page 1 of 2

12/22/97

INFORMATION CLEARANCE FORM

A. Information Category

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

B. Document Number HNF-1942

C. Title In Situ Characterization of Hanford K Basins Fuel

D. Internet Address

E. Required Information

1. Is document potentially Classified? [x] No [ ] Yes (MANDATORY)
   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 Invention? [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 [x] Yes
   If Yes UC- 2070 and B&R- EW7040000
6. Release Level? [x] Public [ ] Limited
7. Charge Code LB07[illegible]

F. Complete for a Journal Article

1. Title of Journal

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, South Carolina
5. Will Information be Published in Proceedings? [ ] No [x] Yes
6. Will Material be Handed Out? [x] No [ ] Yes

H. Author/Requestor
A. L. Pitner (Print and Sign) A L Pitner

Responsible Manager
R. P. Omberg (Print and Sign) R P Omberg 12/15/97

I. Reviewers

	Yes	Print	Signature	Public Y/N (If N, complete J)
General Counsel	[x]	J.T. CURTIS	J.T. Curtis	(Y) / N
Office of External Affairs	[x]	S.A. Woody see attached page 2		(Y) / N
DOE-RL	[x]	J. Shuen	J S Shuen 1/6/98	(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
1/6/98

K. If Additional Comments, Please Attach Separate Sheet

12/22/97

INFORMATION CLEARANCE FORM

page 2 of 2

A. Information Category

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

B. Document Number HNF-1942

C. Title In Situ Characterization of Hanford K Basins Fuel

D. Internet Address

E. Required Information

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

_____ Manager's Signature Required

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

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 [x] Yes
If Yes UC- 2070 and B&R- EW7040000

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

7. Charge Code L8070

F. Complete for a Journal Article

1. Title of Journal

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, South Carolina
5. Will Information be Published in Proceedings? [ ] No [x] Yes
6. Will Material be Handed Out? [x] No [ ] Yes

H. Author/Requestor A. L. Pitner (Print and Sign)

Responsible Manager R. P. Omberg (Print and Sign) 12/15/97

I. Reviewers

	Yes	Print	Signature	Public Y/N (If N, complete J)
General Counsel	[x]	J.T. CURTIS		Y / N
Office of External Affairs	[x]	S.A. Woody	S A Woody	Y / N
DOE-RL	[x]	J. Shuen		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

K. If Additional Comments, Please Attach Separate Sheet

A-6001-401 (10/97)

12/22/97 14:38 DOCUMENT CONTROL SERVICES 001

In Situ Characterization of Hanford K Basins Fuel

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-AC-0696-RL13200

Approved for Public Release; Further Dissemination Unlimited

In Situ Characterization of Hanford K Basins Fuel

A. L. Pitner
Duke Engineering & Services Hanford, Inc.

Date Published
January 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-AC-0696-RL13200

Approved for Public Release; Further Dissemination Unlimited

RELEASE AUTHORIZATION

Document Number: HNF-1942

Document Title: In Situ Characterization of Hanford K Basins Fuel

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

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.

LEGAL DISCLAIMER. This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, not any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof. This report has been reproduced from the best available copy. Printed in the United States of America.

IN SITU CHARACTERIZATION OF HANFORD K BASINS FUEL

A. L. Pitner

I. INTRODUCTION

Irradiated N Reactor uranium metal fuel is stored underwater in the Hanford K East and K West Basins. In K East Basin, fuel is stored in open canisters and defected fuel is free to react with the basin water. In K West Basin, the fuel is stored in sealed canisters filled with water containing a corrosion inhibitor (potassium nitrite). To gain a better understanding of the physical condition of the fuel in these basins, visual surveys using high resolution underwater cameras were conducted. The inspections included detailed "lift and look" examinations of a number of fuel assemblies from selected canisters in each basin. These examinations formed the bases for selecting specific fuel elements for laboratory testing and analyses as prescribed in the characterization plan for Hanford K Basin Spent Nuclear Fuel.[1]

II. K EAST BASIN

Because the fuel is stored in open canisters in K East Basin, a basin-wide survey of the fuel assembly top ends was first performed.[2] Due to various obstacles and debris in the basin, only about 70% of the fuel assemblies were visible, but this nonetheless constituted a comprehensive

12/22/97 14:38 DOCUMENT CONTROL SERVICES 002

survey (~35,000 assemblies). Overall damage projections were made assuming that bottom end damage frequencies were the same as top end observations. While about half of the fuel assemblies appeared to be still intact, varying degrees of damage were noted. Figure 1 (top) shows badly degraded fuel elements contained in an aluminum canister. Severe fuel corrosion and split cladding are evident here.

A "lift and look" campaign was subsequently conducted where about 225 fuel assemblies were individually extracted from selected canisters and examined for damage over their full length.[3] The results basically supported the damage distributions derived from the previous top end only examinations.

III. K WEST BASIN

Fifty canisters were sampled to determine cesium levels, presumably an indicator of failed fuel. Based on these measurements, twenty canisters were selected for opening and "lift and look" examination of all fuel assemblies, about 250 in all.[4] Contrary to general expectations, substantial fuel damage was found in the sealed canisters, including broken elements and elements with split and dilated cladding. However, the extent of damage and observance of sludge was noticeably less than seen in K East Basin, presumably due to the effectiveness of the corrosion inhibitor. A stainless steel canister barrel with one of the highest measured cesium levels is shown in Figure 1 (bottom). While substantial fuel damage is evident here, the overall severity of damage is considerably less than that shown for K East Basin fuel.

12/22/97 14:38 DOCUMENT CONTROL SERVICES 003

IV. SURFACE COATINGS

All fuel elements have a coating on their surface. In K East Basin, this is a light gray film that is easily scratched. In K West Basin, the coatings vary from something similar to that seen in K East Basin, to some local crystalline-like formations, to a relatively heavy translucent coating that tends to flake off when disturbed.[5] In one K West Basin canister barrel, all the fuel elements had a red coating on them. All coatings but the heavy translucent type [identified as $Al(OH)_3$] were easily removed using a wire brush apparatus.

V. DAMAGE DISTRIBUTION

Most damage was observed on the outer elements of the fuel assemblies, which is to be expected based on their greater vulnerability during discharge and handling operations. About half of the outer elements in both basins were found to be intact, with no evidence of cladding rupture. On the order of 10% of the outer elements in each basin were found to be in an advanced stage of degradation, including cladding dilation and splitting. The remaining fraction of the outer elements (~40%) were failed to some degree (moderate rupture), but not grossly distorted.

The frequency of damage observed on the inner fuel elements was about one-fifth of that observed on the outer fuel elements.

12/22/97 14:39 DOCUMENT CONTROL SERVICES 004

The overall severity of damage on degraded fuel in K West Basin was notably less than that for degraded fuel in K East Basin. This is presumed to be a consequence of the corrosion inhibitor added to the sealed K West Basin canisters.

VI. APPLICATION

The fuel conditions established in these surveys is used extensively in the design and analysis of process systems being developed for the disposition of K Basins Spent Nuclear Fuel. This includes the fuel retrieval and cleaning systems, and projected fuel and scrap inventories for loading in Multi-Canister Overpacks (MCO's) for extended dry storage.

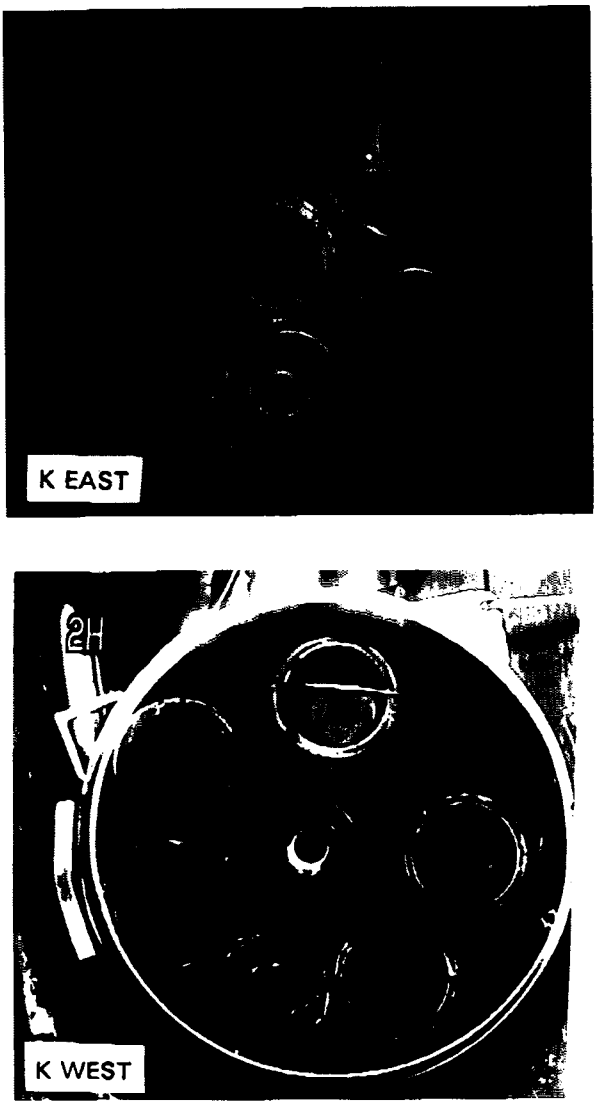
VII. REFERENCES

1. L. A. Lawrence, et al., *Characterization of Hanford K Basin Spent Nuclear Fuel and Sludge*, Proceedings of the Topical Meeting DOE Spent Nuclear Fuel and Fissile Material Management, Reno, Nevada, June 16-20, 1996.

2. A. L. Pitner, *K East Basin Underwater Visual Fuel Survey*, WHC-SD-SNF-TI-012, Rev. 0, February 1995, Westinghouse Hanford Company, Richland, Washington.

12/22/97 14:39 DOCUMENT CONTROL SERVICES 005

Figure 1. Degraded K Basins Fuel.



IN SITU CHARACTERIZATION OF HANFORD K BASINS FUEL

A. L. Pitner

I. INTRODUCTION

Irradiated N Reactor uranium metal fuel is stored underwater in the Hanford K East and K West Basins. In K East Basin, fuel is stored in open canisters and defected fuel is free to react with the basin water. In K West Basin, the fuel is stored in sealed canisters filled with water containing a corrosion inhibitor (potassium nitrite). To gain a better understanding of the physical condition of the fuel in these basins, visual surveys using high resolution underwater cameras were conducted. The inspections included detailed "lift and look" examinations of a number of fuel assemblies from selected canisters in each basin. These examinations formed the bases for selecting specific fuel elements for laboratory testing and analyses as prescribed in the characterization plan for Hanford K Basin Spent Nuclear Fuel.[1]

II. K EAST BASIN

Because the fuel is stored in open canisters in K East Basin, a basin-wide survey of the fuel assembly top ends was first performed.[2] Due to various obstacles and debris in the basin, only about 70% of the fuel assemblies were visible, but this nonetheless constituted a comprehensive

survey (~35,000 assemblies). Overall damage projections were made assuming that bottom end damage frequencies were the same as top end observations. While about half of the fuel assemblies appeared to be still intact, varying degrees of damage were noted. Figure 1 (top) shows badly degraded fuel elements contained in an aluminum canister. Severe fuel corrosion and split cladding are evident here.

A "lift and look" campaign was subsequently conducted where about 225 fuel assemblies were individually extracted from selected canisters and examined for damage over their full length.[3] The results basically supported the damage distributions derived from the previous top end only examinations.

III. K WEST BASIN

Fifty canisters were sampled to determine cesium levels, presumably an indicator of failed fuel. Based on these measurements, twenty canisters were selected for opening and "lift and look" examination of all fuel assemblies, about 250 in all.[4] Contrary to general expectations, substantial fuel damage was found in the sealed canisters, including broken elements and elements with split and dilated cladding. However, the extent of damage and observance of sludge was noticeably less than seen in K East Basin, presumably due to the effectiveness of the corrosion inhibitor. A stainless steel canister barrel with one of the highest measured cesium levels is shown in Figure 1 (bottom). While substantial fuel damage is evident here, the overall severity of damage is considerably less than that shown for K East Basin fuel.

IV. SURFACE COATINGS

All fuel elements have a coating on their surface. In K East Basin, this is a light gray film that is easily scratched. In K West Basin, the coatings vary from something similar to that seen in K East Basin, to some local crystalline-like formations, to a relatively heavy translucent coating that tends to flake off when disturbed.[5] In one K West Basin canister barrel, all the fuel elements had a red coating on them. All coatings but the heavy translucent type [identified as $Al(OH)_3$] were easily removed using a wire brush apparatus.

V. DAMAGE DISTRIBUTION

Most damage was observed on the outer elements of the fuel assemblies, which is to be expected based on their greater vulnerability during discharge and handling operations. About half of the outer elements in both basins were found to be intact, with no evidence of cladding rupture. On the order of 10% of the outer elements in each basin were found to be in an advanced stage of degradation, including cladding dilation and splitting. The remaining fraction of the outer elements (~40%) were failed to some degree (moderate rupture), but not grossly distorted.

The frequency of damage observed on the inner fuel elements was about one-fifth of that observed on the outer fuel elements.

The overall severity of damage on degraded fuel in K West Basin was notably less than that for degraded fuel in K East Basin. This is presumed to be a consequence of the corrosion inhibitor added to the sealed K West Basin canisters.

VI. APPLICATION

The fuel conditions established in these surveys is used extensively in the design and analysis of process systems being developed for the disposition of K Basins Spent Nuclear Fuel. This includes the fuel retrieval and cleaning systems, and projected fuel and scrap inventories for loading in Multi-Canister Overpacks (MCO's) for extended dry storage.

VII. REFERENCES

1. L. A. Lawrence, et al., *Characterization of Hanford K Basin Spent Nuclear Fuel and Sludge*, Proceedings of the Topical Meeting DOE Spent Nuclear Fuel and Fissile Material Management, Reno, Nevada, June 16-20, 1996.

2. A. L. Pitner, *K East Basin Underwater Visual Fuel Survey*, WHC-SD-SNF-TI-012, Rev. 0, February 1995, Westinghouse Hanford Company, Richland, Washington.

3. A. L. Pitner, *Visual Examinations of K East Fuel Elements*, HNF-SD-SNF-TI-045, Rev. 0, February 1997, Duke Engineering & Services Hanford, Inc., Richland, Washington.

4. A. L. Pitner, *Visual Examinations of K West Fuel Elements*, HNF-SD-SNF-TI-046, Rev. 0, February 1997, Duke Engineering & Services Hanford, Inc., Richland, Washington.

5. A. L. Pitner and B. J. Makenas, *Surface and Subsurface Deposits on Irradiated N Reactor Fuel Store in the Hanford K Basins*, Proceedings of the Topical Meeting DOE Spent Nuclear Fuel and Fissile Material Management, Charleston, South Carolina, September 8-11, 1998.

Figure 1. Degraded K Basins Fuel.