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BR2 LEU Conversion with High Density Silicide Fuel

As the Belgian Nuclear Science Center, SCK•CEN has been maintaining and operating the BR2 research reactor since 1962. The BR2 is one of the world's most powerful and versatile research reactors with very high neutron dose rates and extensive experimental positions available for use. The three main utilizations of BR2 are: nuclear fuels and material research, the commercial production of radioisotopes, and the commercial production of doped silicon for high-grade semiconductors. The BR2 is essential for the European Union, and the world, for the security of critical medical isotopes, such as molybdenum-99. Since the BR2 operates with high enriched uranium (HEU), the Belgian government has voluntarily been supporting the minimization of HEU by developing a technically and economically feasible low enriched uranium (LEU) fuel for conversion of the BR2.

The United States has been pursuing the reduction or elimination of HEU around the world as a national program since 1978. Some of the early U.S. led efforts resulted in the licensing and LEU conversion of many research reactors on a new fuel type they developed: 4.8 g/cc loaded silicide (U3Si2) fuel. Over the past 15 years, SCK•CEN has been actively leading European efforts to convert high performance (high power and/or high neutron flux) research reactors to convert from HEU to LEU. These international efforts have been made in close coordination and cooperation with the U.S. Department of Energy efforts for LEU conversion and other key European partners. For some years, BR2 has been pursuing a LEU conversion path with a U-7Mo alloy fuel. However, recently it has become apparent that there is still significantly more to understand about the fuel performance behavior and the back-end solutions of the U-7Mo fuel before LEU conversion to this fuel type can be realized without significant risks. Recent BR2 LEU conversion focus has now shifted to a high density silicide fuel to build upon the extensive fuel performance history of the 4.8 g/cc silicide fuel and capitalize on the existing manufacturing and back-end solutions.

A BR2 LEU conversion project with high density silicide fuel at 5.3 g/cc loading was initiated and is well underway at SCK•CEN to pursue a more streamlined path to LEU conversion with significantly reduced risks then with U-7Mo fuel. The detailed plan has been established, internal approval and funding has been secured, and external contracts have been signed and are currently being executed. The BR2 LEU design is now complete and includes the 5.3 g/cc silicide fuel loading, the addition of a gadolinium burnable absorber, an increased fuel meat and fuel plate thickness, and a slightly modified fuel assembly to allow for the thicker fuel plates. Some changes have been incorporated into the HEU fuel assembly design now, to reduce risks and ensure a smooth transition and from HEU to LEU. The Gd burnable absorber and the physical assembly changes have now been implemented in irradiated HEU fuel assemblies with positive results. Additionally, work for the LEU fuel development of the 5.3 g/cc LEU silicide fuel is underway and the initial fuel plate irradiation is expected to be completed in mid-2020. Upon successful results of the 5.3 g/cc fuel plate irradiation, LEU BR2 fuel assemblies will be fabricated and the "Lead Test Assemblies"(LTAs) will be irradiated. These are necessary to complete the submission of the BR2 LEU conversion licensing package in 2025.

SCK•CEN is leading the way in the development and qualification of LEU high density silicide fuel. Other high performance research reactors such as the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory in the U.S. and the Réacteur nucléaire Haut Flux (RHF) at L'Institut Laue Langevin (ILL) are now investigating the possibility of a LEU conversion to high density silicide. As there are multiple parties interested from various countries, it is imperative that international cooperation and exchange continue for LEU conversion activities, such that a high density silicide fuel can be realized to ensure continued minimization of HEU throughout the world.

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Track Classification: PP: Minimization, on a voluntary basis, of high enriched uranium within civilian stocks and where technically and economically feasible