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HEDL STABILIZER MATERIALS PROGRAM JANUARY
THROUGH MARCH QUARTERLY REPORT
1981

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Hanford Engineering Development Laboratory

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OFFICE OF NUCLEAR WASTE ISOLATION - HEDL STABILIZER MATERIALS PROGRAM
JANUARY THROUGH MARCH QUARTERLY REPORT

REFERENCE: ONWI Memorandum, B. A. Rawles to R. C. Hastler, "Quarterly Progress Report Requirements", dated November 14, 1980.

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Attached is the HEDL contribution to the subject report prepared in accordance with the reference ONWI memorandum. This report is simultaneously going through HEDL clearance. We will notify you when clearance is obtained. Should you have any questions regarding the contents of the report or clearance status, please contact R. J. Cash on FTS 444-4835.

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Enclosure: January through March 1981 Quarterly Report

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Enclosure: January through March 1981 Quarterly Report

ONWI QUARTERLY REPORTPERIOD COVERED January - March 1981DATE 4/14/81**PROJECT TITLE** Spent Fuel Stabilizer Materials Program**CONTRACT NUMBER** DE-AC14-76FF02170**ORGANIZATION/PRINCIPAL INVESTIGATOR** Hanford Engineering Development Laboratory (HEDL)/RJ Cash**ONWI PROJECT MANAGER** D. P. Moak**OBJECTIVE**

The objective of the Spent Fuel Stabilizer Materials Program is to identify, test, select, and qualify stabilizer materials for use in the design of spent fuel waste packages. Emphasis is placed on the selection of stabilizer materials that exhibit minimal interaction with the other waste package components.

PROGRESS REPORTED PREVIOUSLY

The spent fuel stabilizer temperature limit test was conducted in November. This test was performed to establish a conservative temperature limit for spent light water reactor (LWR) fuel during the stabilizer emplacement process. The diametral strain exhibited by pressurized LWR cladding specimens during a simulated heat cycle for stabilizer emplacement was measured as a function of temperature between 500 and 650°C. Maximum cladding strain criteria can be developed on the basis of restricted stabilizer flow, failure strain, cladding interference with grid spacers, or other possible bases. Application of these potential criteria can lead to stabilizer emplacement process temperature limits of between 590°C and 660°C.

Concrete "Formed Under Elevated Temperature And Pressure" (FUETAP) was added to the list of potential stabilizer materials. Preparations for the stabilizer prebreach fill process and disposal condition material interaction tests were initiated.

ACTIVITIES DURING THE REPORTING PERIOD

The spent fuel stabilizer fill process screening test was completed. This test measured the interaction of candidate metal stabilizers with LWR fuel cladding during stabilizer emplacement at elevated temperatures. While the test focused on screening of stabilizer materials, interaction information with a candidate canister material (1018 carbon steel) was also generated and will be useful in future considerations.

The material interaction test unit used for the fill process test consisted of a cladding specimen positioned in the center of a 1018 carbon steel capsule. The cladding specimens were fabricated with either Zircaloy-4 or 304 stainless steel with welded end caps. The Zircaloy-4 specimens were pressurized with helium to 650 psi at room temperature; the 304 stainless steel specimens were filled with helium at one atmosphere. These pressures correspond to specimen cladding stresses equivalent to calculated end-of-life stresses in actual fuel rod cladding. Fourteen Zircaloy-4 and fourteen 304 stainless steel cladding specimens were placed in twenty-eight carbon steel capsules. Individual melts of four zinc and three lead alloys were poured into the capsules containing the two types of cladding specimens (two capsules per cladding type per alloy). This was done in air. The ladle used was cleaned by sandblasting between each alloy melt to prevent contamination of the subsequent alloy. All twenty eight test units were then placed into an air furnace at 425°C (above the melting point for all alloys) and held for one-half hour. The furnace was allowed to cool over a 30 minute period to 300°C where it remained for another 15 hours. At this point, the test units were taken from the furnace and allowed to cool in air. This thermal history simulated a time-temperature cycle which potentially could be experienced by fuel rods in contact with a molten stabilizer in an actual waste canister during the fill process. One half (14) of the test units were subsequently used for the prebreach disposal condition test and the other half for electron microprobe examination to characterize fill process interactions. Neutron radiographs were taken of each fill process test unit from the side and top to help characterize any shrinkage voids that might have occurred during the process.

Metallographic samples were cut from each of the fourteen fill process test units and examined using an electron microprobe; photographs were taken of each capsule and cladding-stabilizer interface at 700-1000x. Measurable penetration by the metallic stabilizers were observed in the 1018 carbon steel only. The stabilizer interaction ranged from minimal for zinc alloy AG40A to as much as about 0.001 inch penetration with the Zn-Cu-Ti alloy, the calcium lead, and the AC41A zinc alloy. The initial surface condition of the capsule components limited interaction determinations to an accuracy of about ± 0.0001 inch. Table 1 summarizes the interactions observed in the fill process test units. The zinc alloy AG40A stabilizer was the only metal that displayed negligible interaction with the carbon steel. As indicated in the table, none of the stabilizers exhibited interactions with the two cladding materials. Neutron radiography results on each fill process test unit indicated relatively large (approximately 1/8" diameter) voids in the commercially pure lead and the calcium lead, smaller voids (less than 1/8" diameter) in the zinc alloys, and no voids in the commercially pure zinc and 1% antimonial lead.

Stabilizer disposal condition material interaction screening tests were initiated during the quarter. The test units are identical to the units used for the fill process tests. A top end-cap was welded onto the unit and a helium cover gas placed inside the capsule to simulate prebreach conditions. The three lead and four zinc alloys are being tested at 300°C along with four particulate/bentonite combinations. Seven particulates are being tested at a temperature of 500°C. Each of the 18 stabilizer candidates is being tested under prebreach disposal conditions (elevated temperature in the absence of groundwater) in conjunction with a Zircaloy-4 and a 304 stainless steel cladding specimen (36 test units). The tests were initiated in February and will be terminated in mid-May. This three-month test will be used to investigate potential stabilizer interactions with the cladding and capsule materials.

TABLE 1
SUMMARY OF INTERACTIONS OBSERVED IN FILL PROCESS TESTS

<u>TEST UNIT IDENT.</u>	<u>STABILIZER</u>	<u>CARBON STEEL CAPSULE* (1018 PENETRATION)</u>	<u>CLADDING PENETRATION (304 SS)</u>	<u>(Zr-4)</u>
C18	Commercial Lead	0.0002 Inch	None	
C33	Commercial Lead			None
C16	1% Antimonial Lead		None	
C30	1% Antimonial Lead	0.0002 Inch		None
C21	Calcium Lead	0.001 Inch	None	
C34	Calcium Lead			None
C23	Zinc Alloy AG40A		None	
C37	Zinc Alloy AG40A	Minimal		None
C26	Commercial Zinc	0.0003 Inch	None	
C40	Commercial Zinc			None
C29	Zn-Cu-Ti Alloy		None	
C43	Zn-Cu-Ti Alloy	0.0008 Inch		None
C24	Zinc Alloy AC41A	0.001 Inch	None	
C38	Zinc Alloy AC41A			None

*An initial iron oxide layer (~0.005 inch thick) was not evident after the fill process. The penetrations indicated were intrusions into the 1018 carbon steel base metal.

ACTIVITIES DURING THE REPORTING PERIOD (Continued)

FUTURE ACTIVITIES

The stabilizer prebreach disposal condition tests which were initiated in February will continue until completion in mid-May. Electrochemical screening tests on metal stabilizers will be initiated.