A Formed-Can Approach to Hot Isostatic Press Manufacturing of LEU-10 wt. pct. Molybdenum Monolithic Fuel Plates

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ABSTRACT

Results from a simplified, formed HIP can design for producing monolithic fuel foils are presented. A goal of the Global Threat Reduction Initiative (GTRI) Convert program is to reduce or eliminate the use of high enriched uranium (HEU) dispersion fuels in high-powered research reactors in the USA by replacement with low enriched uranium (LEU) alloy fuel foils. The baseline process to bond aluminum alloy cladding to monolithic LEU fuel plates consists of HIP processing fuel plate stack-ups within welded and evacuated steel cans. The baseline can design involves a six-sided welded can that requires significant machining and assembly effort. A formed HIP can design is proposed, which will eliminate machining and greatly reduce welding requirements. Experimental and finite element modeling results are presented showing comparable fuel plates and improved stress distributions relative to the baseline process.

INTRODUCTION

In support of the United States' nonproliferation and highly enriched uranium (HEU) minimization policies, the U.S. Department of Energy (DOE)/National Nuclear Security Administration's (NNSA) Global Threat Reduction Initiative (GTRI) is actively working to convert civilian research and test reactors from the use of HEU fuel to low enriched uranium (LEU) fuel. GTRI's Reactor Conversion program provides governments and facilities around the world with technical and economic assistance for conversion. If no suitable LEU fuels are available, the program contributes to the development of new LEU fuels. To date, GTRI has converted or verified the shutdown of 87 research reactors worldwide, including 20 domestic facilities. Of the remaining domestic research reactors, five U.S. high performance research reactors (USHPRRs) and one associated critical assembly will require a new high density LEU fuel and fabrication capability, which is currently under development, to convert. Existing qualified fuels do not meet the high fuel density requirements for the operation of these high-performance reactors, which include the Advanced Test Reactor (ATR) at Idaho National Laboratory, the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory, the University of Missouri Research Reactor (MURR), the Massachusetts Institute of Technology Reactor (MITR), and the Department of Commerce's National Bureau of Standards Reactor (NBSR). To maintain performance requirements, the