NOTICE

PORTIONS OF THIS REPORT ARE AVAILABLE

It has been reproduced from the best available copy to permit the broadest possible availability.

HEDL--7500

DE85 001069

**APPLICATION OF THE PULSED MAGNETIC
WELDING PROCESS TO NUCLEAR BREEDER
REACTOR FUEL PIN END CLOSURES**

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.

BY

WILLIAM F. BROWN

HANFORD ENGINEERING DEVELOPMENT LABORATORY
Operated by Westinghouse Hanford Company, a subsidiary of
Westinghouse Electric Corporation, under the Department of
Energy Contract No. DE-AC06-76FF02170
P.O. Box 1970, Richland, Washington 99352

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

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

Application of the Pulsed Magnetic Welding Process to
Nuclear Breeder Reactor Fuel Pin End Closures

The pulsed magnetic welding process is a solid state welding process in which metallurgical bonding is effected by impacting metal or alloy parts against each other at high velocity by use of controlled high frequency, high intensity pulsed magnetic fields. This process is similar to the explosive welding process except that magnetic energy is used for impacting the parts together instead of using explosive energy.

The pulsed magnetic welding (PMW) process is readily applied to the welding of cylindrical plugs to small diameter tubes. Although breeder reactor fuel pin design may vary in size, the application described here consisted of cladding tubes approximately 6.4 mm in diameter by 244 cm long with a wall thickness of 0.38 mm. After the cladding tubes are filled with fuel pellets and associated metal hardware, tapered end plugs are inserted into the end of the tubes and welded. A typical setup for PMW is illustrated in Figure 1.

To achieve a metallurgical bond between two similar or dissimilar metals or alloys, the atomic structure of one part must be brought sufficiently close to the atomic structure of the second part so that the cohesive atomic forces of each array of atoms can effectively act on the other. The PMW process meets the requirements for metallurgical bonding by the elimination of surface film

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

EDR

material from the joint interface and the concurrent development of an intimate interfacial contact, each as a result of a high pressure collision. Metallographic sections from a typical pulsed magnetic weld is shown in Figure 2. The wavy interface is typical of impact bonded structures.

The axial length of the welds depend upon the welding parameters selected. Usually the parameters are adjusted to provide welds of 1.5 to 2.3 mm long. Since the welds are made at relatively low temperatures, there is no melting or heat affected zones. Hardness surveys along the welded joint show an approximate 25 percent increase in hardness over the original base material hardness.

One hundred percent volumetric nondestructive examination of the welds is accomplished by ultrasonic examination. Since early 1983, 223 stainless steel clad fuel pins welded by the pulsed magnetic welding process have been subjected to continuous irradiation testing in the Fast Flux Test Facility (FFTF) without failure (over 388 equivalent full power days and a peak burnup of approximately 88,500 megawatt days per metric ton of metal). The FFTF is a 400 MW liquid metal cooled reactor located in Richland, Washington. The reactor is operated by Westinghouse Hanford Company for the United States Department of Energy. PMW process development and application was performed by Westinghouse Hanford under the sponsorship of the United States Department of Energy.

The advantages of the PMW process over conventional fusion welding process for end closure welds are listed below:

- More Bond Length
- No Melting or Heat Affected Regions
- No Subsequent Heat Treatments
- Not Sensitive to Material History
- Dissimilar Alloys Easier to Weld
- Crack Susceptible Alloys Easier to Weld
- High Production Rate Capability
- Simple Fixtures - No Moving Parts
- Non-Specialized Operators
- Automated Nondestructive Examination

For further information contact W. F. Brown at Westinghouse Hanford Company,
(509) 376-0939.

PRE-WELD PREP

Figure 1. Typical Setup for Pulsed Magnetic Welding

TYPICAL PULSED MAGNETIC WELD

END PLUG

CLADDING
TUBE

240

500X

240

1000X

240

2000X

HEDL 8004-096.2

Figure 2