MAR 3 1964

BNL 6730

High Burn-up Tests on U-Al Fuel Elements *

by

J. R. Weeks, S. B. McRickard, and D. H. Gurinsky

The desired neutron spectrum for the High Flux Beam Reactor under construction at BNL requires use of U-Al fuel elements with more than 30 wt% U^{235} in the meat. The operating cycle of this reactor requires a minimum burn-up of 20%, and preferably 40% of the uranium in the element.

A series of fuel element irradiations has been performed in ETR and MTR. U in the meat has ranged from 30 to 40 wt%. Burn-up has ranged from 20 to 50%. The meat alloy also contained 3% Si.

Fuel elements mechanically assembled by a "peened-lug" procedure showed observable plate buckling at 16% burn-up, and severe buckling at 40 to 50% burn-up. These elements had flat plates (ETR type) and were clad with X-8001 Al.

Fuel elements mechanically assembled by a "rolled-swage" procedure behaved much better under irradiation up to 30% burn-up. These elements were of both ETR and MTR types, and were clad with 6061 Al.

Facsimile Price \$ 1.10
Microfilm Price \$ .80

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

- 1 -

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:
A. Makes any warranty or representation, expressed or implied with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.
As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

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, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness 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. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

A summary of the tests performed and the results obtained is given in Table I. These tests indicate that roll-swage-assembled elements definitely withstand high burn-up better than peened-lug-assembled elements. They also reconfirm the better irradiation stability of curved-plate over flat-plate elements. These elements received perhaps the highest burn-up of any complete fuel elements, ranging from 1.5 to 2.3% of the atoms of the meat alloy. Pre and post irradiation microstructures of the highest burn-up meat alloy are given in Figures 1 and 2. Test elements type J were identical to ETR flat-plate elements except for the composition of the meat alloy. Elements type D differed in that the end fuel plates were made thicker for greater rigidity. Elements type K were MTR-type curved-plate elements otherwise identical with type D.

* Research carried out under the auspices of the United States Atomic Energy Commission.

Table I

Results of HFBR Fuel Element Tests

<u>Fuel element</u>	<u>Type</u>	<u>Clad</u>	<u>Method of assembly</u>	<u>%U</u>	<u>Burn-up, %</u>	<u>Status</u>
1	ETR (J)	8001	Peened-lug	30.07	45 to 50	Severe buckling of plates. Many channels <65 mils, several <30 mils.
2	ETR (J)	8001	Peened-lug	33.4	39.2	All spacings = >65 mils, <92 mils. Average channel distortion: 15 to 30 mils.
3	ETR (J)	8001	Peened-lug	37.3	15.8	All spacings >65 mils, <92 mils. Average distortion 10 to 25 mils.
5	ETR (J)	6061	Rolled-swage	34.7 to 38.1	30	0.1005 in. probe passed all channels.
6	ETR (D)	6061	Rolled-swage	34.7 to 38.1	29 to 36	0.1005-in. probe passed through all channels, with some difficulty. No distortion visible in-canal. No visible obstruction of channels.
7	ETR (D)	6061	Rolled-swage	34.7 to 38.1	19 to 23	0.1005-in. probe passed through all channels, with some difficulty.
8 } 9 }	MTR (K)	6061	Rolled-swage	35.9 to 36.4	21 to 27	No visible distortion or obstruction. 0.1005-in. probe went through all channels.

Figure 1

**Microstructure of 30% U-Al alloy containing 3% Si.
500×. Etchant: 0.5% HF in H₂O.**

FIGURE 1

Figure 2

Microstructure of plate identical to that in
Figure 1 after 45% burn-up of the U. 500x.

FIGURE 2