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Characterization of Hanford K Basin Spent Nuclear Fuel and Sludge

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CHARACTERIZATION OF HANFORD K BASIN SPENT NUCLEAR FUEL AND SLUDGE

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ABSTRACT

A characterization plan was prepared for the Spent Nuclear fuel and sludge stored in the Hanford Site K Basins to resolve the safety and environmental concerns.

I. INTRODUCTION

A characterization plan was prepared to support the Integrated Process Strategy (IPS)[1] for resolution of the safety and environmental concerns associated with the deteriorating Spent Nuclear Fuel (SNF) stored in the Hanford Site K Basins. This plan provides the structure and logic and identifies the information needs to be supported by the characterization activities. The IPS involves removal of the fuel elements from the storage canister and placing them in a container, i.e., Multiple Canister Overpack (MCO) capable of holding multiple tiers of baskets full of fuel. The MCOs will be vacuum dried to remove free water and shipped to the Container Storage Building (CSB) where they will be staged waiting for hot vacuum conditioning. The MCOs will be placed in interim storage in the CSB following conditioning until final disposition.

Fuel from the N Reactor is stored in the Hanford K Basins in sealed canisters in the K West Basin and in open canisters with contact with the basin water in K East (Figure 1).

There are six general sources of information for the needs established for the SNF and sludge in the K Basins. These six sources are shown in Table 1 for the 12 information needs for SNF identified in the Pacific Northwest National Laboratory (PNNL) characterization Plan for Hanford Spent Nuclear Fuel.[2] In-situ characterization and laboratory examinations of the fuel and sludge are the subject of this plan.

II. PROGRAM LOGIC AND SCHEDULE

The characterization program is structured around two fuel sampling campaigns in K West, one fuel sampling campaign in K East, and basin sludge sampling. The canister sludge sampling will be coincident with the K East and second K West fuel sampling campaigns. Separate activities will sample the floor and pit sludge in the two basins (Figure 2). The first K West fuel and the K East floor sludge sampling campaigns are complete and sampling the K East fuel and canister sludge is in progress. Initial closed canister gas and liquid measurements are complete for K West.[3] Preparations for the closed canister gas and liquid sampling for the second K West fuel and corresponding canister sludge sampling are in progress. Gas and liquid sampling should be completed by the end of the fiscal year (Figure 2).

III. FUEL CHARACTERIZATION

Fuel element characterization activities are divided into two main categories. They are in-situ characterization and laboratory examinations. The near term activities are first establishing the current state of the fuel in the two basins and determining the drying and conditioning characteristics and oxidation kinetics to support process definition. Longer term activities will focus on confirming the design and operating basis for the conditioning process and facility, and establishing the dry storage behavior of the material.

A. IN-SITU CHARACTERIZATION

In-situ examinations include boroscopic examinations of the fuel elements in the basins, video recording during fuel selection and handling, sampling the gases and liquids in selected closed canisters in K West canisters, measuring sludge depth in the canisters, and measurements to estimate sludge volumes.[4]

B. LABORATORY EXAMINATIONS

Fuel was selected from the K West closed canisters to provide bounding information on the fuel state for MCO packaging and transportation, and to confirm process definition for conditioning. Fuel was selected from the K West Basin first because shipping to the hot cells could be expedited from K West Basin in early 1995 and because of the uncertainties and speculations as to the condition of the fuel after extended storage in the closed canisters.[5] The fuel variable expected to have the largest impact on the initial state of the material for drying and conditioning is breached cladding. Cladding breaches provide a pathway for uranium/water corrosion. An as-discharged fuel element (no visible damage), a damaged and a badly damaged fuel element were selected for the initial fuel shipment. A second shipment from K West is planned to provide additional information for bounding and confirmation of conditioning behavior.

The two damaged fuel elements have been sectioned for metallographic examinations, drying and conditioning furnace studies, ignition testing, and Thermo-Gravimetric Analysis (TGA). Initial metallographic examinations and fuel drying and conditioning in a controlled temperature and atmosphere furnace in the hot cells have been completed and results are being reported in a companion paper.[6] Thermo-Gravimetric Analysis measurements for total hydrogen contents and oxidation kinetics for undamaged and damaged fuel samples are in progress.

Fuel selection from K East will similarly provide information to establish bounding conditions on the fuel state. The complete video survey of K East[7] and the planned supplemental examinations of selected canisters will be the basis for fuel selection. A single shipping campaign is planned for K East (Figure 2). Fuel selection and examinations will focus on defining the fuel states which are different for K East compared to the K West data being obtained. In this way duplication can be eliminated where the data shows similar bounding behavior for the two fuel populations.

A total of nine fuel elements will be selected with a range of damage from small cladding breaks with minimal element distortion to elements with gross distortion and significant amounts of reacted fuel. Plans call for the majority of the elements to be subjected to whole element drying and conditioning tests analogous to the small sample testing conducted on the initial fuel samples from K West.

IV. SLUDGE CHARACTERIZATION

Sludge characterization (exclusive of overall volume definition) is divided into sampling and laboratory examinations. Sampling is divided into three main categories which reflect the major types of sludge present. The main types of sludge are K East floor and pit sludge, K East and K West canister sludge, and K West floor and pit sludge. K West floor and pit sludge is assumed to be relatively benign compared to the sludge in K East, and sludge in the fuel canisters. K West floor sludge is likely to consist primarily of dust, insects, and sand that has been deposited on the basin floor since the facility was refurbished.

A. SLUDGE SAMPLING

A major floor and pit sludge sampling activity for K East was conducted in late FY 1995 to obtain representative samples. Sample analysis focused on equipment design parameters and verification of the acceptability of the material for transfer to the Double Shell Tanks (DSTs) for storage and ultimate disposal.[8]

The sludge present in the canisters is expected to contain fuel corrosion products. Canister sludge drying and conditioning data are considered to be critical items to the demonstration of the adequacy of the IPS. Sampling at K West will be coincidental with the second fuel shipping campaign from the K West Basin. The level of sampling will be dependent upon the quantities of sludge present in the closed canisters that are opened for examination and fuel element retrieval for the laboratory examinations. The K East canister sludge is also scheduled to be collected from selected canisters during the fuel shipping campaign.

B. SLUDGE LABORATORY EXAMINATIONS

Sludge characterization activities will be conducted to obtain the following data: quantity, transport properties, drying behavior, pyrophoricity, dry storage behavior, and composition. The near term activities focus on the sludge chemical constituents, how much is

present to be processed, acceptability of the sludge for the different disposal pathways and drying characteristics for the material that must be dried as part of the material inventory in a MCO.

Laboratory measurements and the analysis of the K East floor sludge was completed and is reported in a companion paper.[8]

V. CONCLUSION

A plan was prepared that provides the necessary data to support the Integrated Process Strategy for the SNF and sludge stored in the Hanford K Basins. The program provides bounding behavior for the fuel and acceptability for the transfer of the sludge to the Double Shell Tanks and is scheduled to be completed in FY 1998 consistent with the transfer of material out of the basins.

VI. REFERENCES

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8. B. J. Makenas, et al., *Sampling and Analysis of K East Basin Sludge*, Proceedings of the Topical Meeting DOE Spent Nuclear Fuel and Fissile Material Management, Reno, Nevada, June 16-20, 1996.

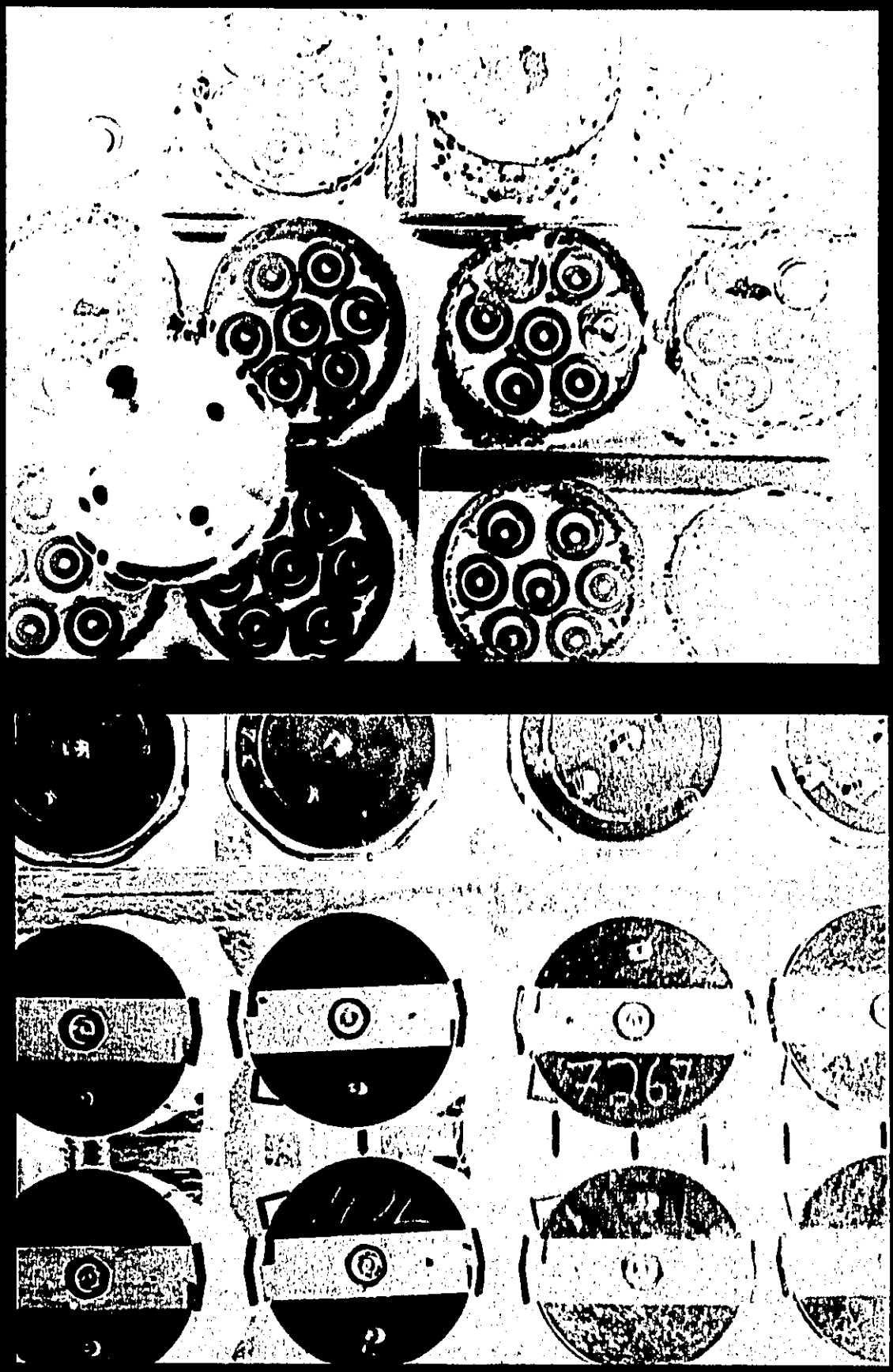

Figure 1. N Reactor Fuel Stored in the K Basins.

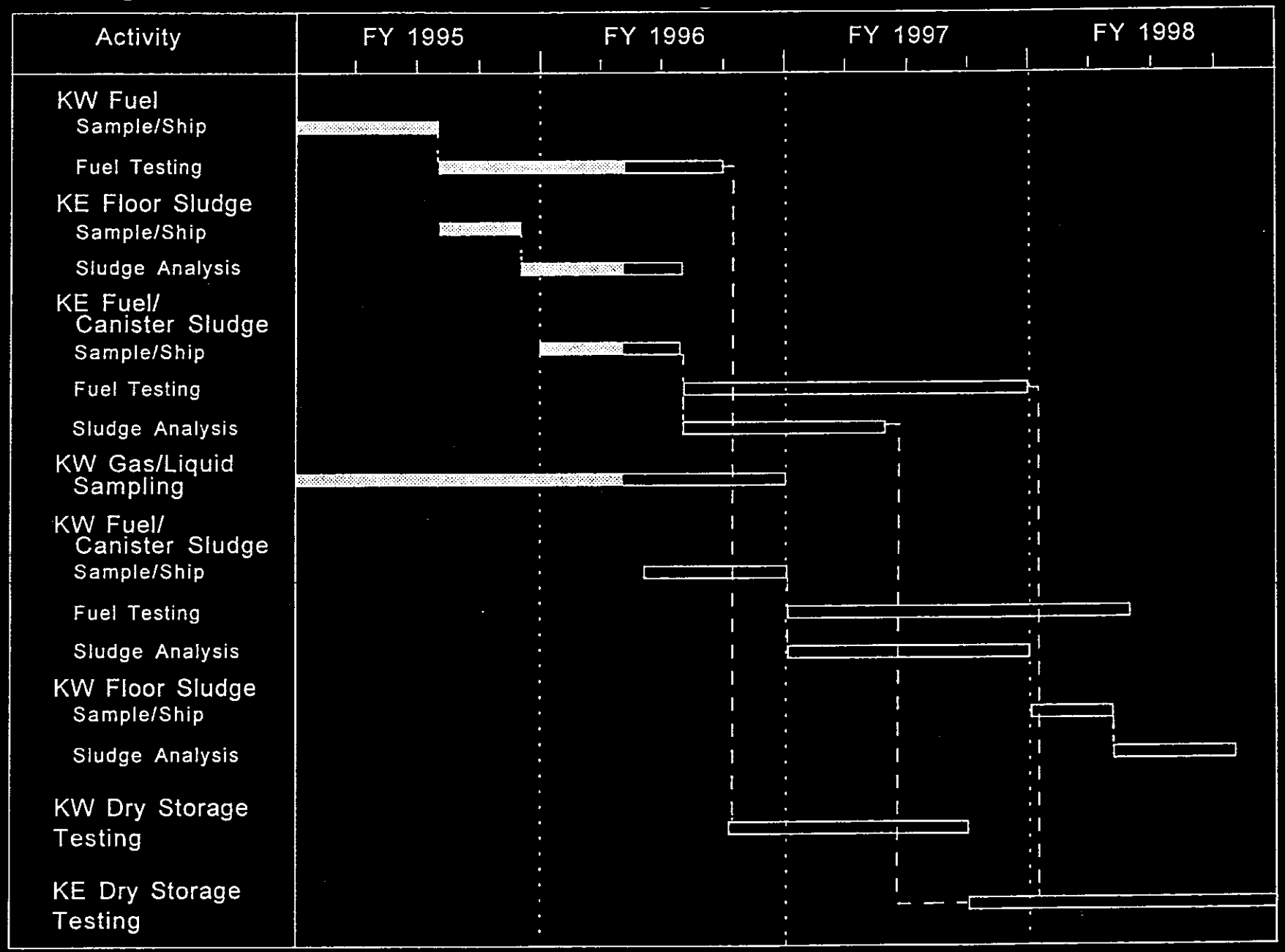

Figure 2. Overall Characterization Schedule for K Basin Fuel and Sludge Supporting the Integrated Process Strategy.

Table 1. Sources of Information for Identified Needs.

(Highlighted Area is the Subject of This Plan)

Information Need	Sources of Information					
	In-Situ Char.	Laboratory Exam.	Modeling Cal.	Foreign Data	Literature Data	Process Demo.
1. Chemical and Isotopic Composition		X*	X			
2. Radionuclide Release Character	X	X				X
3. Chemical and Phase Stability**		X	X		X	X
4. Drying/Oxidation Kinetics**		X	X	X	X	X
5. Corrosion and Degradation**	X	X	X	X	X	
6. Combustibility/Pyrophoricity**		X	X	X	X	
7. Nuclear Criticality			X			
8. Chemical Toxicity						
9. Size/Weight/Density Characteristics	X	X				
10. Physical Properties		X	X		X	
11. Physical Condition/Integrity	X	X				
12. Thermal Properties		X	X		X	

*For sludge only.

**Needs of greatest uncertainty for the Integrated Process Strategy.