Surface and Subsurface Deposits on Irradiated N Reactor Fuel Stored in the Hanford K Basins

Prepared for the U.S. Department of Energy

Fluor Daniel Hanford, Inc.
Richland, Washington

Hanford Management and Integration Contractor for the
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SURFACE AND SUBSURFACE DEPOSITS ON IRRADIATED N REACTOR FUEL STORED IN THE HANFORD K BASINS

A. L. Pitner and B. J. Makenas

I. INTRODUCTION

Irradiated N Reactor uranium metal fuel is being stored in two water filled basins in the 100K Area. The Integrated Process Strategy[1] for this fuel involves transfer to containers called Multi-Canister Overpacks (MCO's) and vacuum drying the MCO's to remove free water prior to extended dry storage. A major concern for MCO loading of this fuel is potential bound water in subsurface particulate material near damaged areas on the fuel elements, and in surface coating deposits. To investigate these characteristics, selected fuel elements were transferred to a hot cell for examination and sampling per the K Basins Spent Nuclear Fuel characterization plan.[2] Fuel elements were taken from both K East Basin where the fuel is stored in open canisters, and from K West Basin where the canisters are sealed and contain a corrosion inhibitor.

II. ELEMENT SELECTION

Selection of the elements for hot cell sampling was based on the visual appearance of the elements recorded during detailed "lift and look" examinations,[3] where about 500 individual fuel elements were extracted from

their canisters and examined full length. Two elements from K West Basin were selected for their unusual coating characteristics; one with a heavy translucent type of coating and the other with a reddish coating. The intent was to remove as much coating as possible from these elements for subsequent testing and analysis. Three elements were selected for subsurface examinations and samplings; one from K East Basin and two from K West Basin. The latter elements were chosen based on the apparent "peelability" of damaged cladding and the potential for corroded fuel beneath the damaged areas. Small surface coating samples were also to be taken from these three elements for compositional analyses.

III. PROCEDURE

Most of the coating samples were removed in the hot cell using an abrasive pad, which worked effectively. For the heavy translucent coating, however, a putty knife was employed to dislodge the material from the cladding surface, as shown in Figure 1. Flakes of the coating were captured in a Petri dish.

To obtain the subsurface samples, areas of split cladding were worked using a combination of small pry bars and gripper tools to peel away the cladding. Figure 2 shows cladding being pried free at a midsection break. Once all the loose cladding was removed, as much particulate material as possible was recovered from the damaged area using picks, scrapers, and brushes.

The water from each shipping container was also strained through a filter to collect any material that might have escaped from the fuel elements during shipping and handling.

IV. RESULTS

The coating samples were effectively removed as described above. The total volume of the reddish coating recovered was about 3 ml and weighed 2.7 g. The volume of the heavy translucent coating recovered in the form of flakes was approximately 15 ml, and weighed 8.5 g. This material has been identified by X-ray diffraction as $Al(OH)_3$ and contains about 35% water. Techniques to remove this coating prior to MCO loading are being developed.

In the subsurface particulate sampling process, the loose cladding around damaged areas would typically peel away freely until it came to a point where it was still bonded to the fuel, and then break off. Based on open areas before and after peeling, the extent of corrosion underneath the cladding appeared to extend laterally about twice the width of the crack in each direction, and to a depth of less than 1 mm.

Sparks were observed about a third of the time that cladding strips were pulled free from the elements. The sparks are believed to be generated as small particles of the zircalloy cladding break off and burn in the cell air atmosphere.

The newly opened areas after cladding peeling were worked to recover as much particulate matter as possible. However, for the most part it was found that the fuel under the peeled cladding was quite firm and it was difficult to remove much particulate material. A conservative estimate of the particulate concentration beneath open breaches is 3 g/cm^2.

Substantial quantities of particulate matter were found in the bottom of all the shipping containers used to transport the failed fuel elements, typically comparable to that obtained in the particulate sampling itself. The escape of this material from damaged areas of the fuel element during normal handling and shipping operations implies that planned fuel cleaning processes should work well for removing sludge and particulate material prior to MCO loading of the fuel.

V. REFERENCES

1. *Integrated Process Strategy for K Basins Spent Nuclear Fuel, Volume I: Strategy and Recommendations*, WHC-SD-SNF-SP 005, Rev. 0, July 1995, Westinghouse Hanford Company, Richland, Washington.

2. 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.

3. A. L. Pitner, *In Situ Characterization of Hanford K Basins Fuel*, Proceedings of the Topical Meeting DOE Spent Nuclear Fuel and Fissile Material Management, Charleston, South Carolina, September 8-11, 1998.

Figure 1. Removing Heavy Coating with a Putty Knife.

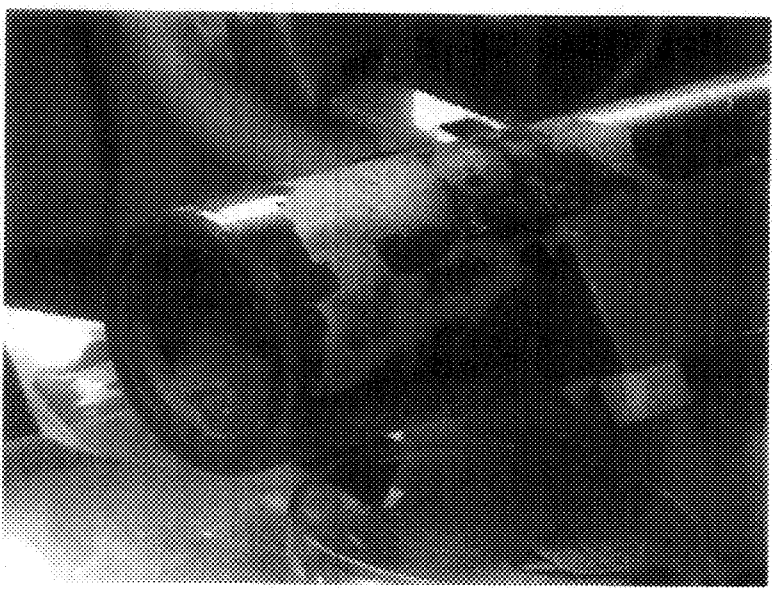
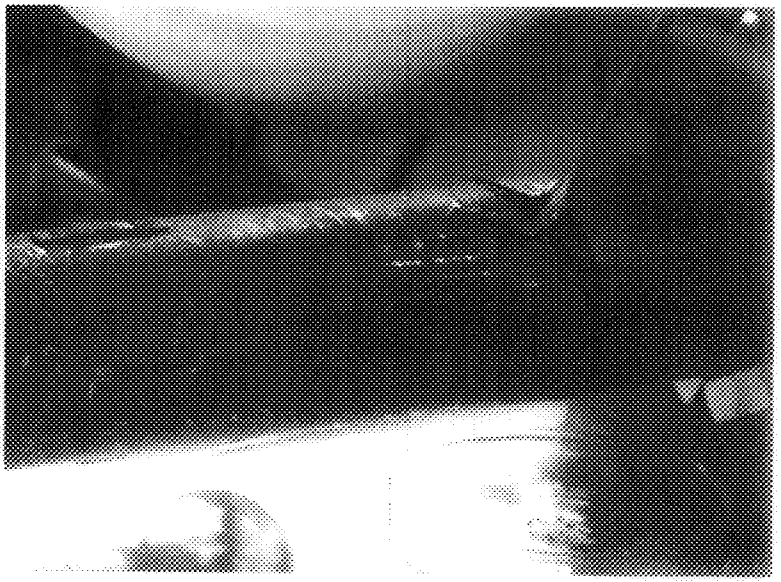


Figure 2. Loose Cladding Being Pried Free.



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