excerpts of filing CD

SC Administrative Law Court Decisions

CAPTION:
SCDHEC vs. Starmet CMI, Inc.

AGENCY:
South Carolina Department of Health and Environmental Control

PARTIES:
Petitioners:
South Carolina Department of Health and Environmental Control

Respondents:
Starmet CMI, Inc.

DOCKET NUMBER:
02-ALJ-07-0249-IJ

APPEARANCES:
Jessica King, Esq. for Petitioner

John A. Hodge, Esq., for Respondent

ORDERS:

ORDER

STATEMENT OF THE CASE

This matter is before the Administrative Law Judge Division ("Division") pursuant to the request of Starmet CMI, Inc. ("Respondent"), filed on June 27, 2002, for an expedited administrative review of the Emergency and Administrative Order ("Emergency Order") issued by R. Lewis Shaw, Deputy Commissioner of the South Carolina Department of Health and Environmental Control ("Department") on June 25, 2002. The Department issued the Emergency Order charging Respondent with violations of various statutes and regulations of the Department. Thereafter, Respondent requested an immediate hearing before the Division, pursuant to S.C. Code Ann. § 48-1-290 (1987) and S.C. Code Ann. § 13-7-50 (1976).

The case was assigned to the undersigned on the morning of June 27, 2002. Upon notice to all parties, a conference was held with the parties at the offices of the Administrative Law Judge Division at 2:00 p.m. on the date of filing. No testimony was taken nor was any other evidence presented at that conference.

As a result of that conference, an emergency hearing was scheduled for Monday, July 1, 2002 at 11:00 a.m. After careful review of all filings in both this case and in the companion contested case filing entitled South Carolina Department of Health and Environmental Control v. Starmet CMI, Inc., Docket No. 01-ALJ-07-0532-CC, a pending case within the jurisdiction of the undersigned, together with all the testimony and evidence presented at the hearing on July 1-3, 2002, all previous orders of this tribunal in this matter only, as well as the emergency order of the Department, are vacated and the following Order is issued. This order does not have any prejudicial effect on the contested case matter docketed with the Division as No. 01-ALJ-07-0532-CC, which is set for a hearing on the merits in August 2002.

ALC Rules & Publications
Decisions
Contact Us
What's New
Judges
Appellate Court Rules
Links
FAQs
Location
Disclaimer
Home

PROCEDURAL HISTORY

Many of the facts and issues in the present case are intertwined with another pending case before the undersigned, and thus, a history of procedural events is helpful. The related case, SC DHEC v. Starmet, CMI, Inc., Docket No. 01-ALJ-07-0532-CC, was filed with the Division on November 21, 2002, as the result of an appeal of the Department's Administrative Order No. 01-01-RW. This Administrative Order, issued on October 29, 2001, cited various regulatory violations concerning radioactive waste and required Starmet to take corrective action (discussed in detail below). As the case proceeded, the parties continued to negotiate. As a result of these negotiations, a Consent Order was filed with this court on December 20, 2001. This Consent Order mainly dealt with setting a schedule for the removal of existing inventory of uranium tetrafluoride (UF4). Another Consent Order was filed on April 30, 2001, which addressed Starmet's Bankruptcy filing and in which Starmet agreed not to receive any further radioactive materials unless an equal amount had been shipped off.

FINDINGS OF FACT

Having observed the witnesses and exhibits presented at the hearing and closely passed upon their credibility, and after taking into consideration the burden of persuasion by the parties, I make the following Findings of Fact:

General

1. Notice of the date, time, place and nature of the hearing was timely given to the parties.

2. The Respondent, Starmet CMI, Inc., formerly Carolina Metals, Inc., owns and operates a uranium processing and conversion facility on a site located at 365 Metal Drive, Barnwell County, South Carolina ("facility" or "site"). This site was originally licensed in 1982 under its prior name Carolina Metals, Inc.

3. Robert E. Quinn is the chairman of the board of Starmet Corporation, with headquarters in Concord, Massachusetts. Mr. Quinn is the sole officer of Starmet Corporation and the sole director of its subsidiaries. Respondent is a subsidiary of Starmet Corporation.

Starmet Corporation has several other subsidiaries: (1) Starmet, NMI, which is located in Concord, Massachusetts where it manufactures depleted commercial shielding products for medical and industrial purposes, however, its operations are winding down. (2) Starmet Powders LLC, (3) Starmet Commercial Casting, LLC, and (4) Starmet Ceralcast, LLC.[1]

4. Petitioner, the South Carolina Department of Health and Environmental Control, is an agency within the executive branch of state government in South Carolina, created pursuant to S. C. Code Ann. § 44-1-10, et seq. It is administered by a commissioner under the supervision of the South Carolina Board of Health and Environmental Control, which consists of seven members.

5. Respondent operates under the terms and conditions of S. C. Radioactive Material License No. 322, with attached Amendment No. 26, ("license") and S. C. Code Ann. Reg. 61-63 ("regulation"). See Pet. Exh. 65.

30. As a result of that conference, Respondent submitted a proposed schedule for the disposition of the current waste inventory on site. It was provided as an attachment to a letter sent to the Department dated May 1, 2000 for its review and approval. Respondent stated in the letter that it would "continue to provide waste inventory generation/reduction activities in the monthly report submitted to your Department." See Pet. Exh. 20.

31. The Waste Reduction Schedule for Calendar Year 2000 outlined its present inventory of its different kinds of waste by drum totals and sealed containers. It projected an end date of July 2001.

32. The Department approved the Waste Reduction Schedule in a letter dated July 10, 2000. See Pet. Exh. 20.

33. Respondent continued with its inventory reporting and provided monthly reports to the Department.

34. In September 2001 the Department became concerned that Respondent would exceed its limit for onsite radioactive materials. The majority of the uranium on site was UF4. Although the Department agreed that Respondent needed UF4 in its reduction process which converts UF4 into uranium metal or "derbies," the Department felt Respondent was collecting too much of the UF4 on site.

35. Further, the Department began to voice concerns that the radioactive material in the drums on site had not been properly measured.

36. The Department also raised the concern of potential theft.

37. The radioactive levels in the drums are of a low level.

38. On October 5, 2001, Respondent sent a letter to the Department with an attachment which outlined its uranium inventory on October 4, 2001. The letter stated that it was taken from "actual laboratory analysis of over 2000 drums in inventory" over the last six months.

39. Respondent provided monthly reports to the Department for the months of January through June, 2002. See Pet. Exh. 73. They reflect the amount of waste shipped off site from December 1, 2001 through May 2, 2002.

40. Pursuant to the ALJ Consent Order dated December 20, 2001, Respondent shipped off more waste inventory than it received for the period January 1, 2002 through June 13, 2002. According to its accounting, it received 178,200.28 pounds of uranium and shipped off 478,338.00 pounds. See Pet. Exh. 48.

pursuant to its license. The Department was concerned that the shipment of uranium counterweights shipped to Respondent on June 6, 2000 were to be processed for disposal.

51. On June 14, 2002 Respondent notified the Department that "all non-legacy hazardous waste will be removed by the end of the week." *See* Respondent's Exhibit 4.

Inspections of the Site by the Department

52. The Department has conducted frequent inspections at the site, usually weekly and oftentimes daily. The inspector for this facility for the last 2 ½ years was Robert Kevin Strickland. His duties include inspecting incoming shipments, providing guidance and surveys, ensuring the facility is complying with its license and Department of Transportation ("DOT") procedures. On many of his inspections, Mr. Strickland was accompanied with other inspectors or agents of the Department. Copies of his written inspection reports for the period October 25, 2001 through June 17, 2002 were reviewed by the court. *See* Pet. Exh. 46.

Among other items in the reports, the major concerns Mr. Strickland noted were

- improper labeling of drums or no labeling of drums
- steel drums containing mixed waste that have been on site for years.
- steel drums with lids missing.
- leaking drums with liquid on the floor near them.
- several drums in such poor condition that they broke apart when moved.
- stored drums with the contents not labeled.
- improper repair of steel ducting with cloth back tape (duck tape)
- phone conversation with David Felkel of Edisto Electric Cooperative on January 25, 2002 indicating the electricity would be cut off at the facility because of unpaid bills by Respondent.
- shipment of non-radioactive equipment from a sister facility in Concord, Massachusetts to this facility for storage.
- contaminated vegetation and soil near the evaporator cooler.
- the three monitor wells on the site were unlocked.
- caved in areas of the side of a pond [one nearest the woods] at the location where the three drains are which lead to the sump area.
- man ways to the sumps from the evaporation ponds had 2 or 3 inches of liquid present and in a rain could overflow.
- shipment from the Concord facility of 22 drums containing LLW notwithstanding previous expressed concerns about further shipments from the Massachusetts site.

53. On July 26, 27 and 28, 2000, agents of the Department inspected the site. This was the point in time when the Department began to have grave concerns about the operation of this facility. As a result of that inspection, the Department made a determination that there were numerous violations of the license and the regulation at the facility. Thereafter, Respondent advised the Department that it would address these problems without the need for any enforcement action.

54. The Department inspected the site almost weekly between late July 2000 and May, 2001. From July 26 through July 28, 2000, the Department conducted an unannounced inspection at the site. Interviews were conducted with Respondent's employees. The Department determined that there were numerous violations of the license and regulation at locations within the facility, at the pond sites and along the boundary fence line. [7] It is noted that the fence line is a great distance from the public road.

55. During an inspection on May 15 and 16, 2001, the Department again determined that there were violations of the license and the regulation at the site. *See* Pet. Exh. 44.

Consent Administrative Order

56. When Respondent did not meet the expectations of the Department, the parties entered into a Consent Order which was signed on June 19, 2001. It was signed by both parties. *See* Petitioner's Exh. 1. The parties agreed that the Respondent would do the following:

to date with their concerns about conditions at the facility. In these conversations, they talked about Respondent as a "sham recycling corporation," about Respondent's alleged stockpiling of waste and about Respondent's alleged financial concerns.

Administrative Order

59. On October 29, 2001, Administrative Order ("Administrative Order") Number 01-01 RW

was issued by the Department; it was signed by the Commissioner of the Department, C. Earl Hunter. *See* Petitioner's Exh. 59. The Department concluded that:

- Pursuant to Radioactive Materials (Title A) Regulation, 25 S. C. Code Ann. Regs. 61-63, Respondent had:
  - Failed to adjust its financial assurance for decommissioning the site to cover increased levels in radioactive wastes at the facility;
  - Engaged in activities that caused it to violate this regulation, its license and license conditions, and a Consent Order executed on June 19, 2001 by the Department;
  - Failed to implement a radiation protection program commensurate with the scope and extent of licensed activities by failing to perform required maintenance, remediate its evaporation ponds, and conduct adequate radiation surveys;
  - Failed to use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational does and doses to members of the public that are as low as is reasonably achievable; failure to ensure that each container of licensed material bears a durable, clearly visible level bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL," or "DANGER, RADIOACTIVE MATERIAL."
- Pursuant to South Carolina Radioactive Material License number 322, issued on July 25, 2001, pursuant to the Atomic Energy and Radiation Control Act, S. C. Code Ann. § 13-7-40 et. seq. (Supp. 1989) and 25 S. C. Code Ann. Regs. 61-63, Respondent violated:
  - License Condition 12 by failing to conduct operations authorized in the licensee's procedures and subsequent revisions and additions approved by th Department;
  - License Condition 18 by failing to submit to the Department certification

from the owner of materials that the products had wastes resulting from activities authorized under the license will be shipped back to the owner or arrangements have been made regarding handling of the products and by storing materials, products and/or wastes for more than six (6)months;

  - License Condition 21 by failing to conduct accurate physical inventories

60. As a result of its conclusions, the Department exercised its authority pursuant to S.C. Code

Ann. §§ 13-7-40 (Supp. 1989), 13-7-85 (Supp. 1989) and S.C. Code Ann. Regs. 61-63, and issued the following order provisions in the Administrative Order:

- Respondent shall have only certain radioactive materials, authorized maintenance and repairs on equipment as needed, and authorized Respondent to ship radioactive waste and materials to licensed facilities.
- Within 45 days Respondent must reduce its inventory of depleted uranium (all forms) to 90 % of the new licensed limit of 5,000 metric tons by disposing of the current waste inventory to a permitted facility. Copies of all receipts must to provided to the Department within 10 days.
- Submit to the Department within 45 days a waste disposal plan which addresses a waste reduction schedule.
- Within 45 days submit to the Department a detailed physical inventory of all radioactive materials, wastes and contaminated equipment.
- Within 15 days submit to the department an updated decommissioning funding plan and additional financial assurance to cover the third party costs for the removal of excess wastes over operational waste levels, the remediation of the evaporation ponds, the removal of five thousand metric tons of depleted uranium to include operational wastes and the decommission for the facilities contaminated equipment.
- Cease using the evaporation ponds immediately; within 15 days submit to the Department for review and approval a revised plan for the remediation and reconstruction of the evaporation ponds within 6 months.
- Within 15 days pay make payable to the Department a civil penalty in the amount of $ 52,000.00.

- A recitation of the Consent Order executed by the Department on June 19, 2001 with the violations agreed to therein by both parties hereto;
- A recitation concerning the appeal by Respondent and the request for review by this tribunal of the Department's Administrative Order dated October 21, 2001, which request by transmitted by the Department to the Division on November 21, 2001;
- The history of the requested injunctive relief the Department had sought in December 2001 before the Division;
- The Consent Order agreed to by the parties and approved by this tribunal on December 20, 2001,
- The bankruptcy filing on March 26, 2002 by Respondent;
- The Order by this tribunal dated April 30, 2002 wherein this court retained jurisdiction over the appeal [since this was an enforcement action and not subject to the stay in the Bankruptcy filing].

122. The Emergency Order further states that the conditions at the facility "have continued to deteriorate, additional serious environmental and public safety concerns have arisen, and Starmet [Respondent] has made very little progress in reducing the inventory of radioactive materials on the Site as consented to and ordered in the December 20, 2001, ALJ [Administrative Law Judge] Consent Order."

123. Thereafter, in subparagraphs 20. a. through 20. j., the Emergency Order notes:

- Respondent has failed to comply with the ALJ order which required timely shipments of radioactive materials offsite;
- The recent sampling of groundwater monitoring wells adjacent to the evaporation ponds showed contamination and a release of uranium and possibly other constituents which came from the pond area.
- The ineffectiveness of the evaporator coolers;
- A failure of Respondent to comply with the Consent Order of June 19, 2001 by failing to commence or complete an assessment and remediation of all outside areas;
- The potential for continuing exposure of radiation to the public by Starmet's failure to move the fence and its failure to establish a security patrol along the fence line during the interim;
- Inadequate security at the facility by its failure to employ twenty-four hour security staff to prevent theft--that such is a threat to "Homeland Security" because the radioactive materials on site could be used to make what is commonly referred to as a "Dirty Bomb;"
- Respondent's failure to secure, store and label drums properly;
- Respondent's violated the December 2001 Consent Order of the ALJ by failing to to ship 40,000 pounds of UF4 off-site prior to January 15, 2001;
- Respondent's violation of the June 2001 Consent Order by significantly failing to reduce its inventory by 25 % by December 18, 2001;
- Respondent violated the December 2001 Consent Order of the ALJ by failing to ship off 1,500,000 pounds of radioactive materials by February 28, 2002.
- Respondent's failure to provide to the Department a good estimate of the radioactive materials on site;
- Improper storage of wastes from its facility in Concord, Massachusetts;
- Respondent's failure to provide 72 hours notification of all shipments of radioactive materials to the facility as required by the ALJ Consent Order and the license.

124. Further, the order provided that Respondent had repeatedly received equipment and licensed material without prior Department authorization.

Interlocutory Order

125. After the parties had presented all their evidence and made their closing arguments at the hearing the court recessed on the evening of July 2, 2002. That same evening the court announced on the record an interlocutory order which would be controlling pending further order, the terms of which were provided to the parties after the hearing concluded. Those terms are:

- All processing, receiving, shipping, recycling, and treatment activities at Starmet shall cease immediately pending further order.
- Releases of wastewater to the evaporation ponds and continued operation of the evaporator coolers shall cease pending further order.
- All systems such as the reduction furnaces, derby processing equipment including tanks containing nitric acid, counterweight plating line, and the ventilation system shall be properly neutralized immediately or contained by Starmet pending further order.

http://www.energy-net.org/N-LET/EN/0BULL/2002/RBULL-03.702

****
07/03/02 **** RADIATION BULLETIN(RADBULL) **** VOL 10.169
****
RADBULL IS PRODUCED BY THE ABALONE ALLIANCE CLEARINGHOUSE
****

NUCLEAR POLICY

NUCLEAR REACTORS

NUCLEAR SAFETY

13 US: S.C. judge overturns order closing plant

Charlotte Observer | 07/02/2002 |

[http://www.charlotte.com]

AARON SHEININ
The (Columbia) State

A judge on Monday overturned the state health department's order that closed a Barnwell County manufacturing plant over a potential uranium leak.

Administrative Law Judge Marvin Kittrell ruled that the S.C. Department of Health and Environmental Control did not have jurisdiction to force Starmet CMI Inc. to close last week.

Kittrell delayed his order until the agency has a chance to ask him for a temporary injunction to keep Starmet closed. The agency and the company were already scheduled to come before Kittrell in August for a hearing on many of the issues DHEC raised in its emergency order.

Kittrell ruled that because the August hearing is before him, he has jurisdiction to decide if Starmet remains closed.

Both sides began arguments Monday as to whether an emergency exists at the plant, and whether Kittrell should grant DHEC a temporary injunction keeping the plant closed.

Testimony continues today.

Kevin Strickland, DHEC's inspector for the Starmet plant, testified that he saw "green salt," a by-product of the uranium metal production process, spilling from drums that had been hit by a forklift. He said employees often had inadequate protective clothing to handle radioactive material and had to borrow monitoring equipment from a nearby plant.

Testing of ponds used to contain uranium also showed increased levels of the radioactive material.

"When we got the results back, it was readily apparent the results had risen," Strickland said.

Still, when questioned by Starmet attorney John Hodge, Strickland said he never indicated in his reports that an emergency situation existed at the plant.

Hodge tried to impugn Strickland's testimony by showing that he failed to notify Starmet directly of problems he found in his weekly or daily inspections.

In its emergency order, DHEC said Starmet had failed to contain water in waste lagoons. The lagoons are supposed to prevent uranium from leaking into groundwater.

Charlotte.com

http://www.deq.utah.gov/Issues/hottopics/depleteduraniumtest.htm

Utah DEQ: Issues: Depleted Uranium

Depleted Uranium History
Definition | Concerns | Regulatory Oversight | Background on Issues

What is Depleted Uranium?

What Concerns Are There to Health and the Environment?
Below the site, the aquifer is naturally of poor quality so the water is not used as a drinking water source without significant treatment.

Issues
The Radiation Control Board on April 14, 2010 approved a new rule that required Energy Solutions to conduct a performance assessment before disposing of depleted uranium. The Board's action was based on the fact that DU's radioactivity increases over a very long period of time. In addition, NRC did not evaluate shallow land disposal of DU when it developed its low-level radioactive waste disposal regulations. In the absence of federal regulation, the Board adopted the new rule.

The Depleted Uranium Performance Assessment Rule, R313-25-8, "Technical Analysis" is posted on the DRC Web. The assessment was originally due on December 31, 2010 however, Energy Solutions asked for another two months, in part to take into account the input received during a series of scoping meetings that have taken place this year. To read more Information on the scoping meetings.

The assessment is expected by the end of February. Once it is received, the staff will review it for completeness and then start a technical review of the Performance Assessment. A stakeholder workshop on the topic is also anticipated.

Uranium's physical and chemical properties make it ideal for use in nuclear reactors and for military uses. To be used, uranium has to be "enriched." During this process, the fraction of U-235 is increased from its natural level (0.72% by mass) to between 2% and 94% by mass. The by-product after the enrichment process has reduced concentrations of U-235 and U-234 and is known as depleted uranium (DU).

DU is classified as a Class A, low-level radioactive waste, yet it does have some commercial use. However, demand is currently much less than the amounts generated. Disposal is the only option for the rest. Under federal law, the Department of Energy is required to accept DU from an NRC licensed uranium enrichment facility. DU can also be accepted by a licensed commercial disposal site. Energy Solutions' Clive facility holds a Class A radioactive waste license.
The risk from DU comes from the fact that it slowly creates radon gas. DU is also harmful, due to its toxicity, if ingested. This process is extremely slow; estimated by scientists to take

between 1,000 and one million years and, at that point, people and/or the environment would still need to come into direct contact before there was a radiological or chemical risk. If it remains properly disposed, there is no contact and therefore no additional risk.

At the Clive location, given its arid climate and low precipitation, the current potential for soil erosion to any

Issues

Depleted Uranium History

Definition | Concerns | Regulatory Oversight | Background on Issues

The Radiation Control Board on April 14, 2010 approved a new rule that required EnergySolutions to conduct a performance assessment before disposing of depleted uranium. The Board's action was based on the fact that DU's radioactivity increases over a very long period of time. In addition, NRC did not evaluate shallow land disposal of DU when it developed its low-level radioactive waste disposal regulations. In the absence of federal regulation, the Board adopted the new rule.

The Depleted Uranium Performance Assessment Rule, R313-25-8, "Technical Analysis" is posted on the DRC Web.

The assessment was originally due on December 31, 2010 however, EnergySolutions asked for another two months, in part to take into account the input received during a series of scoping meetings that have taken place this year. To read more Information on the scoping meetings.

The assessment is expected by the end of February. Once it is received, the staff will review it for completeness and then start a technical review of the Performance Assessment. A stakeholder workshop on the topic is also anticipated.

What is Depleted Uranium?

Uranium's physical and chemical properties make it ideal for use in nuclear reactors and for military uses. To be used, uranium has to be "enriched." During this process, the fraction of U-235 is increased from its natural level (0.72% by mass) to between 2% and 94% by mass. The by-product after the enrichment process has reduced concentrations of U-235 and U-234 and is known as depleted uranium (DU).

DU is classified as a Class A, low-level radioactive waste, yet it does have some commercial use. However, demand is currently much less than the amounts generated. Disposal is the only option for the rest. Under federal law, the Department of Energy is required to accept DU from an NRC licensed uranium enrichment facility. DU can also be accepted by a licensed commercial disposal site. EnergySolutions' Clive facility holds a Class A radioactive waste license.

What Concerns Are There to Health and the Environment?

The risk from DU comes from the fact that it slowly creates radon gas. DU is also harmful, due to its toxicity, if ingested. This process is extremely slow; estimated by scientists to take between 1,000 and one million years and, at that point, people and/or the environment would still need to come into direct contact before there was a radiological or chemical risk. If it remains properly disposed, there is no contact and therefore no additional risk.

At the Clive location, given its arid climate and low precipitation, the current potential for soil erosion to any buried DU is extremely low. Once buried, it is felt that the likelihood of intrusion by natural elements or by humans also remains extremely low. This condition will be evaluated as part of its performance assessment review.

Below the site, the aquifer is naturally of poor quality so the water is not used as a drinking water source without significant treatment.

What Does the Federal Government Have to do With DU?

The NRC (Nuclear Regulatory Commission) regulates commercial nuclear power plants and other uses of nuclear materials. Utah is an "Agreement State" under the NRC. As an Agreement State, Utah's regulations must be consistent with those of the NRC. In order to be more strict, Utah law requires a written finding that the corresponding federal regulation is inadequate to protect public health and the environment of the state.

Background on Depleted Uranium Issue

Because entries are in date order, we suggest that you start at the bottom and scroll up.

Posted Dec. 8, 2010

EnergySolutions Seeks Extension on DU Performance Assessment

EnergySolutions has asked for an extension to submit a performance assessment that analyzes whether its site is suitable for large quantities of depleted uranium. The assessment was due Dec. 31, but EnergySolutions is asking for another two months, in part to take into account the input received during a series of scoping meetings that have taken place this year.

Posted April 20, 2010

DRC Board Approved New Rule

The Radiation Control Board on April 14 approved a new rule that requires EnergySolutions to conduct a performance assessment before disposing of depleted uranium.

The Depleted Uranium Performance Assessment Rule, R313-25-8, "Technical Analysis" is posted on the DRC Web:

> DRC Homepage:
> http://www.radiationcontrol.utah.gov/index.htm
>
> Rulemaking Actions:
> http://www.radiationcontrol.utah.gov/Rules/rulemaking_actions.htm

Posted: April 5, 2010

Test Results Complete: DOE Drums of Depleted Uranium Meet Legal Limits

An Oakridge, Tennessee lab notified the Utah Department of Environmental Quality (DEQ) today that the samples of depleted uranium at EnergySolutions' low-level radioactive waste disposal facility meet health and safety standards set by the State.

The Division of Radiation Control (DRC) last month conducted its own tests at the direction of Governor Gary Herbert. The material was shipped to Utah in December from the Department of Energy's Savannah River, South Carolina, cleanup.

Eberline Services, Inc. analyzed 171 samples randomly collected from the 5,400 drums. DRC used an Environmental Protection Agency method under the Resource Conservation and Recovery Act that determines the number of samples for a statistical approach to find out whether the waste concentrations exceed EnergySolutions' Class A license.

"We took a much more conservative and thorough approach to sampling," said Amanda Smith, Executive Director of DEQ. "We believe that given questions raised about the nature of this waste, the State should do its due diligence and perform additional tests."

Depleted uranium is classified as Class A low-level waste by the Nuclear Regulatory Commission, but the Savannah River waste also contained trace amounts of other radioactive elements, including Technetium, which, if concentrations are too high, would be prohibited from disposal under State law.

The Radiation Control Board is promulgating a rule that would require a performance assessment to determine if depleted uranium can be safely disposed above ground at EnergySolutions. The waste material from Savannah River will continue to be monitored until the performance assessment is completed.

Posted: February 25, 2010

DEQ Uses a Statistical Analysis to Test Depleted Uranium

Salt Lake City, Utah—The Division of Radiation Control (DRC) on Tuesday initiated the sampling of the depleted uranium at EnergySolutions' low-level radioactive waste disposal facility, using a federally-accepted statistical approach to determine whether the waste meets the safety hazards set by the state.

Sampling will continue next week, weather permitting, said Amanda Smith, executive director of the Utah Department of Environmental Quality. At the request of Governor Herbert, Smith directed DRC staff to conduct its own tests of the depleted uranium that the Department of Energy (DOE) shipped to Utah in December from its Savannah River, South Carolina cleanup.

It's a highly laborious process, said Smith. Samplers pop the lid off the 55-gallon drums, and skim 250 grams of the depleted uranium, a powder substance, into a container. The samples are randomly taken from 171 of the 5,400 drums and will be sent to Eberline Services, Inc. in Oakridge, Tennessee for analysis, which will take a couple of weeks to a month to complete.

"We believe that given the questions raised about the nature of this waste, the state should do its due diligence and perform additional testing to assure with statistical confidence that the 5,400 drums do not exceed federal or state standards for radioactivity," said Smith.

Dane Finerfrock, director of DRC, said DEQ is using an Environmental Protection Agency method under the Resource Conservation and Recovery Act (RCRA) that determines the number of samples for a statistical approach to find out whether the waste concentrations exceed EnergySolutions' Class A license.

Depleted uranium is classified as Class A low-level waste by the Nuclear Regulatory Commission but becomes more hazardous over time, up to 1 million years. Depleted uranium consists of many isotopes, including technetium-99, that if concentrations are too high would be prohibited under state law. The Radiation Control Board is currently completing a rule-making that would place specific conditions on depleted uranium disposal.

"We have reviewed the shipping documents and the analytical results from the generator and have no reason to believe at this time that waste exceeds the Class A limits. At the Governor's request DRC is conducting an independent analysis, and we have chosen a much more conservative and thorough approach to sampling."

Governor Herbert stopped the Energy Department from shipping additional trainloads of depleted uranium from Savannah River under an agreement he negotiated with DOE earlier this week. The Energy Department also agreed to take the depleted uranium back if testing shows the material exceeds the Class A limit.

Posted: February 23, 2010

Governor Succeeds in Keeping Second and Third Depleted Uranium Trains Out of Utah

Planned shipments of depleted uranium from the U.S. Department of Energy's Savannah River Site will not be shipped to Utah under an agreement negotiated Monday by Governor Gary R. Herbert.

"This is a monumental win for the State of Utah," Governor Herbert said. "At one point, we were told these trains were all but on the tracks, making their way to Utah. The Department of Energy has now agreed, after we registered our concerns, that those trains will head elsewhere."

The Governor emphasized that, in addition to halting planned shipments, "the Department of Energy has agreed it will take back the depleted uranium it sent in December if we cannot implement disposal processes that ensure the long-term health and safety of all Utahns."

The Governor met Monday in Washington D.C. with Ines Triay, DOE's Assistant Secretary for Environmental Management. As a result of that hour-long meeting, the Department of Energy has agreed to divert two train loads of depleted uranium originally intended for storage at EnergySolutions' facility in Clive, Utah.

Additionally, a DOE representative will travel to Utah to address the state's Radiation Control Board and will work closely with state regulators to develop a site-specific performance assessment to determine if depleted uranium can be safely stored in the State of Utah. That process is expected to take up to two years.

The first DOE shipment of approximately 3,500 tons of material arrived in December from the Savannah River Site in South Carolina. It is being held in temporary storage until acceptable parameters for permanent storage are put in place.

If proper storage procedures cannot be achieved to the state's satisfaction, or if independent testing of the barrels reveals the waste exceeds Class A levels, the Department of Energy will immediately remove the depleted uranium from the state.

"The Department of Energy will be actively engaged in this process, and has committed to me, personally, that it will be responsible if the waste is not what it purports to be," Governor Herbert said. "I appreciate federal officials' time and attention to this matter and their understanding of its critical importance to the people of Utah."

The Governor's Office is currently working on a written document to memorialize the terms of the agreement.

Posted: January 13, 2010

At the direction of Governor Herbert, the Division of Radiation Control staff will conduct independent sampling of the first shipment of depleted uranium, which arrived at EnergySolutions' Clive landfill last month from the Department of Energy's (DOE) Savannah River cleanup. The samples will be sent to an outside lab for testing. Meanwhile, Governor Herbert is still negotiating with DOE regarding two remaining shipments slated for the EnergySolutions' landfill.

Posted: December 21, 2009

Governor Gary Herbert and the U.S. Department of Energy negotiated a deal last week that allows a trainload of depleted uranium to be temporarily stored at EnergySolutions' landfill, but not disposed, until a safety analysis deems DU can be safely buried at EnergySolutions up to 10,000 years in the future. Additional shipments of DU from Savannah River, South Carolina are suspended pending the site safety review that is under way.

Posted: December 16, 2009

Governor Gary Herbert is asking the U.S. Department of Energy to halt shipments of depleted uranium from Savannah River in South Carolina to EnergySolutions' landfill in Clive, Utah. In a December 15 letter to Energy Secretary Steven Chu, Herbert said Utah regulators need more time to make sure the EnergySolutions site can safely dispose of the waste. Read Governor Herbert's letter.

Posted: December 14, 2009

The Department of Energy announced last week that it plans to ship 11,000 tons of depleted uranium from the Savannah River cleanup in South Carolina to EnergySolutions' low-level radioactive waste facility in Clive, Utah. Included in a pending license condition is a requirement that EnergySolutions would have to remove the waste if the site safety analysis demonstrates that depleted uranium could not be safely disposed at the landfill for at least 10,000 years. Get more information on the license amendment.

Posted: December 9, 2009

On Tuesday, Dec. 8, the Radiation Control Board moved forward with rulemaking on the disposal of depleted uranium, looking 10,000 years in the future. The rule is subject to a 30 day public comment period after the rule is published in Administrative Rules.

Posted: November 23, 2009

The Utah Department of Environmental Quality, Division of Radiation Control (DRC), on behalf of the Utah Radiation Control Board, is requesting public comment regarding an amendment to EnergySolutions' Low-Level Radioactive Waste Disposal License (RML UT2300249). The License Amendment is proposed to impose certain requirements regarding the receipt and disposal of Depleted Uranium (DU). The Proposed License Condition No. 35 will be available for review and/or copying between 7:00 a.m. and 6:00 p.m., Monday through Thursday, at:

Utah Department of Environmental Quality
Division of Radiation Control
Room 212, Airport East Business Building (Bldg #2)
168 North 1950 West
Salt Lake City, Utah 84114-4850

A 30-day public comment period will commence on November 23, 2009. Written comments will be accepted until the close of business on December 23, 2009. Written comments should be sent to the address listed above. All comments received within the 30-day comment period will be considered when making a final decision regarding this License Amendment.

Additional information regarding the proposed License Amendment may be obtained by calling Dane Finerfrock at 801-536-4250, or by writing the DRC at the aforementioned address. In compliance with the Americans with Disabilities Act, individuals with special needs (including auxiliary communicative aids and services) should contact Brooke Baker, Office of Human Resources, at 801-536-4412 (TDD 536-4414) at least 10 working days prior to close of the comment period.

Posted: November 12, 2009

The Radiation Control Board at its November 10th meeting decided to seek rulemaking that would require EnergySolutions' to conduct a performance assessment (safety analysis) before disposing of significant amounts of depleted uranium. Considering the regulation wouldn't go into effect for 90 to 120 days, EnergySolutions could still take depleted uranium under an amended license.

Posted: October 13, 2009

In its meeting, the Radiation Control Board decided to require that a performance assessment (safety analysis) be provided to the Division of Radiation Control prior to receiving depleted uranium for disposal. The decision reverses the Board position taken at the September meeting.

Posted: September 24, 2009

On September 22, the Radiation Control Board voted against pursing rulemaking that may have resulted in a temporary moratorium on depleted uranium (DU) disposal at EnergySolutions. The Board directed that the Utah Division of Radiation Control amend EnergySolutions' license to include a performance assessment on the suitability of DU disposal. This would require Energy Solutions to assure that any DU taken prior to final NRC rulemaking is ultimately disposed of in compliance with future performance standards.

Composition of the U.S.DOE Depleted Uranium Inventory

The past use of uranium recycled from spent fuel for the feed of U.S. uranium enrichment plants raises a number of questions concerning the composition of the U.S. depleted uranium inventory. An assessment of the hazards resulting from the use of such depleted uranium (for whatever purpose) is only possible if the composition of the material is fully known. The follwing is a (still incomplete) compilation of currently accessible information.

A first look at the U.S. depleted uranium inventory shows that the material has no uniform quality, given already the wide range of tails assays (Table 1 and Fig. 1). These figures were published in 1992; the inventory since has increased by approx. 90,000 t U [DOE_1999c, p.1-18].
The following information on the characteristics of the depleted uranium used by the U.S. Department of Defense (DoD) is given in [AEPI_1995, p.23]:

> "Military Specification MIL-U-70457 stipulates that DU used by DoD must have a ^{235}U concentration of less than 0.3 percent [...] DoD actually uses DU containing approximately 0.2 percent ^{235}U."

and:

> "DU may have trace amounts (about 0.003 weight percent) of ^{236}U."

The majority of the depleted uranium produced so far still is located at the enrichment plants where it was generated, mostly in the chemical form of UF_6. Of the 118,784 t U in the 1992 depleted uranium stocks meeting the tails assay of less than 0.21 wt% U-235 used by DoD, 64% were located at Paducah, 17% at Portsmouth, and 19% at Oak Ridge.
Since each of these plants had a different operation history, the DU inventory of each plant has to be looked at separately.

Paducah enrichment plant (PGDP), Kentucky

The Paducah gaseous diffusion plant enriched the UF_6 from its natural assay of 0.71 wt% U-235 to about 2.75 wt% U-235. For further enrichment, the material was shipped to the Oak Ridge and Portsmouth plants.
In addition to natural uranium, also uranium recycled from spent fuel was fed into the Paducah enrichment cascade (Table 2 and Fig. 2). The recycled uranium introduced various isotopes not found in natural uranium into the cascade: fission products, such as Technetium-99; transuranics, such as Neptunium-237 and Plutonium-239; and the artificial uranium isotope of Uranium-236.
The spent fuel, from which uranium was recycled, originated from the Hanford and Savannah River military plutonium production reactors. This uranium was recycled, although its assay of U-235 was somewhat lower than in natural uranium (Table 2). This obviously must be seen in the context of the Cold War era, when uranium was a scarce resource. Due to the low burn-up of the military reactors, concentrations of artificial U-236 are comparatively low in this recycled uranium. The recycled uranium represents about 13% of the total feed to the plant. In single years, up to 65% of the feed were from recycled uranium.

Oak Ridge enrichment plant (ORGDP, K-25), Tennessee

The Oak Ridge gaseous diffusion plant processed natural uranium, pre-enriched uranium from Paducah, 5104 t U recycled from spent fuel of military reactors (Table 3), and a total of approx. 420 t U of uranium recycled from spent fuel of (mostly foreign) commercial reactors, the latter

representing about 1% of the total feed to the plant (Tables 4+5). Most of the latter material had U-235 assays higher than natural and a wide range of U-236 concentrations.

Portsmouth enrichment plant (PORTS), Piketon, Ohio

The Portsmouth gaseous diffusion plant processed natural uranium, pre-enriched uranium from Paducah, 1112 t U recycled from spent fuel of military reactors, and minor amounts of uranium recycled from spent fuel of miscellanous sources. The recycled uranium represented 0.35% of Portsmouth's total feed; in single years, the recycled uranium constituted up to 6.77% of the feed (Table 6).

Table 1: U.S. DOE Depleted Uranium Inventory as of June 30, 1992

U-235 Assay [wt %]	Paducah [t U]	Portsmouth [t U]	Oak Ridge [t U]	Total [t U]	Total [%]
< 0.21	75405	20628	22751	118784	32.87%
0.21 to < 0.24	752	2696	1823	5271	1.46%
0.24 to < 0.26	51883	39635	9546	101064	27.97%
0.26 to < 0.28	1129	1671	683	3483	0.96%
0.28 to < 0.31	28270	4584	1574	34428	9.53%
0.31 to < 0.50	59586	35300	0	94886	26.26%
0.50 to < 0.60	506	0	0	506	0.14%
0.60 to < 0.711	2931	0	0	2931	0.81%
Total	220462	104514	36376	361352	100.00%
Total [%]	61.01%	28.92%	10.07%	100.00%	

t = metric tonne
Source: [DOE, 1994]

Fig. 1:

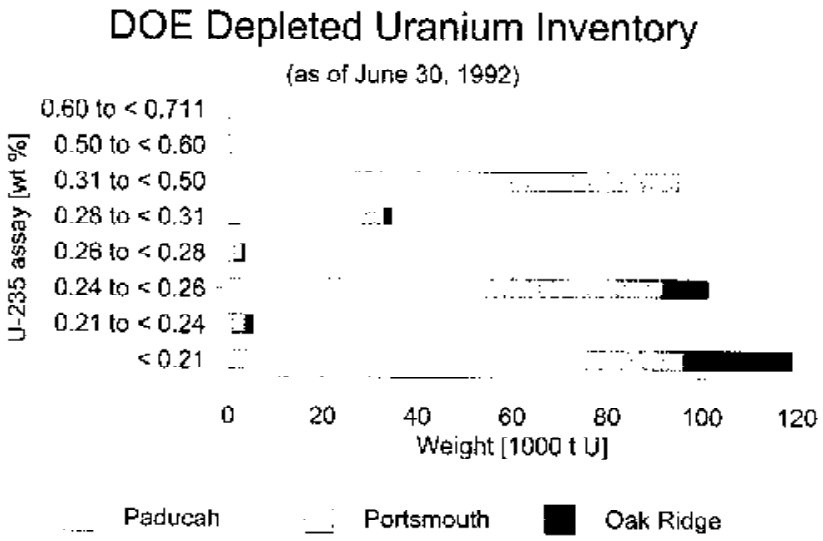
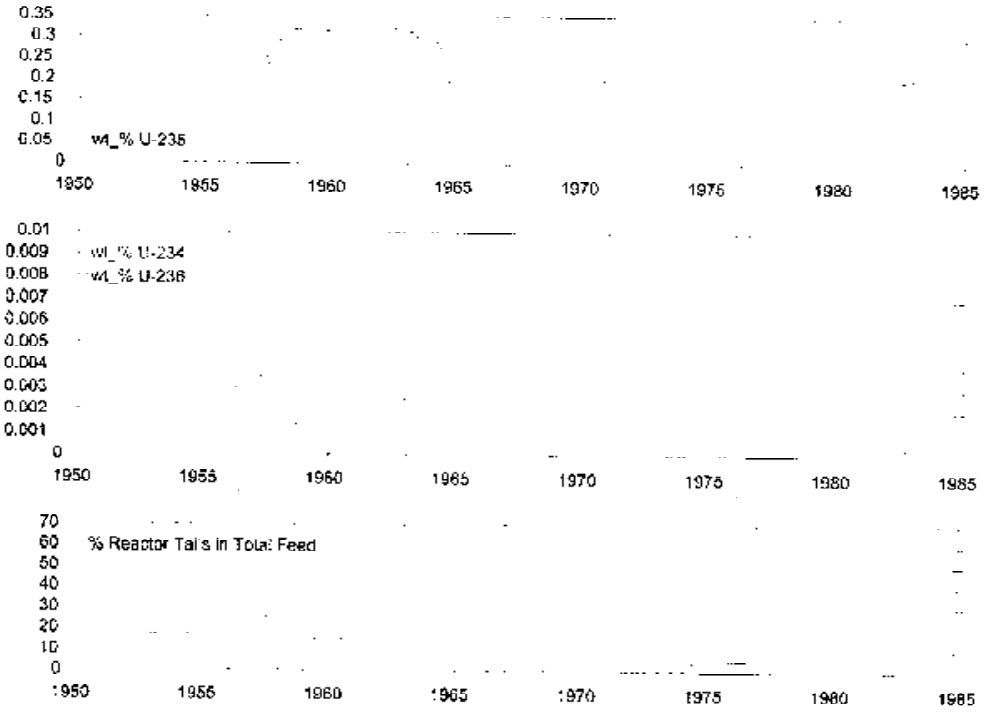


Table 2: Minor isotopes in reactor tails fed into Paducah cascade 1953 - 1976

	Depleted Reactor Tails		Enriched Reactor Tails	Total
Origin	Hanford	Savannah River	?	
Weight [short tons U]	95492	3622	2154	101268
U-235 [wt_%]	0.64%	0.59%	0.73%	0.64%
U-236 [wt_%]	0.011%	0.017%	0.041%	0.012%

1 short ton = 907.185 kg
Concentrations shown in the "Total" column are weighted averages (added by WISE Uranium)
Source:[DOE_1984, p. 35/41]

Fig. 2: Minor isotopes in Paducah cascade tails



Source: data: [DOE_1984, p. 29, 51-53], drawing: WISE Uranium

Table 3: Oak Ridge Domestic Reactor Tails Feed Summary 1958 - 1974 [short tons]

	Origin		
	Hanford	Savannah River	Total
1958	1596		1596
1959	487		487
1960	1256	88	1344
1961	242	932	1174
1962		318	318
1970	392		392
1974	316		316
Total	4289	1338	5627

1 short ton = 907.185 kg
Source: [DOE_1984, p. 31]

Table 4: Oak Ridge GDP Reactor Return Feed Summary: Toll Enrichment
[number of cylinders]

	Reactor Return Feed						Natural Feed	% Reactor Return Feed *)
	Euro-Chem (B)	BNFL (UK)	Cogéma (F)	German	Russian	Subtotal		
1969			10			10	252	0.98%
1970	2	2	10			14	549	0.63%
1971						0	223	0.00%
1972		2	17			19	333	1.41%
1973		7	28			35	524	1.64%
1974		15	16			31	497	1.54%
1975		14				14	563	0.62%
1976		9	3			12	592	0.50%
1977	5	13				18	565	0.79%
1978		4	12			16	492	0.81%
1979			11	2		13	187	1.71%
1980			28		3	31	340	2.23%
1981			53			53	369	3.47%
1982			8			8	659	0.30%
Total	7	66	196	2	3	274	6145	1.10%

*) assuming the following cylinder contents:

Cylinder capacity [short tons UF_6]	2.5	10	

Reactor Return cylinder capacity according to [KY/L-1239 p.14]
Natural Feed cylinder capacity assumed by WISE Uranium
1 short ton UF_6 = 0.907185 t UF_6 = 0.613 t U
Source: [DOE 1983, p. 13], percentages added by WISE Uranium

Table 5: U-236 Concentrations in Oak Ridge GDP Feed: Toll Enrichment [wt_% U-236]

	Reactor Return Feed						Total Feed *)
	Euro-Chem (B)	BNFL (UK)	Cogéma (F)	German	Russian	Subtotal *)	
1969			0.039%			0.039%	0.000%
1970	0.185%	0.050%	0.232%			0.199%	0.001%
1971							0.000%
1972		0.071%	0.158%			0.149%	0.002%
1973		0.045%	0.242%			0.203%	0.003%
1974		0.011%	0.176%			0.096%	0.001%
1975		0.012%				0.012%	0.000%
1976		0.011%	0.022%			0.014%	0.000%
1977	0.029%	0.057%				0.049%	0.000%
1978		0.051%	0.152%			0.127%	0.001%
1979			0.042%	0.028%		0.040%	0.001%
1980			0.254%		0.016%	0.231%	0.005%
1981			0.239%			0.239%	0.008%
1982			0.240%			0.240%	0.001%

*) weighted average, assuming the above cylinder sizes

Source: [DOE_1983, p. 14]: Subtotal and Total percentages added by WISE Uranium

Average tails assay of the domestic reactor tails fed to Oak Ridge: 0.64 wt_% U-235 for Hanford material, 0.60 wt_% U-235 for Savannah River material

Table 6: Portsmouth GDP Feed Summary 1955 - 1997 [t U]

	Hanford and Savannah River Reactor Tails	Total Feed	% Reactor Tails
1955	93.4	14112.4	0.66%
1956	363.1	9814.7	3.70%
1957	6.2	4516.5	0.14%
1958	64.2	4913	1.31%
1961	16.9	5804.7	0.29%
1970	168.2	4019.7	4.18%
1974	400	5907.4	6.77%
Total 1955 - 1997	1112	320817.2	0.35%

Source: [DOE_2000b, p.85/86] (years with no feed from reactor tails not shown in detail)

References

[AEPI_1995] Health and Environmental Consequences of Depleted Uranium Use in the U.S.Army: Technical Report. Army Environmental Policy Institute, Atlanta, Georgia 1995, 200+ p.,
<http://www.aepi.army.mil/Library/AEPI%20Publications/DU/techreport.html>

[DOE_1983] W.D. Hedge: Toll enrichment uranium hexafluoride: Natural and reactor return feed analyses at ORGDP for CY 1982, including summaries for CYs 1969 - 1982, K/TL/AT-58, Rev. 1, Addendum 2, April 1983
<http://www.oakridge.doe.gov/Foia/GDP-0630.awd>

[DOE_1984] Historical Impact of Reactor Tails on the Paducah Cascade, by R. F. Smith, U.S. DOE, March 1984 (unclassified)
<http://www.oakridge.doe.gov/Foia/KY-L-1239.pdf>

[DOE_1994] T.J. Hertzler, D.D. Nishimoto: Depleted Uranium Management Alternatives, EGG-MS-11416, August 1994

[DOE_1999a] Past Recycled Uranium Programs Under Review as Energy Department Investigation Continues. U.S. DOE news release R-99-262 of Sept. 29, 1999.
<http://www.energy.gov/HQPress/releases99/seppr/pr99262.htm>

[DOE_1999c] Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride, Vol. 1, U.S. Department of Energy, Office of Nuclear Energy, Science and Technology. DOE/EIS-0269, April 1999
<http://web.ead.anl.gov/uranium/finalpeis.cfm>

[DOE_2000b] Recycled uranium mass balance project Portsmouth, Ohio, site report. April 14, 2000, BCJ/PORTS-139
<http://www.oakridge.gov/Foia/GDP-0972.awd>

WISE Uranium Project, Peter Diehl
http://www.wise-uranium.org

revised: June 17, 2005

WISE Uranium Project - Fact Sheet

Hazards from depleted uranium produced from reprocessed uranium

There has been concern about the detection of uranium-236 in depleted uranium (DU) used for the production of ammunition. U-236 is an artificial nuclide of uranium which only can result from the use of uranium recycled from spent fuel. Therefore, the question is raised, whether other nuclides usually found in spent fuel, such as the transuranics plutonium (Pu-239) and neptunium (Np-237) might also be present in the depleted uranium, and what the health hazard from their presence would be. Due to their heavy atomic weights, transuranics introduced into the enrichment process would concentrate in the tails stream and would therefore show up in the depleted uranium.

The amounts of recycled uranium used in U.S. enrichment plants were first disclosed by the U.S. Department of Energy (DOE) in 1999:

> "At the Paducah uranium enrichment plant, recycled uranium was introduced into the enrichment "cascade" shortly after the startup of the plant in 1953 and continued through 1964. Activities were resumed in 1969 and continued through 1976. Paducah received approximately 100,000 tons (90,000 metric tons) of recycled uranium containing an estimated 328 grams of plutonium, 18.4 kilograms of neptunium and 661 kilograms of technetium-99. Operations at Paducah included the conversion of uranium oxide to uranium hexafluoride at a feed plant located onsite. The converted material was subsequently introduced into the gaseous diffusion "cascade" for further enrichment." [DOE_1999a]

These figures are based on [DOE_1984]; more details are also available in [DOE_2000].

For an assessment of the hazards from the transuranics, we first have to determine the concentrations of all nuclides of interest in the depleted uranium. For this purpose, we first need to calculate the mass balance of the enrichment process. We then calculate the inhalation doses from the depleted uranium and compare the dose contributions from the nuclides of interest.

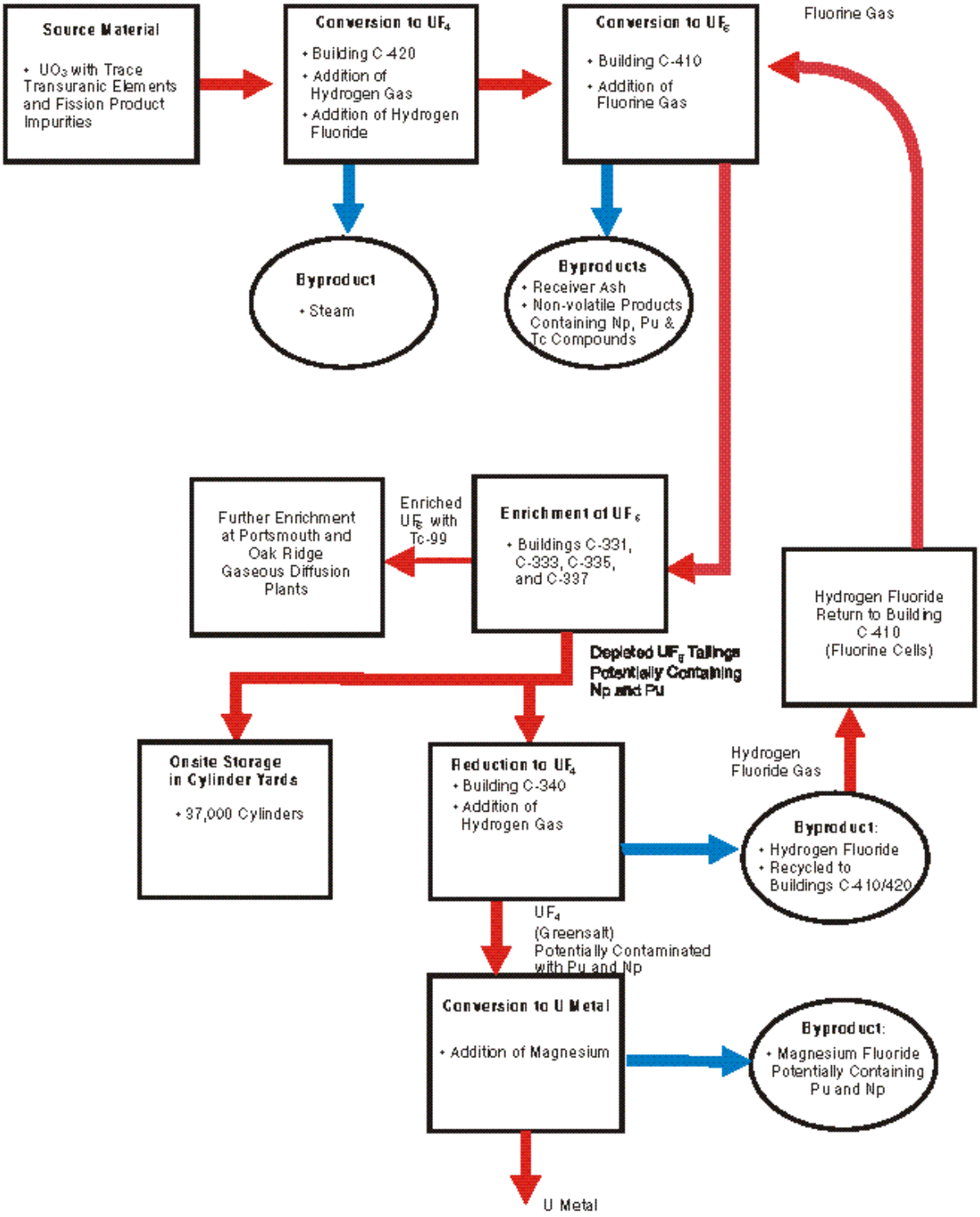
Mass balance for uranium enrichment at Paducah [DOE_1984, p.35]

	Feed	Product	Tails	Other
Mass [st]	758002	124718	621894	11390
Mass fraction	100.00%	16.45%	82.04%	1.50%

Concentration of plutonium in tails (depleted uranium) from enrichment of reprocessed uranium, assuming that all plutonium were transfered to the tails:

$$0.328 \text{ kg} / (101{,}268 \text{ st} \cdot 907.185 \text{ kg/st} \cdot 0.8204) = 4.352 \cdot 10^{-9} = 4.352 \text{ ppb}$$

Concentration of neptunium in tails from enrichment of reprocessed uranium uranium, assuming that all neptunium were transfered to the tails:



Schematic of historic uranium enrichment process at Paducah [DOE_1999b]

$$18.4 \text{ kg} / (101{,}268 \text{ st} \bullet 907.185 \text{ kg/st} \bullet 0.8204) = 2.441 \bullet 10^{-7} = 244.1 \text{ ppb}$$

For comparison, we first calculate the inhalation dose from depleted uranium produced from natural uranium. We assume that the short-lived decay products have reached secular equilibrium with their parent nuclides (shown in bold).

Inhalation Dose from Depleted Uranium from Enrichment of Natural Uranium
(from enrichment to 3.5%, tails assay 0.2%)
ICRP72 (public) inhalation, adults, Type S (insoluble forms)

Nuclide	Half-life	Spec. act. [Bq/g]	Conc. [wt_%]	Dose fact. [Sv/Bq]	**Eff. dose** [Sv/g DU]	Dose fraction
U-238	4.468e9 a	1.245e+04	9.980e+01	8.000e-06	9.936e-02	83.73%
Th-234	24.1 d			7.700e-09	9.563e-05	0.08%
Pa-234m	1.17 m					
U-235	7.038e8 a	8.001e+04	2.000e-01	8.500e-06	1.360e-03	1.15%
Th-231	25.52 h			3.300e-10	5.281e-08	0.00%
U-234	2.445e5 a	2.313e+08	8.210e-04	9.400e-06	1.785e-02	15.04%
Total			1.000e+02		**1.187e-01**	100.00%

(Nuclide concentrations after [Neghabian_1991])

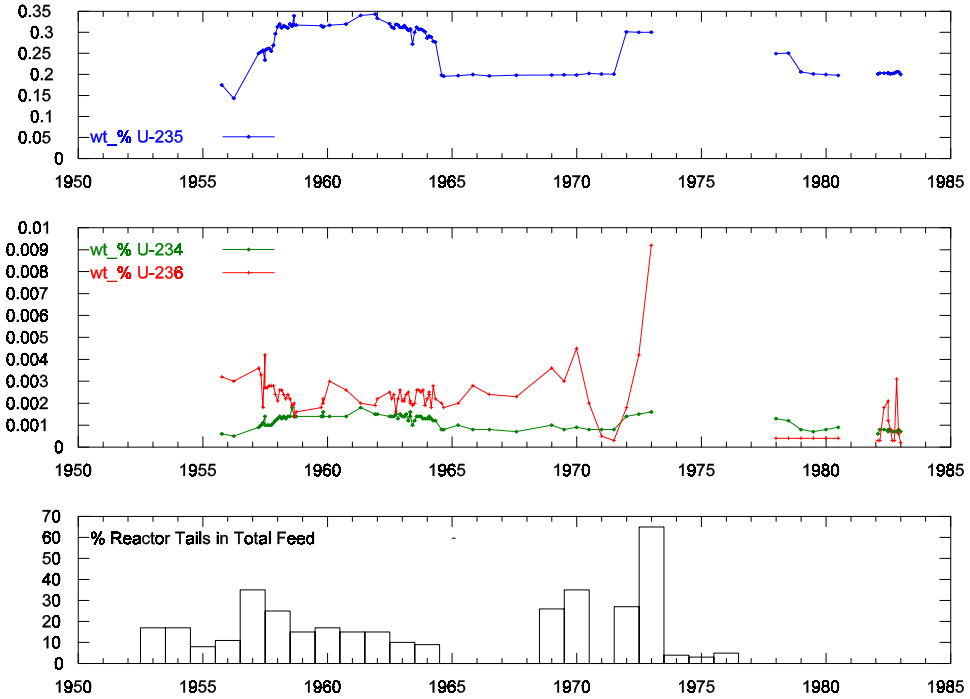
So, the effective dose from inhalation of depleted uranium produced from natural uranium would be 119 mSv/g.

For depleted uranium from enrichment of reprocessed uranium, the isotope composition is different, and several new nuclides have to be considered - mainly U-236, Pu-239, and Np-237.

Data from Paducah tails shows concentrations of U-236 of up to 0.0045 wt_%, with typical values in the range of 0.002 - 0.003 wt_% for a tails assay of 0.2% U-235 [DOE_1984 pp.18, 53-55]. Actual monitoring results from DU used for ammunition are as follows: [AEPI_1995] gives a figure of 0.003% U-236; this was confirmed by independent measurements in the U.S. [Dietz_1996]; UNEP found a slightly lower 0.0028% in Kosovo [UNEP_2001a], 0.0027% in Serbia [UNEP_2002a], and 0.0027 - 0.0029% in Bosnia [UNEP_2003a].
Note: these figures are about 75-fold lower than would be expected, if the Paducah feed had been obtained from commercial reactors. This is due the fact that the vast majority of the reprocessed material came from military reactors in Hanford and Savannah River (low burnup), and that the reprocessed material constituted only approx. 13% of the Paducah feed.

U-234 concentrations in Paducah tails ranged rom 0.0006 to 0.0010 wt_% for a tails assay of 0.2% U-235 [DOE_1984 p.15]; this is a typical tails assay for the DU used in ammunition [AEPI_1995].

Minor uranium isotopes in Paducah tails [after DOE_1984]



With this data, we obtain the following results:

Inhalation Dose from Depleted Uranium used in DU penetrators
(assuming that all Pu-239 and Np-237 shows up in tails)
ICRP72 (public) inhalation, adults, Type S (insoluble forms)

Nuclide	Half-life	Spec. act. [Bq/g]	Conc. [wt_%]	Dose fact. [Sv/Bq]	**Eff. dose** [Sv/g DU]	Dose fraction
U-238	4.468e9 a	1.245e+04	9.980e+01	8.000e-06	9.936e-02	83.45%
Th-234	24.1 d			7.700e-09	9.563e-05	0.08%
Pa-234m	1.17 m					
U-236	2.342e7 a	2.396e+06	3.000e-03	8.700e-06	6.254e-04	0.53%
U-235	7.038e8 a	8.001e+04	2.000e-01	8.500e-06	1.360e-03	1.14%
Th-231	25.52 h			3.300e-10	5.281e-08	0.00%
U-234	2.445e5 a	2.313e+08	8.000e-04	9.400e-06	1.739e-02	14.61%
Pu-239	24131 a	2.295e+09	4.352e-07	1.600e-05	1.598e-04	0.13%
Np-237	2.14e6 a	2.610e+07	2.441e-05	1.200e-05	7.645e-05	0.06%
Pa-233	27 d			3.900e-09	2.485e-08	0.00%
Total			1.000e+02		**1.191e-01**	100.00%

So, the inhalation dose from DU used for penetrators would be only 0.7% higher than from DU obtained from enrichment of natural uranium. U-236 would contribute 0.53% to the dose, Pu-239 0.13%, and Np-237 0.06%.

The above calculations have assumed that all transuranics contained in the reprocessed uranium would have been introduced into the enrichment cascades. This is, however, a gross overestimation:

> "At both Paducah and Oak Ridge sites, the majority of the plutonium and neptunium was separated out as waste during the initial chemical conversion to uranium hexafluoride. Because of this, only a fraction of the plutonium contamination was actually introduced to the gaseous diffusion cascade at either plant. This waste was subsequently reprocessed to recover additional uranium and then reused.
> Of the 328 grams of plutonium present in the 100,000 tons of recycled uranium processed at the Paducah plant, only 0.1 gram of plutonium is estimated to have been introduced into the Paducah cascade. Transuranics including plutonium are believed to have been deposited on internal surfaces of the feed process equipment, with concentrations also being deposited in waste products." [DOE_1999a] (emphasis added)

If it is assumed, that all of these 0.1 g of plutonium were transfered to the tails, the plutonium-concentration in the tails would be 0.0013 ppb. It is, however, questionable whether any significant fraction of these 0.1 g of plutonium was transfered to the tails, according to DOE [DOE_1984 p.17].
There exists only sporadic monitoring data of plutonium concentrations in Paducah tails and in DU metal made from it for the years the reprocessed uranium was fed into the cascade. In no case has plutonium been found in amounts above the detection limit given by the respective measuring techniques used:

Monitoring data for plutonium in Paducah tails and products made thereof

Year	Item	Plutonium concentration	Reference
1957	DU metal	< 1 ppb (based on U)	[DOE_1963]
1963	tails	< 1 ppb (based on U)	
1964	tails	< 10 ppb	[DOE_1984, p.17]
1973	tails	< 0.01 ppb	
from 1975	tails	< 0.01 ppb	

1 ppb = 1 part per billion = 10^{-9}

And, of the18.4 kg of Np-237, only 4.6 kg is estimated to have been fed into the cascade. [DOE_1984 p.11]

According to these estimates, only less than 0.03% of the total plutonium and 25% of the total neptunium could have shown up in the tails. **Therefore, the inhalation dose from plutonium would cause only less than 0.000039% of the total dose, and the dose from neptunium would cause less than 0.016% of the total dose from the DU used for penetrators.**

Since February 2001, first monitoring results for plutonium in DU penetrators spent in Kosovo

are available. In several cases, the detection limit was low enough to actually find traces of plutonium. The results confirm, albeit for a few penetrators only, that the above assumptions (0.0013 ppb) are realistic. New data from penetrators recovered from target areas in Southern Serbia and Bosnia-Herzegovina shows plutonium concentrations up to 30 times higher.

Monitoring data for plutonium in uranium penetrators

Location	Plutonium concentration	Reference
Kosovo	< 0.0032 ppb (based on U)	[GSF_2001]
Kosovo	0.00035 - 0.0056 ppb	[UNEP_2001b]
Southern Serbia	0.019 ppb	[McLaughlin_2003]
Southern Serbia	0.0058 - 0.0138 ppb	[UNEP_2002a]
Bosnia	0.0022 - 0.0382 ppb	[UNEP_2003a]

1 ppb = 1 part per billion = 10^{-9}

For comparison: plutonium concentrations in the range of a few thousandth parts of a ppb are naturally found in uranium ore deposits: uranium-238 captures neutrons coming from various natural sources, such as cosmic radiation, and spontaneous fission of uranium-235. The product is uranium-239, which decays at a half-life of 23.4 minutes to neptunium-239, which, in turn, decays at a half-life of 2.355 days to plutonium-239. The plutonium actually found in penetrators would, however, nearly completely be from artificial sources. This is a result of the chemical processing of the material, reducing plutonium concentrations from any source.

In its 2003 assessment for Bosnia-Herzegovina, UNEP also reports concentrations of neptunium for 3 penetrators recovered:

Monitoring data for neptunium in uranium penetrators

Location	Neptunium-237 conc.	Reference
Bosnia	< 0.15 - 0.62 ppb	[UNEP_2003a]

1 ppb = 1 part per billion = 10^{-9}

The only database available so far of more than sporadic monitoring data of contaminants found in DU is for DU metal used for the fabrication of tank armor: The Idaho Nuclear Technology and Engineering Center (INTEC) has analyzed 60 samples of depleted uranium metal billets for transuranics and fission products [Army_2000]. Transuranics concentrations above the detection limits have been identified in this material, including not only plutonium-239, but also americium-241, neptunium-237, and plutonium-238. Furthermore, the fission product technetium-99 was detected.

Monitoring data for transuranics and fission products in DU armor

	Nuclide data			max. values found in DU armor		
	Half-life	Specific Activity [Bq/g]	Dose Coeff. [3]) [Sv/Bq]	Activity Conc. [2]) [Bq/g DU armor]	Conc. by weight [ppb]	Effective Dose [3]) [Sv/g DU armor]
Am-241	432.2 a	1.271e+11	4.2e-05	0.703	0.0055	3.0e-05
Np-237	2.140e6 a	2.611e+07	2.3e-05	0.137	5.2470	3.2e-06
Pu-238	87.75 a	6.340e+11	4.6e-05	0.074	0.0001	3.4e-06
Pu-239/240 [1])	24.13e3 a	2.296e+09	5.0e-05	0.1	0.0436	5.0e-06
Tc-99	213.0e3 a	6.280e+08	4.0e-08	19.98	31.8153	8.0e-07
Total						4.2e-05

[1]) nuclide data of Pu-239 only
[2]) [Army_2000]
[3]) ICRP 72 (Public) Inhalation, Adults, AMAD = 1 µm, Class M (Note: Other than for uranium and technetium, the inhalation dose coefficients for the transuranics increase rather than decrease with the solubility of the material.)

Thus, for DU armor containing 0.2% U-235 and 0.003% U-236, **the excess inhalation dose from transuranics and fission products of max. 0.042 mSv/g represents only a 0.035% increase over the dose from the DU alone**.

References

[AEPI_1995] Health and Environmental Consequences of Depleted Uranium Use in the U.S.Army: Technical Report. Army Environmental Policy Institute, Atlanta, Georgia 1995, 200+ p., <http://www.aepi.army.mil/Library/AEPI%20Publications/DU/techreport.html>

[Army_2000] Analysis of Transuranics and Other Contaminants in Depleted Uranium Armor Department of the Army, January 19, 2000 <http://www.nato.int/du/docu/us000119a.pdf>

[Dietz_1996] Contamination of Persian Gulf War Veterans and Others by Depleted Uranium, by Leonard A. Dietz, Niskayuna 1996 <http://www.wise-uranium.org/dgvd.html>

[DOE_1963] Plutonium Content of Depleted Uranium, Feb. 1, 1963 (unclassified)

[DOE_1984] Historical Impact of Reactor Tails on the Paducah Cascade, by R. F. Smith, U.S. DOE, March 1984 (unclassified) <http://www.oakridge.doe.gov/Foia/KY-L-1239.pdf>

[DOE_1999a] Past Recycled Uranium Programs Under Review as Energy Department Investigation Continues, U.S. DOE news release R-99-262 of Sept. 29, 1999, <http://www.energy.gov/HQPress/releases99/seppr/pr99262.htm>

[DOE_1999b] Phase One Independent Investigation of the Paducah Gaseous Diffusion Plant, U.S. DOE, October

1999
<http://tis.eh.doe.gov/oversight/paducah/pad_ph1.pdf>

[DOE_2000] Exposure Assessment Project at the Paducah Gaseous Diffusion Plant, Dec. 2000, <http://tis.eh.doe.gov/portal/feature/pr01007.html>

[GSF_2001] Kein Plutonium im Urangeschoss, Pressemitteilung GSF - Forschungszentrum für Umwelt und Gesundheit, GmbH, Neuherberg, 3./5.2.2001, <http://www.gsf.de>

[McLaughlin_2003] Actinide analysis of a depleted uranium penetrator from a 1999 target site in southern Serbia, by J.P. McLaughlin, L. León Vintró, K.J. Smith, P.I. Mitchell, Z.S. Zunic, in: Journal of Environmental Radioactivity 64 (2003) 155–165

[Neghabian_1991] Verwendung von wiederaufgearbeitetem Uran und von abgereichertem Uran, von A.R. Neghabian, H.J. Becker, A. Baran, H.-W. Binzel, Der Bundesminister für Umwelt, Naturschutz und Reaktorsicherheit (Hg.), Schriftenreihe Reaktorsicherheit und Strahlenschutz, BMU-1992-332, November 1991, 186 S.

[UNEP_2001a] UNEP Balkans press release, January 16, 2001

[UNEP_2001b] UNEP Balkans press release, February 16, 2001

[UNEP_2002a] Depleted Uranium in Serbia and Montenegro, Post-Conflict Environmental Assessment in the Federal Republic of Yugoslavia, UNEP, Geneva, March 2002, 200 p.
<http://postconflict.unep.ch/publications/duserbiamont.pdf>

[UNEP_2003a] Depleted Uranium in Bosnia and Herzegovina , Post-Conflict Environmental Assessment, United Nations Environment Programme, March 2003
<http://postconflict.unep.ch/publications/BiH_DU_report.pdf>

WISE Uranium Project, Peter Diehl
http://www.wise-uranium.org

first published: January 16, 2001
last revised: June 17, 2005

(es ist auch eine deutsche Version dieses Textes verfügbar)