Examination of Sludge from the Hanford K Basin Fuel Canisters

B.J. Makenas
R.B. Baker
R.P. Omberg
Duke Engineering & Services Hanford, Inc.

Date Published
April 1998

To Be Presented at
DOE Spent Nuclear Fuel and Fissile Materials Management
ANS/DOE
Charleston, South Carolina
September 8-11, 1998

Prepared for the U.S. Department of Energy

Fluor Daniel Hanford, Inc.
P.O. Box 1000
Richland, Washington

Hanford Management and Integration Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Examination of Sludge from the Hanford K Basins Fuel Canisters

Prepared for the U.S. Department of Energy

Fluor Daniel Hanford, Inc.
Richland, Washington

Hanford Management and Integration Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

RELEASE AUTHORIZATION

Document Number:	HNF-2034-FP
Document Title:	Examination of Sludge From the Hanford K Basin Fuel Canisters

This document, reviewed in accordance with DOE Order 1430.1D, "Scientific and Technical Information Management," and DOE G 1430.1D-1, "Guide to the Management of Scientific and Technical Information," does not contain classified or sensitive unclassified information and is:

APPROVED FOR PUBLIC RELEASE

V. L. Birkland — 4/22/98

V. L. Birkland
Lockheed Martin Services, Inc.
Document Control/Information Clearance

Reviewed for Applied Technology, Business Sensitive, Classified, Copyrighted, Export Controlled, Patent, Personal/Private, Proprietary, Protected CRADA, Trademark, Unclassified Controlled Nuclear Information.

INFORMATION CLEARANCE FORM

A. Information Category

- [ ] Abstract
- [ ] Summary
- [ ] Visual Aid
- [X] Full Paper
- [ ] Other
- [ ] Journal Article
- [ ] Internet
- [ ] Software
- [ ] Report

B. Document Number HNF-2034 ~~Rev 0~~ FP HNF-2034-FP

C. Title EXAMINATION OF SLUDGE FROM THE HANFORD K BASIN FUEL CANISTERS

D. Internet Address

E. Required Information

1. Is document potentially Classified? [X] No [ ] Yes (MANDATORY)

   R P Omberg
   Manager's Signature Required

   If Yes ______ [ ] No [ ] Yes Classified
   ADC Signature Required

2. Internal Review Required? [X] No [ ] Yes
   If Yes, Document Signatures Below

   Counsel ______

   Program ______

3. References in the Information are Applied Technology [X] No [ ] Yes
   Export Controlled Information [X] No [ ] Yes

4. Does Information Contain the Following: (MANDATORY)
   a. New or Novel (Patentable) Subject Matter? [X] No [ ] Yes
      If "Yes", Disclosure No.: ______
   b. Information Received in Confidence, Such as Proprietary and/or Inventions?
      [X] No [ ] Yes If "Yes", Affix Appropriate Legends/Notices.
   c. Copyrights? [X] No [ ] Yes If "Yes", Attach Permission.
   d. Trademarks? [X] No [ ] Yes If "Yes", Identify in Document.

5. Is Information requiring submission to OSTI? [ ] No [ ] Yes
   If Yes UC-2070 and B&R-EW 704 0000

6. Release Level? [X] Public [ ] Limited

7. Charge Code LB030

F. Complete for a Journal Article

1. Title of Journal N/A

G. Complete for a Presentation

1. Title for Conference or Meeting DOE SPENT NUCLEAR FUEL AND FISSILE MATERIALS MANAGEMENT
2. Group Sponsoring ANS/DOE
3. Date of Conference Sept 8-11 1998
4. City/State Charleston SC
5. Will Information be Published in Proceedings? [ ] No [X] Yes
6. Will Material be Handed Out? [X] No [ ] Yes

H. Author/Requestor A. MAKENAS (signature) (Print and Sign)

Responsible Manager R P Omberg RP OMBERG (Print and Sign)

I. Reviewers

	Yes	Print	Signature	Public Y/N (If N, complete J)
General Counsel	[X]	J. W. DEE	(signature)	(Y) / N
Office of External Affairs	[X]	Approval per telecon	S.A. Woody V.B. 4/20/98	(Y) / N
DOE-RL	[X]	J. S. SHUEN	J. S. Shuen 4/9/98	(Y) / N
Other	[ ]			Y / N
Other	[ ]			Y / N

J. If Information Includes Sensitive Information and is not to be released to the Public indicate category below.

- [ ] Applied Technology
- [ ] Personal/Private
- [ ] Proprietary
- [ ] Business-Sensitive
- [ ] Predecisional
- [ ] UCNI
- [ ] Protected CRADA
- [ ] Export Controlled
- [ ] Procurement-Sensitive
- [ ] Patentable
- [ ] Other (Specify) ______

Information Clearance Approval

APPROVED FOR RELEASE
OFFICIAL DOCUMENT
VB
Date 4/22/98

K. If Additional Comments, Please Attach Separate Sheet

A-6001-401 (10/97)

EXAMINATION OF SLUDGE FROM THE HANFORD K BASIN FUEL CANISTERS

B. J. Makenas, R. B. Baker, and R. P. Omberg
Duke Engineering & Services Hanford, Inc.
Post Office Box 350
Richland, Washington 99352
(509) 376-5447, 376-5109, 376-9353

ABSTRACT

Samples of sludges with a high uranium content have been retrieved from the fuel canisters in the Hanford K West and K East Basins. The composition of these samples contrasts markedly with the previously reported content of sludge samples taken from the K East Basin floor. Chemical composition, chemical reactivity, and particle size of sludge are summarized in this paper.

INTRODUCTION

The two water-filled Hanford K Basins (East and West) have been used to store uranium metal fuel from the N Reactor for roughly 20 and 15 years respectively. Efforts are currently underway to move the fuel to interim dry storage. Surrounding the fuel over a dozen different types of sludge (Figure 1) are found in these basins and their specific chemical and physical characteristics depend on the particular location of origin. Characterization is being performed to facilitate removal, transportation, treatment, and storage of sludge. A previous paper (Baker 1996) covered the characterization of sludge found on the floor of the K East Basin. This work has now proceeded through examination of the sludge found in the stainless steel and aluminum canisters used to store fuel in both basins (Figure 2). These in-canister sludges proved to be quite different than that found on the K East floor. There are also clear differences between sludges recovered from the K East versus K West canisters. K West canisters are sealed through a system that allows only limited water exchange with the basin. K East canisters are open to the pool. The compounds formed by the metals present are different in the two situations because of water stagnation and higher pH in the K West case.

RESULTS

The composition of various sludge types is summarized in Figure 3. The uranium content of sludge, primarily in the form of oxides and hydrates, was greatest in canister sludges (as a result of damaged fuel element corrosion) while the iron content (from rusty structural racks) was greatest in floor sludge. The inference of some hydride and unoxidized metallic uranium in the canister sludge can also be made respectively from X-ray Diffraction data and high dry particle density in excess of what would be expected for oxide. The presence of reactive materials in canister sludge is further demonstrated by the generation of hydrogen bubbles in samples of sludge during laboratory operations (see Figure 4).

K West canister sludge tends to have a smaller particle size (as determined by wet sieving and by laser scattering) than K East canister sludge and to settle more slowly. An example of particle size measurements is shown in Figure 5. K West canister sludge tends to have a higher uranium content than similar K East material because it is not diluted with the sand, concrete, paint chips, and organic material that enter the open-top K East canisters. Conversely, K West canister sludge contains a considerable amount of the graphite material that makes up the canister lid gaskets and some aluminum hydroxide that forms as a coating on assemblies housed in sealed aluminum canisters (Pitner 1998).

FUTURE WORK

Current efforts are focused on characterizing sludge from other areas of the basins as well as on the chemical treatment aspects of sludge disposal. Such treatments will include the oxidation of pyrophoric materials, the adjustment of particle size and the elimination of some organic compounds. These efforts will result in a reduction in the potential for hydrogen generation, better criticality control, and less regulatory rigor for hazardous constituents. Characterization information is being gathered to ensure that the chosen conditioning process can handle most or all of the various sludges at K Basins since they will nearly all wind up on the same ultimate disposal path.

ACKNOWLEDGEMENT

This work was supported by the United States Department of Energy. It was made possible through the efforts of many people at the Hanford K Basins, Hanford 222-S Laboratory, and Pacific Northwest National Laboratory.

REFERENCES

R. B. Baker, B. J. Makenas, and R. P. Omberg, "Sampling and Analysis of Sludge from the Hanford K East Basin," ANS, DOE Spent Fuel and Fissile Material Management, Reno, Nevada, June 1996.

A. L. Pitner, and B. J. Makenas, "Surface and Subsurface Deposits on Irradiated N Reactor Fuel Stored in Hanford K Basins," ANS, Charleston, DOE Spent Nuclear Fuel and Fissile Materials Management, September 1998.

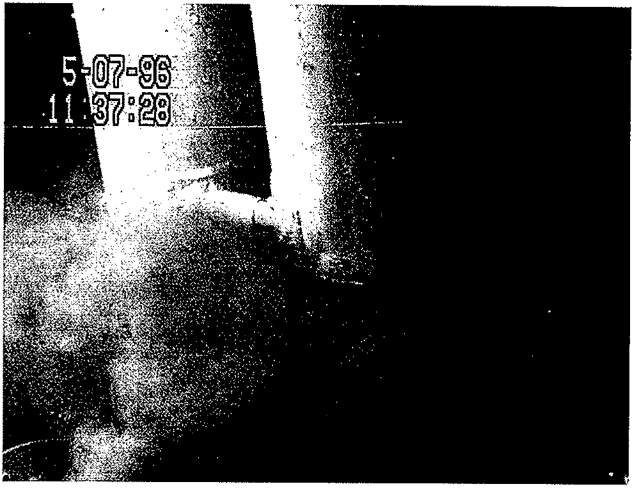

Figure 1. Sludge Trails from a Canister as it is Lifted from the K East Basin Floor.

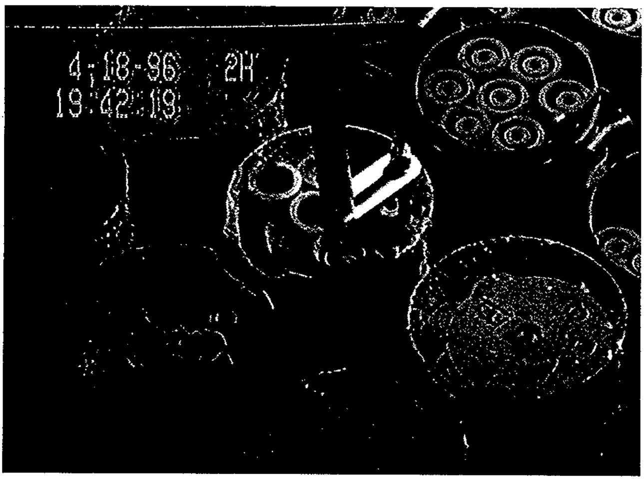

Figure 2. Sludge Extraction Tube Inserted in a K East Basin Canister.
Note the canister barrels are 8 inches in diameter with up to
seven fuel assemblies per barrel.

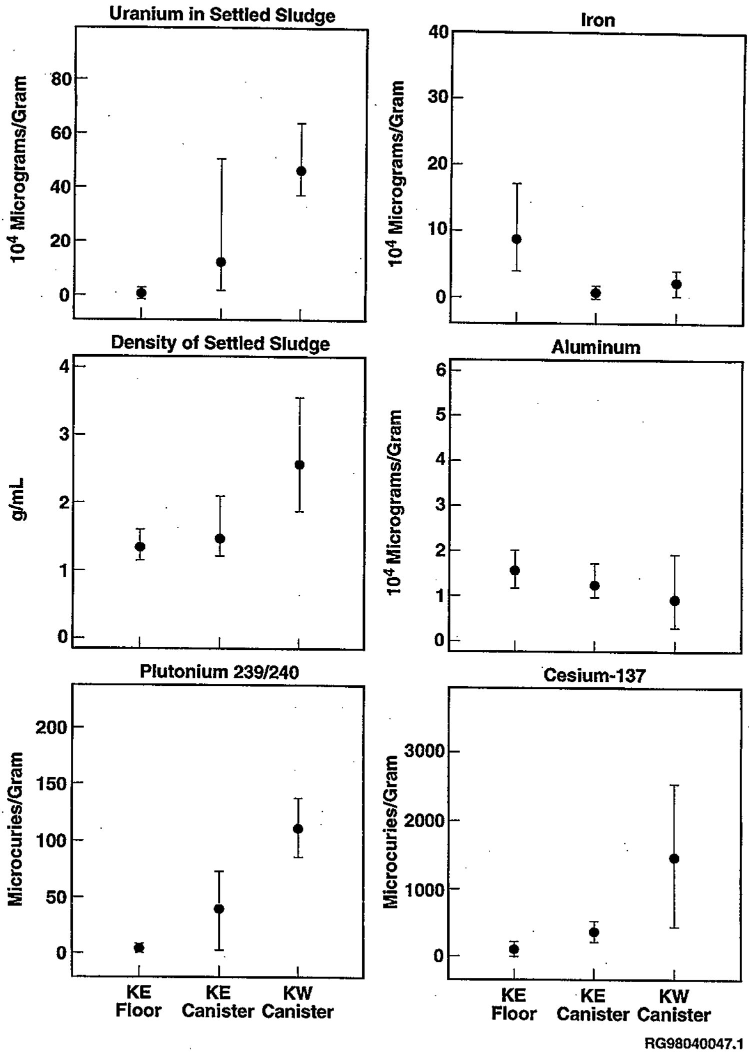

Figure 3. Comparison of Settled Sludge Composition for K East Basin Floor, K East Basin Canisters, and K West Basin Canisters.
Points are the median of data and error bars encompass 50% of the data.

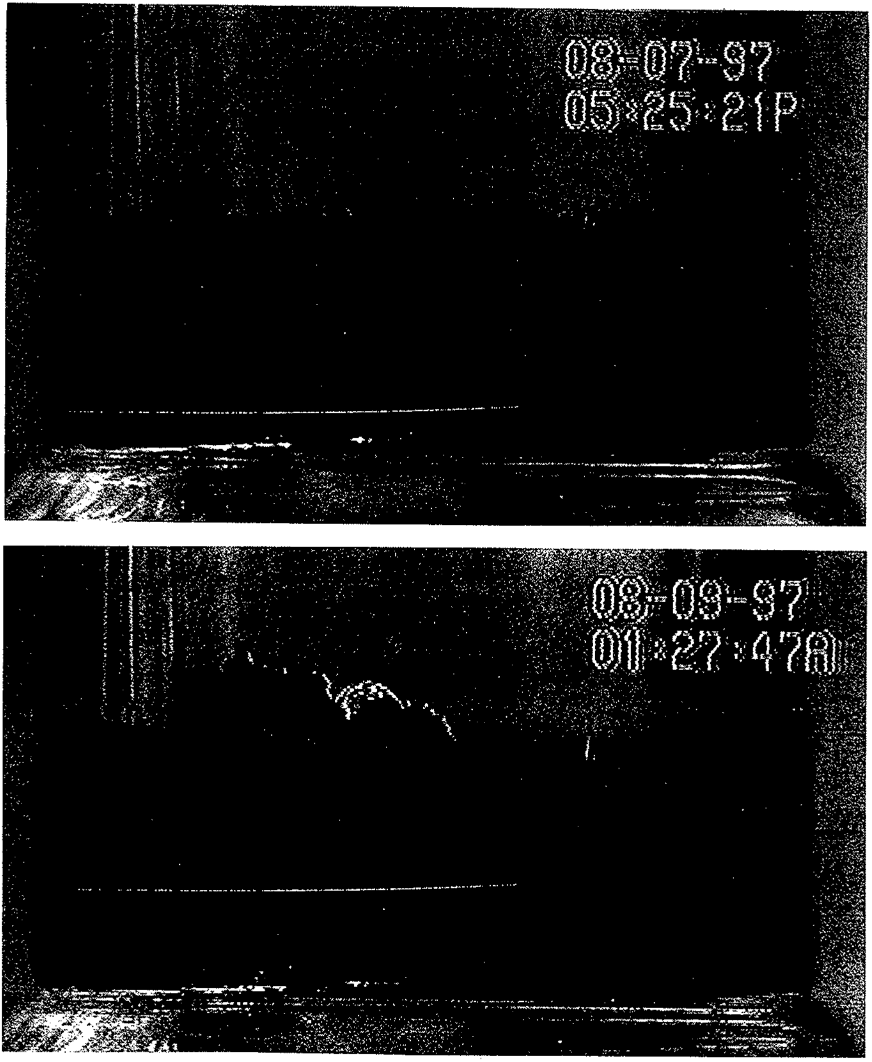

Figure 4. Two Views in a Hot Cell of a K East Canister Sludge Sample (Approximately 32 Hours) Apart. Includes only as-sieved sludge less than 710 microns in diameter. Note hydrogen bubble and displacements due to bubble formation.

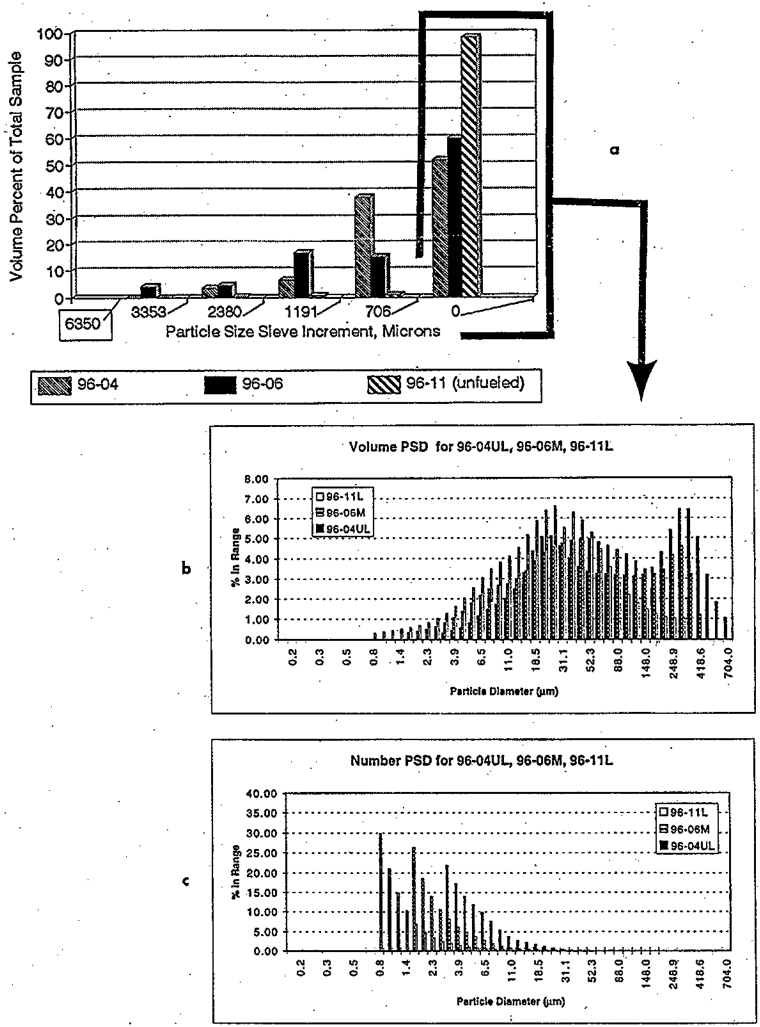

Figure 5. Particle Size Distribution for Three Samples of K East Basin Canister Sludge. (a) Sieving of all particles (b) volume distribution and (c) number distribution by laser scattering for particles less than 700 µm in diameter.