission Order CLI-05-20 Regarding Depleted Uranium*, Nuclear Regulatory Commission, March 18, 2009, on the Web at <http://www.nrc.gov/reading-rm/doc-collections/commission/srm/2008/2008-0147srm.pdf>.

believe that it is logical to argue that that waste that requires additional requirements for disposal (similar to those required for Class C waste) can still be labeled as Class A waste.<sup>6</sup>

## **B. Arjun Makhijani's workshop notes**

There were three broad topics discussed;

1. Narrow rule changes for disposal of large amounts of DU from enrichment plants and from other waste streams, since DOD and DOE have non-enrichment DU waste streams.
2. A long term process for a "risk-informed" review of low-level waste regulations.
3. Other "unique" waste streams besides DU that are not now covered explicitly in the low-level waste rules.

Most of the discussion was on the first topic.

### *1. NRC staff presentations on the Commission's order and SECY-08-0147.*

#### a. Larry Camper

The initial NRC staff presentation was by Larry Camper, who noted that only small quantities were considered in the low-level waste EIS: about 6 metric tons were considered at a concentration of 0.05 microcuries per cc. Large amounts of DU were a new issue.

He stated that DU is currently Class A waste by default since it captures all radionuclides not specified explicitly in 10 CFR 61.55. As regards performance assessment for demonstrating compliance with 10 CFR 61 Subpart C, he stated that it was a "living tool."

#### b. Dr. David Esh

Dr. Esh reiterated that large amounts of DU were not analyzed in the final low level waste EIS: the draft of that EIS only considered 17 curies of U-238 (about 5 metric tons of pure depleted uranium or about 6 metric tons of DU in oxide form by my calculation) or 3 curies of U-235. This amount of DU is far lower than the amounts produced by uranium enrichment plants. Dr. Esh laid out some of the technical details of the modeling of disposal of large amounts of DU that form the basis of the analysis in SECY-08-0147, which was the technical background to the Commission's (divided) decision to pursue Option 2.

The following are features of the analysis:

- It considers sites in various climatic zones, but is not site specific.

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<sup>6</sup> *Commissioner Jaczko's Revised Comments on SECY-08-0147 Response to Commission Order CLI-05-20 Regarding Depleted Uranium*, March 6, 2009, on the Web at <http://www.nrc.gov/reading-rm/doc-collections/commission/cvr/2008/2008-0147vtr.pdf>. See pdf pages 7 and 8.

- It assessed doses for one million years – the approximate period during which the decay products of U-238, the main ingredient of DU, continue to build up. This approximates a peak dose calculation.
- As radium-226 builds up over thousands of years, radon-222 emissions increase. Radon-222 doses were included in the analysis. A clay layer that would inhibit radon migration was included. Given the assumption of no erosion, this layer would essentially stay intact over a million years.
- Shallow burial (defined as less than 30 meters depth) at various depths was considered.
- Chronic intruder as well as offsite resident doses were considered.
- Various exposure pathways were considered.
- Both air and water induced erosion were assumed to be zero for one million years.
- An ad hoc model, consisting of a commercial Monte Carlo package and an in-house spreadsheet was developed.
- The dose assessment was based on TEDE, which is Total Effective Dose Equivalent (defined as the sum of deep external dose and committed effective dose equivalent for internal dose).
- For the offsite resident a 25 millirem TEDE dose limit was applied as the performance objective. For the chronic intruder who builds a house above the disposal site, a 500 millirem dose limit (TEDE) was applied as the performance objective.<sup>7</sup>

The following limitations of the analysis should be noted (most came up during the presentations or the discussion):

- Climate change was not considered – that is, a constant climate was assumed for one million years.
- Colloidal transport of radionuclides was not included.
- The clay barrier to radon migration into a home built over or near the disposal area was assumed to stay intact over a million years (e.g., no cracks would develop that may allow more migration of radon into the house).
- Changes to the chemical form of uranium over one million years were not considered.
- Disposal in above-ground structures, such as those used by EnergySolutions at its Clive, Utah, site, was not analyzed.
- Organ doses, which are required under 10 CFR 61 Subpart C to be limited (25 millirem per year to any organ except for 75 millirem to the thyroid) were not evaluated.

The results were as follows:

- Using the TEDE approach, the analysis concluded that shallow land burial, less than 3 meters deep, was not suitable for DU, except for “small quantities” defined as 1 to 10 metric tons.<sup>8</sup>

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<sup>7</sup> It should be noted that 10 CFR 61 requires assurance that an inadvertent intruder be protected after institutional control expires, but does not specify a dose limit. 10 CFR 61.42 states in its entirety: “Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.” A figure of 500 mrem per year is often used for performance assessment.

<sup>8</sup> SECY-08-0147 2008, Enclosure 1, p. 16.

- Disposal of DU in large amounts at humid sites “with viable water pathways is probably not appropriate.”<sup>9</sup>
- For disposal at 5 meters or deeper, up to 30 meters, SECY-08-0147 concluded that disposal at arid sites could meet performance criteria:

Depleted uranium can be disposed of under arid conditions and meet the Part 61 performance objectives for 1,000 to 1 million years performance periods, if the waste disposal depth is large, or robust barriers are in place to mitigate radon.<sup>10</sup>

There were also other technical presentations on details of some issues. Specifically, there was consideration of:

- Site specific geochemistry issues
- Site specific radon issues

These were presented by Dr. Karen Pinkston.<sup>11</sup>

Finally, there were legal and regulatory framework discussions on topics such as:

- What changes should be in the rule versus what should be just in the guidance document.
- Compatibility between federal regulations and regulations adopted by Agreement States. This is connected to the question of guidance and rule changes.

## *2. Discussion*

There were invited panelists around the table as well as members of the public who were asked for comment. Invited panelists included other federal government entities (DOE, DOD), state regulators, representatives of waste companies (EnergySolutions and Waste Control Specialists), academics, consultants, and NGO representatives. Diane D’Arrigo and Arjun Makhijani were present representing Nuclear Information and Resource Service and IEER, respectively.

### a. Performance issues – 10 CFR 61 Subpart C

SECY-08-0147 concluded that shallow land burial (at five meters or more) of large amounts of DU could meet the performance criteria of 10 CFR 61 (see above). However, the analysis does not actually correspond to the performance criteria in 10 CFR 61, which requires an organ dose annual limit of 25 millirem (except for the thyroid, which has a 75 millirem limit).<sup>12</sup> For instance, the bone surface dose from drinking water contaminated with lead-210 (a decay product of radon-222) is more than 30 times bigger than the committed whole body dose.<sup>13</sup>

<sup>9</sup> SECY-08-0147 2008, Enclosure 1, p. 16.

<sup>10</sup> SECY-08-0147 2008, Enclosure 1, p. 16. Emphasis in the original.

<sup>11</sup> Slides were co-authored by Karen Pinkston and Christopher Grossman.

<sup>12</sup> 10 CFR 61.41 (2008)

<sup>13</sup> Lead-210 would be inhaled since it is present in the air as a result of radon-222 seepage into a house. It is a decay product of radon-222. Dose conversion factors in these comments are from EPA’s *Federal Guidance Report 13*, supplement CD published in 2002.

Similarly, the bone surface dose from ingestion of U-238 (the main radionuclide in DU) is about 16 times bigger than the committed effective dose equivalent. When I asked about why the performance assessment was not according to the criteria in 10 CFR 61 Subpart C, Dr. Esh stated that the NRC staff had used a “modern” approach and used TEDE as the performance criterion:

Primarily because in more recent evaluations; in particular, for waste incidental to reprocessing, we have had direction from the Commission to use more modern methods, instead of those old methods. So we followed that direction.<sup>14</sup>

I pointed out that human beings still have organs, and Subpart C requires organ dose calculations, so it is not a question of modern methods of calculation or not, but whether Subpart C was on the table and whether the Commission had authorized it to be on the table in this particular proceeding rather than the long-term proceeding to review the whole low-level waste rule. Dr. Esh’s answer indicates that somewhere, in some document, the Commission had indeed given direction to the staff to not calculate organ dose but only the TEDE. I have been unable to find any such direction. On the contrary, SECY-08-0147 itself sets out to show whether compliance with 10 CFR 61 Subpart C can be achieved with shallow land burial:

The technical analysis addressed whether amendments to § 61.55(a) are necessary to assure large quantities of DU are disposed of in a manner that meets the performance objectives in Subpart C of 10 CFR Part 61.<sup>15</sup>

The issue of changing the dose criteria or ignoring organ doses or “modern methods” of dose calculation does not appear at all in either SECY-08-0147 or the Commission’s decisions and orders. As part of this discussion, Dr. Esh explicitly stated that the NRC was not proposing to modify Subpart C.<sup>16</sup>

Yet, a review of the numbers and results in SECY-08-0147 leads me to conclude that its conclusion that shallow land burial could in some cases meet the 10 CFR 61 performance criteria is premature at best, since the analysis did not actually address a critical aspect of those criteria. Indeed, the graphs for resident doses (Figures 7a and 7b) in SECY-08-0147 indicate that doses to the most exposed organs could very well exceed 25 millirem per year over the period of performance evaluated (one million years). In effect, the staff eliminated an essential performance criterion and the Commissioners made their decision to pursue Option 2 based on a potentially false reassurance that shallow land burial could meet the regulatory performance criteria of Subpart C under some circumstances, even if the shortcomings of the analysis are ignored.

Other participants indicated that Subpart C may need to be on the table in this rulemaking. The facilitator, Mr. Chip Cameron, stated in summing up the discussion that

I think we know that Subpart C could be on the table in this proposed rule....<sup>17</sup>

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<sup>14</sup> NRC DU meeting transcript, September 2, 2009, p. 104.

<sup>15</sup> SECY-08-0147 2008, p. 1.

<sup>16</sup> NRC DU meeting transcript, September 2, 2009, p. 105.

<sup>17</sup> NRC DU meeting transcript, September 2, 2009, p. 237.

Dr. Esh raised a question as to whether the regulatory limit for radon dose for an intruder from DU disposal could be set at a small fraction of natural radon dose. An industry representative stated that exposure scenarios should be site specific. For instance, water at the EnergySolutions Utah site is saline and so it is unreasonable to assume that anyone would drink it.

An industry representative suggested that the radon standard should not be dose based. Rather the same standard as is now applied to mill tailings could be used.

I argued for a federal NRC specification of the general types of scenarios to be considered, with common sense constraints. In the absence of this, states may allow exclusion of even realistic scenarios, such as hunters going on to the site.

I asked whether the performance part of the low-level waste rule was on the table in this proceeding. The indicated answer both in regard to the dose limits and period of performance was that it was indeed on the table. I suggested that in that case the NRC should go back to the drawing board and publish a new notice in the *Federal Register* stating the 10 CFR 61 Subpart C was going to be revised.

#### b. Is the analysis conservative?

SECY-08-0147 and its Enclosure 1, state that the staff developed a “screening model” to do a “screening analysis” whose purpose “was to evaluate key variables such as disposal configurations (disposal depth and barriers), performance periods, institutional control periods, waste forms, site conditions, pathways, and scenarios.”

I asked whether the term “screening” was being used to indicate a conservative analysis – that is an analysis that would give an upper bound for the dose estimate, so that one could be reasonably assured that a more realistic analysis would yield a lower dose estimate. In other words, such a screening analysis would lead to an assurance that the conclusion that DU could be disposed of in shallow land burial and meet specified performance criteria was robust.

Dr. Esh indicated that the term screening was not used in that sense in the paper. He agreed with the suggestion that the screening model in SECY-08-0147 “wasn’t conservative.”<sup>18</sup>

#### c. Climate and long-term modeling

The failure to consider erosion and climate change are among the non-conservative elements in the NRC staff analysis. Dr. Peter Burns, a geoscientist from the University of Notre Dame, noted that climate projections cannot be relied on for 10,000 or 100,000 or 1 million years. As an example he stated that Death Valley was deep under water 10,000 years ago. There was also wider discussion on the problems of modeling for long time frames and the period for which performance would be evaluated (see below). The terms “silly” and “silliness” came up in the context of trying to describe attempts to model shallow land burial for a million years, but it was

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<sup>18</sup> NRC DU meeting transcript, September 2, 2009, p. 83.

suggested by the moderator, Chip Cameron, that this was perhaps not the best language to use in a regulatory context.<sup>19</sup>

#### d. Geochemistry

Shallow land burial above the water table with a soil cover for the waste is by its nature an oxidizing environment. Uranium can be quite mobile over the long term in such an environment, especially if it is also humid. A reducing environment for DU disposal could be created by choosing the right chemical form and providing reducing engineered barriers. Three factors need to be considered together in any assessment:

- The waste form,
- The nature of the engineered barriers, and
- The geology of the site.

In this context, Peter Burns noted that using existing sites would pose problems. It would be a better solution to take a fresh site and match the waste form to the geology.

It should be noted that the generic analysis in SECY-080-0147 did not do the analysis in this way since it was admittedly a generic rather than site-specific analysis and since no chemical changes to the form of the uranium were taken into account. Dr. Burns pointed out that some clay deposits in Tennessee that are now mined for various purposes, such as use in food additives, appeared to be very stable and might provide a natural analog for future investigations.

#### e. Stability and erosion

The analysis in SECY-08-0147 assumed that the site would be stable for the period of performance evaluated – that is, for one million years. Zero erosion was assumed for this period. This is one of the non-conservative aspects of the analysis. Zero fluvial or aeolian erosion means that there would be no uncovering of the waste and direct external radiation dose would therefore be low. There would be essentially no dose from radium-226, a powerful gamma emitter, since this was assumed to remain well below the surface and therefore shielded.

The analysis did not consider disposal in above-ground structures, which, by their very nature are vulnerable to fluvial and aeolian erosion over long periods of time.

Further, the assumption of long term cover stability means that there would be no large cracks that would develop in the clay, for instance, through wet and dry cycling especially in periods of extreme weather conditions. Such cracks would greatly enhance the mobility of the radon through the clay cover and hence greatly increase doses to a resident at the site boundary or to an intruder with a house above the disposal location.

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<sup>19</sup> NRC DU meeting transcript September 2, 2009, at various places in pp. 98 to 116 and also pp. 185, 195, and 251.

#### f. Long term modeling of shallow land disposal

The above factors all point to the problem of modeling DU disposal in shallow land burial facilities over long periods of time. Dr. Burns pointed out that there was no way in which one could show quantitatively that there would not be a problem with shallow land disposal over periods like one-and-a-half million years. There was no dispute on this point from the NRC staff.

#### g. Period of performance

My impression was that the following was generally agreed regarding DU and long-term performance assessment

- Uncertainties become very large over periods as long as 10,000 to one million or more years,
- Modeling shallow land burial over periods as long as a million years or more appeared infeasible quantitatively, and
- The main radiological problems in dry areas other than those that might be associated with uncovering the waste, appear over the long term (thousands of years or more), presuming the areas remain dry.

There was considerable discussion of what to do as a result of the above realities. Precedents were discussed. Yucca Mountain standard is the only one that goes out to a million years. The WIPP standard (40 CFR 191) requires performance assessment for 10,000 years. Tailings for 1,000 years. (40 CFR 192) There was also a comment that beyond 100 years the performance has to be assessed in the context of intruders. There was a suggestion, from Bill Dornsife of WCS, that an endpoint of dose for radon may not be suitable and that a mill tailings standard of radon emanation rate might be considered instead.<sup>20</sup>

Industry representatives, among others, wanted a limitation on period of performance – that is, the period over which doses would be estimated. This would evidently bypass the difficulty that scientifically defensible modeling shallow land disposal for a period corresponding to peak radiation dose from DU disposal appears to be unfeasible.

However, a difficulty with such an approach is that 10 CFR 61 Subpart C does not contain a time limitation. There is therefore a requirement to protect whoever is most exposed in the future in a manner that does not exceed the dose limits specified there.

Limiting the period of performance would mean a change to 10 CFR 61 Subpart C. I suggested that instead of doing that, the NRC consider adopting the modeling approach of the French high-level waste rule. That rule recognizes that the uncertainties increase greatly beyond 10,000 years. But instead of changing the dose performance standard, it changes the method by which the modeling is done:

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<sup>20</sup> NRC DU meeting transcript, September 2, 2009, p. 251.

- For up to 10,000 years, the uncertainties in the parameters are specified explicitly and probability distributions are provided. This gives a realistic set of estimates of what the performance would be, assuming the parameters are well characterized.
- Beyond 10,000 years the conservative, fixed values are used for parameters so as to calculate an upper limit of the dose. The same dose reference number is maintained but now we have what would be a bounding value for the long term, presuming the upper bound parameters: climate, geological, and others can be specified in a scientifically defensible way.

I provided a copy of the French regulation to the NRC staff and also to the DOE staff.

The staff's position in SECY-08-0147 is possibly along these lines, though more ambiguous:

Considering the technical aspects of the problem, the performance assessment staff recommends a performance period of *10,000 years* for the analysis of *DU* disposal. However, analyses should be performed to peak impact, and if those impacts are significantly larger than the impacts realized within 10,000 years, then the longer term impacts should be included in the site environmental evaluation.<sup>21</sup>

It is unclear from this whether or not the staff proposes to require that the requirements of 10 CFR 61 be met up to the peak time of dose.

#### h. Existing and interim waste disposal

DOD, DOE, as well as private disposal companies have been disposing of some DU. They may also want to dispose of DU from enrichment plants in the interim – that is, before a rule for that waste stream is finalized. The question arose as to whether such disposal would be “grandfathered in” or would the waste have to be dug up if prior disposal did not conform to the rule. There was considerable sentiment from several quarters that it should be grandfathered in.

I pointed out that the DOE was recovering buried waste at a transuranic waste site in Idaho. This waste had been disposed of prior to the creation of a TRU waste category in 1970, but now is being recovered anyway.

#### i. Classification of DU

This tangled issue came up again. Larry Camper of the NRC staff said that DU was Class A waste. This derives from 10 CFR 61.55(a)(6) that states that waste not specifically defined in the tables of the rule is Class A. However, the whole proceeding for rulemaking is happening because the NRC recognized in October 2005 that the final EIS for low-level waste had not analyzed large amounts of DU for disposal. I repeatedly asked Mr. Camper whether he considered DU from enrichment plants as Class A waste. He did not directly reply, but repeated that DU was Class A waste.

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<sup>21</sup> SECY-08-0147 2008, Enclosure 1, p. 21. Emphasis in original.

### i. The Rights of Agreement States

States that regulate civilian nuclear licensees under agreement with the NRC (“Agreement States”) are required to meet a complex set of “compatibility” requirements to ensure that NRC requirements are being met. The regulation and enforcement is done at the state level in such cases. But the NRC has the responsibility to ensure that there is compliance with applicable federal regulations. There was a presentation on compatibility issues in regard to DU disposal. One important procedural issue is what items should be in the new rule and what items should be in the guidance. The industry and state regulator sentiment is for the NRC to give the maximum possible leeway to state authorities. States can generally set more conservative standards than those at the federal level.

I expressed concerns as to whether there was adequate oversight regarding the two sites that may, in the near future, dispose of DU from enrichment plants – Utah (EnergySolutions site) and Texas (WCS site). Specifically, I raised the issue of whether the NRC was adequately exercising its oversight responsibilities. I had raised the same issue during my testimony as an expert witness for the intervenors in the National Enrichment Facility licensing case.

Specifically, I found that some of the results of the modeling done in a performance assessment underlies the EnergySolutions license contained physically impossible numbers. For instance, more uranium-238 was proposed to be disposed of per gram of Utah soil than the weight of the Earth. I was asked whether I was comfortable with the State of Texas agreeing to a DU concentration limit for the WCS site. I said that the last time I looked at the WCS issue, which was four years ago, I was not convinced that WCS was even qualified to receive radioactive waste – since, among other things, their license application at that time proposed to dispose of more U-235 as waste than had ever been mined.

If the NRC and the state of Utah have failed to require a correction of such evident scientific problems, even though they have been formally put on the table, how could one be confident of the process for licensing and enforcing DU disposal regulations?

I also pointed out that IEER has done the only independent site specific analysis of DU disposal by shallow land burial for the WCS site and of a site with parameters corresponding to the Utah site. Our analysis had shown that doses would be exceeded at both sites by large margins in well under one million years and in most cases on times scales on the order of 10,000 years. I was told, informally, that NRC staff would look into the record of the LES proceeding. In response, I told them I would supply the IEER LES reports to the staff. IEER has sent the URLs for the reports to the moderator, Chip Cameron.<sup>22</sup>

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<sup>22</sup> IEER’s LES reports: Arjun Makhijani and Brice 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*, Institute for Energy and Environmental Research, Takoma Park, MD, November 24, 2004, and the *Update* to this report, July 5, 2005. Redacted versions for public release are on the Web at <http://www.ieer.org/reports/du/lesrpt.pdf> and <http://www.ieer.org/reports/du/LESrptupdate.pdf>.

#### k. Other issues

There was some discussion of whether there should be a discussion of what “significant” quantities of DU were. Some suggested that this was not needed, if performance was going to be the key.

A number of other issues were discussed, including defining what other “unique” waste forms there might be. There seemed to be a general agreement that there was no point in trying to define “unique” waste forms at this time.

It was also stated that it would not be appropriate to try to consider reprocessing waste streams as part of the current rulemaking.

#### l. Overall low-level waste rule changes

The commission is currently on a path to a two-step low level waste rulemaking. The first is for large amounts of DU and other “unique” waste forms that may allow shallow land disposal if a site specific analysis shows compliance with performance criteria. The second would be a revamping of the whole low-level waste rule on a “risk-informed” basis. It was not clear to me from the meeting discussion whether the revamping of the rule would be retroactively applied.<sup>23</sup> Some statements from the NRC staff indicated that the rule change would not be retroactive. But other statements were more ambiguous.

### **C. Bottom lines for Arjun Makhijani**

1. There was some excellent technical discussion during the workshop. I appreciate that and learned a great deal.
2. Doing quantitative analysis of shallow land burial over a period of a million years is not reasonable. Yet the NRC staff did it.
3. The NRC staff’s assumptions are admittedly not conservative. Some of the assumptions, such as no erosion, no chemical changes in an oxidizing environment, site stability, and no climate change for a million years are not scientifically defensible. While the word “silliness” that was used to describe the modeling assumption in regard to climate was later retracted, it seems to me that it is perhaps the most apt term under the circumstances. Whatever the term, the Commission based its decision (with one dissenting vote) on an analysis that has several scientifically indefensible assumptions in it. This indicates to me that the process should start over, with a defensible modeling exercise.
4. The Commission asked only that a revision to 10 CFR 61.55(a)(6) be considered – a new paragraph 10 CFR 61.55 (a)(9) would be added requiring site specific analysis for DU disposal. SECY-08-0147 states that

The technical analysis addressed whether amendments to § 61.55(a) are necessary to assure large quantities of DU are disposed of in a manner that meets the performance objectives in Subpart C of 10 CFR Part 61.

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<sup>23</sup> See, for instance, NRC DU meeting transcript September 2, 2009, pp. 49-51.

However, as a matter of fact, the technical analysis did not estimate organ doses and therefore failed to address whether disposal of large amounts of DU would meet the requirements of Subpart C of 10 CFR 61. It is quite possible that, even without any other changes, evaluation of organ doses would materially change the conclusions of the paper. It is therefore also possible that Commission's decision may also have been different.

5. ***A change to the performance standard – either for period of performance (no limit now) or for dose (25 millirem to the whole body per year, or 25 millirem to the most exposed organ, except 75 millirem to the thyroid) was not proposed in the present rulemaking. Yet it seems clear that revisions to the performance criteria are being considered both in regard to period of performance and dose limits. This is inappropriate. If such revisions are to be considered, the rulemaking must be started all over again, with a proper notice of the extent of the proposed rule changes.***
6. While a change in performance standards is not appropriate in the context of this limited rulemaking, since it was not included in the description of the rulemaking by the NRC, I do think that it is reasonable to define the way modeling is done beyond 10,000 years. In this regard, the French high-level waste regulation seems appropriate. In other words, the dose limits 10 CFR 61 should be maintained, and the indefinite time period should also be maintained, but modeling approach can be modified beyond 10,000 years to take account of much greater uncertainties.
7. All said and done, there was no scientific material at the workshop that would cause IEER to revisit its conclusion, based on lengthy analysis, including site-specific analysis, that DU should be classified as Greater Than Class C waste under 10 CFR 61.55. On the contrary, all of the evidence, including that put forth by the NRC staff as explanations of their modeling as well as other expert discussion from invited participants confirmed that DU is not suitable for shallow land burial.
8. Prior to the workshop, IEER asked for the model that was used in SECY-08-0147 before the workshop, but was refused. During the workshop Larry Camper stated that the model was not subject to the Freedom of Information Act since it was used for a pre-decisional matter. However, he stated that he would see what he could do to release as much material as possible to IEER. I appreciate the spirit of openness in which that commitment was made. IEER will keep the public informed if and when it receives the model and/or model-related materials.

**Walker-Smith, Antoinette**

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**From:** Esh, David  
**Sent:** Tuesday, October 13, 2009 1:56 PM  
**To:** dck@senes.com  
**Cc:** John Tauxe; Grossman, Christopher; Pinkston, Karen; McKenney, Christopher; Yadav, Priya  
**Subject:** Workshop follow-up - Radon DCF

David,

We really appreciated your input at the workshop. You made direct and very helpful comments and observations.

I wanted to follow-up on a question that you had asked during the workshop. You had asked what dose conversion factors we had used for radon, and I had responded that we used the values from FGR-11 and FGR-12 reports. As you were probably aware, FGR-12 has radon DCF's but FGR-11 has zero values. I had not built that part of the calculation and had misspoke. The text below is from the staff member who was responsible for that part of the calculation. Hope this answers your question better than I did at the workshop.

Regards,

Dave

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The value we used in the DU GoldSim model for inhalation was 1.35e-8 Sv/Bq and 0 for ingestion. For inhalation see the calculation below. Direct DCFs came directly from FGR12 for water immersion, air submersion, soil depths of 1cm and 15 cm.

**INHALATION DCF ESTIMATE CALCULATION:**

We used the occupational ALI for Rn222 from 10 CFR 20, App. B, Table 1, Col. 2. The value was 1e2 microCurie (with daughters present). The value is 1e4 microCurie (with daughters removed). We presume that the "with daughters" the table refers to include the very short-lived daughters (e.g., Po-218...Po-214) and not the longer-lived daughters (e.g., Pb-210, Po-210). We specifically accounted for the two longer-lived daughters mentioned, but not the very short-lived daughters which were rolled up into Rn222. If the ALI also includes those longer lived daughters, then we may have been conservative with our DCF for Rn222.

$$5 \text{ rem} = 1e2 \text{ microCurie} : 0.05 \text{ rem/microCurie} * (1e6 \text{ microCurie/Curie}) * (\text{Sievert}/100 \text{ rem}) * (\text{Curie}/3.7e10 \text{ Sievert}) = 1.35e-8.$$

We kept the two decimal places which should have been dropped for use in the model given the significant figures in the underlying "data".

David W. Esh, PhD  
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11545 Rockville Pike  
Rockville, MD 20852  
(301) 415-6705  
(301) 415-5390 (fax)

**Walker-Smith, Antoinette**

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**From:** Grossman, Christopher  
**Sent:** Wednesday, July 22, 2009 5:36 PM  
**To:** 'lois@ieer.org'  
**Cc:** 'Chip Cameron'  
**Subject:** 10 CFR Part 61 Background Documents  
**Attachments:** RE: FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification; Fwd: FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification

Lois-

Listed below are several documents that should provide the background information Dr. Makhijani requested through Chip Cameron on June 17, 2009 (request e-mail attached), regarding the analyses supporting the initial development of 10 CFR Part 61. The documents listed below are referenced in NUREG-0782, Appendix G (1981), which summarizes the analysis performed at that time. The documents are available via the NRC Agencywide Documents Access and Management System (ADAMS) in the Electronic Reading Room at the NRC public website - <http://www.nrc.gov/reading-rm/adams.html>. The documents can be accessed in ADAMS by searching on the ADAMS Accession Numbers listed with each document:

NUREG/CR-1759, "Data Base for Radioactive Waste Management Review of Low-Level Radioactive Waste Disposal History," Vol. 1-3.

ADAMS Accession Numbers: Vol. 1, ML092010353; Vol. 2, ML091870523; Vol. 3, ML092010352

NUREG/CR-1005, "A Radioactive Waste Disposal Classification System," Vol. 1-2.

ADAMS Accession Numbers: Vol. 1, ML091870288; Vol. 2, ML091870287

NUREG-0456, "A Classification System for Radioactive Waste Disposal - What Waste Goes Where?"

ADAMS Accession Number: ML091870289

Christopher J. Grossman  
Systems Performance Analyst  
Performance Assessment Branch  
Division of Waste Management and Environmental Protection  
Office of Federal and State Materials and Environmental Management Programs  
U.S. Nuclear Regulatory Commission

**Walker-Smith, Antoinette**

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**From:** Grossman, Christopher  
**Sent:** Wednesday, July 01, 2009 5:43 PM  
**To:** 'Chip Cameron'  
**Cc:** Yadav, Priya; McKenney, Christopher  
**Subject:** RE: FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification

Chip-

FYI. I contacted Lois over at IEER tonight to let her know we got her request through you and are working on getting several documents that should address their request regarding the analyses for the classification system. The documents have to be printed from microform and scanned into ADAMS so we can send electronic copies. They have been printed and are to be scanned within the next 10 days (I'd estimate).

Chris

-----Original Message-----

**From:** Chip Cameron [mailto:fxcameo@gmail.com]  
**Sent:** Tuesday, June 30, 2009 8:16 AM  
**To:** priya.yatev@nrc.gov; Grossman, Christopher  
**Cc:** Cameron, Francis  
**Subject:** Fwd: FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification

Priya, Chris:

A request from Arjun Makajani's group - we need to talk about how to accommodate

Chip

----- Forwarded message -----

**From:** Cameron, Francis <Francis.Cameron@nrc.gov>  
**Date:** Thu, Jun 18, 2009 at 1:08 PM  
**Subject:** FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification  
**To:** Chip Cameron <fxcameo@gmail.com>

**From:** Lois Chalmers/IEER [mailto:lois@ieer.org]  
**Sent:** Wednesday, June 17, 2009 3:35 PM  
**To:** Cameron, Francis  
**Cc:** Arjun Makhijani  
**Subject:** NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification

Chip Cameron  
cell = 240 205 2091

Dear Chip:

Thanks so much for getting back to me. Attached are the pages associated with Table 7.2 on Waste Classification from NUREG-0782 v2 1981 Draft EIS LLW (my scanned pages attached).

Arjun would like background documents, models, computer runs, especially concerning uranium.

Thanks so much for getting back to me. Please let us know what questions you might have concerning this request.

Lois

Ms. Lois Chalmers  
Librarian  
Institute for Energy and Environmental Research (IEER)  
6935 Laurel Avenue, Suite 201  
Takoma Park MD 20912 U.S.A.  
Phone: 1-301-270-5500; Fax: 1-301-270-3029  
e-mail: [lois@ieer.org](mailto:lois@ieer.org)  
website: <http://www.ieer.org>

=====

**Walker-Smith, Antoinette**

---

**From:** Chip Cameron [fxcameo@gmail.com]  
**Sent:** Tuesday, June 30, 2009 8:16 AM  
**To:** priya.yatev@nrc.gov; Grossman, Christopher  
**Cc:** Cameron, Francis  
**Subject:** Fwd: FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification  
**Attachments:** NUREG-0782 v2 1981 Draft EIS LLW pp.7-17 to 7-21.pdf

Pruiya, Chris:

A request from Arjun Makajani's group - we need to talk about how to accommodate

Chip

----- Forwarded message -----

**From:** Cameron, Francis <Francis.Cameron@nrc.gov>  
**Date:** Thu, Jun 18, 2009 at 1:08 PM  
**Subject:** FW: NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification  
**To:** Chip Cameron <fxcameo@gmail.com>

**From:** Lois Chalmers/IEER [mailto:lois@ieer.org]  
**Sent:** Wednesday, June 17, 2009 3:35 PM  
**To:** Cameron, Francis  
**Cc:** Arjun Makhijani  
**Subject:** NUREG-0782 v2 1981 Draft EIS LLW - Table 7.2 on Waste Classification

Chip Cameron  
cell = 240 205 2091

Dear Chip:

Thanks so much for getting back to me. Attached are the pages associated with Table 7.2 on Waste Classification from NUREG-0782 v2 1981 Draft EIS LLW (my scanned pages attached).

Arjun would like background documents, models, computer runs, especially concerning uranium.

Thanks so much for getting back to me. Please let us know what questions you might have concerning this request.

Lois

Ms. Lois Chalmers  
Librarian  
Institute for Energy and Environmental Research (IEER)  
6935 Laurel Avenue, Suite 201

Takoma Park MD 20912 U.S.A.  
Phone: 1-301-270-5500; Fax: 1-301-270-3029  
e-mail: [lois@ieer.org](mailto:lois@ieer.org)  
website: <http://www.ieer.org>

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**Draft**  
**Environmental Impact Statement**  
on 10 CFR Part 61 "Licensing  
Requirements for Land Disposal  
of Radioactive Waste"

Main Report

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**U.S. Nuclear Regulatory  
Commission**

Office of Nuclear Material Safety and Safeguards

September 1981



Section 7.4 only  
pp. 7-17 to 7-21

radionuclides, a better approach would be to establish inventory limits on a site and facility specific basis for those nuclides that are important with respect to ground-water migration.

In the previous analysis in Chapter 5, the NRC staff has identified three isotopes which are both long lived and mobile. That is, the isotopes move with the approximate speed of the ground water and ion exchange has relatively little effect to retard movement. These isotopes include C-14 (5,730 year half-life), Tc-99 ( $2.12 \times 10^5$  year half-life), and I-129 ( $1.7 \times 10^7$  year half-life). These isotopes have been identified as those contributing the principal long-term ground-water impacts. Tritium has also been identified as an isotope resulting in potentially significant ground-water impacts. Although it is relatively short lived (12.3 year half-life), it has the highest leach factor of the radionuclides considered in the analysis and has a retardation factor equal to 1 (moves with the speed of ground water). In addition, tritium composes the largest inventory of all the radionuclides disposed in the reference disposal facility. As shown in Chapter 5, impacts due to migration of tritium are almost totally observed close to the disposal facility, and it is the most significant contributor to exposures at the boundary well. Farther away from the disposal facility--e.g., at the population well and surface water access location--the ground-water migration time is such that tritium decays to the point that it is not a particular problem.

For these four isotopes, NRC staff believes that each disposal facility should be analyzed on a case-by-case basis and based on the analysis, inventory limits established for each facility that should not be exceeded.

In addition, the analyses in Chapter 5 also identified the fact that the presence of certain chemicals (e.g. chelating agents) in large concentrations in waste increased the potential for migration of radionuclides. Small quantities of these agents contained in waste do not significantly increase the potential for migration. Large single or multiple shipments, however, could affect the long-term ground-water impacts. To address these aspects, wastes containing chelating agents in relatively large amounts (defined by NRC to exceed 0.1% by weight) should be disposed of only upon prior approval of the Commission. This will enable site specific consideration of the increased potential for migration that disposal of these chemicals at the site might present.

#### 7.4 FINAL CLASSIFICATION

This section presents the final classification of waste for near-surface disposal based upon consideration of the previous three sections of this chapter. This classification is presented as a list of radionuclides in Table 7.2. In the table, Column 1 lists the maximum concentrations ( $\mu\text{Ci}/\text{cm}^3$ ) for "Class A segregated waste." Above these concentrations, the waste must be placed into a stable waste form and disposed in a segregated manner from unstable waste, and so becomes "Class B stable waste." Column 2 presents a list of concentrations above which the Class B stable waste becomes "Class C intruder waste." That is, these wastes must be in a stable waste form, segregated from unstable waste forms, and also disposed with a barrier to an intruder. This barrier

Table 7.2 Waste Classification Table

Isotope	Column 1 Maximum Concentration for Class A Segregated Waste. Above This, It Is Class B Stable Waste $\mu\text{Ci}/\text{cm}^3$	Column 2 Concentrations Above Which Some Wastes Become Class C Intruder Waste $\mu\text{Ci}/\text{cm}^3$	Column 3 Maximum Concentration For Any Waste Class $\mu\text{Ci}/\text{cm}^3$
Any with half-life less than 5 years	700	70,000	Theoretical maximum specific activity
H-3	40	$10^8$	Theoretical maximum* Specific Activity
C-14	0.8	0.8	0.8*
Ni-59	2.2	2.2	2.2
Co-60	700	70,000	Theoretical maximum specific activity
Ni-63	3.5	70	70
Nb-94	0.002	0.002	0.002
Sr-90	0.04	150	700
Tc-99	0.3	0.3	0.3*
I-129	0.008	0.008	0.008*
Cs-135	84	84	84
Cs-137	1.0	44	4600
Enriched Uranium	0.04	0.04	0.04
Natural or Depleted uranium	0.05	0.05	0.05
Alpha-emitting transuranic isotopes			10 nCi/g
Pu-241			350 nCi/g

\*Near-surface disposal facilities will be limited to a specified quantity for the disposal site. This quantity will be determined at the time the license is issued and will be governed largely by the characteristics of the site.

For isotopes contained in metals, metal alloys, or permanently fixed on metal as contamination, the values above may be increased by a factor of ten, except natural or depleted uranium which can be the natural specific activity.

For isotopes not listed above, use the values for Sr-90 for beta-emitting isotopes with little or no gamma radiation; the values for Cs-137 for beta-emitting isotopes with significant gamma radiation; and the values for U-235 for alpha-emitting isotopes other than radium.

Wastes containing chelating agents in concentrations greater than 0.1% are not permitted except as specifically approved by the Commission.

For mixtures of the above isotopes, the sum of ratios of an isotope concentration in waste to the concentration in the above table shall not exceed one for any waste class.

Concentrations may be averaged over the volume of the package. For a 55-gallon drum, multiply the concentration limits by 200,000 to determine allowable total activity.

Until establishment and adoption of other values or criteria, the values in this table (or greater concentrations as may be approved by the Commission in particular cases) shall be used in categorizing waste for near-surface disposal.

could take many forms (e.g., concrete covers), but the minimum acceptable barrier would be disposal so that a minimum of 5 meters of earth or lower activity (Class B) waste, or a combination thereof, separates the waste from the potential inadvertent intruder. Other types of barriers would also be considered on a case-by-case basis.

Column 3 presents a list of radionuclide concentrations above which the waste would generally not be considered suitable for near-surface disposal. Wastes which exceed this concentration would need to be disposed of by disposal methods providing greater protection against potential intrusion. These methods could include much deeper disposal, mined cavity disposal, or special engineered disposal techniques. As noted in Chapter 2, NRC plans to address these other methods in subsequent rulemaking actions.

As discussed in Section 7.1, NRC also considered the use of a specially designed and engineered near-surface disposal facility (a "hot waste" facility) for disposal of wastes containing radionuclides in concentrations exceeding those listed in Column 3. NRC has not listed these concentrations because at this time staff believes that there are some uncertainties involved in use of such a facility and the volume of waste which could require disposal by this method would be small. NRC staff would prefer to address use of this potential disposal method on a case-by-case basis. From the analysis performed, however, the NRC staff believes that such an engineered disposal method would be suitable for wastes containing higher (than Column 3) concentrations of relatively short-lived isotopes such as Cs-137, Sr-90, or Ni-63. The additional long-term protection from longer-lived isotopes would be negligible.

Waste form requirements for the three classes of waste are presented in Table 7.3. These requirements were developed based upon the analyses in Chapters 4 through 6, and can be separated into minimum requirements and stability requirements. The minimum requirements are principally meant to help assure operational safety during handling and disposal, and should be met by all waste classes. The stability requirements are to be met by Classes B and C and are mainly intended to help provide long term structural stability and to minimize potential for inadvertent intrusion into and migration from Class B and Class C waste. In addition, each package of waste must be labeled to identify whether it is Class A, B or C waste and the total activity of H-3, C-14, I-129 and Tc-99 must be shown in the shipping manifest to enable the site operator to maintain an inventory of these isotopes disposed of at each site.

Alpha-emitting transuranic isotopes with a half life greater than 5 years are limited to 10 nCi/gm for near surface disposal. For Pu-241, which is a beta emitter and decays to Am-241, a limit of 350 nCi/gm is established.

As shown on the table, there is no upper limit on the allowable concentration of any isotope with a half-life under 5 years, H-3, or Co-60. The calculated limits exceed the natural specific activity of the isotopes. For isotopes with half-lives less than 5 years in Columns 1 and 2, NRC staff have used the concentration limits for Co-60. This is believed to be conservative, since Co-60 emits two energetic gamma rays. As discussed earlier, there is little cause for concern for potential intruder impacts for isotopes with half-lives less

Table 7.3 Waste Form and Packaging Requirements in Accordance with Waste Classification

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Minimum Requirements for all Waste Classes

1. The waste must be packaged and the waste form and packaging must meet all applicable transportation requirements of the Commission set forth in 10 CFR Part 71 and of the Department of Transportation set forth in 49 CFR Parts 171-179, as applicable.
2. Wastes must not be packaged for disposal in cardboard or fiberboard boxes.
3. Waste containing liquids must be packaged in sufficient absorbent material to absorb twice the volume of the liquid.
4. Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.
5. Waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste.
6. Wastes must not be pyrophoric. Pyrophoric materials contained in wastes shall be treated, prepared, and packaged to be nonflammable.
7. Wastes in a gaseous form must be packaged at a pressure that does not exceed one atmosphere at 20°C. Total activity must not exceed 100 curies per container.
8. Wastes containing biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard.

Stability Requirements for Classes B and C

1. Waste must have structural stability. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal. A stable waste form will maintain its physical dimensions within 5% and its form, under the expected disposal conditions of compressive load of 50 psi, and factors such as the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Stability is intended to assure that the waste does not degrade and promote slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.
  2. Liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free-standing noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste.
  3. Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.
-

than 5 years. For example, and as shown in Section 7.2, the calculated limits for Fe-55, which has a 2.6 year half-life, exceeded the natural specific activity of the isotope in all columns. The principal reason for inclusion of classification limits is to help provide some additional operational safety during handling and disposal.

Other considerations are discussed below.

#### 7.4.1 Limits for Ground-Water Migration

The concentration limits in the three columns were established based upon consideration of impacts to a potential inadvertent intruder. The NRC staff also believes that ground-water impacts are of critical importance but recognizes the extremely site-specific nature of ground-water migration and potential impacts. In addition, ground-water impacts are a function of the total inventory of particular radionuclides at the disposal facility, and it is difficult to convert this total inventory to concentration limits. Therefore, NRC has adopted a different approach for ground-water migration.

Based on the analyses in Chapter 5 and as discussed in Section 7.3, four isotopes were identified that are most important with respect to groundwater impacts. For these isotopes--H-3, C-14, Tc-99, and I-129--NRC staff believes that it would be most workable to analyze each disposal facility on a case-by-case basis. Depending upon the specific environmental conditions of the disposal facility, as well as the particular design of the disposal facility, a maximum site inventory of these radionuclides would be derived for the particular site. Then, a running inventory of these isotopes from waste delivered to the disposal facility would be maintained. This will also require special consideration by waste generators for the reporting of these isotopes.

#### 7.4.2 Isotopes Not on List

The table lists 11 isotopes having half-lives over 5 years, natural, depleted and enriched uranium, plus transuranic radionuclides. These are believed to generally cover many, if not most, of the longer-lived radionuclides currently delivered to any disposal facility. Of the hundreds of radioactive isotopes that have been identified, most have half-lives in the range of days or less and only about 100 have half-lives exceeding 5 years. Many of these isotopes are so exceedingly long-lived--e.g., K-40 ( $1.26 \times 10^9$  year half-life), Pt-190 ( $6.9 \times 10^{11}$  year half-life), Re-187 ( $4.3 \times 10^{10}$  year-half life)--or occur in such small abundances that development of classification limitations is not believed to be of high priority.

However, it is recognized that there are several isotopes--particularly those of heavy metals such as thorium, lead, or radium--for which concentration limits should be developed. Others may also be identified. Development of concentration limits for such radionuclides are planned subsequently. In the meantime, some working concentration limits should be considered for isotopes not presently analyzed. For these, the NRC staff believes a reasonable, yet conservative, rule of thumb would be the following:

**Walker-Smith, Antoinette**

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**From:** Esh, David  
**Sent:** Tuesday, August 25, 2009 7:47 AM  
**To:** Grossman, Christopher; Pinkston, Karen; Yadav, Priya; McKenney, Christopher  
**Subject:** FW: Barnwell Source Material Inventory  
**Attachments:** Barnwell Source Material Inventory 082009.pdf

FYI

-----Original Message-----

**From:** Bill House [mailto:WBHOUSE@energysolutions.com]  
**Sent:** Thursday, August 20, 2009 12:49 PM  
**To:** Susan Jenkins; Esh, David  
**Cc:** Richard Haynes; Mark Yeager; Joseph Still  
**Subject:** Barnwell Source Material Inventory

Good Afternoon Folks,

Attached is a memo and table providing information on the source material inventory at Barnwell. Let us know if you have any questions.

bh

-----Original Message-----

**From:** Bill House  
**Sent:** Wednesday, August 05, 2009 2:06 PM  
**To:** Susan Jenkins; David Esh  
**Cc:** Richard Haynes; Mark Yeager; Joseph Still  
**Subject:** RE: FW: Reports of DU disposed of at Barnwell, Clive, andUS Ecology

Thanks, Susan,

We are trying to categorize the DU (source material) values to be able to provide more information than just a total number of source pounds.

Jimmy Still and Cliff are sorting it out as best they can, at least into general categories by waste type / form.

Thanks for your patience. bh

-----Original Message-----

**From:** Susan Jenkins [mailto:JENKINSE@dhec.sc.gov]  
**Sent:** Wednesday, August 05, 2009 1:36 PM  
**To:** David Esh  
**Cc:** Richard Haynes; Mark Yeager; Bill House  
**Subject:** Re: FW: Reports of DU disposed of at Barnwell, Clive, andUS Ecology

Dave,

To my knowledge the report has not been generated yet. We will be sure to provide the information to you when available.

Thanks,

Susan

>>> "Esh, David" <David.Esh@nrc.gov> 8/4/2009 3:52 PM >>>

Hi Susan and Bill,

I got this task as Chris Grossman is out on paternity leave. When the information is generated can you please send it to me? If it has already been sent, can it be forwarded to me?

Thanks,

Dave

-----Original Message-----

From: Pinkston, Karen

Sent: Tuesday, August 04, 2009 3:33 PM

To: Esh, David

Subject: FW: Reports of DU disposed of at Barnwell, Clive, and US Ecology

-----Original Message-----

From: Grossman, Christopher

Sent: Friday, July 31, 2009 4:34 PM

To: Pinkston, Karen

Subject: FW: Reports of DU disposed of at Barnwell, Clive, and US Ecology

-----Original Message-----

From: Susan Jenkins [mailto:[JENKINSE@dhec.sc.gov](mailto:JENKINSE@dhec.sc.gov)]

Sent: Tuesday, July 21, 2009 4:56 PM

To: Yadav, Priya

Cc: Richard Haynes; Andrew H (DOH) Thatcher; Gary (DOH) Robertson; [WBHOUSE@energysolutions.com](mailto:WBHOUSE@energysolutions.com);

Grossman, Christopher; Dane Finerfrock

Subject: Re: Reports of DU disposed of at Barnwell, Clive, and US Ecology

Good afternoon all,

Bill House, VP of Regulatory Affairs with Energy Solutions/Chem-Nuclear Systems has agreed to provide information for such disposals at the Barnwell Site in accordance with your request. The Department has volume numbers for disposals of source material but does not have those numbers broken down. Bill should be able to provide more detailed data, however, it will take some time and effort to compile the data.

If you wish, you may contact Bill directly at:

office: 803-758-1809

cell: 803-530-2821

e-mail: [wbhouse@energysolutions.com](mailto:wbhouse@energysolutions.com)

or you may work through our Department.

Bill plans to attend the DC Meeting and possibly the Salt Lake City Meeting.

Richard Haynes, our Director, will be attending the DC meeting, however I will not as I have other travel plans within that relative time period. We will be glad to provide any assistance we can.

Thanks,  
Susan

>>> "Yadav, Priya" <[Priya.Yadav@nrc.gov](mailto:Priya.Yadav@nrc.gov)> 7/20/2009 11:19 AM >>>

We are collecting some information in preparation of the workshops about DU that has been disposed of at your licensee's sites. Can you please forward to us any reports you have of quantities of DU that have been disposed of in terms of DU, U235 and U238? If you don't have access to such reports, can you direct us to where we can find this info? Please contact Chris Grossman (301-415-7658) with any questions and copy him on your responses.

Thanks,

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)



## Barnwell Licensing Department

**Date:** August 19, 2009 LC-107-09-JJS  
**To:** Bill House  
**From:** Jimmy Still *J. Still*  
**Subject:** Barnwell Source Material Inventory

EnergySolutions has performed a search of our computerized waste tracking system for waste shipments received at the Barnwell Waste Management Facility containing source material. Source material waste shipments received at the facility consist of U-238, Depleted Uranium (DU) and Th-232. The results of this search are described herein.

In 1996, when the current waste tracking database was initially set up the source material data for wastes disposed from 1971 to 1996 was recorded as source pound amounts; associated radionuclides were not identified. Source pound data for shipments received in 1997 and forward can be extracted by source pounds and the individual radionuclides. DU typically was recorded in the system as U-238.

To determine if the source pound radionuclides were DU/U-238 and not Th-232 and to quantify the percentages of source pounds to waste types, we reviewed microfilmed shipment manifests of various waste generators that shipped source material to the Barnwell facility. Since there are thousands of shipments containing source material, a limited number of manifests were selected for review. Manifests were selected based on the types of generators, the amount of source material received per generator, and personal knowledge of the types of wastes shipped for disposal. Review of manifests revealed that several waste generators shipped the same type of source material wastes over large numbers of shipments. For example, a product manufacturing facility may ship DU ingots and turnings; a processing facility's waste could be DU/U-238 contaminated soils and equipment; and a DOD facility waste forms could be DU penetrators, ingots, and shields. These reviews revealed that the source pounds recorded seemed to be very conservative in some cases.

Two waste generators that shipped considerable waste volume to the Site showed Th-232 as the source material shipped. These two generators accounted for 4,267,624 source pounds. This amount was subtracted from the total source material disposed and the remainder is considered DU/U-238. Other generators have shipped small quantities of source material manifested as Th-232. Therefore, from April 1971 through December 2008, approximately 31,077,260 pounds of source material comprised of DU/U-238 wastes were disposed at the Barnwell facility. Of this total, 37% is comprised of metals and 63% is dry active waste from various generators (see the attached table).

## Barnwell Disposal Facility Source Material Inventory 1971 - 2008

Total Source Material in Pounds	35,344,884
Thorium Source Material in Pounds	- <u>4,267,624</u>
Depleted Uranium (DU)/U-238 Source Pounds	31,077,260

### DU/U-238 Source Material Waste Form Percentages

Metals (including penetrators, ingots, turnings, shields)	37%
DAW (including contaminated equipment, debris, soils, slag, oxide)	<u>63%</u>
Total	100%

## Walker-Smith, Antoinette

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**From:** McKenney, Christopher  
**Sent:** Monday, August 17, 2009 10:57 AM  
**To:** rhelbig@sfo.com  
**Cc:** Yadav, Priya; Cameron, Francis; Grossman, Christopher; Bubar, Patrice; Suber, Gregory  
**Subject:** FW: Misrepresentation of Decay Characteristics of DU, U-238

Dear Mr. Roger Helbig,

I have looked into obtaining the response to your 4:49 email below. We do not have a consolidated list of only these licenses readily available. Due to the need to gather information from several sources including our databases of terminated licenses, you would need to utilize the Freedom of Information Act process to ensure that it is a systematic and thorough search of the licenses is performed. You can obtain more information on what is the Freedom of Information Act, NRC's process for responding to Freedom of Information Act requests, and how to submit a Freedom of Information Act request at <http://www.nrc.gov/reading-rm/foia/foia-request.html>.

Christopher McKenney, Chief  
Performance Assessment Branch  
Environmental Protection and  
Performance Assessment Directorate  
Division of Waste Management and  
Environmental Protection  
Office of Federal and State Materials  
and Environmental Management Programs

Phone: (301) 415-6663  
Cell: (202) 507-3961  
Fax: (301) 415-5369  
Email: [Christopher.McKenney@nrc.gov](mailto:Christopher.McKenney@nrc.gov)  
Website: <http://www.nrc.gov/waste.html>

---

**From:** Roger Helbig [mailto:rhelbig@sfo.com]  
**Sent:** Sunday, August 09, 2009 4:49 PM  
**To:** Grossman, Christopher; Yadav, Priya  
**Cc:** francis.cameron@nrc.gov  
**Subject:** FW: Misrepresentation of Decay Characteristics of DU, U-238

Christopher, Priya,

I think that this might be better directed to one of you. I would also like to obtain a list of every DU license ever granted to the Department of Defense or its contractors for the production of DU munitions. My objective is to show that there is no license for any conventional bomb, particularly a "bunker buster" type bomb. I have searched ADAMS for this, but have not been able to find a consolidated list. Thank you.

Roger Helbig

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**From:** Roger Helbig [mailto:rhelbig@sfo.com]  
**Sent:** Sunday, August 09, 2009 1:29 PM

**To:** '

**Subject:** Misrepresentation of Decay Characteristics of DU, U-238

Francis,

Since you are working with DU disposal, can you comment on or direct me to accurate information regarding the following statement from the Salt Lake City Tribune,

“Called "D.U." by some, depleted uranium is a waste product of the enrichment process with the unusual characteristic of becoming more hazardous as it decays”

My understanding is that this based purely on a review of the decay cycle daughter elements and isotopes and not on their respective quantities or total radioactivity of the entire quantity of disposed U-238 with those elements and isotopes in equilibrium at a given time.

Thank you.

Roger Helbig

## Walker-Smith, Antoinette

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**From:** McKenney, Christopher  
**Sent:** Wednesday, August 12, 2009 2:35 PM  
**To:** rhelbig@sfo.com  
**Cc:** Walker-Smith, Antoinette; Yadav, Priya; Suber, Gregory; Cameron, Francis; Bubar, Patrice  
**Subject:** Misrepresentation of Decay Characteristics of DU, U-238

Dear Mr. Roger Helbig,

I am responding for Mr. Cameron to your question you posed on the statement in the Salt Lake City Tribune, which is posted below this message.

Essentially your understanding is correct. As the depleted uranium ages, daughter products will be formed from the decay of the uranium and the daughter products themselves. Because of the long half-life of uranium, the activity of U-238 will not appreciably decrease with time, while the presence of the forming daughter products will result in the total activity of uranium and its daughter products increasing in time until equilibrium is reached. In addition, some of these daughter products (e.g., radium and radon) have appreciably different characteristics than uranium, and thus, may result in new possible modes of exposure to the public.

With regard to your second question on DU munition manufacturing licenses, we are pursuing getting that information at this time.

Christopher McKenney, Chief  
Performance Assessment Branch  
Environmental Protection and  
Performance Assessment Directorate  
Division of Waste Management and  
Environmental Protection  
Office of Federal and State Materials  
and Environmental Management Programs

Phone: (301) 415-6663  
Cell: (202) 507-3961  
Fax: (301) 415-5369  
Email: [Christopher.McKenney@nrc.gov](mailto:Christopher.McKenney@nrc.gov)  
Website: <http://www.nrc.gov/waste.html>

-----  
Francis,

Since you are working with DU disposal, can you comment on or direct me to accurate information regarding the following statement from the Salt Lake City Tribune,

“Called "D.U." by some, depleted uranium is a waste product of the enrichment process with the unusual characteristic of becoming more hazardous as it decays”

My understanding is that this is based purely on a review of the decay cycle daughter elements and isotopes and not on their respective quantities or total radioactivity of the entire quantity of disposed U-238 with those elements and isotopes in equilibrium at a given time.

Thank you.

Roger Helbig

## Walker-Smith, Antoinette

---

**From:** Elsen, Mike (DOH) [Mike.Elsen@DOH.WA.GOV]  
**Sent:** Wednesday, July 22, 2009 12:32 PM  
**To:** Yadav, Priya  
**Cc:** Thatcher, Andrew H (DOH); Robert Haight; Schwab, Kristen (DOH); Fordham, Earl W (DOH)  
**Subject:** Reports of DU disposed of at Barnwell, Clive, and US Ecology  
**Attachments:** USE Uranium breakout 072109.xls

Priya-

Per your request attached is the source terms that we used in the preparation of the Environmental Impact Statement that was prepared for the US Ecology LLRW disposal facility. This represents the best estimate that we have for the source terms that you requested. Please let me know if you have any questions. Thanks

Mike

<<USE Uranium breakout 072109.xls>>

**From:** Yadav, Priya [mailto:Priya.Yadav@nrc.gov]  
**Sent:** Monday, July 20, 2009 8:20 AM  
**To:** Dane Finerfrock; Susan Jenkins; Robertson, Gary (DOH); Thatcher, Andrew H (DOH)  
**Cc:** Grossman, Christopher  
**Subject:** Reports of DU disposed of at Barnwell, Clive, and US Ecology

We are collecting some information in preparation of the workshops about DU that has been disposed of at your licensee's sites. Can you please forward to us any reports you have of quantities of DU that have been disposed of in terms of DU, U235 and U238? If you don't have access to such reports, can you direct us to where we can find this info? Please contact Chris Grossman (301-415-7658) with any questions and copy him on your responses.

Thanks,  
Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection  
US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)

Mikel Elsen, Supervisor  
Waste Management Section  
Office of Radiation Protection  
Department of Health  
PO Box 47827  
Olympia, WA 98504-7827  
Phone: (360) 236-3241  
Fax: (360) 236-2255

*Public Health -- Always working for a safer and healthier Washington.*

<b>Isotopes</b>	<b>U-total (Ci)</b>	<b>U-238 (Ci)</b>	<b>U-235 (Ci)</b>	<b>U-234 (Ci)</b>
Source				
Depleted Uranium	1613.3	1454.7	23.4	135.2
Natural Uranium	49.7	24.3	1.08	24.3
Enriched Uranium	151.1	26.1	6	119
	1814.1	1505.1	30.48	278.5

1. The basis for the 3.5% enrichment is the average of the old enrichment and new enrichment for Sier.

2. My calculations for the individual activity of the isotopes for the enriched uranium is based upon an  
 These values are slightly different for U-234 (119 Ci versus 110Ci as Bob Haight recommended).

nens

. interpolation of the data provided in N13.22.

## Walker-Smith, Antoinette

---

**From:** Yadav, Priya  
**Sent:** Saturday, September 26, 2009 8:18 PM  
**To:** 'Andrade Joe'  
**Cc:** Grossman, Christopher  
**Subject:** RE: depleted U

Prof. Andrade,  
Attached is a link to background materials developed for the workshops. If you need more technical information, please contact Chris Grossman, who is a Systems Performance Analyst on this effort. thanks,

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html>

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection  
US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)

---

**From:** Andrade Joe [mailto:joe.andrade@utah.edu]  
**Sent:** Friday, September 25, 2009 5:21 PM  
**To:** Yadav, Priya  
**Subject:** depleted U

I was unable to attend the SLC workshop earlier this week.  
I would appreciate background educational materials related to Depleted U, especially radioactivity, decay sequence, and activity as a function of time.

Thanks.

Joe Andrade, Distinguished Prof.,  
University of Utah  
Warnock Engineering Building  
72 South Central Campus Drive, Rm. 2646  
Salt Lake City, UT 84112  
Science Advisor, The Leonardo

801-484-4904; cell: 801-706-6747;  
U of Utah office: 801-581-4379  
[joe.andrade@utah.edu](mailto:joe.andrade@utah.edu) [www.bioen.utah.edu/faculty/jda](http://www.bioen.utah.edu/faculty/jda)  
[www.theleonardo.org](http://www.theleonardo.org)

## Walker-Smith, Antoinette

---

**From:** Grossman, Christopher  
**Sent:** Monday, September 28, 2009 3:34 PM  
**To:** 'Andrade Joe'  
**Cc:** Yadav, Priya; McKenney, Christopher  
**Subject:** RE: depleted U

Professor Andrade,

Depleted uranium is uranium having a percentage of uranium-235 smaller than the 0.7 percent found in natural uranium. Thus it is depleted in the uranium-235 isotope from natural uranium. You can find additional information on depleted uranium at these links:

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams/bg-info-du.html>

<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-du-other-waste-disposal.html>

You can find information on the decay series for the two primary uranium isotopes (U-238, U-235) at this Argonne National Laboratory publication:

<http://www.ead.anl.gov/pub/doc/natural-decay-series.pdf>

DU is obtained from spent (used) fuel elements or as byproduct tails, or residues, from uranium isotope separation such as uranium enrichment facilities. Below is a link to information on uranium enrichment facilities:

<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/enrichment.html>

---

**From:** Yadav, Priya  
**Sent:** Saturday, September 26, 2009 8:18 PM  
**To:** 'Andrade Joe'  
**Cc:** Grossman, Christopher  
**Subject:** RE: depleted U

Prof. Andrade,

Attached is a link to background materials developed for the workshops. If you need more technical information, please contact Chris Grossman, who is a Systems Performance Analyst on this effort. thanks,

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html>

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection  
US Nuclear Regulatory Commission  
301-415-6667 (phone)

301-415-5370 (fax)

---

**From:** Andrade Joe [mailto:joe.andrade@utah.edu]

**Sent:** Friday, September 25, 2009 5:21 PM

**To:** Yadav, Priya

**Subject:** depleted U

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Thanks.

Joe Andrade, Distinguished Prof.,  
University of Utah  
Warnock Engineering Building  
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Salt Lake City, UT 84112  
Science Advisor, The Leonardo

801-484-4904; cell: 801-706-6747;

U of Utah office: 801-581-4379

[joe.andrade@utah.edu](mailto:joe.andrade@utah.edu) [www.bioen.utah.edu/faculty/jda](http://www.bioen.utah.edu/faculty/jda)

[www.theleonardo.org](http://www.theleonardo.org)

## Walker-Smith, Antoinette

---

**From:** Andrade Joe [joe.andrade@utah.edu]  
**Sent:** Wednesday, September 30, 2009 1:58 PM  
**To:** Grossman, Christopher  
**Subject:** Re: depleted U

Thanks.

On Sep 28, 2009, at 1:34 PM, Grossman, Christopher wrote:

Professor Andrade,

Depleted uranium is uranium having a percentage of uranium-235 smaller than the 0.7 percent found in natural uranium. Thus it is depleted in the uranium-235 isotope from natural uranium. You can find additional information on depleted uranium at these links:

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams/bg-info-du.html>

<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-du-other-waste-disposal.html>

You can find information on the decay series for the two primary uranium isotopes (U-238, U-235) at this Argonne National Laboratory publication:

<http://www.ead.anl.gov/pub/doc/natural-decay-series.pdf>

DU is obtained from spent (used) fuel elements or as byproduct tails, or residues, from uranium isotope separation such as uranium enrichment facilities. Below is a link to information on uranium enrichment facilities:

<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/enrichment.html>

---

**From:** Yadav, Priya  
**Sent:** Saturday, September 26, 2009 8:18 PM  
**To:** 'Andrade Joe'  
**Cc:** Grossman, Christopher  
**Subject:** RE: depleted U

Prof. Andrade,  
Attached is a link to background materials developed for the workshops. If you need more technical information, please contact Chris Grossman, who is a Systems Performance Analyst on this effort. thanks,

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html>

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection  
US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)

---

**From:** Andrade Joe [<mailto:joe.andrade@utah.edu>]  
**Sent:** Friday, September 25, 2009 5:21 PM  
**To:** Yadav, Priya  
**Subject:** depleted U

I was unable to attend the SLC workshop earlier this week.  
I would appreciate background educational materials related to Depleted U, especially radioactivity, decay sequence, and activity as a function of time.

Thanks.

Joe Andrade, Distinguished Prof.,  
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Warnock Engineering Building  
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801-484-4904; cell: 801-706-6747;  
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[www.theleonardo.org](http://www.theleonardo.org)

**Walker-Smith, Antoinette**

---

**From:** David Esh  
**Sent:** Wednesday, November 19, 2008 3:52 PM  
**To:** Drew Thatcher; Yadav, Priya  
**Cc:** McKenney, Christopher; Kennedy, James; Kock, Andrea; Esh, David  
**Subject:** RE: DU SECY paper - data request

Hi Drew:

Below you will find the information you requested. If you have further questions, feel free to email or give me a call.

Dave

\*\*\*\*\*

1) What was the solubility limit for uranium and the basis for it?

*We implemented solubility limits as a response surface that was a function of pH and pCO<sub>2</sub>. The response surface covered a pH range of 4 to 10.5 and log(pCO<sub>2</sub>) of -5 to -1.5. Because pH and pCO<sub>2</sub> were sampled over non-extreme environmental conditions, the resulting range in uranium solubility was 1E-8 to 9E-4 mol/L over all conditions (grouted waste, non-grouted arid and humid). For non-grouted waste the solubility output range was 4E-6 to 4E-5 mol/L (~1 to 10 mg/L). In general, the controlling phase was schoepite.*

*The reference for the data used to develop the lookup tables was "BSC, 'Dissolved Concentration Limits of Radioactive Elements.' ANL-WIS-MD-000010 Rev 3, Bechtel SAIC Company, Las Vegas, NV. 2004.". Under grouted conditions we used a couple of other references, mainly a 2008 draft report by the Center for Nuclear Waste Regulatory Analysis on grout and cements. This report should be available shortly that I could send you a copy. We recognize that solubility limits/controls are much more complicated than applied here. We felt the range of output was reasonable to provide for a generic screening assessment. Hopefully the paper clearly articulated the need for a site-specific analysis.*

2) For the unsaturated zone, what was the distribution coefficient?

*For the unsaturated zone we used a similar approach to what we did for solubility developing response surfaces based on pH and pCO<sub>2</sub>. The range of output K<sub>d</sub> values for U were generally from 3E-3 to 170,000 ml/g for ungrouted conditions. The median of the distribution was 5 ml/g. The resultant output distributions spanned many orders of magnitude, but was consistent with Sheppard and Thibault (1990). For example the observed range (based on 24 observations) for sandy soil was 0.03 to 2200 ml/g. Our distributions had to cover a broad range of potential chemical and mineralogical conditions.*

*We would expect that a site-specific analysis may be able to justify a much more narrow range of distribution coefficients.*

3) Colloidal transport?

*We did not consider colloidal transport simply because we did not have enough resources or data to properly develop and parameterize a model, and the range of K<sub>d</sub> values implemented were such that uranium transport was rapid on the timescale of the analysis for some realizations. Essentially, colloids would be one of many processes or features that may enhance transport over 'normal' site conditions, and that impact was represented in the analysis*

4) Uranium form?

*Primarily U3O8. The uranium form primarily impacted the waste quantity and distribution assumed to be disposed of. It also impacted the release rate from the wastefrom (e.g., thru specific surface area)*

\*\*\*\*\*

-----Original Message-----

From: Drew Thatcher [mailto:thatcher.drew@comcast.net]  
Sent: Tuesday, November 11, 2008 3:49 PM  
To: Priya Yadav  
Cc: David Esh; Christopher McKenney; James Kennedy  
Subject: Re: DU SECY paper - data request

Priya:

I appreciate the enclosure you sent but I would like additional information. I'd really like to know the solubility limit for U-238 that you used and the basis for the limit. For unsaturated zone analysis, I'd like the distribution coefficient used. We have always included colloid transport in our work and we have observed indications of movement in the Richland site. Finally, and perhaps a more fundamental question, is the uranium that is deconverted primarily a U3O8 or a UO2?

Thanks again,  
Drew Thatcher

Andrew H. Thatcher, MSHP, CHP  
Washington Department of Health  
522 North "E" St  
Tacoma, WA 98403  
253.617.1449 office (new number)  
253.627.4927 fax  
thatcher.drew@comcast.net

----- Original Message -----

From: "Priya Yadav" <Priya.Yadav@nrc.gov>  
To: "Drew Thatcher" <thatcher.drew@comcast.net>  
Cc: "David Esh" <David.Esh@nrc.gov>; "Christopher McKenney" <Christopher.McKenney@nrc.gov>; "James Kennedy" <James.Kennedy@nrc.gov>  
Sent: Monday, November 10, 2008 12:20 PM  
Subject: RE: DU SECY paper - data request

I did read an article about Int'l isotopes looking at sites in Idaho. Our specific assumptions are listed on page 9 in Enclosure 1 (attached). If you need more detail, can you be more specific on what you are looking for? If necessary, I can arrange a conference call with Dave Esh, the lead for our analysis, after you send us specific data requests.

-----Original Message-----

From: Drew Thatcher [mailto:thatcher.drew@comcast.net]  
Sent: Monday, November 10, 2008 2:31 PM  
To: Priya Yadav  
Subject: Re: DU SECY paper - data request

Priya:

It appears that one of the possible locations for locating the DU deconversion facility is Idaho. This would mean that the facility is within the Northwest Compact. There is an interest in determining now whether disposal of the waste as the USE facility is a possibility. With that in mind, I would like to receive the input parameters and assumptions regarding the DU following deconversion used in the NRC analysis.

Thanks in advance for your assistance on this.

Regards,  
Drew Thatcher

Andrew H. Thatcher, MSHP, CHP  
Washington Department of Health  
522 North "E" St  
Tacoma, WA 98403  
253.617.1449 office (new number)  
253.627.4927 fax  
thatcher.drew@comcast.net

## Walker-Smith, Antoinette

---

**From:** Priya Yadav  
**Sent:** Wednesday, November 05, 2008 1:06 PM  
**To:** 'Drew Thatcher'  
**Cc:** Esh, David; McKenney, Christopher  
**Subject:** RE: DU SECY paper

Hi Drew. The analysis does conclude that disposal of DU could be acceptable at arid sites under certain conditions. If you have to rely on an engineered feature (e.g., radon barrier) to meet the performance objectives then you would need to provide basis for it's performance over the analysis period. For long periods of time this would be challenging. The recommended approach would be to increase disposal depth and cover thickness.

You are correct that we did not include other waste streams in our analysis, as we were looking at a generic site. As you mention, if DU was disposed of with other waste, the other waste would possibly decrease the amount of DU that could be safely disposed of. So your site specific analysis for US Ecology would need to include all waste disposed of.

Let me know if you have any other questions,

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)

-----Original Message-----

**From:** Drew Thatcher [mailto:[thatcher.drew@comcast.net](mailto:thatcher.drew@comcast.net)]  
**Sent:** Wednesday, November 05, 2008 12:58 AM  
**To:** Priya Yadav  
**Subject:** Re: DU SECY paper

Priya:

Question for you on the analysis of DU disposal. The analysis arrives at the conclusion that disposal of DU may be acceptable for arid sites, particularly with a radon barrier (regardless of time period considered). I did not see any inclusion of the existing waste streams at a given site. Such inclusions could significantly limit the fraction remaining (of the limit) for either the intruder or offsite resident scenarios.

Was this included somewhere that I missed?

Regards,  
Drew Thatcher

Andrew H. Thatcher, MSHP, CHP  
Washington Department of Health  
522 North "E" St  
Tacoma, WA 98403  
253.617.1449 office  
253.627.4927 fax  
[thatcher.drew@comcast.net](mailto:thatcher.drew@comcast.net)

----- Original Message -----

From: "Priya Yadav" <Priya.Yadav@nrc.gov>

To: "'Susan Jenkins'" <JENKINSE@dhec.sc.gov>; "Richard Haynes" <HAYNESRA@dhec.sc.gov>; "'DOH'" <Gary.Robertson@DOH.WA.GOV>; "'Mike(DOH) Elsen'" <Mike.Elsen@DOH.WA.GOV>; "'Susan Jablonski'" <SJABLONS@tceq.state.tx.us>; "'Dane Finerfrock'" <dfinerfrock@utah.gov>; <earl.fordham@doh.wa.gov>; "'Drew Thatcher'" <thatcher.drew@comcast.net>

Cc: "Anna Bradford" <Anna.Bradford@nrc.gov>; "David Brown" <David.Brown@nrc.gov>; "David Esh" <David.Esh@nrc.gov>; "James Kennedy" <James.Kennedy@nrc.gov>; "Patrice Bubar" <Patrice.Bubar@nrc.gov>

Sent: Friday, October 24, 2008 10:43 AM

Subject: DU SECY paper

The DU SECY paper we have been discussing is now publicly available on the NRC website, and attached for your convenience. We are still waiting to get all the Commissioners votes on the paper. Let me know if you have any questions.

Priya Yadav, PE

Project Manager

Division of Waste Management and Environmental Protection US Nuclear Regulatory Commission

301-415-6667 (phone)

301-415-5370 (fax)

**Walker-Smith, Antoinette**

---

**From:** Grossman, Christopher  
**Sent:** Friday, September 18, 2009 4:12 PM  
**To:** 'Jasen Lee'  
**Subject:** RE: NRC Public Workshop 2 on Unique Waste Streams - Depleted Uranium

Currently, NRC staff plans to complete the technical basis document for this rulemaking by September 30, 2010; the proposed rule and draft guidance document by September 30, 2011; and the final rule by September 30, 2012.

---

**From:** Jasen Lee [mailto:JLee@desnews.com]  
**Sent:** Friday, September 18, 2009 4:06 PM  
**To:** Grossman, Christopher  
**Subject:** Re: NRC Public Workshop 2 on Unique Waste Streams - Depleted Uranium

Chris,

After gathering all the information regarding DU storage in Utah, about how long might it take for the NRC to make a determination of any potential rule changes? Week, months, years?

JL

On 9/14/09 2:17 PM, "Grossman, Christopher" <Christopher.Grossman@nrc.gov> wrote:

The U.S. Nuclear Regulatory Commission (NRC) staff is hosting a public workshop on a potential rulemaking for the disposal of unique waste streams including significant quantities of depleted uranium in Salt Lake City, UT. The web link below is to our public website that contains information on the upcoming workshop. You can follow the links at the bottom of the aforementioned page, under "Public Workshop Information", to the agenda for the 2nd workshop which will be in Salt Lake City, UT. In the agenda, you will find the exact location of the workshop.

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams.html>

The conflicting information is likely confusion with a meeting held the same week by a separate group known as the Low Level Waste Forum, which will be hosting their meeting in Park City, UT the two days prior to the NRC workshop. You can find information on that group's meeting at the following link:

<http://www.llwforum.org/>.

I hope that clears up the conflict for you. If not, please let me know.

Chris

**From:** Jasen Lee [mailto:JLee@desnews.com]  
**Sent:** Monday, September 14, 2009 3:50 PM  
**To:** Grossman, Christopher  
**Subject:** FW: NRC Public Workshop 2 on Unique Waste Streams - Depleted Uranium

----- Forwarded Message

**From:** Jasen Lee <[jlee@desnews.com](mailto:jlee@desnews.com)>

**Date:** Mon, 14 Sep 2009 13:43:00 -0600

**To:** <[Priya.Yadav@nrc.gov](mailto:Priya.Yadav@nrc.gov)>, <[Karen.Pinkston@nrc.gov](mailto:Karen.Pinkston@nrc.gov)>

**Conversation:** NRC Public Workshop 2 on Unique Waste Streams - Depleted Uranium

**Subject:** NRC Public Workshop 2 on Unique Waste Streams - Depleted Uranium

Having been given what I believe is conflicting information, I am attempting to verify the location of the above-referenced event in Salt Lake City and/or Park City next week. Could you confirm the exact location(s) please?

Jasen Lee  
Business Writer  
Deseret News  
Salt Lake City, UT  
801-237-2142 Desk  
801-949-3530 Mobile  
E-mail: [jlee@desnews.com](mailto:jlee@desnews.com)

----- End of Forwarded Message

Jasen Lee  
Business Writer  
Deseret News  
Salt Lake City, UT  
801-237-2142 Desk  
801-949-3530 Mobile  
E-mail: [jlee@desnews.com](mailto:jlee@desnews.com)

## Walker-Smith, Antoinette

---

**From:** Dane Finerfrock [dfinerfrock@utah.gov]  
**Sent:** Tuesday, July 21, 2009 9:50 AM  
**To:** Yadav, Priya  
**Subject:** Re: Reports of DU disposed of at Barnwell, Clive, and US Ecology  
**Attachments:** Fractional Cell Quantity.pdf

Priya: Attached is a table that EnergySolutions prepared for me in March, 2009. It's a pdf file. Please let me know if you have a problem opening the file or it doesn't contain the needed data.

Dane

>>> "Yadav, Priya" <Priya.Yadav@nrc.gov> 7/20/2009 9:19 AM >>>

We are collecting some information in preparation of the workshops about DU that has been disposed of at your licensee's sites. Can you please forward to us any reports you have of quantities of DU that have been disposed of in terms of DU, U235 and U238? If you don't have access to such reports, can you direct us to where we can find this info? Please contact Chris Grossman (301-415-7658) with any questions and copy him on your responses.

Thanks,

Priya Yadav, PE

Project Manager

Division of Waste Management and Environmental Protection

US Nuclear Regulatory Commission

301-415-6667 (phone)

301-415-5370 (fax)

## Uranium Fractional Cell Quantity Estimate

Isotope	Disposed mCi	Specific Activity (mCi/g)	grams	lbs	DU Density (lbs/ft <sup>3</sup> )	DU ft <sup>3</sup>	DU (yds <sup>3</sup> )	LARW/Class Waste (yds <sup>3</sup> )	DU ft <sup>3</sup> /Waste ft <sup>3</sup>
Th-230	2.40E+06	2.02E-02	1.19E+08	2.62E+05	624	4.19E+02	16	6.31E+06	0.00%
U-234	6.40E+05	6.25	1.02E+05	2.26E+02	686	3.29E-01	0	6.31E+06	0.00%
U-235	2.07E+04	0.00216	9.60E+06	2.11E+04	686	3.08E+01	1	6.31E+06	0.00%
U-238	3.08E+05	0.000336	9.16E+08	2.02E+06	686	2.94E+03	109	6.31E+06	0.00%
U-Dep	1.75E+07	0.0004	4.36E+10	9.61E+07	686	1.40E+05	5,191	6.31E+06	0.08%
U-Nat	3.53E+05	0.0007	5.04E+08	1.11E+06	686	1.62E+03	60	6.31E+06	0.00%
Grand Total									0.09%

**Assumptions:**

1. The amount of uranium disposed was determined using manifested isotopic radioactivity from "WasteX" database.
2. The specific activity for each isotope and the density was used to convert radioactivity into a volume.
3. The isotopic volume was divided by the current "As Built" cell volumes to determine the cell fraction.
4. The density value for Uranium Oxide was used to determine the Uranium volume as listed in <http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=272>
5. The density value for Thorium Oxide was used to determine the Thorium volume as listed in [http://en.wikipedia.org/wiki/Thorium\\_dioxide](http://en.wikipedia.org/wiki/Thorium_dioxide)

## Walker-Smith, Antoinette

---

**From:** Susan Jenkins [JENKINSE@dhec.sc.gov]  
**Sent:** Tuesday, July 21, 2009 4:56 PM  
**To:** Yadav, Priya  
**Cc:** Richard Haynes; Andrew H (DOH) Thatcher; Gary (DOH) Robertson; WBHOUSE@energysolutions.com; Grossman, Christopher; Dane Finerfrock  
**Subject:** Re: Reports of DU disposed of at Barnwell, Clive, and US Ecology

Good afternoon all,

Bill House, VP of Regulatory Affairs with Energy Solutions/Chem-Nuclear Systems has agreed to provide information for such disposals at the Barnwell Site in accordance with your request. The Department has volume numbers for disposals of source material but does not have those numbers broken down. Bill should be able to provide more detailed data, however, it will take some time and effort to compile the data.

If you wish, you may contact Bill directly at:

office: 803-758-1809  
cell: 803-530-2821  
e-mail: [wbhouse@energysolutions.com](mailto:wbhouse@energysolutions.com)

or you may work through our Department.

Bill plans to attend the DC Meeting and possibly the Salt Lake City Meeting.

Richard Haynes, our Director, will be attending the DC meeting, however I will not as I have other travel plans within that relative time period. We will be glad to provide any assistance we can.

Thanks,  
Susan

>>> "Yadav, Priya" <[Priya.Yadav@nrc.gov](mailto:Priya.Yadav@nrc.gov)> 7/20/2009 11:19 AM >>>

We are collecting some information in preparation of the workshops about DU that has been disposed of at your licensee's sites. Can you please forward to us any reports you have of quantities of DU that have been disposed of in terms of DU, U235 and U238? If you don't have access to such reports, can you direct us to where we can find this info? Please contact Chris Grossman (301-415-7658) with any questions and copy him on your responses.

Thanks,

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)

## Walker-Smith, Antoinette

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**From:** Priya Yadav  
**Sent:** Thursday, April 02, 2009 7:14 PM  
**To:** 'thatcher.drew@comcast.net'  
**Cc:** Patrice Bubar; Tison Campbell; 'gary.robertson@doh.wa.gov'  
**Subject:** RE: DU SECY paper - data request

Drew:

Thank you for your email. As you know, the Commission issued SRM-SECY-08-0147 on March 18, 2009, which directs staff to proceed with a limited rulemaking to require a site-specific analysis prior to disposal of large quantities of DU. Staff are proceeding with this direction and are planning to hold a workshop in September to begin collecting information from stakeholders about issues that should be included in the rulemaking and issues that should be considered in the technical analysis. Until this rulemaking is final, existing regulations in Part 61 do not require that a site-specific analysis is performed for large quantities of DU, however, Part 61 licensees are required to meet the performance objectives of Part 61. If one of DOH's licensees expects to receive waste that is not accounted for in their PA (e.g., large quantities of DU), DOH could require under conforming regulations to Part 61 that their PA be updated to address impacts from this new waste stream. Beyond this requirement, it is within DOH's discretion to perform/update the PA for US Ecology. If any technical assistance is needed from the NRC, please contact your Regional State Agreements Officer in Region IV and the Agreement State Programs Branch in FSME.

Priya Yadav, PE  
Project Manager  
Division of Waste Management and Environmental Protection  
US Nuclear Regulatory Commission  
301-415-6667 (phone)  
301-415-5370 (fax)

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**From:** thatcher.drew@comcast.net [mailto:thatcher.drew@comcast.net]  
**Sent:** Tuesday, March 24, 2009 7:47 PM  
**To:** Priya Yadav  
**Subject:** Re: DU SECY paper - data request

Priya:

I have a favor to request of you. I've talked with the Waste section today and we appear to be in agreement that we need to perform the Performance Assessment and that our program will pay for the assessment as opposed to the site operator. What we'd like from you all is a push in that direction - in essence - a simple letter or email stating that the NRC would be interested in the results of a performance assessment at the low level waste site in Richland, WA and would encourage the state to perform such an assessment. I see this performance assessment as having applicability to other sites at least in terms of the modeling parameters related to DU solubility if nothing else.

Please call me if you have any questions about this.

Regards,  
Drew Thatcher

360.236.3231 voice